ISSN 0111-6851

N.Z. GEOMECHANICS NEWS

No. 50

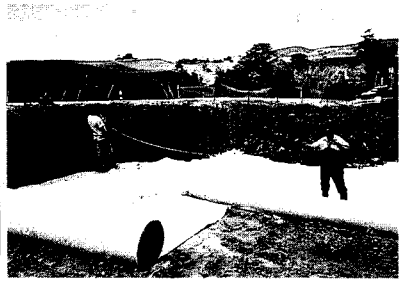
DECEMBER 1995

A NEWSLETTER OF THE N.Z. GEOMECHANICS SOCIETY

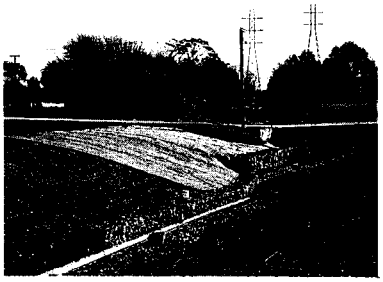
INNOVATIVE SOLUTIONS

If it's related to retaining, erosion control, drainage, poor subgrades or pavement resealing — we have the solution for you.

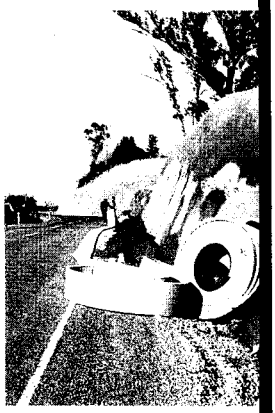
ENKADRAIN
walls, basements, roof gardens, turf drains



BIDIM
roading & sub-soil fabrics

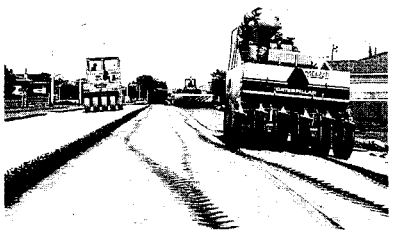


GABIONS & RENO MATTRESSES
TERRAMAT
erosion & re-veg. biomat



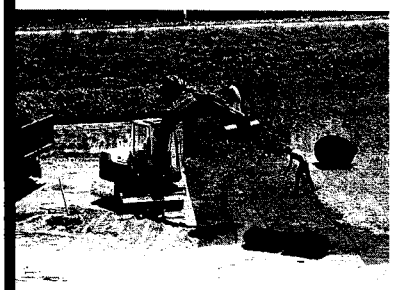
MEGAFLO
roadside, turf, subsoil drain

®MACCAFERRI NEW ZEALAND



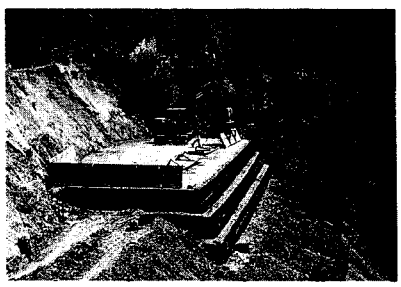
BIDIM Paving Reseal fabric & HATELIT grids for asphalt and slurry seals

STABILENKA
embankment stability and
COLBONDDRAIN
vertical wick drains for consolidation of soft soils



ENKAMAT
erosion mat for grass, floodways, spillways, channels, stopbanks

FORTRAC geogrid for subgrade/ sub base and slope reinforcement



Technical manuals, specifications and CAD design assistance available on all products

AUCKLAND — Peter Finlay. Box 12-536, Penrose. Ph 0-9-634 6495. Fax 0-9-634 6492. Mobile 0-25-931 505

CHRISTCHURCH — Tony Lingley. Box 6227, Upper Riccarton. Ph 0-3-349 5600. Fax 0-3-349 5796. Mobile 0-25-321 700

Phone or complete the coupon and mail to us today

Please send me information on:

- ☐ GABIONS & RENO MATTRESSES
- ☐ TERRAMESH Reinforced gabion walls
- ☐ BIDIM Geofabrics, drains, roads, marinas
- ☐ BIDIM Paving fabrics
- ☐ BITACK High strength crack bandage
- ☐ MEGAFLO Subsoil drain
- ☐ SARMAC Protection of submerged pipelines
- ☐ GEOMAC Soil containment system
- ☐ TERRAMAT erosion biomat
- ☐ ENKAMAT erosion reinforcement mat
- ☐ FORTRAC Geogrids roads/slopes
- ☐ ENKADRAIN Walls, roads, turf, roof gardens
- ☐ STABILENKA Embankment stability of soft soils
- ☐ COLBONDDRAIN Consolidation drainage
- ☐ HATELIT Grid for asphalt/slurry seal
- ☐ BARRIER FENCE Site safety

Name:_____
Position:_____
Company:_____
Address:_____
_____
Phone:_____
Fax:_____

NZ GEOMECHANICS NEWS

NO.50 DECEMBER 1995

A NEWSLETTER OF THE NZ GEOMECHANICS SOCIETY

CONTENTS

EDITORIAL POLICY

NOTES FOR CONTRIBUTORS

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 NZGS
  - 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 sub-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.

Geoff Farquhar
EDITOR

THIS IS A REGISTERED PUBLICATION

"NZ Geomechanics News" is a newsletter issued to members of the NZ Geomechanics 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: G.B. Farquhar
P.O. Box 4241
AUCKLAND, 1
Phone: (09) 379 1200
Fax: (09) 379 1210

Sub-Editor: S.A. Crawford
P.O. Box 5271
AUCKLAND
Phone:(09) 377 1865
Fax: (09)307 0265
E-mail: SAC@tontay.co.nz

Advertising: S. Palmer
P.O. Box 3942
WELLINGTON
Tel: (04) 473 7551
Fax: (04) 473 7911

EDITORIAL

Geomechanics News celebrates its 50th issue along with a taste of summer. Geotechnical engineering is well established as an engineering discipline and is becoming known to the public. They are becoming used to Councils requiring geotechnical assessments of building sites and it is timely that the society is preparing guidelines for stability assessments in conjunction with the planned February symposium on *Geotechnical Issues in Land Development.* It is also timely that the Second Young Geotechnical Professionals Conference has just been held in Auckland. The discipline is indeed maturing and it is also fortunate in NZ that our society is broad enough to embrace engineers, geologists and scientists within the one group, despite being a technical group of IPENZ. We need to strive to maintain that diversity as it will be our strength in the future.

PEER REVIEW

The issue of peer review was raised at a recent Auckland branch meeting. Excellent oral presentations were made by Alan Pickens, David Cook and Grant MacDonald and we felt it worthwhile printing these discussion notes. Not much is generally available in the literature regarding the requirements for peer review despite it being a more frequent part of geotechnical practice. A recent set of guidelines from the Australian Geomechanics Society is also included. Letters to the editor on this issue are welcomed.

A PIECE OF HISTORY

25 years ago, John Blakeley compiled the first edition of *NZ Geomechanics News* - November 1970. Dr Roy Northey and Peter Taylor reported on the VIIth ISSMFE 1968 (Mexico) conference as did a *"young"* engineer named Alan Pickens. Other names included on the national committee) were J.H. Galloway, K. Gillespie, M.J. Pender, C.M. Strachan, P.W. Taylor & R.M. Tonkin. Recent theses were listed by the likes of I.M. Parton, G.J. Hadfield, R.W. Smith, G. Ramsay, N.S. Luxford, D.V. Toan and T.J. Kayes. Book reviews covered recent publications: Soil Mechanics - Lambe & Whitman ($17), Foundation Analysis & Design - Joseph E. Bowles ($21), The Design of Piled Foundations - Thomas Whitaker ($5).

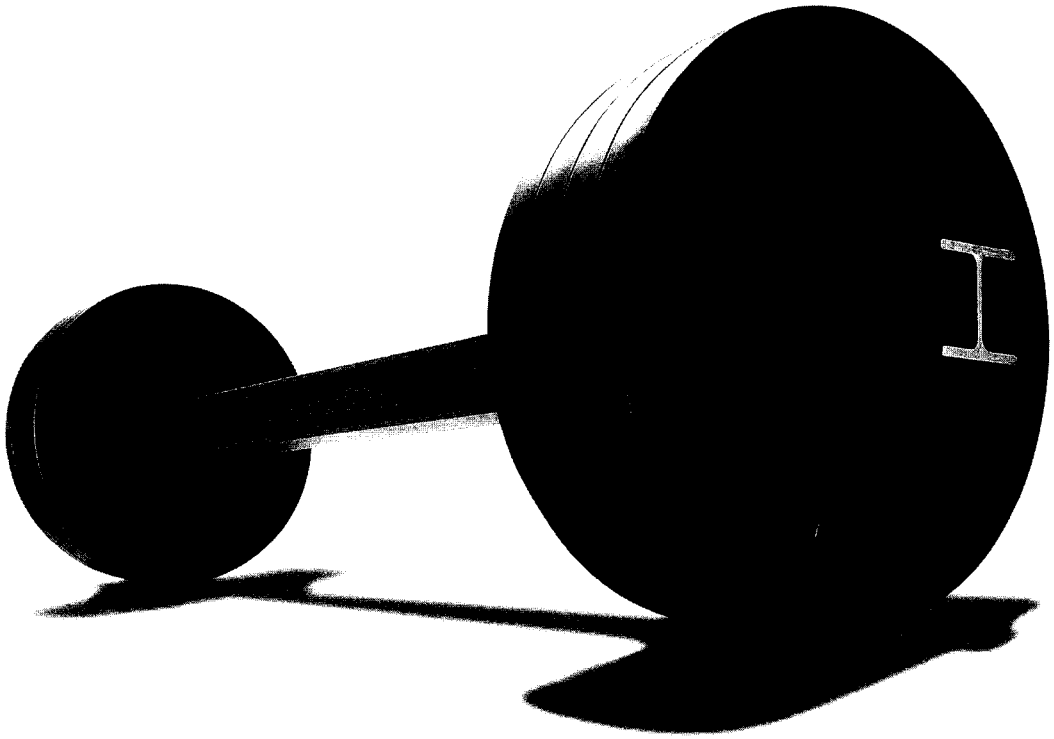
The annual subscription was **one dollar**. There were no advertisements. In issue No.2 (disguised unintentionally as No.1 - there were a few covers left over) there was a reference (again unintentional - perhaps a Freudian *slip(!)* to soil merchants.

In Issue No.4, P.W. Taylor introduces metrication to the uninitiated: *"When you go home after a tiring day and say to your wife, "I am so exhausted I could sleep for a mega second", you will have been metricated".* Today, a politically correct geotechnician after returning "home" after a three month overseas stint might say to his/her "partner" "I could sleep for 11.574 days." Sorry Pete.

From the current Eds to all other the past Eds (I.M. Parton, A.J. Olsen, S.A.L. Read, G.G. Grocott, P.J. Millar, G.G. Grocott, Yolanda Thorp (the first woman as ed), T.J.E. Sinclair and all those unnamed souls of bygone days, here's to a happy half century!

So, to wind up this long year and editorial, we wish everyone a Merry Christmas and a Happy New Year. Most of us are working hard at present, so take a holiday, and take Geomechanics News as holiday reading (not seriously). Have fun at the beach and with family, but take care in the water and on the roads (keep off the dirt). See you at the Symposium.

Geoff Farquhar and Steve Crawford
EDITORS



Carry more weight with new grade 300PLUS.

Introducing 300PLUS™, BHP's new grade for Structural Steel and "H" Pile sections. It replaces Grade 250 as the base grade for all Universal Beams and Columns, Parallel Flange Channels and large Angles. 300PLUS provides significant strength to weight ratio advantages with around 20% weight savings in many applications, and is available in all sections and standard lengths. For a 300PLUS data pack including the 1994 Hot Rolled and Structural Steel Products Book, call one of our specifier consultants on 09-375 8999 or fax 09-375 8829.

BHP BHP New Zealand Steel

OMNI SRA 9425

GEOTECHNICAL ISSUES IN LAND DEVELOPMENT

The year has, in retrospect, been an extremely busy one for both committee and Society members alike. The two-yearly timeframe that we have adopted for the Society's Symposia Series does have its downside, as the next one on *"Geotechnical Issues in Land Development"* will be held in Hamilton from 16-18 February 1996 just 21 months after the very successful Wellington Symposium on "Waste Management". Many of those approached to participate next year were simply "too busy", and that is unfortunate because the subject is a very important one for the geotechnical profession. This is the first opportunity to revisit the material of the 1981 Symposium entitled "Geomechanics in Urban Planning", and whilst the 1996 Symposium will focus on wider issues than merely urban planning, it is also significant because of the existence of two major new pieces of legislation - the Resource Management Act 1991 and the Building Act 1991. On the positive side, I hope that many members will at least attend and contribute from the floor because this is an important area of involvement for consultants and administrators alike, and the advent of new computer-based map generation techniques has had a dramatic impact on hazard assessment in the past 15 years.

TECHNICAL MEMBERSHIP OF IPENZ

Members of the Society who are not already members of IPENZ will by now have received an invitation to join through the TM.IPENZ route. This is an important development for those who are not engineering graduates, and will assist (amongst others) those who are practising engineering geologists and who wish to gain some form of professional recognition. With appropriate experience, it should be feasible for non-engineers to satisfy the requirements for full membership of IPENZ now, and it is hoped that a number of the more senior engineering geologists within the profession will make application in time for the April 1996 interviews. On the subject of IPENZ, we have been advised that a very broad Competency Listing will be introduced along the lines of IEAust Register 3, but that no specialist "Geotechnical" listing can be expected. Instead, the Society may wish to consider establishing the first IPENZ Practice College for which the entry standards can be set so as to recognise professional status amongst members and maintain an appropriate level of CPD. The Management Committee has also given consideration to introducing membership classes of "Senior Member" and "Fellow" to recognise standing within the Society, but without the entry requirements that would apply to a "Geotechnical Practice College". Feedback from members on these matters is encouraged via "Geomechanics News".

NAME CHANGE FOR NZ GEOMECHANICS SOCIETY

This brings me to a further matter which will be presented to the AGM, and that is the proposed name change to the "New Zealand Geotechnical Society". At the October committee meeting it was agreed without dissent that a recommendation would be forthcoming to effect a change in the Society's name by replacing the word "Geomechanics" with "Geotechnical". The feeling amongst committee members was that the term "Geotechnical" more accurately reflects the future direction and greater breadth of the Society and its membership, and that we have to take a lead in this broader area of "Environmental Geotechnics" if the Society wishes to remain in the preferred professional organisation in this field as well as in the more narrow construction-based "Geomechanics" disciplines.

There is, of course, no intention of moving away from the Society's obligations in the "traditional" fields of Engineering Geology, Rock Mechanics and Soil Mechanics where existing links with the international societies will be maintained (and even strengthened).

AUSTRALIA NZ LIAISONS

The final matter that I wish to address briefly is the continued support by the Society for its international obligations. At this time last year, we have had a significant financial burden supporting two Australasian Vice-Presidents (Mick Pender and Warwick Prebble), and have been pleased to foster the continued close relations with our Australian counterpart - the Australian Geomechanics Society. As an example, Max Ervin attended our October committee meeting as ISSMFE Vice-President and Warwick Prebble then attended their early November meeting as IAEG Vice-President, and the exchange of relevant information and ideas is critical to the long-term functioning of both Societies. Some 15 papers have been offered from New Zealand for the Seventh Australia-New Zealand Conference on Geomechanics to be held in Adelaide next July, and I certainly hope that the Society is well represented at what has become a highly prestigious international meeting co-sponsored by the three international societies.

I wish all our members the compliments of the coming festive Season, and I hope to see many of you at our AGM in Hamilton next February.

David H Bell
CHAIRMAN

1. MEMBERSHIP

The following new members are welcomed to the society:

J W S Chisnall	P A Cox	D Dennison
D L Fellows	D A Kettle	J Patel
R R Lal	S Lim	M Middleton
T J Pike	S P Rodwell	R B Strong
D M Sunderland	C A Wylie	

2 MANAGEMENT COMMITTEE

The recent request for nominations for the management committee for 1996 resulted in eight names being put forward. As the committee requires eight members, no election will be required. The new committee members will be:

Dick Beetham	P Brabhaharan
James Burr	Stephen Crawford
Geoffrey Farquhar	Guy Grocott
Alexi Murashev	Colin Newton

It likely that the Committee will co-opt one or two additional members. The current Management committee held its second and last meeting for 1995 on 19 October. Issues discussed that are of special interest are outlined in the following paragraphs. The next management meeting will be held immediately after the NZGS (Hamilton) in February 1996.

3. NAME OF THE SOCIETY

The response to the article in the ***NZ Geomechanics News*** showed a majority of respondees favoured changing the name to ***New Zealand Geotechnical Society***. The issue was discussed at the October Management Committee and it was decided that the name change will be put to the membership at the AGM during the NZGS Symposium in February 1996.

4. VISIT BY ISSMFE AUSTRALASIAN VICE PRESIDENT

Mr Max Ervin attended the October committee meeting in his role of Australasian Vice-Chairman. He was able to bring the committee up to date with issues relating to the Australian Society and the ISSFME.

The Australian Society was requiring New Zealand support for:

- the nomination of Harry Poulos as the new ISSMFE President, and
- the support for the nomination of Perth to hold the 15th ICSMFE.

Both items were supported by the Committee.

5. NZGS SYMPOSIUM - GEOTECHNICAL ISSUES IN LAND DEVELOPMENT

The local organising committee is well underway with the preparatory work for this symposium. It is being held at the University of Waikato, in Hamilton on 16 to 18 February 1996. Tim Browne is the local convener.

The symposium has been divided into eight sessions and will cover a wide range of topics from technical and legal issues to GPS. More information on the Symposium follows in this issue.

6. CONFERENCES

6.1 Second ANZ Young Geotechnical Professional Conference

By the time this issue of *NZ Geomechanics News* goes to print, the conference will have been held. The conference registrations have had a strong response with virtually all the available places taken. In particular, there was very good support from Australia.

6.2 Seventh ANZ Conference on Geomechanics, Adelaide

Similarly, the organisation of this conference is well underway with a date of the first week in July 1996. As in the past, the conference will be very stimulating and well worth attending. Max Ervin was able to provide a detailed update on progress to the NZGS Management committee. Information on this conference is presented later in this issue.

7. MINISTERIAL CONSULTATION ON MINING CONTROL REGULATIONS

The Society was asked to review draft regulations on Mining Control. Trevor Matuschka, in liaison with others, has undertaken the task and has responded back to Occupational Safety and Health Services on behalf of the Society.

Colin Newton
MANAGEMENT SECRETARY

ISSMFE AUSTRALASIAN VICE-PRESIDENT VISITS NEW ZEALAND

The ISSMFE Vice-President Mr Max Ervin attended our NZGS Management Committee Meeting in October 1995, and briefed us on developments in the ISSMFE front.

ISSMFE XIV TH INTERNATIONAL CONFERENCE, HAMBURG, 1997

No papers had been received as of October 1995, from New Zealand. We urge members to consider putting forward papers. Details were given in the last Geomechanics News, June 1995.

NAME CHANGE

As we advised you earlier, ISSMFE are considering a name change. The following motion will be put forward at the ISSMFE Council Meeting on 10 December 1995 in Cairo, in conjunction with the XIth African Regional Conference on Soil Mechanics and Foundation Engineering :

"The name of the International Society for Soil Mechanics and Foundation Engineering is to be changed to the International Society for Soil Mechanics and Geotechnical Engineering This name will become effective immediately following the closing session of the XIV ICSMFE to be held in Hamburg in 1997"

The New Zealand Geomechanics Society's position has been discussed within our management committee and with the Australasian Vice-President, Mr Max Ervin. While NZGS felt that this would not be an appropriate name, it was decided to support the move as it would be a step in the right direction, hopefully leading to an International Geotechnical Society in the long term.

As no NZGS members will be attending, Mr Max Ervin has been appointed our proxy to vote at the Cairo ISSMFE Council meeting.

ISSMFE, ISRM AND IAEG CO-ORDINATION

The Presidents and Secretary-Generals of the three societies met on 20 October 1995, in the UK to discuss co-ordination between the sister societies.

COMMUNICATIONS TASK GROUP

Mr Max Ervin, the Australasian Vice-President leads a Communication Task Group of ISSMFE, and reports that he is working towards the setting up of a ISSMFE Information Retrieval System.

NEWS FROM THE AUSTRALIAN GEOMECHANICS SOCIETY

The Australian Geomechanics Society are bidding to host the XV International Conference of the Society of Soil Mechanics and Foundation Engineering in Perth in 2001. In the 60 year history of the ISSMFE, only the Australasian and African regions have not yet been given the opportunity to host one of the 13 conferences to date. The NZ Geomechanics is supporting the AGS bid.

7TH AUSTRALIA-NEW ZEALAND CONFERENCE ON GEOMECHANICS

The above regional conference of ISSMFE will be held from 1-6 July 1996 in Adelaide. The Australian Geomechanics Society is organising the conference. Further details elsewhere in Geomechanics News.

P Brabhaharan
VICE-CHAIRPERSON ISSMFE

DRAFT IAEG STATUTES

Draft bylaws to the new statutes of the IAEG have recently been prepared, and any member interested to review the new bylaws should contact either the IAEG Vice Chairman or Dr Warwick Prebble of the Department of Geology, University of Auckland.

BUILDING STONES, ANCIENT MONUMENTS AND HISTORICAL SITES

Minutes of the meeting of the IAEG C-10 Commission on "Building Stones and Ornamental Rocks" which was held in Copenhagen on Thursday, 1 June 1995 are available from the IAEG Vice Chairman on request. Also, the IAEG is presently surveying National Groups to evaluate engineering geological factors influencing the protection of ancient monuments and historical sites. Any member of the NZGS with an interest in assisting with the survey should contact the IAEG Vice Chairman.

RICHARD WOLTERS PRIZE

This prize is awarded every two years specifically to recognise meritorious scientific achievement by a younger (under 40 years) member of the engineering geology profession. The prize is awarded to honour Dr Richard Wolters' many contributions to international understanding and co-operation. Applications closed with the Secretary General on 30 October 1995. After due consideration, the NZ National Group declined to forward a nomination. If any one member is interested in obtaining a copy of the requirements for nomination, these can be obtained from the Vice Chairman.

Guy Grocott
NZ VICE CHAIRMAN, IAEG

c/o Riddolls & Grocott Ltd
P O Box 28090, Christchurch

AUCKLAND BRANCH

Hays Creek Dam Upgrading

On 24th May, Dr Laurie Wesley (Auckland University) and Mr V. Jairaj (Watercare Services Ltd), presented a talk on the repair work carried out on this water supply dam in Auckland's Hunua Ranges. In 1993-94, a central chimney drain was installed into this 1970's vintage structure using a trench supported by a biopolymer slurry. The dam is constructed of rolled earth and is 27 m high, storing 1 million m^3 of water. Installation of the drain was necessary to control leakage through the core and reduce the risk of failure during a moderate-strong earthquake. Trial panels were constructed to perfect the installation technique before proceeding to full construction.

Lake Thistle Emergency Drainage Project

In 1983, a record snowfall in the Rocky Mountains triggered a large landslide of montmorrillonite which blocked a river canyon on the Spanish Fork River forming a 74 million m^3, 61 m deep lake. The rising lake drowned the town of Thistle. On 6th June, Mr Randy Essex, Vice President of Woodward Clyde presented an interesting talk of the construction of the diversion tunnel to drain this lake. Construction of the tunnel began after efforts to construct a simple diversion over the dam failed. The permanent diversion comprised a 680 m long, 4.3 m dia rock-tunnel, a 4.9 m dia, 5.5 m deep shaft with a valved bulkhead within the tunnel. Construction lasted from April to November 1983 and cost approximately $US10 million.

Stability Assessments Forum

On 26 July, a panel comprising Professor Peter Taylor, Mr Paddy Luxford (Geotechnical Engineer, Babbage Consultants Ltd), Mr Bernard Hegan (Engineering Geologist, Tonkin & Taylor Ltd) and Mr John White (Developments Engineer, Manukau City Council), presented their views on the development of sloping sites. A spirited discussion of the issues followed with audience members. Full details of this meeting are presented elsewhere in this issue.

The Roles and Liabilities of Peer Reviewers in Geotechnical Engineering

On 23rd August, Mr Alan Pickens (Tonkin & Taylor Ltd), Mr David Cook (Indemnity & General Insurance Company) and Mr Grant MacDonald (Phillips Fox), presented their views on this topic, outlining the ethical and legal issues which can arise for reviewers. The topic and views expressed are relevant to all engineering disciplines. Elsewhere in this issue are full details of their narratives.

Ewen Bridge Foundations

In October, Dr Graham Ramsay (Geotechnical Engineer, Beca Carter Hollings & Ferner, Wellington) presented an interesting talk on the careful construction work required for the Ewen bridge foundations so as to prevent leakage of the important Hutt Valley water supply aquifer. The full content of Dr Ramsay's presentation was given in a paper in the June 1995 issue of *NZ Geomechanics News*. He received the 1995 Fulton-Downer Award (Gold Medal) for this paper.

Clive Anderson
AUCKLAND BRANCH CO-ORDINATOR

AUCKLAND BRANCH MEETING - STABILITY ASSESSMENTS FORUM

The forum held on 26/7/95 comprised a three-member panel under the control of Prof. P.W. Taylor. The panel members were:

(Paddy) N.S. Luxford	(Babbage Consultants Ltd)
Bernard Hegan	(Tonkin & Taylor Ltd)
John White	(Manukau City Council)

Professor Taylor opened the meeting with a brief outline of the essential elements of a stability assessment. He emphasised the three main requirements were:

1. The geotechnical model must represent the site conditions;
2. The strength parameters must be accurately determined; and
3. Pore water pressure conditions within the slope must be well understood.

The process of determining all the above for each specific site is often involved, expensive and can seldom be justified for individual household development.

Paddy Luxford gave an outline of the meaning of Factor of Safety (FOS) and the factors affecting it. The NZ Building Code while specifying a minimum FOS=1.5 does not outline the soil strength and groundwater conditions which should apply. Paddy referred to the Hong Kong (GCO) experience which relates FOS to economic risk and risk to life. He outlined two approaches, viz. moderately conservative soil strength and groundwater conditions and higher FOS (1.4 to 1.5); and the worst credible above conditions and lower FOS (1.0 to 1.1).

Bernard Hegan briefly outlined an engineering geological approach stating that it was essential to get the model right. If the model was wrong then no amount of 'number crunching' will correct it. Bernard then raised the issue of registration of geotechnical professionals in order to let them practise for local councils. There was a problem here with councils being at risk if they accepted substandard geotechnical reports but not always having the resources or capability to carry out adequate assessment or review of professional's report. An alternative currently being practised by at least one council was to have a restricted register of approved professionals. There was discussion as to whether a register would be effective or whether peer review of reports was preferred.

John White related the Manukau City Council (MCC) experience of dealing with stability assessments. MCC had developed their own set of Engineering Standards which was modelled on the Building Code/Act. These Standards were compiled by a working group of MCC Engineers, private developers and consultants/practitioners. The Standards are seen as a living document under regular review. A stability report when submitted to Council was taken on its merits, whether compiled by an experienced professional or a graduate. A register of approved practitioners was thus not "considered necessary". Issues to be resolved by the report included:

- Have the site conditions been appreciated?
- Are the slope stability analyses sufficient?
- Have all cases been addressed?

A lively discussion ensued, typically revolving around sensitivity of the factor of safety to varying conditions and the need for councils to comply with the minimum FOS of 1.5 in the Building Code and the regulatory requirements to be met for insurance purposes.

S.A. Crawford
TONKIN & TAYLOR LTD

WELLINGTON BRANCH ACTIVITIES

The Wellington Branch activities has centred around the technical meetings held at the IPENZ meeting rooms in Molesworth Street, Wellington. Seven meetings were held this year, approximately on a monthly basis between May and November 1995. The meeting highlights are summarised below.

18 May 1995 The Lake Thistle Emergency Drainage Project
Randall Essex, Woodward-Clyde, USA
Randy gave an excellent description of the emergency works carried out to drain the lake created by a landslide dam. This involved tunnelling through the bluff to carry the river and discharge downstream of the dam, involving clever tactics to deal with the breakout into the lake, as well as keeping away from the media ! About 30 people attended and enjoyed the interesting talk.

24 May 1995 Seismic Strengthening of Gibraltar & Littlerock Dams
John Bischoff, Woodward-Clyde, USA
John gave a good description of the use of roller compacted concrete to buttress two 1920s dams to improve their seismic resistance. The 15 or so present were interested to hear of the use of roller compacted concrete. But the pictures of the slender multiple-arch concrete dam structure designed by an "ingenious" engineer drew the most attention. We heard that most dams he designed needed retrofit!!

15 June 1995 Museum of New Zealand - Foundation Investigation, Design & Construction
Peter Millar, Tonkin & Taylor, Auckland
The Museum of NZ is close to the heart of Wellingtonians, and about 30 people gathered to hear Peter's excellent description of the ground improvement for the massive structure which is springing up on the Wellington waterfront. Of particular interest was the improvement achieved by dynamic compaction particularly the old beach layer, and the expected performance in a major earthquake.

12 July 1995 Design and Construction Challenges - the Glenwood Canyon Highway Tunnels
Randy Essex, Woodward Clyde, USA
Another interesting talk by Randy of some award winning highway tunnelling projects in the scenic canyon in the USA. The story of the lost spanner made the 20 or so members realise what "open joints" can mean! The treatment of the rock cut faces to match the canyon's weathered colour reminded us that "landscaping" isn't necessarily green.

21 September 1995 Auckland Sky City Casino Foundations
D V Toan, Beca Carter Hollings & Ferner, Auckland
(Joint meeting with the IPENZ Local Branch included presentation of the 1995 Fulton Downer Award to Dr Graham Ramsay)
Dr Toan gave an interesting description of how monitoring helped overcome potential groundwater problems for the Sky City Casino foundations in Auckland. The seismic design of the foundations as well as the tower itself also attracted the interest of the 25 or so present, and was the source of many questions.

19 October 1995 Design and Construction Issues - Melbourne Casino
Max Ervin, Golder Associates, Melbourne, Australia
The 15 or so members gathered to hear about site investigations had a pleasant surprise when Max Ervin came prepared to talk about the Melbourne Casino. It was interesting to hear Max describe the variable ground conditions, how the excavation slope failures were dealt with, and the complexities and quality control nightmares associated with the contract arrangements adopted for the project.

23 November 1995 Norway's Olympic Ice Hockey Cavern at GjØvik - Investigation & Design using the Norwegian Method of Tunnelling
Lloyd Tunbridge, Norwegian Geotechnical Institute, Oslo (presently with Works Consultancy Services)
Although the attendance was small at about 10, Lloyd gave an informative talk on the Norwegian Method of Tunnelling, well tuned to the audience in Wellington. Of particular interest was the Norwegian tunnelling practice, where the contractor and consultant worked together to successfully complete the project. The talk was illustrated by a vivid video of the cavern hall at GjØvik, seating 6000.

P Brabhaharan
WELLINGTON BRANCH CO-ORDINATOR

CHRISTCHURCH BRANCH

(i) **Guangzhou Pumped Storage Scheme, China:** Professor Laurie Richards of the Department of Natural Resources Engineering, Lincoln University presented a talk on 27 June 1995 on the GUANGZHOU Pumped Storage Scheme. Located in GUANGDONG Province, the scheme is being constructed in two stages which, when completed will be the largest pumped storage scheme in the world. The first stage of 1,200 MW is completed, and construction of the second stage also of 1,200 MW is in progress. Underground excavations involve 22 m span caverns.

(ii) **Christchurch Lifeline Study:** The Christchurch Branch combined with the IPENZ Canterbury Branch for a joint meeting on 16 August. Mr John Ramb, Christchurch Civil Defence co-ordinator chaired a panel of speakers who presented a progress report on the disaster planning study being prepared as part of the Christchurch Lifeline Study. Mr John Blakeley of the Centre for Advanced Engineering, Christchurch presented a summary report on the Wellington "After the Quake" conference held earlier this year.

(iii) **Glenwood Canyon Highway Tunnels, Colorado:** Mr Randy Essex of Woodward Clyde's Oakland, California office presented a talk on a 19 km long section of realigned Interstate 70 highway to a local meeting on 17 October. Because of a need to minimise disturbance to the natural landscape, the realigned highway was located in tunnels at two separate highway sections. These tunnels are the first approved by the Federal Highway Administration to have a permanent rock reinforcement and shotcrete support system.

(iv) **The NZ Geomechanics Society Southern Zone Student Prize** was held at a local Christchurch Branch meeting on 20 October 1995. Three students from the University of Canterbury participated in the event, each presenting short 20 minute talks on the following topics:

- Philip Clark, Department of Geological Sciences: Rippability assessment of the proposed open pit gold mine at Globe-Progress, Reefton.
- Sonia McManus, Department of Geological Sciences: Geological hazard zonation and land use planning assessment in the south eastern Marlborough Sounds, New Zealand.
- Adam Milligan, Department of Civil Engineering: Piezocone penetrometer testing and dimensionless excess pore pressure.

A panel of two judges comprising Professor Rob Davis and Mr Brian Paterson awarded the prize jointly to Sonia McManus and Adam Milligan. All three participants are to be congratulated for the high standard of their presentations including the technical content and delivery. Prizes were presented to the winners at the local branch meeting on 1 December 1995.

Guy Grocott
CHRISTCHURCH BRANCH CO-ORDINATOR

OTAGO BRANCH

Slope Stability Forum

The Otago Branch ran a forum on the slope stability Factor of Safety (FOS) issue on 13 October 1995. The forum was attended by 30 people representing territorial authorities and engineering and geological consultants.

Phil Glassey (IGNS) introduced the subject outlining the issues involved and then called upon Graham Salt (Tonkin & Taylor Ltd) to outline how a Factor of Safety is derived. Graham went on to outline the Hong Kong GCO scheme which he put forward as a scheme which could be adopted in this country (see *NZ Geomechanics News No.48*).

John Henderson and Rod MacLeod (City Consultants - the engineering consultancy branch of Dunedin City Council) then outlined how a Factor of Safety is derived. They do not enforce a Factor of Safety of 1.5 but require that it be demonstrated that the land has long term stability. However, a draft code of subdivision recently put out by a different department of the Council does state that all land should have a Factor of Safety of 1.5.

Don Hatfield (DG Hatfield & Associates - Planners and Surveyors) outlined the principles of the RMA as being a philosophy which requires avoidance or mitigation of effects and that Territorial Authorities cannot be too prescriptive.

A general discussion of the issue followed and a number of points were raised.

(i) It was queried why the limit equilibrium method was still used as opposed to the Limit State Design. Phil Glassey replied that many engineering geologists had very little understanding of the Limit State Design theory and little experience in using it. Therefore some continuing education was required.

(ii) It was noted that not only education on Limit State Design was required but also on hazard and risk analysis especially if the Hong Kong GCO method was to be adopted.

(iii) It was asked of the Dunedin City Council representatives who adjudges that the geotechnical advice is proficient?" The Council replied that there were very few consultants in their territory and that their capabilities were well known to Council staff. They also considered that they had sufficient experience to be able to judge the merits of the technical aspects of a report.

(iv) It was pointed out that the less prescriptive principles of the RMA seemed to be at odds with the highly prescriptive Building Act. However, some considered that the two worked well together.

(v) The usefulness of a FOS was discussed in general. It was decided that slope stability precedent was a valid method for assessing slope stability and that FOS was of more importance when development involved significant modification to the slope.

(vi) If FOS = 1.5 is to be enforced then the code needs to be more specific of how that value is arrived at. That is:

- does this include or exclude earthquake loading?
- is this under extreme groundwater conditions or average conditions?;
- does it require the use of measured strength parameters at the site or can values derived from back analysis or similar tested materials from another site be used?

(vii) The consensus of the meeting was that enforcement of a FOS = 1.5 was too prescriptive and undervalued the use of observation and precedent as a valid method of assessing slope stability.

Philp Glassey
OTAGO BRANCH CO-ORDINATOR

ANOTHER PIECE IN THE AUCKLAND VOLCANIC FIELD JIGSAW PUZZLE - OR ARE WE STUMPED?

In April this year, excavations for a new building at the Royal New Zealand Foundation for the Blind, Maunsell Road, Parnell, cored through part of a large upright insitu totara stump, 5.5 m below the surface. The stump was extremely well preserved, and measured approximately 2 m in diameter by 1.5 m high. The stump was an obstruction to augering and a large coring tool was used to get through it. We were notified of the existence of the stump only after the 1 m auger hole had been filled with concrete, entombing the remaining stump material once more. The driller's descriptions, and subsequent logging by us of another auger hole 20 m away, revealed the following stratigraphy:- 0.5 m of very dark brown volcanic soil, approximately 5 m of orange-brown weathered, laminated lapilli-tuff erupted from the Domain Volcano, approximately 0.5 m of grey-brown sediment interpreted to be a Palaeosol, and approximately 6 m of the pale grey, weathered Waitemata Sandstone. The hole finished in fresh medium grey, fine grained Waitemata Sandstone. The drillers were confident that the stump had been encountered at the level of the Palaeosol and buried by the orange brown tuff material. We speculate that the original tree was felled by a lateral blast from initial phreatomagmatic eruptions of the Domain Volcano (centred 600 m away), leaving the stump.

A 10 cm long by 3 cm thick wood sample was sawn off, and the rest of the stump fragment was retained by the Blind Foundation to be used in a display within the new building. The wood was identified by Rod Wallace, Archaeology Department, Auckland University, as being definitely totara and was dated by the Waikato University Radiocarbon Lab as being older than 60,000 years BP. Although beyond radiocarbon dating considering the paucity of dates from Auckland's volcanoes this date at least gives a minimum age for the Domain Volcano and confirms ideas that it is one of the oldest volcanoes in the Auckland Field.

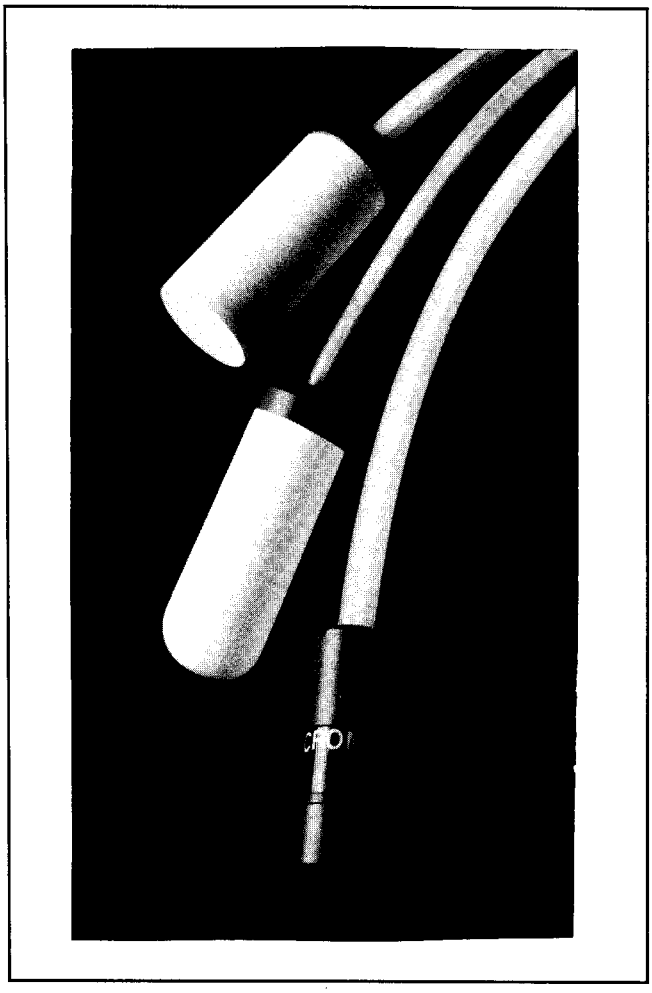
Hugh Grenfell and Jill Kenny
AUCKLAND INSTITUTE AND MUSEUM

(Reproduced from Geological Society of NZ Newsletter)

GEOTECHNICAL INSTRUMENTATION

- Pneumatic Piezometers
- Hydraulic Piezometers
- Inclinometer Tubing
- Data Loggers
- Vibrating Wire Piezometers
- Load Cells
- Hydrostatic Profile Gauges

Agents for: ***Soil Instruments (UK)***
Geosystems (Aust.)
QED - Groundwater Specialists (USA)
BAT - Groundwater Systems
Enviroequip (Aust.)
Solinst (Canada)
RST Instruments (Canada)



Pneumatic Piezometers

Water Level Meter

MONITORING/SAMPLING EQUIPMENT

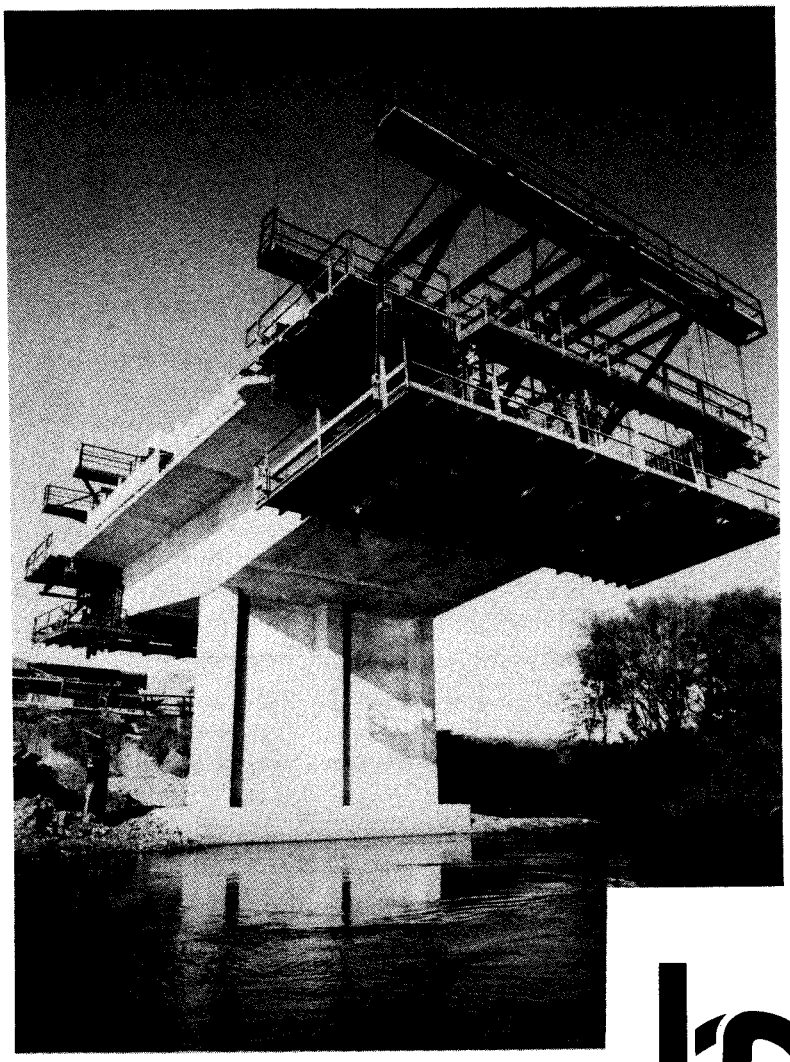
- Borehole Screen (slotted PVC & access)
- Water Level Meters
- Filter Sock
- Borehole Upstands - lockable
- Disposable Bailers
- Waterra Pumps and Access
- Walton Park sand and gravel
- pH, Temp and Conductivity Meters
- Toby Boxes
- Soil Probes
- NOMIS Seismograph (standard or mini version)

GEOTECHNICS LTD — SALES DIVISION
UNIT 3C 76 CARR ROAD MT ROSKILL AUCKLAND
PO BOX 27 053 MT ROSKILL AUCKLAND
PH 09 620 0280 TOLL FREE 0508 223 444 FAX 09 620 0281

NEW ROADING LINK AND RIVER BRIDGE FOR HAMILTON

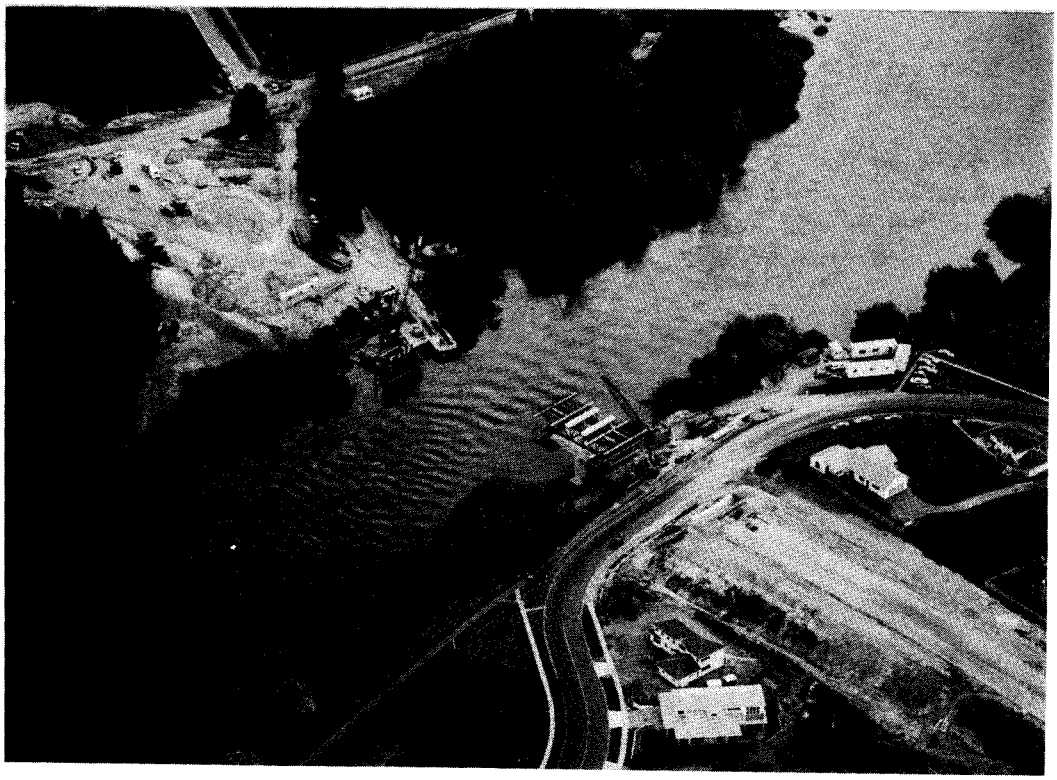
The R1 Arterial Roading Link comprises the new 150 m long Pukete bridge over the Waikato river, 1.5 km of roading and a 60 m long overbridge, for the Hamilton City Council. Construction of the project is being undertaken by Hamilton-based Brian Perry Ltd, specialists in marine and civil engineering works both in New Zealand and internationally. Works Consultancy Services are responsible for the design and supervision of the project.

Construction of the Pukete Bridge's reinforced concrete superstructure is being undertaken segmentally using travelling cantilever falsework. Each traveller weighs approximately 70 tonnes and can support segments weighing up to 90 tonnes. On completion of each successive segment, the travelling falsework is jacked forward on rails laid on the new segment, ready for the construction of the next. The completed bridge consisting of one 70 m long main span and two 40 m spans, will provide two traffic lanes and combined cycle and pedestrian track.



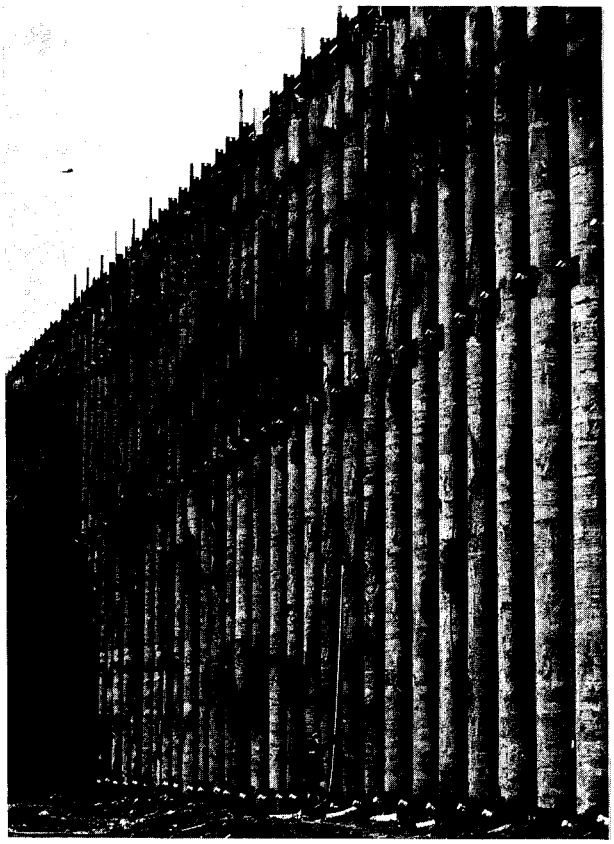
BRIAN PERRY LIMITED

The 26 piles for the East pier in the Waikato River were driven through preformed holes in the base of a precast concrete pile cap shell. River levels varied during construction and the 12.3 m long, 3.8 m wide, and 1.7 m deep shell was often fully submerged. On completion of the pile driving, the holes in the shell were sealed underwater and the shell pumped out to permit construction of the pipe cap.



Nearly 30% of Hamilton's residents now live North of existing bridges across the Waikato River. Completion of the project late in 1996 will ease the congestion on existing bridges under peak traffic flows, and shorten travel routes for many residents.

When we promise ...

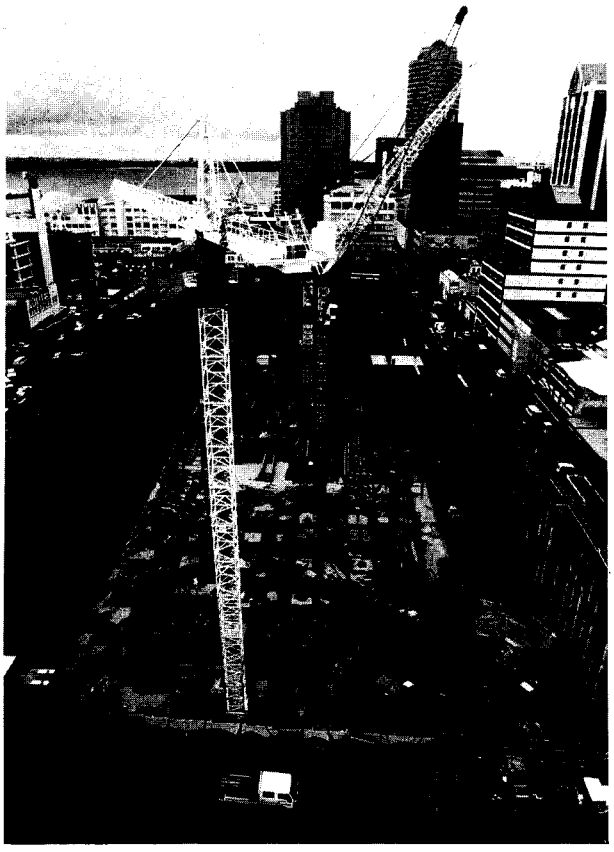


we perform

Civil Engineering Construction including

- Pile Foundations
- Ground Retention Systems
- Slurry Walls
- Pipelines
- Bridges
- Concrete Works
- Wharves
- Marinas
- Sewerage Outfalls

Sky City Casino Ground Retention 1994



BRIAN PERRY LIMITED

Our Track Record Speaks for Itself

- Wellington Civic Centre Foundations
- Sky City Casino Ground Retention
- Maui A-B Pipeline Fabrication
- Cook Strait HVDC Link 1991
- NW Motorway Bridge Widening
- Auckland Airport Runway Repairs
- Wynyard Wharf Repairs
- Westhaven Marina Extension
- Timaru Sewer Outfall

AUCKLAND - Ph: 09-573 0690 HAMILTON - Ph: 07-849 2879 WELLINGTON - Ph: 04-568 9442

ISCHEBECK TITAN INJECTION ANCHORS

A local company Ischebeck NZ Ltd has recently been formed to import and market the German range of Ischebeck TITAN injection anchors. These anchors, which can also be used as rock bolts and micropiles are the drill rod, grouting conduit and anchor/pile member all in one. The use of casing can generally be eliminated as can the 2 stage normal process of drill first, the secondly place and grout the anchor into the drilled shaft. The anchors are continuously threaded hence readily joined in convenient lengths to suit confined application.

CASE HISTORY - TE AWAMUTU CO-GENERATION PLANT

This project, undertaken by the Auckland company ***Gilberd Hadfield*** initially involved the installation of 9 m x 30/11 galvanised Ischebeck anchors using a proprietary 75 mm ϕ soft ground bit. The system was specified to cope with the restricted access when working from inside the plant to retain an existing retaining wall prior to demolition of the main structure. Installation lengths were typically 1.5 m and equipment access was extremely limited. Gilberd Hadfield elected to use a hand-held pneumatic hammer drill.

Initial drilling soon highlighted that the ground behind the wall was a very wet soft fill material with occasional timber or concrete obstructions. Air flushing was used but no return was possible. At 9 m the anchors were grouted, again with no return, and somewhat predictably the anchors failed to take any reasonable load.

Casing the hole and using conventional construction was suggested but rig access precluded this option.

Gilberd Hadfield contemplated using the full benefits of the Ischebeck system by grouting with a weak mix during installation to stabilise the shaft, but given the apparent weakness of the ground, the large voids and groundwater flow, elected to use a cased system based around the Ischebeck product.

The initial 6 m of soft weak fill was drilled with an air/water flush and a dressed out 75 mm ϕ bit to achieve a 90-100 mm ϕ hole. This material was stable encased for only short periods of time, and beyond the 6 m depth changed to peat. This upper 6 m was subsequently cased with a PVC pipe 80 mm ID pushed in using the pneumatic equipment.

The 30/11 galvanised Ischebeck was reinserted through the upper cased 6 m but this time with a standard 75 mm ϕ bit and drilling advanced through the peat taking a 50 mm casing on behind the bit. Water/air flushing was used throughout and a return achieved. The anchor was advanced to a depth of 12-15 m, beyond the peat, and into the firm pumicite sand layer.

Once in the sand, drilling continued encased into a firm silt at 21 m, still using the 75 mm ϕ soft ground bit and water/air flushing.

At depth the anchor was pressure-grouted, and subsequently tested to load.

The Ischebeck Titan anchor system allowed for the existing internal retaining wall to be fully supported by tension anchors despite the very limited access and poor ground conditions.

ISCHEBECK®
TITAN

THE NEW WAY IN ANCHORING TECHNOLOGY

THE TITAN ANCHORS ARE: DRILL ROD, GROUTING CONDUIT AND ANCHOR TENDON ALL IN ONE

Tubular anchors continuously threaded excellent shear values

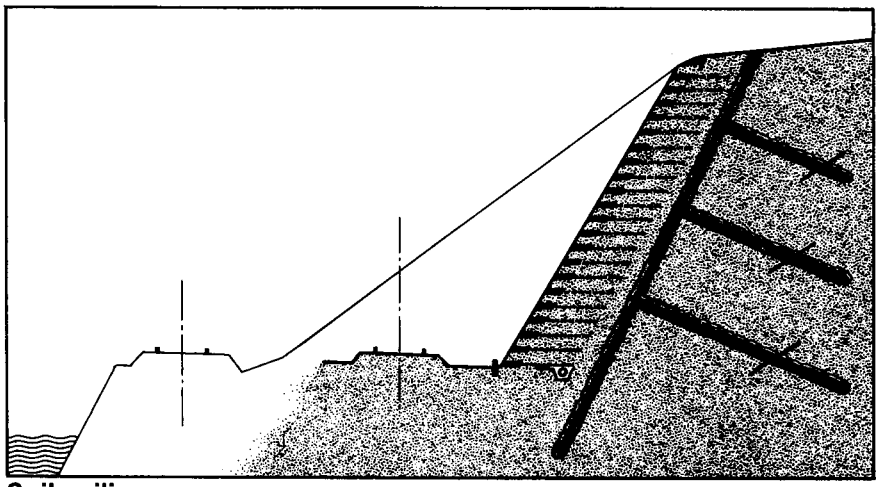
Working load 150 or 570 KN

IDEAL FOR:

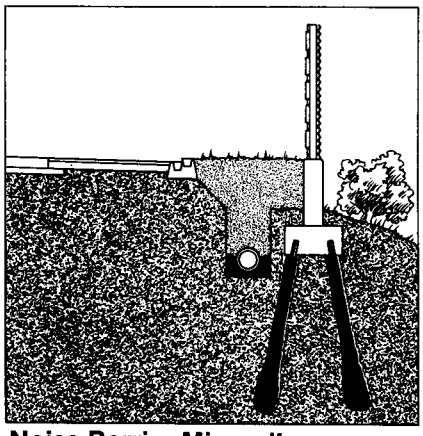
- Instable soils
- Close quarters - Fractured rock
- Underpinning
- Micropiles
- Soil nailing
- Rock bolts
- Forepiling
- Mining
- Coupling small lengths
- Restoration

No casing required

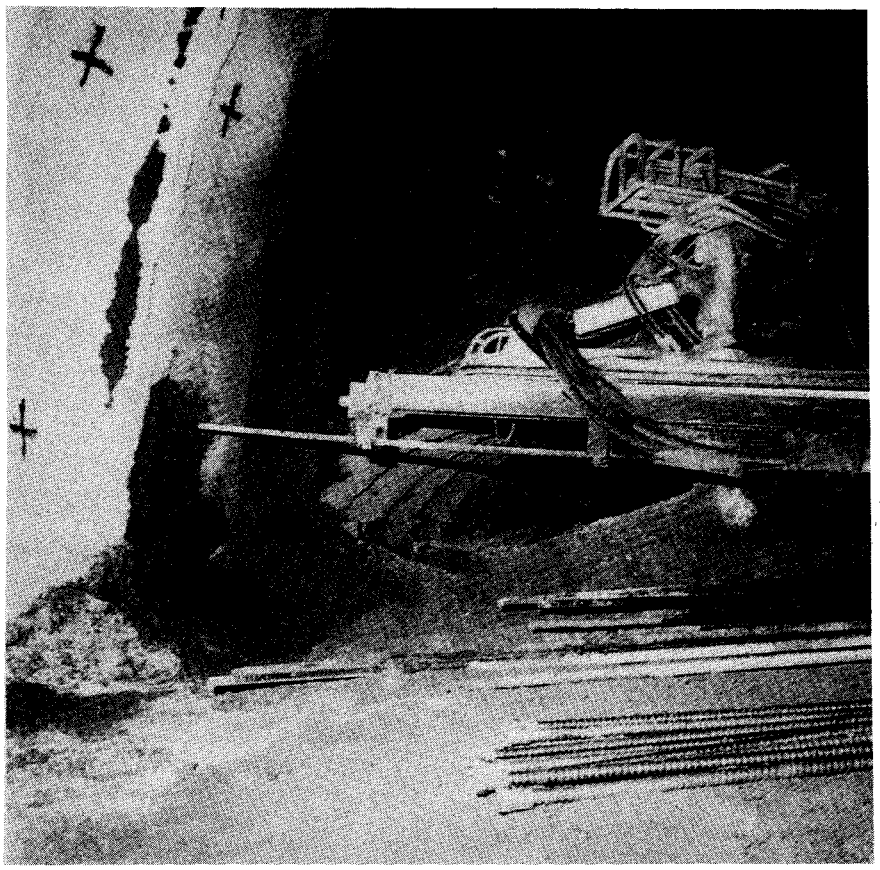
ISCHEBECK N.Z.
1 WHARANGI ST
P O BOX 13 613
ONEHUNGA
PH: 634 1973 FAX: 634 5176



Soil nailing



Noise Barrier Micropiles



Rock Bolts

CASE HISTORY - AUCKLAND SOIL NAIL WALL

This project undertaken by the Auckland Company ***Gilbert Hadfield*** involved the installation of some 200 soil nails for a shotcrete retaining wall in a 75 mm ϕ hole with drill depths typically 6-9 m.

Given the relatively high cost of setting up and drilling with a conventional rig in a discontinuous operation, ***Gilberd Hadfield*** elected to drill using the 30/11 Ischebeck system with hand-held pneumatic equipment and air/water flushing. Given the stable nature of the ground it was then possible to withdraw the drill string and install and grout a reinforcing bar nail.

The standard 75 mm ϕ soft ground bit designed for softer soils soon became blocked in the firm Auckland clays with progress slow and retraction difficult.

In a move to better break up the drillings ***Gilberd Hadfield*** modified the drill bit by removing the guide tube and tungsten dressing the cutting edges. The flushing hole was changed from one large one to three small ones to create greater flushing pressures.

This technique proved efficient throughout the upper clay layers and even for the unexpected hard well cemented sandstone encountered in the bottom 2 layers of nails.

The use of the Ischebeck Titan system to drill allowed full resource flexibility and avoided the need for a large conventional drill with intermittent usage to generally clutter an already restricted site.

John Yonge
GILBERD HADFIELD LTD

50TH ISSUE CELEBRATION!

At the left is one of the first advertisement to be placed in *NZ Geomechanics News*

A PIECE OF HISTORY

TENSAR GEOGRIDS HOLD BACK CANAL WALLS AT PRESTIGIOUS DEVELOPMENT

IDYLLIC SETTING

Tensar geogrid reinforced soil walls faced with Keystone blocks support the canal walls in an exclusive residential development at Gulf Harbour. Located on the Whangaparaoa peninsular just north of Auckland, the Gulf Harbour Marine Village is destined to provide an idyllic setting for those who love the water.

Stage one of Gulf Harbour - a 969 berth marina - was completed in 1988, and is the second biggest marina of its kind in Australasia. Stage two which commenced in December 1994 will see the creation of the Gulf Harbour Marine Village, a residential canal development.

EXTENSIVE WALLING

The walls have a significant impact on the appearance of the canal system. They extend for a total length 900 m and vary in height from 4.5 m to 6.5 m giving a total area of up to 4,500 square metres. An additional 1,500 square metres is being used for the development of the Village Basin area.

MARINE ENVIRONMENT

The marine environment which the walls must endure is one of the toughest in the civil engineering industry. The permanent materials of the Tensar Geogrid supplied by Ground Engineering Ltd and Keystone block supplied by W Stevenson and Sons do not rot or corrode and are ideal for these conditions.

ECONOMICAL DESIGN FEATURES

The Tensar Geogrids form the structural component of the wall which was designed by Beca Carter Hollings & Ferner to withstand a 10 kPa surcharge and the conditions of rising and falling tide. The walls were founded on sandstone, and costs were kept to a minimum by using crushed sandstone available on site for backfill material. The designers initially considered a wide variety of wall types including timber, sheet piling and concrete post plank. The Tensar Geogrid/Keystone walling system was chosen for its competitive pricing and durability.

ELEGANT CURVING LINES

The architects, Anthony Woods and Associates, required a near vertical wall, and a system with an elegantly curving face for the highly visible walls. A combination of the Keystone standard (for base) and Keystone International units were chosen to form an attractive facing. The architects liked the appearance of the Keystone/Tensar Geogrid system and felt that it was aesthetically the best option for the gulf harbour canal project.

When finished the Gulf Harbour Marine Village and Canal Development will include a mix of shops, professional chambers, restaurants and cafes, a supermarket and tavern, sporting facilities - including a brand new 18 hole golf course - to cater for the residents and visitors (no doubt including the America's Cup devotees) alike.

The road below the failure comprises the hillside lane on a filled bench supported by a retaining wall, and the riverside lane on a bridge structure. Following removal of the last major slip debris the retaining wall and bridge structures were found to be damaged.

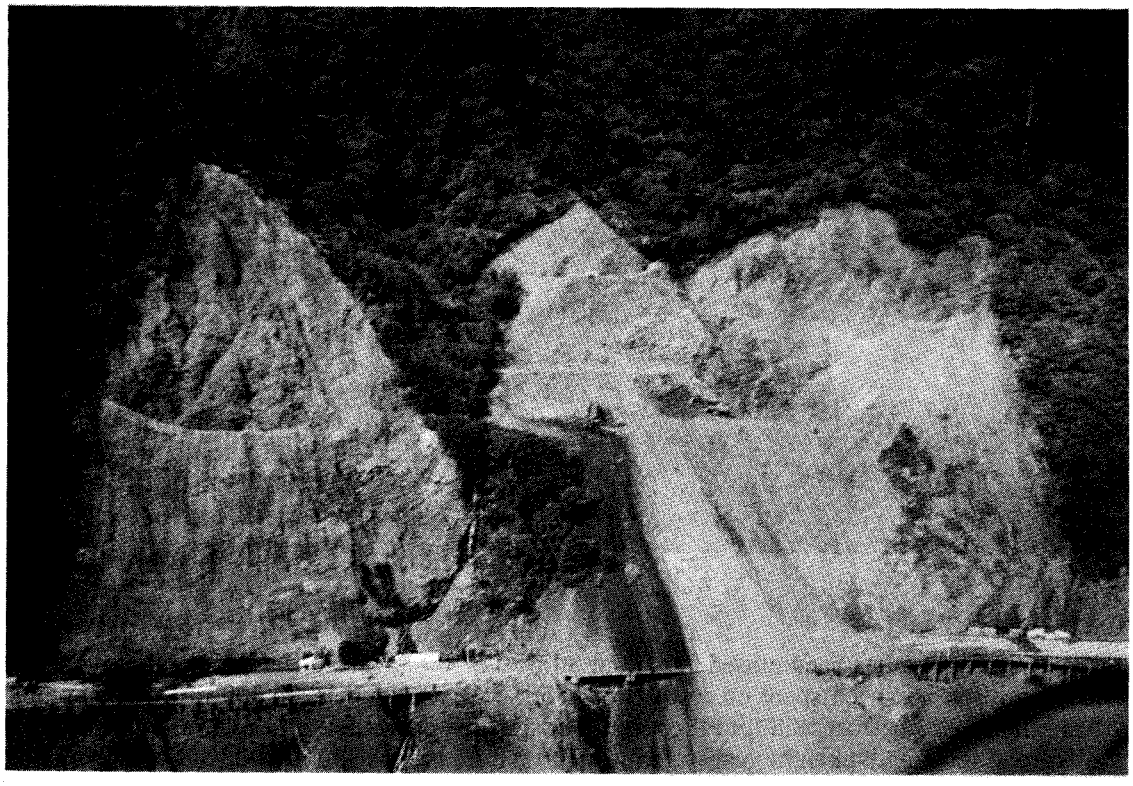
The geology of the failure area comprises indurated siltstone (argillite), sandstone (greywacke) and volcanic derived sediments. Structural geology within the gorge is extremely complex with 3 major shear orientations observed within the slip region.

The causes of the failure relate to water pressures in major rock structures, poor rock quality and steepness of the natural slopes (55°-60°). Streams flowing adjacent to slip areas were observed to disappear into the rock mass on occasions.

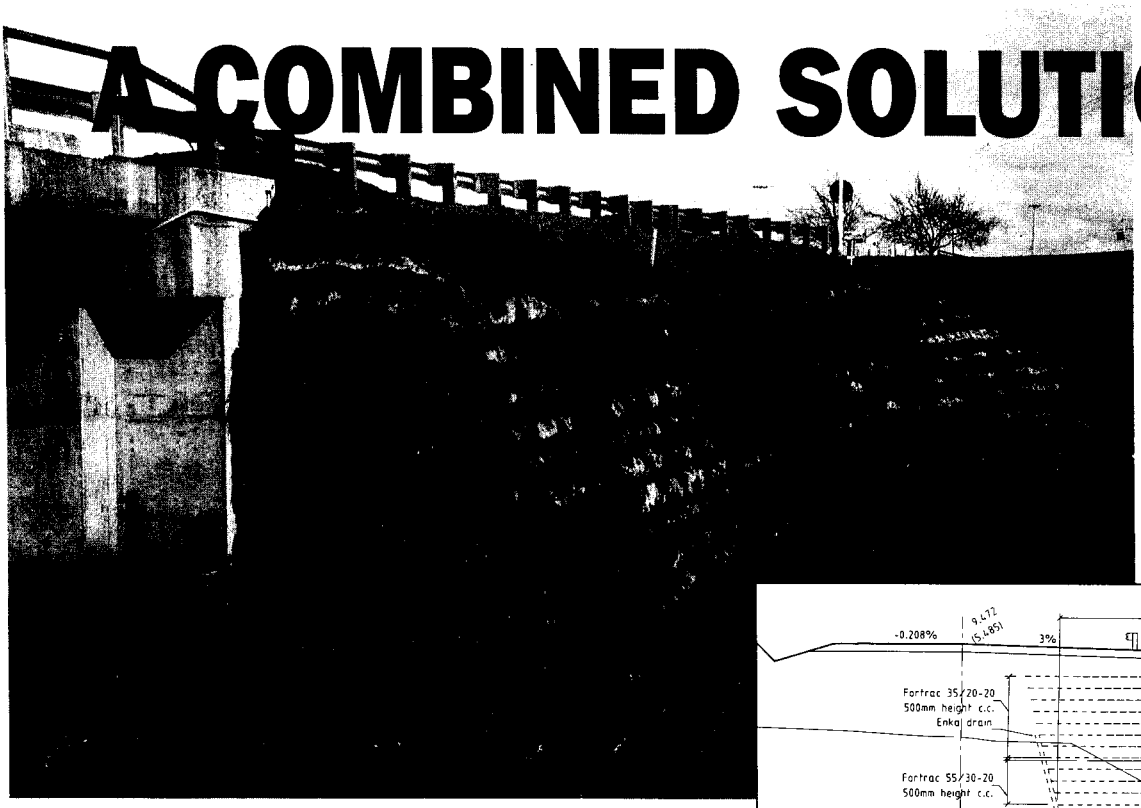
Remedial works have comprised reprofiling of the slope by benching in the head scarp area, installation of safety netting and drilling of drainage holes.

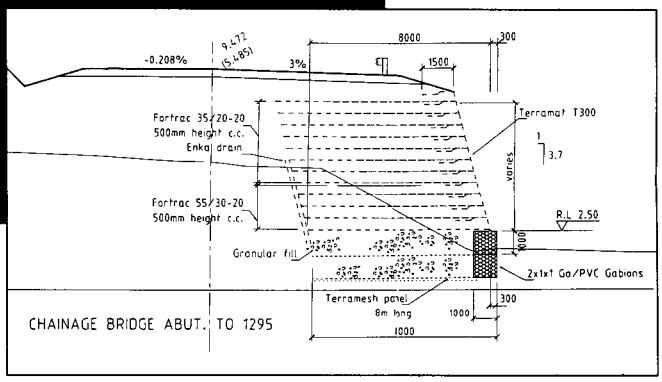
Transit's consultant for the Manawatu, region is ***Worley Consultants Ltd.*** The highway maintenance contractor is Higgins Contractors.

Geoff Farquhar
WORLEY CONSULTANTS LTD



A COMBINED SOLUTION:





Terramesh Gabions & Fortrac Geogrid

The Waokauri bridge and approach fill makes up part of the new Eastern Access to the Auckland International Airport.

Manukau Consultants, designers of the bridge section, tendered the balance of the contract as a "design and build". Maccaferri worked with Worley Consultants to provide the certified design to meet the special requirements of the site. The design had to consider steep slopes up to 8m to limit encroachment into a marine tidal zone, with an allowance for the excavation of low strength marine muds in the foundation area. For economical reasons the local ash material being excavated further along the road was the preferred fill material.

The design proposal submitted by Maccaferri, using in-house computer based design programs, recommended the combined use of the Terramesh and Fortrac systems of soil reinforcement.

The Terramesh system consists of a gabion facing unit and hexagonal mesh panel with a tensile strength of greater than 43 kN/m located at foundation level, to +/-0.5m above the high water spring tide level. An imported granular backfill was proposed for use with the Terramesh reinforcement, which would allow the contractor to achieve the desired compaction within a tidal zone. Furthermore, the gabions would prevent the loss of the reinforced fill during high water.

Above this level soil reinforcement using Fortrac geogrids with tensile strengths up to 55 kN/m was proposed allowing the more economic ash fill to be used. The geogrid was designed to be used in wraparound fashion to provide a vegetated green facing. The use of Terramat T300, a biodegradable coir fibre matting, was also recommended to prevent loss of fill from wind and rain erosion during establishment of the vegetation.

By combining the Terramesh systems and Fortrac geogrids at a slope angle of 75 degrees, Maccaferri was able to provide a solution that met both the needs of the landowner (who required minimal fill encroachment) and that of the tenderer to have not only an economical solution but one that was practicable for the specific conditions.

PROJECT

Auckland Airport Eastern Access Road Waokauri Bridge.

CLIENT
Manukau City Council/ Transit NZ.

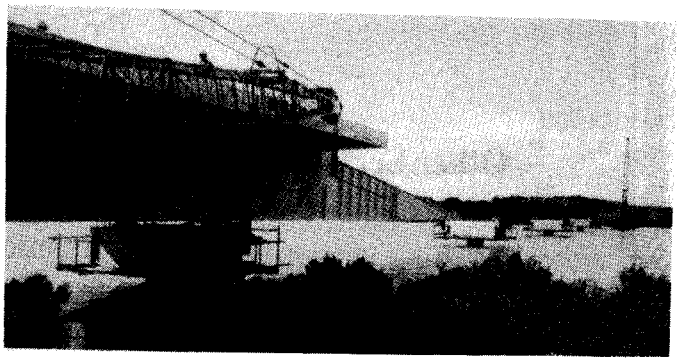
DESIGN AND BUILD TEAM
Maccaferri
Worley Consultants
Works Civil Construction

PRODUCTS
Terramesh Gabions,
Fortrac Geogrid
Terramat

® MACCAFERRI NEW ZEALAND

PUKAKI CREEK BRIDGE
AUCKLAND INTERNATIONAL AIRPORT

The $17 million Pukaki Creek bridge has now snaked its way 280 metres across Pukaki Creek to cut 10 minutes driving time between Manukau and Auckland International Airport. Every Monday a new 14 metre pre-cast segment was added by the Fletcher Construction NZ and South Pacific Ltd crew. The bridge was pushed out across the creek by 275-tonne hydraulic jacks using sliding bearings supplied by Ludowici-Addington. The project, jointly funded by Transit New Zealand, Manukau City Council and Auckland International Airport Company, is expected to be complete by March 1996. The bridge was designed by Woodward-Clyde which recommended the launch technology due to the tidal flow environment and the lower costs.



South Port expects to start soon on a $1 million upgrade of the oil tanker berth at Bluff wharf. The work involves anchoring four huge concrete blocks at the front of the wharf to give the 24,000-tonne tankers a stronger mooring point. Technical engineering manager, Russell Slaughter, said the 12 m square blocks would be similar to those used across the harbour at the Tiwai Point aluminium smelter wharf. The town wharf was built about 100 years ago and had not been significantly upgraded since the 1930s. It would be demolished within the next ten years and replaced with bridges to carry the oil pipelines from the moorings to the shore. About 16 oil tankers visited Bluff each year and Mr Slaughter said the oil companies had advised they were looking at upgrading the size of their ships to about 30,000 tonnes.

DML Resources, the New Zealand based mining and contracting company, has won another gold mining contract in Western Australia. The Skellerup Group Limited subsidiary now has three hard rock gold mining contracts on the State's eastern gold fields near Kalgoorlie. The three-year contract, worth $30 million, involves removal of hard rock waste, excavation of the ore and transporting it to the crushing plant. DML entered the Western Australian market less than a year ago with the purchase of New Zealand owned Baker Construction which has one contract operating. The company has also started a contract at the Golden Cross gold mining project near Waihi. The Golden Cross contract is for 30 months with a value of more than $20 million.

GEOTECH DRILLING

A fully mobile, self contained, auger & penetrometer rig, specialising in:

Auger & Penetrometer Work.
Site Investigation.
Environmental Drilling.

Mobile: 025 949726
Ph/Fax: 07 3782016
TAUPO, NZ

AUCKLAND CBD TUNNEL PROJECT

In order to meet forecast growth demands and provide a more secure system for its customers, Mercury Energy Limited plans to undertake a major power reinforcement project to supply the Central Business District (CBD) of Auckland. The development will involve installing new high capacity cables in a 10 km tunnel which will run from the industrial area of Penrose to Hobson Street in the heart of Auckland, along a route mostly adjacent to the city's Southern Motorway.

The project has been initiated because of the increasing power demand in the CBD and the need to replace some of the current 110 kV supply lines before they reach the end of their operational life. At least 50,000 city workers, about 10,000 businesses and an increasing number of inner city residents are dependent on the CBD power supply. The new cables planned in the CBD project will more than double the capacity of the existing ones and will be the largest polymeric cables installed in New Zealand.

OPTIONS FOR REINFORCEMENT OF SUPPLY

Mercury Energy considered both trench and tunnel options for the installation of the cables for the CBD supply reinforcement project. Overhead lines were not considered viable or desirable.

Laying the cables in a trench would have required two excavations 2 or 3 metres wide along major suburban roads through Ellerslie shopping centre, along Great South Road to Manukau Road, then along residential streets to the central city area. The work would have caused major traffic disruption and restricted options for other services. Night work, which may have lessened the impact on traffic flows, would have created noise pollution problems.

Cables laid in a trench are always prone to damage during subsequent excavation work by others. Although this can be minimised through suitable protective covering, the risks are still significant and repair costs are extremely high. A tunnel, on the other hand, involves minimal disruption, provides a high level of security from damage and enables easy access for maintenance work. In addition, the tunnel option, which allows a more direct route, is 1.7 kilometres shorter, with a consequent significant reduction in cable and accessory costs.

THE TUNNEL

The tunnel from Penrose to Hobson substation will be approximately 10 kilometres long. Therefore, it must be large enough to not only provide sufficient space for present and future power cable needs but also big enough to allow for battery powered vehicles to travel through.

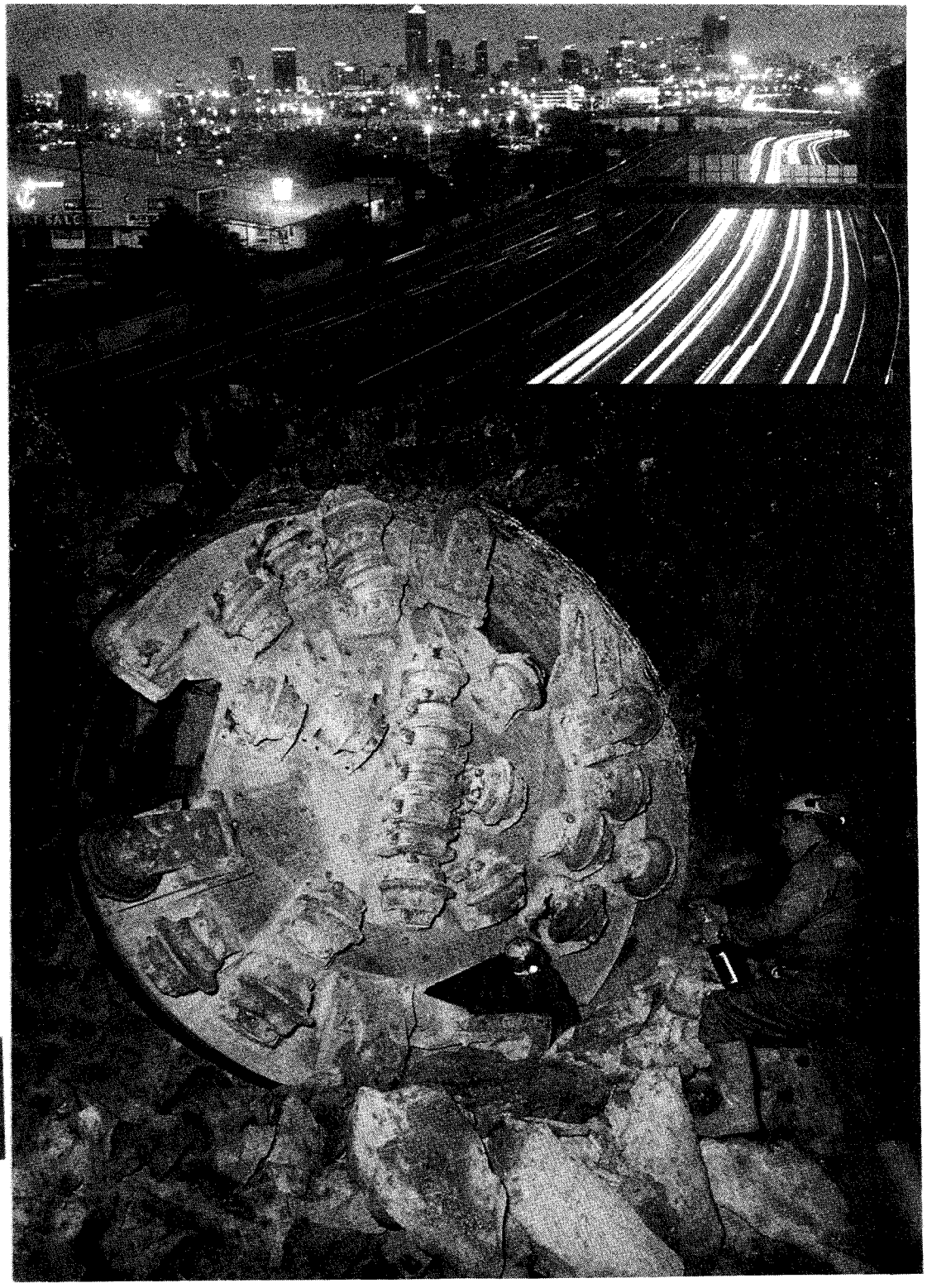
Designed with a high quality, formed and reinforced concrete lining to withstand ground and water pressures as well as seismic loadings, the tunnel will be approximately 3.4 metres in diameter. The cables will be supported on brackets attached to the walls of the tunnel.

Two electric powered vehicles, able to be driven forwards and in reverse, will operate on a guided track system to ensure they cannot run free and damage the cables.

Additional space will be available in the tunnel for future expansion and reinforcement of Mercury's network and other services.

WHO ARE INVOLVED?

A project of this magnitude and complexity requires highly skilled and experienced professionals in all areas. These include geotechnical, geohydrological, civil, structural, and heavy power electrical engineering specialists. Mercury Energy has engaged **Tonkin & Taylor Ltd, Worley Consultants Ltd** and Russell McVeagh McKenzie Bartleet & Co, among others, in the development of this project.



In addition, experts in other areas, including traffic, noise, environmental, archaeological and property valuation issues, have been required during the investigative and detailed design stages. The tangata whenua have also been consulted about all aspects of the project.

Article compiled by S. Crawford (Tonkin & Taylor Ltd) from the Mercury Energy Information Bulletin July 1995:CBD Tunnel Project

THE BRITOMART UNDERGROUND TRANSPORT CENTRE

(amended extract Auckland City Council Public Consultation Document, July 1995)

General Description

The Britomart transport centre consists of a five-level reinforced concrete basement structure housing a bus station, rail station, car parking and truck docking facilities plus associated plant and services.

The levels can be briefly described as follows:

Ground level

- street/public plaza level/promenades/commercial residential and historic buildings
- pedestrian entries including through the historic CPO

Level 1

- public parking
- residential parking
- Quay St underpass
- services diversion

AUCKLAND CITY

Level 2

- a rail station to provide for the extension of railway lines from Beach Rd and for the future integration of a light rail transit (LRT) system, and a terminal for inter-city and suburban rail services.
- a bus terminal for scheduled suburban services, separated by the rail tracks
- a taxi rank, tenant parking and loading docks

Level 3

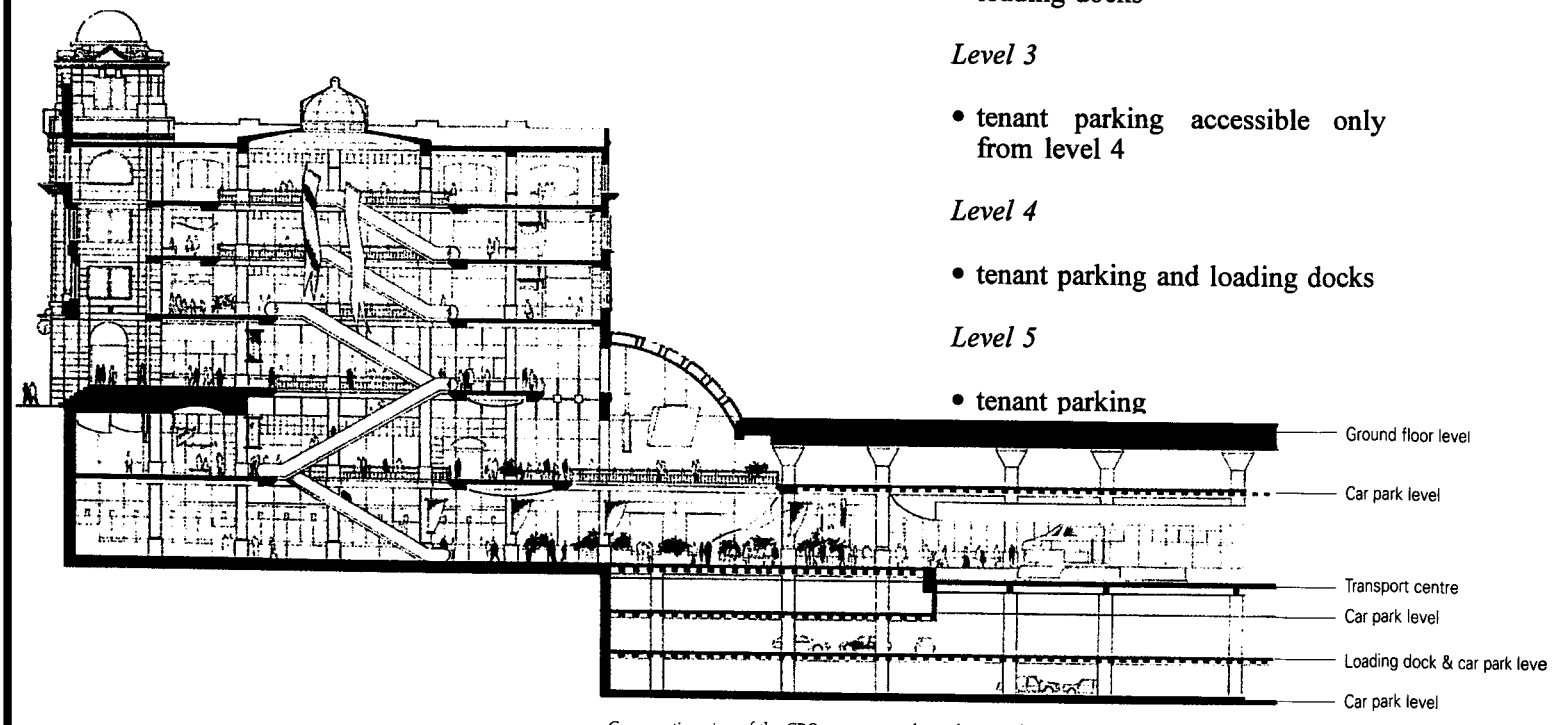
- tenant parking accessible only from level 4

Level 4

- tenant parking and loading docks

Level 5

- tenant parking



Cross section view of the CPO entrance to the underground transport terminal

At ground level the basement structure is capped by a 500 mm thick reinforced concrete slab for future development of buildings and public plaza space. The structure has been designed to support up to 12 commercial developments of varying sizes and heights (including at least two hotels, as well as residential complexes and office building).

The basement structure extends underneath a number of heritage buildings on the site. These buildings will be supported by a series of large concrete beams supported on reinforced concrete piles.

Quay Street will run along a reinforced concrete underpass located on the northern boundary of the site. This will allow level pedestrian promenades on the surface between the site and the wharves including the ferry terminals.

Structural Elements

Foundations - reinforced concrete pads founded directly on the well-cemented Waitemata sandstones.

Basement exterior walls - 800 mm thick reinforced concrete. These walls act as large shear walls resisting seismic loads and as a retaining wall supporting the soil and water loads acting on the basement structure. Their thickness will prevent water infiltration and they will extend into Waitemata sandstone which has very low permeability. Water inflow through the sandstone will be very small and easily relieved by scoria drainage trenches below the basement slab. These will drain into a basement drainage chamber from where any water can be pumped away.

Suspended car parking and bus station floors - precast prestressed floor units with a cast insitu concrete topping. These are supported by precast concrete beams spanning onto reinforced concrete columns.

Railway support - rail lines are supported on a grid of precast concrete beams spanning onto reinforced concrete columns. The railway lines will be located on anti-vibration mounts, ensuring that any vibration caused by the trains is dampened out and not transferred to the structure.

Plaza slab - 500 mm thick reinforced concrete slab, spanning between basement columns. Designed to support a nominally 2 to 2.5 m deep transfer structure that will act as the foundations for the tower buildings above, and to support plaza loads such as landscaping, road reserves and fire appliance loads. The slab also acts as a large diaphragm transferring the lateral wind and seismic loads from the towers above to the stiff walls enclosing the perimeter of the basement.

Quay Street underpass - will descend to a depth of nine metres. The northern wall of the underpass will be a 500 mm thick diaphragm wall, similar to the main basement walls, to act as a retaining wall and vertical support to the roof slab. The floor of the underpass is a 300 mm thick cast insitu reinforced concrete slab. Since it is not founded on the sandstone it will be subjected to uplift water pressures. These will be resisted by hold down anchors spread evenly across the slab.

Construction Technique

A special technique for excavating reclaimed land below water level will be used. This method of construction has been used around the world for 30 years, and in areas close to the water and to depths in excess of 50 m. It is quieter and cheaper than traditional methods of piling and excavating.

The walls of the basement structure are constructed first to seal off the site from surrounding land. This is done by digging a deep trench around the site and casting a concrete diaphragm wall that is sealed into the underlying sandstone strata. This allows excavation to take place inside the concrete wall and prevents water from leaking into the finished building.

In order to cast the concrete wall, the trench is first filled with a bentonite slurry. This retains the walls of the trench and is simply displaced by the concrete.

STATE HIGHWAY 20 MANGERE MOTORWAY EXTENSION PROJECT

FULTON HOGAN HOLDINGS LTD
IN ASSOCIATION WITH
ALBERT SMITH INDUSTRIES LTD

TONKIN & TAYLOR LTD
TRAFFIC DESIGN GROUP LTD
ISTHMUS GROUP LTD
HOLMES CONSULTING GROUP
MARSHALL DAY ASSOCIATES

TITLE
TRANSIT NEW ZEALAND

INTRODUCTION

The construction of the SH20 motorway extension through Mangere began in November 1993. The motorway will establish an important link between Auckland International Airport, Auckland City, Mangere and Manukau City.

Transit New Zealand awarded the design and build contract to Fulton Hogan Holdings Ltd for the 30 million dollar project, the first of it's type in New Zealand to be let by Transit New Zealand. The project will take three years to complete.

The project involves the construction of about 4.5 kilometres of motorway linking Mangere Bridge to the Papatoetoe Bypass and a 1.6 kilometre extension from the George Bolt Drive/Kirkbride Road intersection. Purchase of most of the required land was undertaken some 20 years ago.

INVESTIGATION

- 120 N° Boreholes, CPT's, Hand Augers and Testpits
- Consortium of Five Consultants prior to tender

COMMUNITY ACCESS

The area intended for motorway construction has been informally used by pedestrians over the years. Many of the existing access routes will be unavailable during construction. However, the motorway project will ensure that access in the form of footbridges, footpaths and cycleways will be available at convenient locations.

GEOLOGICAL SETTING

The SH20 project is underlain by three main geological formations:

- up to approximately 4 m of weathered volcanic ash of tuff (Auckland Volcanic Group)
- up to approximately 30 m thickness of interbedded silty sand, clay and peat (Tauranga Group)
- very dense uncemented sand (10 m plus thickness interpreted to be the Kaawa Formation) underlying the Tauranga Group sediments. The top of the Kaawa Formation was generally encountered at between RL-16 m to RL-20 m.

GEOTECHNICAL ASPECTS OF DESIGN

Earthworks

- **Excavation and Stability of Cuts** - up to 6-9 m maximum height
- **Placement of Fill - Structural and Landscaping** - materials handling and specification
- **Fill Embankment Stability** - 10 m high embankment on soft ground, bridge abutments at creek
- **Fill Embankment Settlement** - 10 m high embankment on soft ground, profilometer
- **Preparation and Formation of Subgrades** - on varying volcanic and alluvial conditions
- **Erosion Control During Construction** - silty fine sands, Local Government consents
- **Earth Retaining Structures** - cantilever and tied back walls to 6.4 m in 8 m cuts
- **Seismic Design** - slope stability, wall design, liquefaction

Bridges

- Foundation Design - driven piles up to 35 m long, 500 mm oct. precast
- Abutment Design - friction slabs and passive resistance for seismic loads
- Settlement Effects - negative skin friction, bitumen coated piles
- Interaction Analysis - 6.4 m tied back walls and adjacent overbridge under seismic load

Footbridges

- Surface Footings - settlement and seismic rocking action, preloads

Pavement

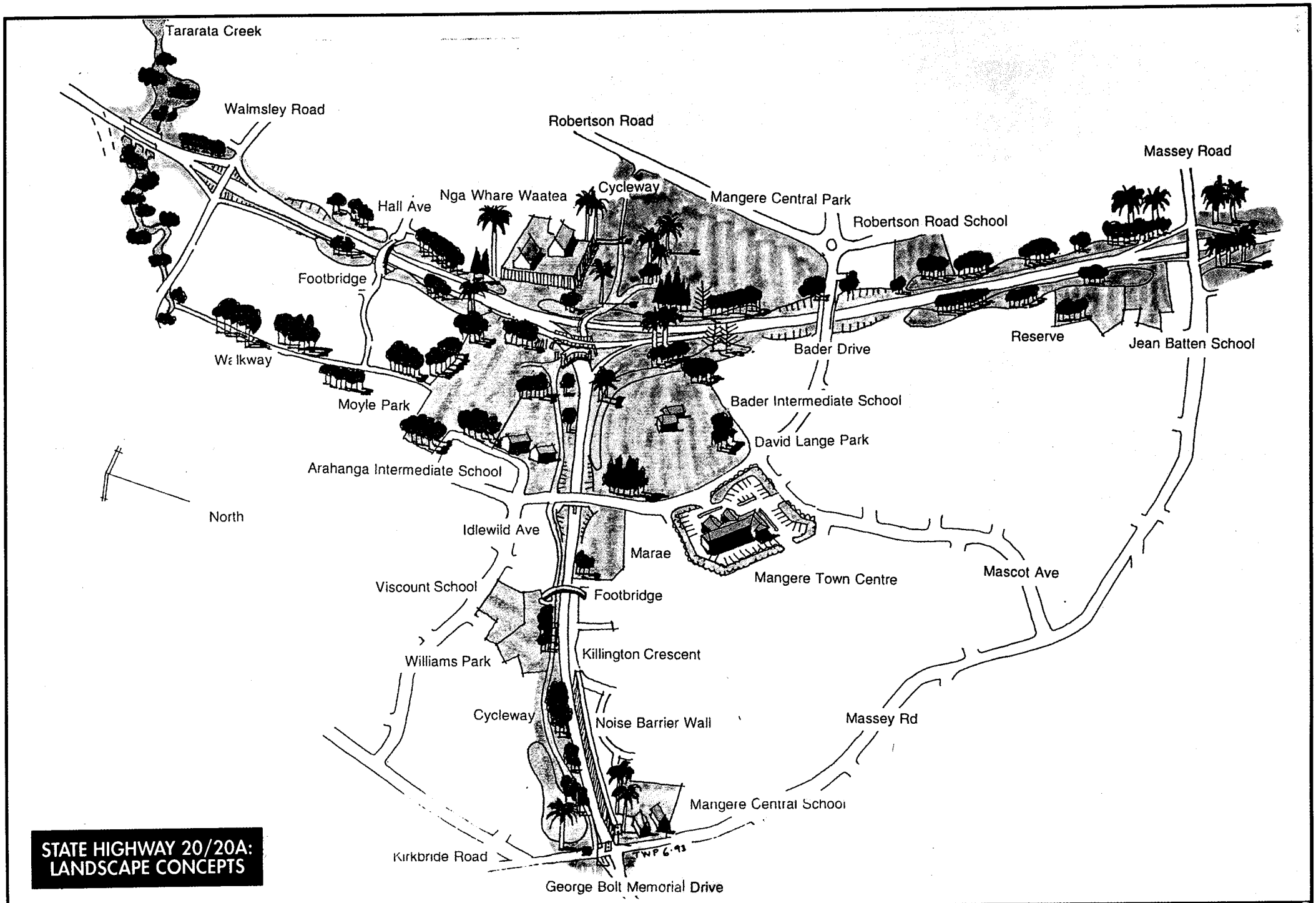
- Subgrade condition estimation
- Pavement Design - stabilised and non-stabilised (cement, lime)

Drainage

- Settlement of sewer and stormwater lines beneath fills

Quality Assurance

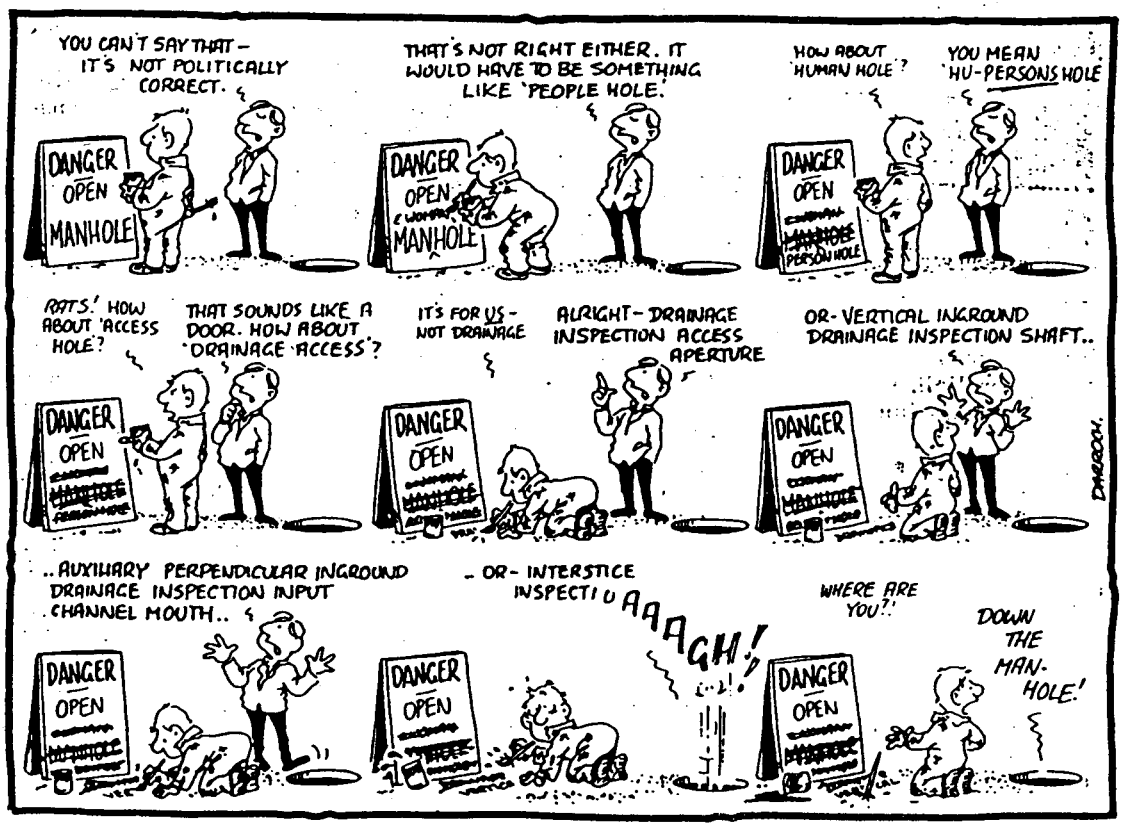
- Levels of QA - design checks, internal review, external review, contractor's review


Tararata Creek
Walmsley Road
Robertson Road
Massey Road
Hall Ave
Nga Whare Waatea
Cycleway
Mangere Central Park
Robertson Road School
Footbridge
Walkway
Bader Drive
Reserve
Jean Batten School
Moyle Park
Bader Intermediate School
David Lange Park
Arahanga Intermediate School
North
Idlewild Ave
Marae
Mangere Town Centre
Mascot Ave
Viscount School
Footbridge
Killington Crescent
Williams Park
Cycleway
Noise Barrier Wall
Massey Rd
Mangere Central School
Kirkbride Road
George Bolt Memorial Drive
TWP 6·93
STATE HIGHWAY 20/20A:
LANDSCAPE CONCEPTS

OSH GUIDELINES

The Occupational Safety and Health Service (OSH) says new regulations which came into effect in October make it much easier for employers to understand and comply with workplace health and safety law. The regulations are supported by a series of guidelines on how the regulations applied to specific industries. These guidelines explain the relevant regulations in user-friendly language so that people don't have to wade through pages of legal jargon. The regulations apply to almost all New Zealand workplaces and came under the Health and Safety in Employment (HSE) Act. The Act requires those with control over workplaces to take *all* "practicable steps" are. The regulations are mostly carried across from legislation repealed when the HSE Act came into effect. The most important change is that people designing or supplying plant or protective equipment are required to build in safety and health considerations from the start. More information can be obtained at any OSH branch office.

DARROCH'S VIEW



AUSTRALIAN ROADING STANDARDS BENEFIT NEW ZEALAND

Standards New Zealand is now the official local retailer of publications written by *Austroads* – the Australian Road Transport and Traffic Authorities Association.

The exclusive appointment was made in an agreement signed between Standards New Zealand, Austroads and Transit New Zealand in August this year. Transit is a member of the Austroads Council.

The agreement gives Standards New Zealand exclusive rights to sell Austroads publications and to endorse certain publications as Standards New Zealand Handbooks.

Many Austroads publications will be of interest to engineers, road designers, architects and policy makers.

Two publications of particular interest will be AP-1/89 *Rural road design – Guide to the geometric design of rural roads* and AP-17/92 *Pavement design.*

Rural road design embodies the philosophy of designing rural roads for observed vehicle speeds. Thus the 85th percentile value of observed vehicle speed is adopted as the basis for geometric form, rather than designing to a predetermined speed standard. The guide gives extensive supporting explanations of the practices recommended, either in the text or by directing the reader to specific references.

Pavement design gives pavement designers the latest information for the analysis and design of pavements where the primary distress mode is load associated. The guide includes procedures for designing flexible pavements consisting of unbound granular materials, flexible pavements that contain one or more bound layers, rigid pavements and overlays for flexible pavements. Detailed discussion of subgrade elevation, pavement materials evaluation, analysis of traffic loading and economic comparison of pavements.

Austroads has almost 100 publications that promote best practice and deliver latest research findings from areas relevant to roads and road transport. Topics covered include traffic engineering, roads and pavements, bridges and structures, road management, environment, heavy vehicles, safety and many other transport related issues.

A free pricelist of the catalogue of Austroads publications can be obtained from the Standards New Zealand Information Centre on Tel: (04) 498 5992.

PRUDENT PLANNING OF ROADS

A massive joint Australian/New Zealand draft Standard for the information structure and format of road centre-lines and other features is out for comment until April next year.

DR 95417 *Geographic data file* is based on a European Standard with modifications to suit New Zealand and Australian needs.

The draft is designed to meet the needs of professionals and organizations involved in the creation, update, supply and application of referenced and structured road network data.

It has been created to improve the efficiency of the capture, production and handling of road related geographic information. This increase in efficiency is obtained by supplying a common reference model on which users can base their requirements and producers can base their product definition.

DR 95417 is available for comment from Customer Services for $42.20 (Standards New Zealand members $35.36) until 30 April 1996.

RISK MANAGEMENT

A new joint standard, AS/NZS 4360:1995 *Risk Management* has been prepared by Standards Australia and Standards New Zealand with the objective of providing a generic framework for identification, analysis, assessment, treatment and monitoring of risk. It includes a glossary of terms and application guidelines.

Risk management is an iterative process consisting of well- defined steps which, taken in sequence, support better decision-making by contributing a greater insight into risks and their impacts. The risk management process can be applied to any situation where an undesired or unexpected outcome could be significant or where opportunities are identified. Decision makers need to know about possible outcomes and take steps to control their impact.

Risk management is recognized as an integral part of good management practice. To be most effective, risk management should become part of an organization's culture. It should not be viewed or practised as a separate program but be integrated into the organization's philosophy, practices and business plans. When this is achieved, risk management becomes the business of everyone in the organization.

This Standard specifies the elements of the risk management process, but it is not the purpose of this Standard to enforce uniformity of risk management systems. It is generic and independent of any specific industry or economic sector. The design and implementation of the risk management system will be influenced by the varying needs of an organization, its particular objectives, its products and services, and the processes and specific practices employed.

PAVEMENT STRUCTURAL CONDITION EVALUATION AND REHABILITATION DESIGN

Graham Salt, Geotechnical Engineer, Tonkin & Taylor Ltd

Transit NZ have now adopted the AUSTROADS' Guide as the recommended method for the structural design of New Zealand pavements. A principal change from the superseded NRB Design and Rehabilitation Manual is the greater emphasis on mechanistic design methods and utilization of structural deflection testing. The design procedures utilize both the central deflection of the pavement under the standard (8 tonne) axle and the deflection bowl curvature, thereby giving meaningful structural evaluation of the effective load spreading ability of the pavement layers.

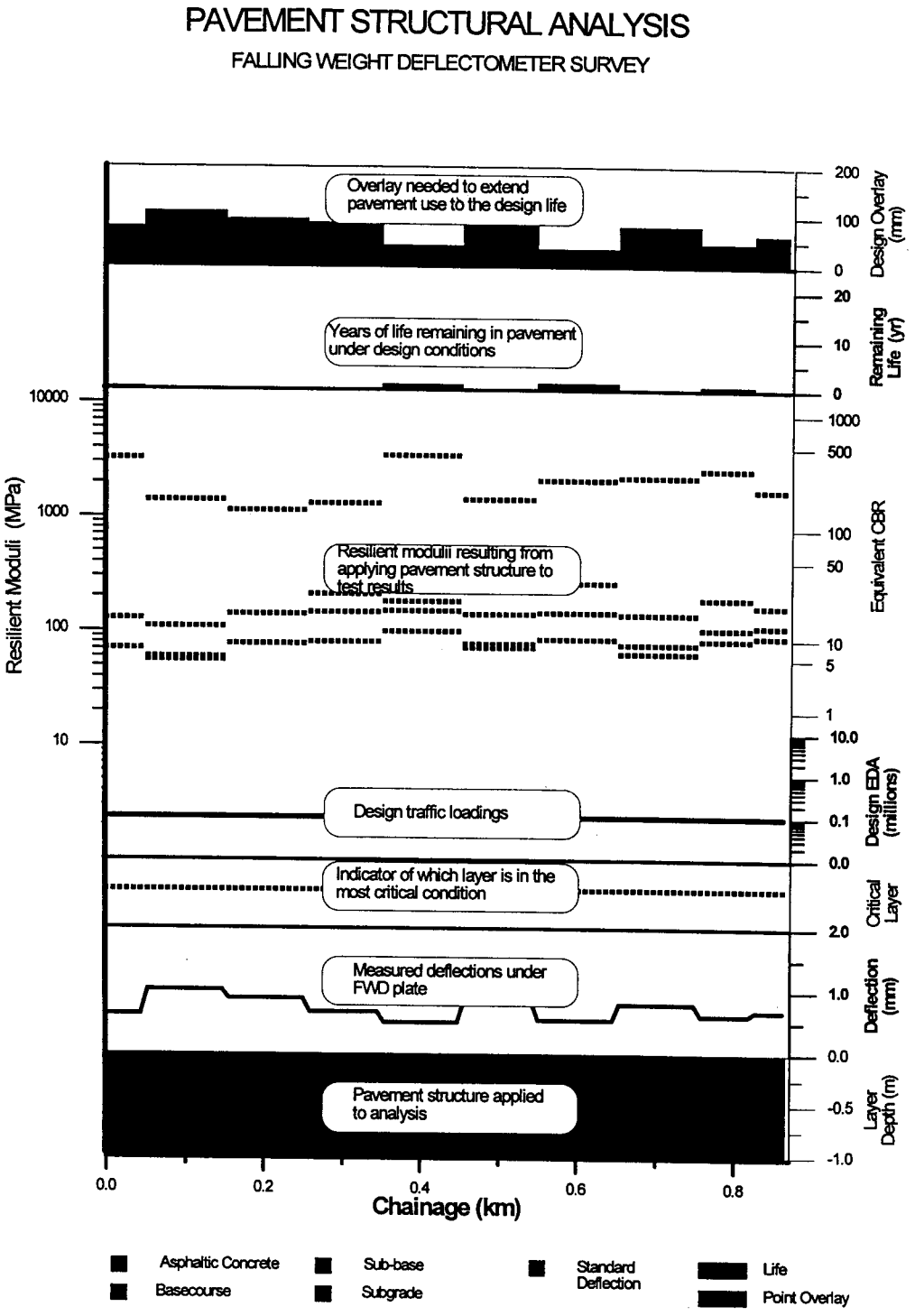
The Falling Weight Deflectometer operated by Tonkin & Taylor Ltd is an effective means of quickly and accurately determining the full dynamic deflection bowl beneath a standard wheel load. The shape of the deflection bowl allows detailed structural analysis of the pavement layers. Basically, the outer deflections define the stiffness of the subgrade while the bowl shape close to the load allows analysis of the stiffness of the near surface layers. A broad bowl with little curvature, indicates that the upper layers of the pavement are stiff in relation to the subgrade. A bowl with the same maximum deflection but high curvature around the load, indicates that the upper layers are weak in relation to the subgrade. With the critical layer identified in this manner, the residual life may be calculated, and the most fitting treatment may be prescribed.

An example of the analysis and design is given in the attached Figure, "Pavement Structural Analysis". Starting at the foot of the page, the lower graphs give the layer thicknesses used in the model (as found from back-analysis and/or as-builts, coring, penetration testing and test pitting) and the actual dynamic deflections (corrected to standard temperature for an 8 tonne equivalent design axle loading travelling at 60 km/hr). The next graph shows the critical layer, ie the layer that governs the design life of the pavement according to the adopted strain criteria (specified in the AUSTROADS Guide). The next set of graphs show the results of the structural analysis, giving the moduli for each layer: basecourse (if unbound granular chip seal, or asphalt if structural), subbase and subgrade. The resilient modulus scale is shown on the left, while the equivalent CBR (again using Transit NZ recommended relationships) is shown on the right margin. Colour coding is used to allow the various layers to be identified readily.

The adjoining graphs provide the interpretation and design guides. For each point the remaining life is shown and calculated overlay (where required to provide the projected design life). The individual results are then grouped into structurally uniform sub-sections to show practical intervals for which individual forms of treatment may be specified for construction. This vital step ensures a cost effective approach to ensure the design life is achieved without superfluous overlay. The emphasis is placed on obtaining comprehensive in-situ test data so that sections which are structurally deficient can be clearly delineated from areas which require no strengthening, thus avoiding the over design that can result where a single form of treatment is applied to an extended length of pavement.

The overlay refers in each case to the same material as is present in the surface layer of the existing pavement (ie an overlay of asphaltic concrete for structural asphaltic pavements, or unbound M/4 overlay with chip seal in the case of existing unbound granular pavements). For the case of seal extensions, the overlay requirement assumes M/4 basecourse overlay with reduction factors to compensate for any crustal effects in an unsurfaced road. Alternative designs (including stabilisation, reconstruction or widening if appropriate) can also shown be presented where required. These allow comparative costings (using local unit rates) to enable the most economic design to be adopted.

A concise report is prepared for each project, along with the graphical and tabular summaries. All data are also supplied in ASCII files on IBM compatible diskette for incorporation with the RAMM database where required.



REFERENCES

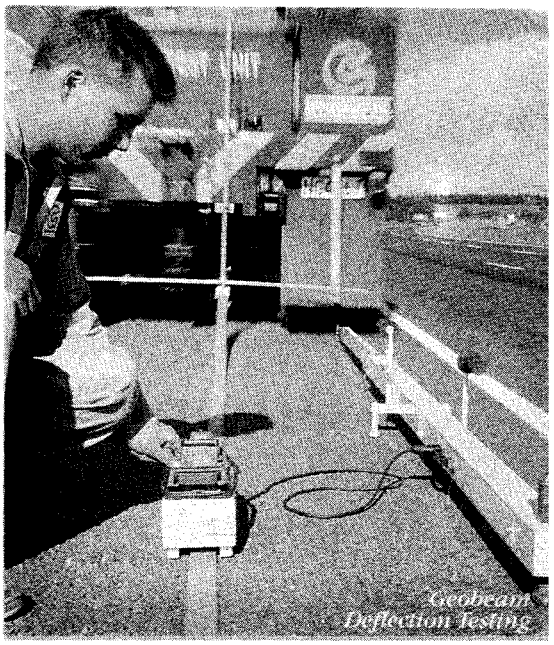
Austroads (1992) Pavement Design. *A Guide to the Structural Design of Road Pavements.*
Ullidtz, Per (1987). Pavement Analysis. *Developments in Civil Engineering 19. Elsevier.*

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.

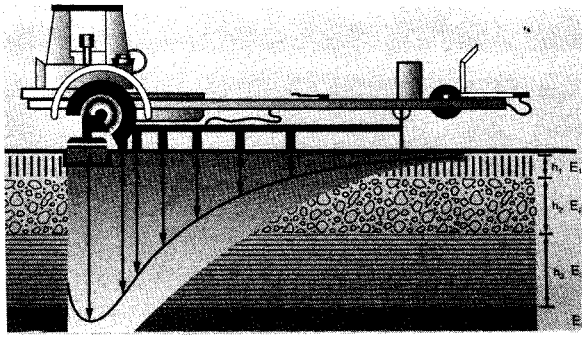
Standard test loads of 7.3 tonnes and 8.2 tonnes are available for deflection testing.

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

Workshop 527-7346
Facsimile 526-9943

Mobile (021) 433-137
Day or Night 526-9943

GRIFFITHS DRILLING (NZ) LTD

Member of N.Z. Drillers Federation

★ **Geotechnical, Environmental Investigations & Sampling**

★ **Horizontal, Diamond Coring & Ground Anchors**

★ **Static Cone Penetration Testing**

★ **Water Well Drilling**

The company has been in operation for 25 years with director experience of 47 years in the drilling industry throughout New Zealand. Carried out investigation drilling on most hydro dams in the North and South Islands of New Zealand. Marine drilling off barges and jack up platforms. Investigation drilling for multi-storey buildings, bridges and motorways. Waterwell drilling up to 250 mm diameter, domestic and irrigation schemes. Anchor drilling and grouting.

NZ Trade Qualifications

★ Contact Melvin or Gordon Griffiths

15 Nicolaus Street, Trentham
P.O. Box 40-422, Upper Hutt

THE ROLE OF PEER REVIEW

David Cook, Indemnity & General Insurance
G. Alan Pickens, Tonkin & Taylor Ltd
Grant MacDonald, Phillips Fox

An Auckland branch meeting of the NZ Geomechanics Society was held on 23 August 1995 to discuss issues relating to peer review. The above panel members gave presentations from different perspectives. The following notes are repeated here for the benefit of readers. However, these notes were prepared for oral presentation and comments made are sometimes candid. Opinions expressed here should not be construed as legal or professional advice.

PEER REVIEW - AN INSURER'S PERSPECTIVE

David Cook - Claims Assistant
Indemnity & General Insurance Company

I'm on this panel tonight as a member of the claims committee of the Indemnity Insurance Company which provides professional indemnity insurances to consulting engineers. The review of one engineer's work by another plays a significant part in our work.

I bring you the rather sobering information that in our group of insured firms, over the past year, of 100 claims notifications, 46 were related to unsatisfactory performance of soils or foundations. Shaken down to potential losses, the percentage reduces to 43%, still a significant proportion that will be of concern to this audience tonight. From the point of view of an insurance company, the more effective pre-construction reviews of any type can be, the better.

Broadly speaking, "reviews" will fall into 4 main categories:

1. General in-house reviews or over-views by a colleague or superior.
2. Client required review - usually carried out by an independent person engaged either by your firm or directly by your client.
3. Review as part of statutory process for consent.
4. Disaster or failure review.

Category 1: General In-house Reviews - I don't have a lot to say about category 1 reviews except that the more of it, the better! A most important area to address in these reviews is communications - make sure that all the necessary information is obtained and made available to all those people who need to take account of it.

Also make sure that opinions expressed are carefully qualified as to their application. I must say geotechnical engineers are usually very good at this- I've seen a couple of foundations investigation reports that have been so severely qualified as to provide virtually no usable information.

Category 2: Client Required reviews - I believe this area will be addressed in detail by Alan Pickens. The only case I can recall was where a review panel of wise men had been appointed in a major civil engineering project where problems developed due to an inadequacy in detailed design. In that case, the review panel were not able to detect and prevent the problem, nor was the clients' liability reduced by their involvement.

BROWN BROS
(N.Z.) LTD.

EST. SINCE 1937

TECHNICALLY SUPERIOR

COST EFFECTIVE

FROM – Environmental Drilling – to U.S. – E.P.A. Standards.
Our people are certified in Hazardous Waste Operations
FROM – City to Village Ground Water Supplies
FROM – Mine Scout Exploration Drilling to Large De-Watering Wells
FROM – Plain Geotechnical to Deep Off-Shore for Marine Installations
FROM – Reverse Circulation to Bulk Sampling
FROM – Quarries to Stabilisation
FROM – Camera Bore Hole Surveys to Directional and Controlled Drilling
FROM – Simple Seismic to Deep Stratagraphic.

TOP HEAD DRIVE – MULTI PURPOSE – HYDROSTATIC
DRILLING RIGS – ALL TERRAIN – MOUNTED & HELIPORTABLE
ENVIRONMENTALLY SENSITIVE EQUIPMENT
TAKE ADVANTAGE OF OUR 58 CONTINUOUS YEARS
THE LOGO SAYS IT ALL.

Try us, we've probably done it, or are about to

DRILLING IS "OUR" BUSINESS

CONTRACTORS, ENGINEERS & CONSULTANTS

Telephone 07-849 2919, 09-298 0449, Facsimile 07-849 1729 After Hours 025-928 635

Category 3: Statutory Reviews or Checking for Consent - Many local authorities engage independent consultants to review designs submitted to them for consent or approval. The Association of Consulting Engineers NZ (ACENZ) has a practice note, dating back to 1987 advising its members on how to handle this role. As a reviewer:

1. You should accept such engagements on the understanding that you will be permitted full rights of discussion with the designer.

2. You should notify the designer of your engagement.

3. You should exercise discretion, tact and restraint in your reviewing role and carry out the review in an atmosphere of mutual confidence and understanding.

4. In this type of review, it is not your role to comment on the choice of design, only on the designs' validity and compliance with the bylaws and codes that it is required to meet.

5. You should always consider the consequences of your decisions as that may affect the risks and costs to the owner and the public, the reputation and livelihood of the designer and equal importantly the good standing of the profession itself. If you feel the designer's work is seriously at fault, you should make every effort to resolve the matter with the designer and obtain another independent opinion if you think it necessary.

It is most important from a liability point of view (for the reviewer) to resist the temptation to become involved in modifications to the design. The reviewer's job is to point out areas of the design you believe need to be addressed and invite the designer to resolve those areas to your satisfaction.

Category 4: Disaster or Failure Review - The last group of review is that occasioned by failure and the need to discover why? and whose fault? ACENZ again has a set of recommendations for members to follow in this role and the principles apply to all experts engaged in this way. As a reviewer:

1. You should accept engagement on the basis that you reserve the right to discuss the design and its philosophy with the designer, should she or he wish to do so.

2. You should again notify the designer of your appointment and make every effort to obtain a full knowledge of the facts before expressing an opinion.

3. Avoid as far as possible the intrusion of your own concepts and assess the adequacy of the design to meet normally accepted standards - don't, with the benefit of hindsight, overstate these standards.

You should not treat your engagement as an opportunity to carry out a marketing exercise for your own or your firm's skills. Remember that the designer will have had cost budgets to work within and that while bullet-proof designs may seem to have been the best option after a failure, their adoption from the outset could well have put the economics of the project in jeopardy. Hopefully, the designer will have given the owner or developer the option of electing for a more conservative but expensive design and they have elected to take the risk. Discussion with the designer may reveal that such options have slipped the owner's or developer's mind.

SPECIMEN LETTER ACKNOWLEDGING ENGAGEMENT

Suem & Suem
Barristers & Solicitors
Prettywell Anywhere

Sirs

Re: BROKEN DOWN JOB, ROTTEN ROW

This will serve to acknowledge your instruction to make a detailed inspection of the above project and to report to your client on the engineering defects complained about.

We understand that the project was carried out by Careless Contracting Ltd to an engineering design prepared by Knowall & Partners for which a consent was issued by Notown City Council.

Your instructions seek an opinion on the cause of certain problems which will require a review of the design as well as the construction methods.

In order to reach such an opinion, it will be necessary for us to review both the design calculations and the design philosophy. While the former may be available at the council offices, it is unlikely that all the information will be contained in council records.

We propose therefore to approach Knowall & Partners and, if they agree, to review this material with them.

We are sure you will appreciate that misleading conclusions can arise out of incomplete information, as much of the source material is available only to the original designer. Experience has demonstrated that there are considerable advantages to your client in respect to both cost and time if we are able to review this material with Knowall & Partners.

Yours faithfully
GOOD GUY & PARTNERS

I hope you will always remember the saying "there but for the grace of God go I" and that any unrealistically high standards you profess to be the norm, may one day be the precedent by which your own work is judged.

Avoid ever giving an opinion as to **negligence** even though your client or his lawyer may press you for it. This is an area for the courts to decide and such allegations made by a reviewing engineer are often difficult to retract.

I have a couple of specimen letters which illustrate the points of establishing your rights to discuss the issue with the designer and the avoidance of an opinion on negligence.

SPECIMEN LETTER TO COMMISSIONING SOLICITOR ON QUESTIONS OF LIABILITY

Suem & Suem
Barristers & Solicitors
HERE, THERE AND EVERYWHERE

Sirs

Re: BROKEN DOWN JOB, ROTTEN ROW

We acknowledge your letter raising further questions arising from our report on the above project.

We are pleased to answer these with the exception of question 13 in which you ask us to give our opinion on whether Knowall & Partners were negligent in this matter.

We regret that we are unable to give such an opinion, which we understand is properly a question of law. All we are prepared to comment on is the general practice of the profession in dealing with similar matters.

However, we enclose our replies to your other questions and trust that these have further clarified the position.

Yours faithfully
GOOD GUY & PARTNERS

Note: These notes have been prepared for the purposes of discussion at the Auckland Branch of the NZ Geomechanics Society on 23 August 1995. While opinions expressed are intended to outline aspects of peer review, they cannot be construed as professional or legal advice.

PEER REVIEW - THE ROLE OF REVIEWER

G. Alan Pickens
Geotechnical Engineer, Tonkin & Taylor Ltd

1. INTRODUCTION

My contribution to this discussion is about the role of the Reviewer, which involves issues such as defining the review criteria, procedures and both operational and professional relationships. David, in introducing our topic, has already canvassed most of the key issues. I may repeat some aspects he has covered but hopefully will help emphasise key aspects. David has outlined the three main types of review which we encounter and a fourth which is internal review. I will discuss the review role issues under the following main headings, which are not perfect headings by any means:

- what do we *mean* by peer review and what are the key Reviewer attributes required
- defining the *scope of reviews* and being clear about what is excluded from the review
- *managing relationships* between the parties for effective and professionally appropriate reviews
- important aspects in *getting the best out of reviews*
- who should *appoint* the Reviewer, what should the *reporting procedures* be and the importance of *defining the role contractually*

It is not easy to separate out various issues associated with this topic and you will find overlap between the headings. Grant (MacDonald) will continue the overlap into the professional liability pitfalls and hopefully make it clear to us how to avoid them. The fact that we have not found any readily accessible material on the topic which we could plagiarise, has not made it any easier for us.

2. MEANING OF PEER REVIEW AND ATTRIBUTES

Setting aside royal connotations, "peer" essentially means of equal rank or standing, and in the technical context, usually implies equal experience as well as equal technical ability. However, in practice the term seems to be used a bit loosely. For example:

- in a building consent peer review, the Reviewer is probably acceptable if she or he is technically qualified to carry out principle and numerical checks or reviews and the issue of years of experience compared with the Designer is not considered particularly relevant - if this is the case, is "peer review" an appropriate term or should "design check" be used?

- in a larger civil project design involving geological and hydraulic issues or a geotechnical review situation and where decisions often require judgement and application of engineering art, the experience of the Reviewer becomes much more relevant and an appropriate level of seniority and relevant prior experience is or should be sought - if the project involves high hazard or financial consequences (e.g. Clyde Power Project) then the review requirements may move to a higher plane with the skill and/or experience sought of the Reviewer, being above that of the design team

- in post-problem/failure reviews, again it is usual to involve a very high level of skill and experience both to analyse the situation and ensure corrective measures are sound

I have used "Reviewer" in the singular but as we are all aware, for more complex situations involving different facets of engineering, a team of Reviewers is common. I have not yet found a good definition for peer review and because of the varying situations which occur, maybe it is too difficult to develop a suitable definition. Grant (MacDonald) may like to comment on whether case law has a clear interpretation of peer review. Perhaps that is the reason why the Client on a dam job I am involved with has preferred the term "Design Reviewer" for the review team members, instead of "Peer Reviewer". Please note throughout that we are discussing review by persons external to the Designer. The Designer may well also have a level of internal peer review.

What does the audience think about the terminology and the need for clarity?

Clearly technical skills and experience are fundamental attributes for a Reviewer. As will become clearer in following discussion, often it is also very important that the Reviewer has good communication skills, and can operate with sensitivity to the Designer's feelings and situation. Even in a litigious situation after a problem has developed, someone acting as a post-facto Reviewer may do harm to the cause of justice, and his or her client, by not communicating thoroughly and failing to uncover or appreciate all of the environment with which the Designer was working.

3. SCOPE OF REVIEWS

We have recognised three broad types of review. Within each type of review and each individual project, it is critical to define the scope of the review and in particular, in my opinion, which is excluded from the review. This is fundamental to defining relationships and the brief or service contract, with all its liability implications.

As I do not get involved in designs for building structures, I am not familiar with the detail of peer reviews accepted by Councils, for example Auckland City Council. However, my limited enquiries indicate that Auckland City again by way of example generally does its own reviews but will accept external review drawn from a list of approved reviewers.

Where something has gone wrong, the Client may terminate the original Designer's service and the review, except from the perspective of finding out what went wrong for litigation purposes, is no longer a review but becomes a new design brief. However, irrespective of whether litigation may eventuate, the Reviewer frequently undertakes assessments and provides opinions, but design of corrective action is left with the original Designer. It is vitally important to define the extent of the review service, how opinions as to corrective action are to be translated into resolutions accepted by all parties involved, and where responsibilities for various decisions and actions lie.

There are administrative advantages in the Designer organising and administering review and this kind of arrangement is more likely to avoid conflict. However, the Client has to be satisfied about the whole procedure and the Designer and Reviewer have to exercise the highest professional standards. Situations arise where other parties may insist on the review team being appointed by the Client : e.g., project financiers. In my opinion, appointment by the Designer to a brief agreed and accepted by Client is preferable, but the Designer should have a hand in the brief in any case.

While close interaction is necessary between the Designer and Reviewer, and the Client may or may not wish to be involved in review meetings, there must be a final report (or reports on stages) by the Reviewer to the Client, which as a minimum summarises the review process and confirms that the review brief has been completed.

As far as the Reviewer contract is concerned, whether it be effectively as subconsultant to the Designer or directly with the Client, we have traversed the fundamentals of the contract in earlier discussion. Grant (MacDonald) will have a lot more to say on this issue. We must remember that in most cases, the Reviewer is expected to fulfil the review role as a subsidiary activity compared with the main design role and with considerably less input than that of the Designer. The practicality and equity of this situation needs to be recognised and a fundamental point in my opinion is that the Reviewer should not be expected to carry liability disproportionate to the level of input. I suggest that the contract for reviewer services should address the following fundamentals:

- what the review does cover
- what the review excludes or inherent limitations
- how the review is to be conducted
- how the Reviewer's liability is limited fairly, relative to the above

Note: These notes have been prepared for the purposes of discussion at the Auckland Branch of the NZ Geomechanics Society on 23 August 1995. While opinions expressed are intended to outline aspects of peer review, they cannot be construed as professional or legal advice.

PEER REVIEW - LEGAL CONSIDERATIONS

Grant MacDonald
Barrister, Phillips Fox

PRELIMINARY COMMENTS

Traditionally the law requires you to act with skill and care when carrying out your services. The standard of care required is the standard of a competent geotechnical engineer. In theory you do not guarantee your advice - only that you will give it carefully. While traditionally the obligation is only to act with reasonable skill and care, in practice the Courts often apply the standard in such a way that the obligation amounts to something like a guarantee that your work is correct. This being the case we can say that the standard of skill and care required of geotechnical engineers (and other professionals) is very high. The rationale for the courts' approach for applying the standard in a way that is akin to a guarantee while paying lip service to the traditional standard, is insurance. Most geotechnical engineers are insured. Clients are not normally insured against the loss and therefore are less financially able to bear the loss. So the Court finds the insured professional fully liable for the damage. The rationale for doing so has been as described by the Courts as "the loss adjustment mechanism".

As there is a discrepancy between the traditional standard and the application of that standard the Courts are open to the criticism of intellectual dishonesty and susceptible to reversal by the Privy Council - if a case goes that far.

Traditionally engineers could limit their liability to their clients by agreement (disclaimer/ limitation clauses), However, the application of recent legislation prevents that in certain situations. An analysis of the application of those Acts (the Fair Trading Act, The Consumers Guarantee Act) is beyond the scope of this paper but their effects on contracting out of liability needs to be borne in mind (refer notes in Appendix A).

PEER REVIEW

If you are considering undertaking a peer review the most important legal matters you need to address are your contract with the client, and your report.

THE CONTRACT

There should be a written contract between yourself and the client. The contract should address the matters discussed below:

Who is Engaging You and Who can Rely on the Review

The person who is engaging you will normally be paying your fee. This person will be entitled to rely on your review. But other persons involved in the project may also rely on your review. As it is foreseeable they may do so, you owe them a duty of care in tort to carry out your review with reasonable skill and care. In order to minimise your risk in this regard you should state in the contract who can rely on the review.

The Scope of your Review

The purpose and scope of the review should be written out in full. The explanation should state exactly what you will be doing, and also what you will not be doing.

What is Your Liability

The contract should record the agreement you have reached with the client concerning:

- Whether you are disclaiming all liability in contract and tort
- Whether you are limiting your liability in contract and tort to a certain sum of money
- Whether you are contracting out of the Consumers Guarantees Act 1993

The clauses recording this agreement should be written by your lawyer.

THE REPORT

The report, like the contract, should:

- State who is entitled to rely on the report
- State what is the scope of the report
- State what is the purpose of the report
- Limit or disclaim your liability in contract and tort, and contract out of liability under the Consumer Guarantees Act 1993

In addition, the report should include appropriate qualifying statements. A qualifying statement is a statement which sets out and explains the limitations which attach to the report. Qualifying statements should be used in the following circumstances:

- When you have not done something you said in the contract you would do, or you have not done something you ought to have done
- When matters require further investigation or information
- When you are relying on information provided by another person
- When you are making assumptions

COUNCIL ENGAGEMENT

The legal considerations which are relevant to carrying out a peer review are also relevant when you are engaged by a Council to review the work of another engineer. That is, you should have a written contract with the Council and that contract should address the matters discussed in the section under Peer Review. Likewise, your report to Council should also address the matters discussed under the section on Peer Review.

As mentioned before, if you are only engaged to check whether another engineer's design or calculations are correct you should not go beyond this and suggest or recommend remedies or solutions. If you do so, and your suggestions or recommendations are wrong, then you increase your potential exposure.

EXPERT IN COURT PROCEEDINGS

When you are engaged to act as an expert witness in a Court proceeding, your involvement commonly includes advising and providing a report to your client's lawyers on whether the engineer has acted in accordance with the usual standards. Your advice and report will form an important part in the lawyers' and client's decision whether to settle the claim, and if so at what amount, or whether to proceed to trial. If a trial does eventuate then you will provide evidence in Court. That usually involves the lawyers first writing down your evidence (called a Brief of Evidence). You will read the brief in Court. Then you will be cross-examined by the other party's lawyers on what you have said, and re-examined by your client's lawyer.

Approach When engaged as Expert in Court Proceedings

When acting as an expert in Court proceedings you should:

- Act in an independent and unbiased manner. (While you are engaged by one side to act as their expert, do not act as their advocate as this discredits your testimony)
- Be circumspect about using the benefit of hindsight
- Be factual, and able to justify your conclusions and options

Note: These notes have been prepared for the purposes of discussion at the Auckland Branch meeting of the NZ Geomechanics Society on 23 August 1995. While opinions expressed here are intended to outline aspects of Peer Review, they cannot be construed as legal or professional advice. For advice on specific issues or cases, the reader should consult a lawyer.

APPENDIX A: RECENT LEGISLATION

Fair Trading Act 1986

This Act prohibits you engaging in conduct which misleads or deceives, or may mislead or deceive. The conduct may be something you wrote, said or did, or something you omitted to write, say or do.

Both your client and third persons may bring a claim against you for a breach of the Act.

You cannot limit or disclaim liability under the Act. If you attempt to do so you may be in breach of the Act and liable for up to $30,000 in the case of an individual, and up to $100,000 in the case of a company.

Consumer Guarantees Act 1993

This Act only came into effect on 1 April 1994.

The Act applies when the service being supplied in ordinarily acquired for personal, domestic or household use or consumption.

Most notably, when the Act applies, the following two guarantees apply to your services as an expert:

- A guarantee that the service will be carried out with reasonable skill and care
- A guarantee that service, and any product resulting from it, will be fit for the purpose and able to achieve the particular result the client makes known to you (called "the particular purpose guarantee")

There is, however, a proviso to the particular purpose guarantee. This is, it will not apply when the circumstances show that the client does not rely on your skill or judgement or it was unreasonable for the client to rely on your skill or judgement.

You cannot limit or disclaim liability under the Act unless the service is being acquired for a business purpose. Contracting out involves agreeing with the client in writing that the Act does not apply to your services.

*These presentations were followed by a session of questions and answers. Space does not allow for full presentation of this session and we prefer that the reader send in a letter to the editors to discuss these topics further in the next issue of NZ **Geomechanics** News.*

As chance would have the Australian Geomechanics Society has recently published some guidelines for their geotechnical members reviewing the work of other engineers (and engineering geologists) for the purposes of litigation. These guidelines are reproduced in the following pages - Ed.

Guidelines for Members Reviewing the Work of Other Engineers for the Purposes of Litigation

Endorsed by the National Committee of the Australian Geomechanics Society
25 September 1987

PREAMBLE

Engineers[1] are frequently asked to review the work of other engineers for the purpose of litigation in cases of suspected shortcomings in the design and construction of a geotechnical project. Clause 1 of the Code of Ethics (IEAust 1981) implies that engineers should make their services available to the community to examine the work of another engineer. Hence the concept of "closing ranks" to protect the interests of fellow engineers is unethical.

In cases of litigation the Code of Ethics has been interpreted (ACEA 1985) so that an enginner may give an opinion on the technical cause of the problem and to offer a view on whether the design and/or construcion were consistent with the state of the art of the profession at the time. The work of the engineer must be strictly factual and opinions must be given in an objective manner.

The National Committee of the Australian Geomechanics Society has been made aware of instances[2] where it may be argued that the engineer, in carrying out the role of the expert witness, has not followed this interpretation of the Code of Ethics. In cases of litigation against engineers, this can only mean that the Geomechanics Profession as a whole will suffer. It can also lead to increasing litigation and result in further problems in obtaining professional indemnity cover for our activities.

As a result, at its meeting on 27th September 1987, the National Committee of the Australian Geomechanics Society has endorsed the following for its members.

ROLE OF THE EXPERT WITNESS

When asked to be an expert witness, the engineer should confine his/her evidence to the following:

- the presentation of facts;
- giving an opinion on the technical cause of the problem;
- describing in detail the methodology that enabled the cause of the problem to be determined;
- recommending or specifying remedial measures if so requested;
- giving an opinion as to whether a departure from the state of the art of the profession at the time of the design and construction actually led to the problem;
- giving an opinion as to whether an appropriately qualified person might have acted similarly at the time, in the matter relevant to the cause of the problem.

Engineers as expert witnesses in litigation cases should resist going beyond this role. The following Guidelines have been formulated to minimise the future occurrence of the problems experienced in some recent litigation cases. These Guidelines are to be read with the Code of Ethics (IEAust 1981).

GUIDELINES

GUIDELINE 1:

Before accepting a commission as an expert witness in a case against another engineer, the member should insist on the right to discuss the matter with the other engineer involved.

Previous Guidelines (eg. ACEA 1986) have recommended that no contact be made between opposing experts, with the only contact being written notification to the subject engineer that the engineer's work is being examined (Fargher 1979, page 15). The legal profession

1. The use of the word engineer is to include engineering geologists.
2. The National Committee is aware of at least nine cases.

has supported this lack of contact because it preserves 'legal professional privilege'.

However, recent recommendations (eg. IPENZ 1984, page 61, CEASA 1986, Section 15.05, Note 2a) have argued that consultation between the engineers involved increases the chance of a realistic settlement without a Court hearing. Even if the case proceeds to Court, this consultation will very likely substantially reduce the length of the hearing (Herriott 1987).

GUIDELINE 2:

An engineer acting as an expert witness must always remain objective and impartial

As outlined in Reference 3, Note 10, the prime objective of an expert witness is to assist the Court in arriving at a just decision. In the giving of evidence the engineer may be required to give opinions on matters whether or not they are favourable to the engineer's client (Antill 1976). It is very easy for an engineer to become involved in the Court case and to support a satisfactory outcome for his/her client. However, the engineer should guard against becoming an advocate for the client, and should remain dispassionate as to the outcome of the court case.

GUIDELINE 3:

The engineer should avoid being judgemental, and should not offer an opinion as to negligence.

It is the role of the Court to provide the judgement on these issues.

The National Committee of the Australian Geomechanics Society is aware of recent instances where at least five engineers have given similar judgemental type statements. Comments have been similar to "...the backfill has settled because of negligent supervision of the earthworks at the time of construction".

As outlined in Ref.8 and Ref.5 page 62, negligence is a legal concept, not an engineering term and a finding as to negligence is a matter for the Court and the Court only. The engineer should thus try to avoid giving either praise or blame.

GUIDELINE 4:

An engineer should refrain from using law reports as truths.

The National Committee of the Australian Geomechanics Society is aware of several instances where engineers have quoted a Court judgement, or Act of Parliament to emphasise a particular point. For example, comments have been similar to "...based on the Smith vs. Jones case, it could be argued that the engineer should have carried out an inspection of the earthworks".

Court judgements are based on the evidence presented in the particular case and although they set legal prec edence, legal interpretation is an evolutionary proces Engineers should avoid the interpretation of legal matter unless they have specific competence (i.e. legal trainir and experience in law).

GUIDELINE 5:

The engineer should only give an opinion on the departu from acceptable practice when it is relevant to the cau of the particular problem.

There have been at least two instances where engineers have given opinions on matters in other engineer's reports or designs, that were not relevant to the particular cause of the problem. These resulted in engineers defending unnecessary claims.

Different engineers may adopt different approaches to solve a geotechnical problem. For example, the number of boreholes to carry out the site investigation will differ from engineer to engineer. When commenting on this, another engineer must recognise that many different approaches are acceptable and only give an opinion when the specific approach adopted was relevant to the actual problem forming the subject of the litigation.

This is particularly important in a field such as

geomechanics, because it deals with earth materials which are inherently variable and extremely complex, so that much of our work is still based on "engineering judgement". The expert witness should avoid the intrusion of personal preferences but limit his/ her evidence to the technical cause of the actual failure.

REFERENCES

The Institution of Engineers, Australia (1981) "Code of Ethics".

Association of Consulting Engineers Australia (1985), Practice Note D8, April.

Association of Consulting Engineers Australia (1986), Practice Note D10, July.

Fargher, P.J. (1979) "Background and Approaches", Chapter I in "Footings and Foundations for Small Buildings in Arid Climates", IEAust, SA Division & Adult Education Department, University of Adelaide, Adelaide, June.

Institution of Professional Engineers, New Zealand, (1984) "Engineering Risk", Wright & Carman Ltd, 95p.

Consulting Engineers Advancement Society of Australia Ltd, (1986) "Risk Management for Australian Consulting Engineers".

Herriott RM. 'The Liability Crisis", (1987) Guest Editorial, Australian Geomechanics, p.3, No 13, June.

Association of Consulting Engineers Australia (1982), Practice Note D6, 30th August.

Antill, J.M. (1976) 'The Role of the Expert Witness", The Journal of Institution of Engineers, Australia, pp 33-34 July/August.

Editors' Note: This article is republished in accordance with the direction of the National Committee of the AGS to remind members of their duties and responsibilities. Together with the Codes of Ethics of IEAust and AustMM, it will be republished every two years.

TECHNICAL PAPERS

- USE OF BIO-POLYMER SLURRY FOR THE CONSTRUCTION OF A CHIMNEY DRAIN AT HAYES CREEK DAM
  - V. Jairaj & L.D. Wesley
- CPT '95: INTERNATIONAL SYMPOSIUM ON CONE PENETRATION TESTING LINKOPING, SWEDEN, OCTOBER 1995 - Review by Peter Barker
- CONE PENETRATION TESTING IN NEW ZEALAND
  - D.N. Jennings & P.J. Waugh
- SECOND AUSTRALIA-NEW ZEALAND YOUNG GEOTECHNICAL PROFESSIONALS CONFERENCE

  Technical papers were recently presented at the 2nd ANZ Young Geotechnical Professionals Conference in Auckland. Abstracts of the papers presented are contained later in this issue. The full papers will be published as proceedings of the conference. If you wish to obtain a copy of these proceedings at $25.00 (members) and $40.00 (non-members), please contact:

  Mr Stuart Palmer
  NZGS Publications Officer
  C/- Beca Carter Hollings Ferner
  P O Box 3942
  WELLINGTON

  Tel: (04) 473 7551
  Fax: (04) 473 7911

TECHNICAL NOTES

- DENSITY OF REFUSE - B. Horide

USE OF BIO-POLYMER SLURRY FOR THE CONSTRUCTION OF CHIMNEY DRAIN AT HAYS CREEK DAM

By:

V Jairaj (1)

&

L D Wesley (2)

ABSTRACT :

This paper deals with some of the processes and details that were behind the philosophy to upgrade this zoned embankment dam. The thrust of this paper is with regard to the geotechnical aspects that were dealt in retrofitting a sand chimney drain using a revertible bio-polymer to facilitate construction in this dam. The first of its kind to be successfully completed in an operating dam in this country.

BACKGROUND

Hays Creek dam is a rolled earth embankment 27m high at the deepest section and has a crest length of 77m. It is located at the Hunua Gorge, south of Auckland in New Zealand. It impounds approximately 1 million cubic meters of water at top water level. The dam and the associated filter station are currently owned and operated by Watercare Services Ltd (WSL) for the water supply of Papakura district.

The reservoir was commissioned in 1967 and operated until 1989 by Papakura City Council. In 1989 under Local Government Reform the ownership and operational responsibility for the dam and Papakura filter station were transferred to the Auckland Regional Council (ARC) .

At the time of transfer, the dam and its ancillary structures were in a poorly maintained condition. There were very little monitoring or operational details of the dam. ARC, with the advice of its in-house staff and external consultants, effected emergency repairs to the downstream shoulder of the dam and the downstream spillway channel.

INVESTIGATIONS

To investigate the overall condition of the dam, Tonkin & Taylor Ltd (Consulting Engineers) were commissioned by the ARC in 1989 to conduct a Safety Evaluation Study (Stage I) followed in 1990 by a commission to Works Consultancy to conduct a (stage II) study. To obtain better information on the performance of the dam, eleven piezometers were installed for the first time on this dam during the Stage II study (Fig 1).

Further analyses of the pore water pressure variations on the dam were conducted by WSL's staff. The results of this study identified that additional piezometers were required at strategic locations to obtain better understanding on the performance of the dam. In Dec 1991 five drill holes were put down and 14 more piezometers were installed. The results of the piezometer readings revealed that the dam in fact operated as a zoned embankment and not as a homogeneous embankment as previously inferred (Fig 2). Fig 2 is a highly idealised cross section of the dam. Investigations showed that while there is a core in the sense that the central part of the dam has lower permeability than the shoulders, there is no well defined boundary between core and shoulder, and no significant filter zones. All that can really be said is that the central section is substantially more clayey than the shoulders, but is certainly not free of random granular zones. Also the data gathered from a limited period of monitoring of the dam showed that there were no symptoms of distress, incipient failures (visible on the face of the dam), or discolouration of seepage water through the dam. However, due to the standards adopted by the designer at that time and the techniques used in the construction the integrity of the dam was in doubt.

---

(1) Project Engineer (Geotechnical) Watercare Services Ltd

(2) Senior Lecturer University of Auckland

Introduction of such a filter system would prevent the migration of fines from the suspect clay core to the downstream embankment and thereby secure the dam against sudden piping failure. Although the filter drain option is a "neat " solution to the problem, case histories of such construction works were not readily available; particularly using revertible polymer mud.

WSL therefore made world wide enquires regarding the installation of deep trenches and discovered that similar works were underway in the USA . These were in the installation of deep drainage trenches and one on a 13m deep embankment levee. The embankment levee was in Phoenix , Arizona. It was the first known such trial on levees or dams in the USA. The trial was conducted by the United States Bureau of Reclamation (USBR) using EZI mud a synthetic bio polymer. WSL's staff visited this site and other similar sites in Taipei , Taiwan. With the valuable information gathered from these site visits the decision was made to proceed with the vertical chimney drain, and minor modifications were made to the preliminary tender documents to obtain the desired outcome for the completed work.

TRIAL TRENCH EXCAVATION:

Before commencing with work on the dam itself, the Contractor was required to excavate two trial trenches (side by side) using the proposed bio polymer, and each trench to be not less than 15m deep, 2.8m long and 0.8m wide. The site designated for the trial trenches was close to the spillway and away from the dam site. The trial trench excavation began in February '94.

EZI-Mud a synthetic bio polymer was made into a slurry that had a viscosity of approximately 43 sec. as measured in a Marsh Funnel viscometer. During the excavation the viscosity of the slurry was maintained at not less than 40 sec. The mechanism of operation of the slurry is that it forms a semi-permeable film on the freshly excavated surface and prevents further loss of slurry in to the ground. Throughout the excavation the slurry was maintained at near surface level and at the prescribed viscosity. At the completion of the excavation the slurry was replaced with graded saturated sand that was fed through a tremmy pipe from the top of the trench, thereby displacing the slurry. Experience gathered from the USBR showed that saturated sand passed through this polymer " in lumps" and thereby segregation of sand was controlled. When the trench was completely backfilled with sand, a mixture water and sodium hypochlorite was circulated through previously installed well points in the sand trench. This sodium hypochlorite mixture 'broke down' the polymer slurry and thereby increased the permeability of water through the sand filter. On completion of this task the sand was compacted using a 'lance vibrator' to achieve the required relative density.

Relative density (R/D) measurements on the backfilled sand showed that it was too loose and failed to meet the prescribed (R/D) values. Although the selected sand for the trial panel satisfied the specified grading requirements, it contained considerable fines in the form of iron sand . It is believed that the fines may have separated out into lenses of low permeable layers and trapped large volumes of slurry mixed water. Pumping or draining the slurry mixed water proved ineffective. Hence the test site was abandoned . A second trial panel was successfully completed on top of the dam using silica sand from a different source where fines below 150 μm were limited to a maximum of 5% .

INSTALLATION OF THE CENTRAL COLLECTOR DRAIN

A 2m diameter hole was drilled from the crest of the dam under bio polymer slurry to intersect the 900mm concrete conduit. On reaching the required depth a 2m diameter steel caisson was lowered into the hole, and the slurry that remained in the caisson was pumped for storage and reuse. The location of the central drain and the detail of the connected works are shown in Fig 4. The contractor sank the caisson at exactly the intended location and no dificulties were experienced in carrying out this work.

The base of the 2m diameter caisson was carefully cleaned until the 900mm concrete conduit was exposed. A level concrete platform was constructed on top of the exposed pipe. A series of 50mm diameter drainage holes was put through the concrete platform and the 900mm concrete conduit to provide a central drainage path for the chimney drain. Graded gravel filters followed by sand were backfilled to a depth of 1m from the top of the platform of the caisson. The 2m diameter steel caisson was "gas cut" at the top of the sand level i.e 1m from the platform level. The caisson was withdrawn above the gas cut line while sand was backfilled in the caisson. This technique ensured that the central filter arrangement remained intact when the caisson was withdrawn. (Fig 5)

INSTALLATION OF SAND CHIMNEY DRAIN

The installation of the chimney drain began with a 2.8m long panel immediately east of the 2m caisson. The excavation of the panel was completed successfully and a 'stop-end' was placed 500mm from the end away from the caisson. The stop-end consisted of two identical I beams of 400 x 800 welded across the flange with a steel plate to provide a 'square box girder ' . The stop-end was lowered into the trench with the webs of the girder parallel to the trench wall. The stop-end was to prevent the flow of sand from the backfilled section into the unfilled 500mm space, so that construction of the adjacent panel could proceed with the sand retained in the completed panel. This arrangement was vital for the continuity of the sand drain.

However the trench walls were uneven because of the presence of granular fill and cobble to boulder sized particles in the silty CLAY core, and a tight seal between the stop-end and the wall of the trench proved impossible. When sand was placed in the 2.3m length of the trench some sand /slurry flowed around the stop end (Fig 6a). This was accentuated by the excavation of the adjoining panel (by the movement of the clam shell in the slurry). The excavation was abandoned when the flow of sand from one trench to the other had detrimental effect on the clam shell operation and possibly on the quality of construction.

The stop-end was removed and the trenches were re-excavated as a single trench of 5.6m length to the foundation level of the dam . The stop-end was placed at a distance of 500mm from the furthest wall and the space between the web of the stop-end and the trench wall was packed with gravel filled geo-fabric sock. The contractor believed that the "gravel-sock" arrangement would control the flow of sand from one trench to the other during the construction procedure (Fig 6b). However this arrangement also failed. Sheet piling the space between the trench wall and the stop end was also tried (Fig 6c), but driving sheet piles through the sand proved unsuccessful and this alternative too was abandoned.

Yet another variation was tried out. Having gained confidence in working with panels of longer than 2.8m, WSL agreed to a longer panel length of 7.8m with a 900 mm "soil-plug" ie the existing soil left in place between excavated panels to act as stop-ends to separate these panels. In all five panels and five "soil-plugs" were created and the panels were successfully backfilled with sand (Fig 7). A caisson of 1400mm diameter was driven vertically with short rotational oscillations to completely encompass the 900mm soil-plug. While the caisson was advanced the soil-plug was excavated by a 'benoto grab' working inside the caisson. When the caisson reached to the foundation levels it was backfilled with sand and withdrawn in stages.

On achieving a continuous sand chimney drain the remaining bio polymer in the sand was flushed out and the sand was compacted in a similar manner to the trial trenches. The dam, valve tower, and the concrete conduit were completed and the lake filling started in July '94. Following a number of intense rainstorms the lake began to spill over in August '94.

CONCLUSION

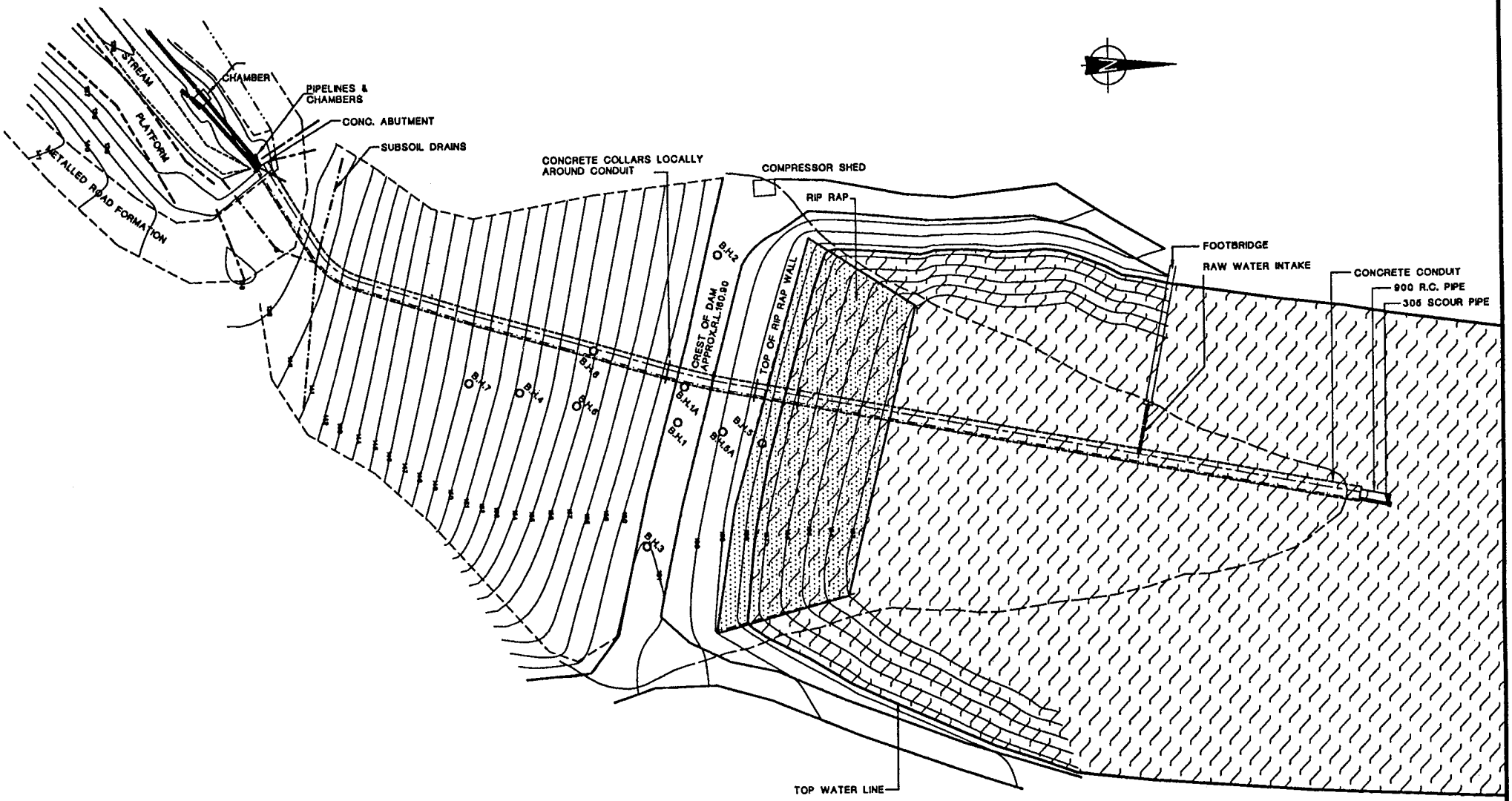
The construction of a vertical chimney drain has been successfully completed in an existing dam by using a polymer slurry trench procedure follwed by sand replacement. Some difficulties were experienced during construction with the intended "stop-end" arrangement. These were overcome by replacing the intended steel stop-end with a column of intact earth which was later removed and replaced by sand so as to complete the continuous chimney drain. Recommissioning of the dam has resulted in seepage flows from the drain only slightly greater than previous seepage rates and in keeping with expectations.

Acknowledgement:

We are grateful to Watercare Services Ltd to have allowed us to carry out successfully this pioneering work on Hays Creek Dam and presentation of this paper.

REFERENCES:

GEOTECHNICAL ENGINEERING OF EMBANKMENT DAMS	*R Fell, P MacGregor, D Stapleton*
HAYS CREEK DAM - EVALUATION AND INTERPRETATION OF PIEZOMETER READINGS	*V Jairaj*
STATE OF THE ART IN BIO-POLYMER CONSTRUCTION	*S R Day & C R Ryan*
NEW TRENCHING METHOD USING SYNTHETIC BIO-POLYMERS	*G R Tallard*
SLURRY WALLS: DESIGN, CONSTRUCTION, AND QUALITY CONTROL,, ASTM STP 1129	*D B Paul, R R Davidson, N J Cavalli*
NEW CORRELATION OF PENETRATION TESTS FOR DESIGN PRACTICE	*M Jamiolkowski, V N Ghionna, E Pasqualini* *(Penetration testing 1988 , ISOPT-1, -1988 Balkema - Rotterdam)*

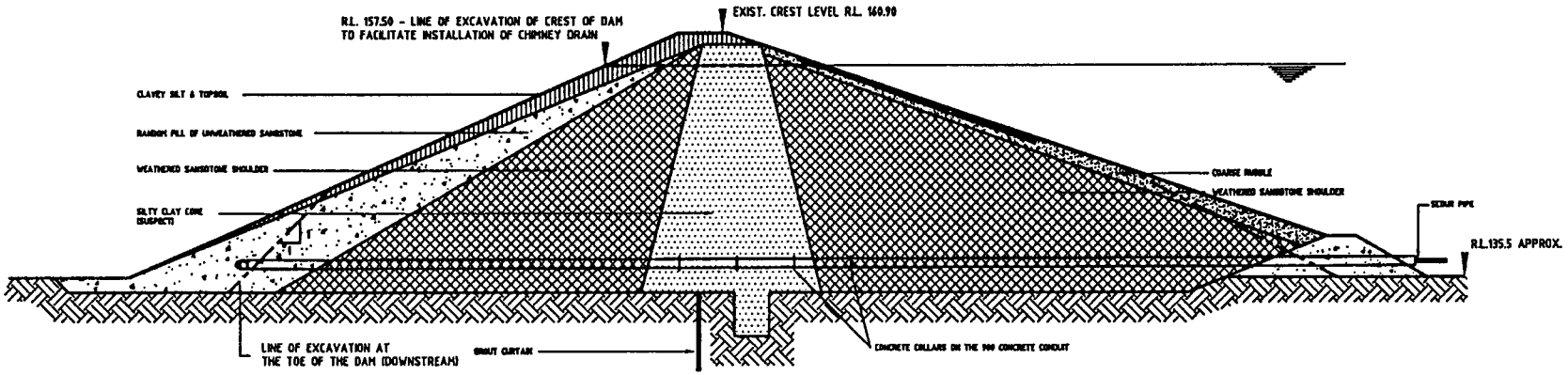


HAYS CREEK DAM
Papakura, AUCKLAND
DAM LAYOUT (PRIOR TO 1994 UPGRADE)
Scale 1 : 750

NOTE :

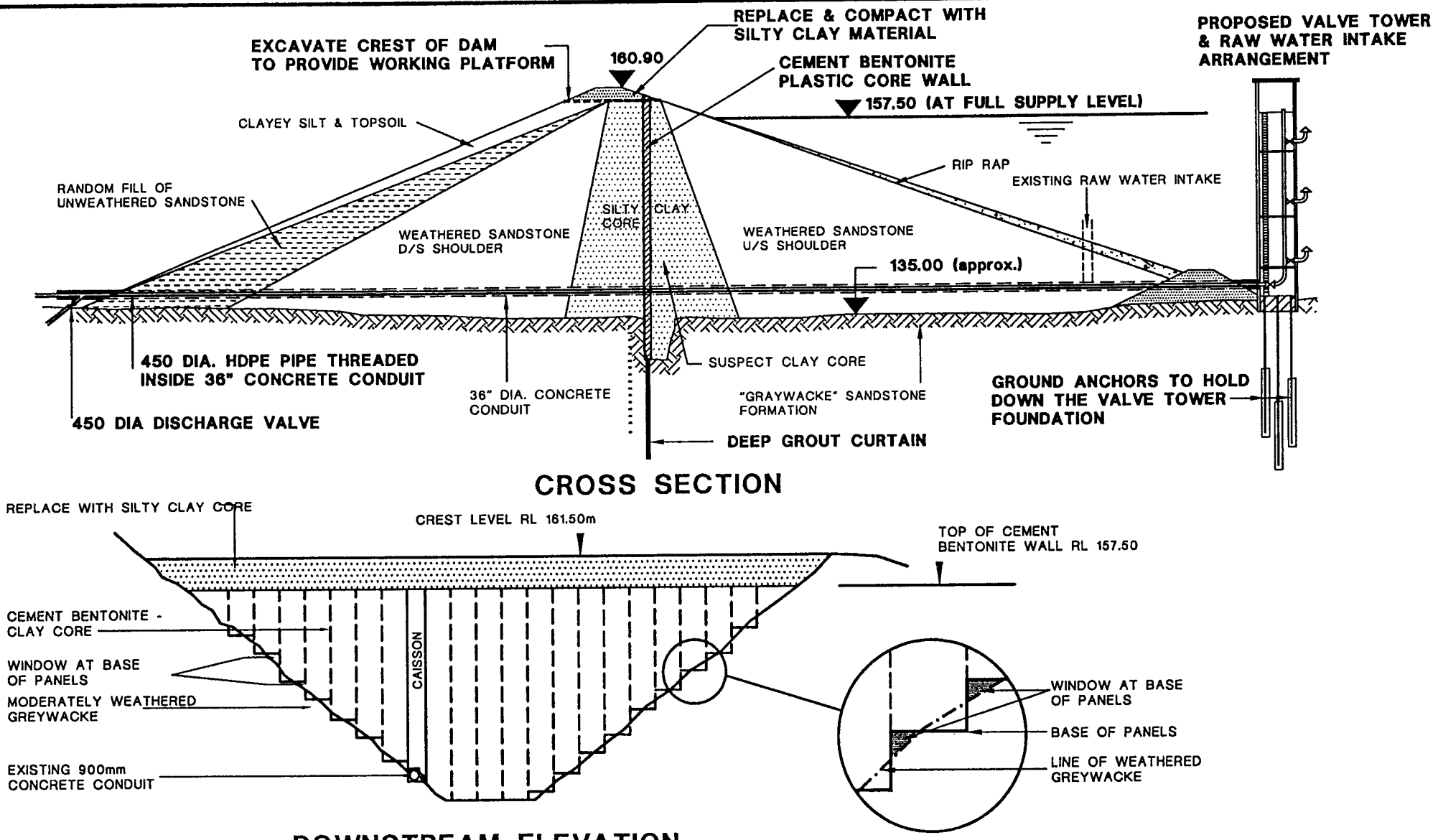
ALIGNMENT OF EXISTING CONCRETE CONDUIT INTERPOLATED FROM CONSTRUCTION DRAWINGS OF NOVEMBER 1966.

FIG. 1



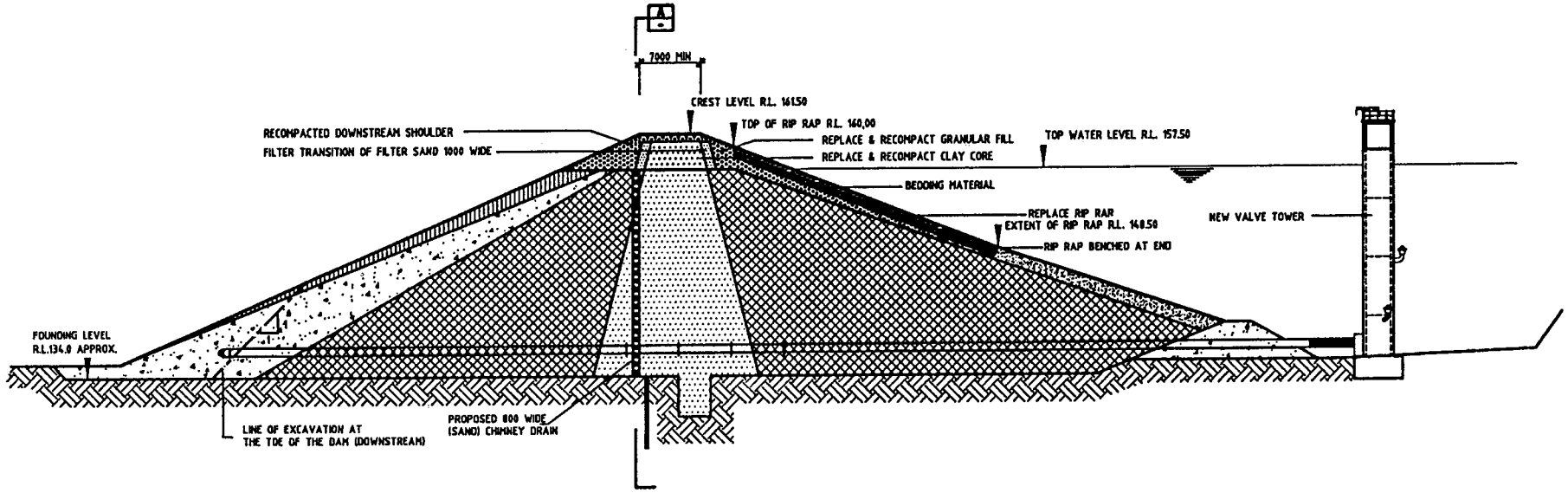
HAYS CREEK DAM
Papakura, AUCKLAND
CROSS SECTION THROUGH DAM (PRIOR TO 1994 UPGRADE)
Scale 1 : 750

FIG. 2

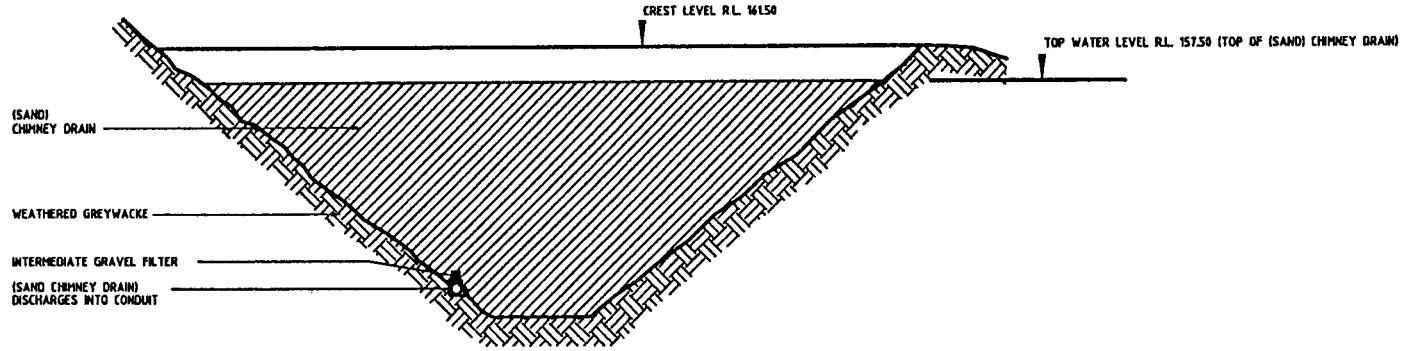


HAYS CREEK DAM
Papakura, AUCKLAND
DETAILS OF BENTONITE CORE WALL OPTION
Scale 1 : 600

FIG. 3



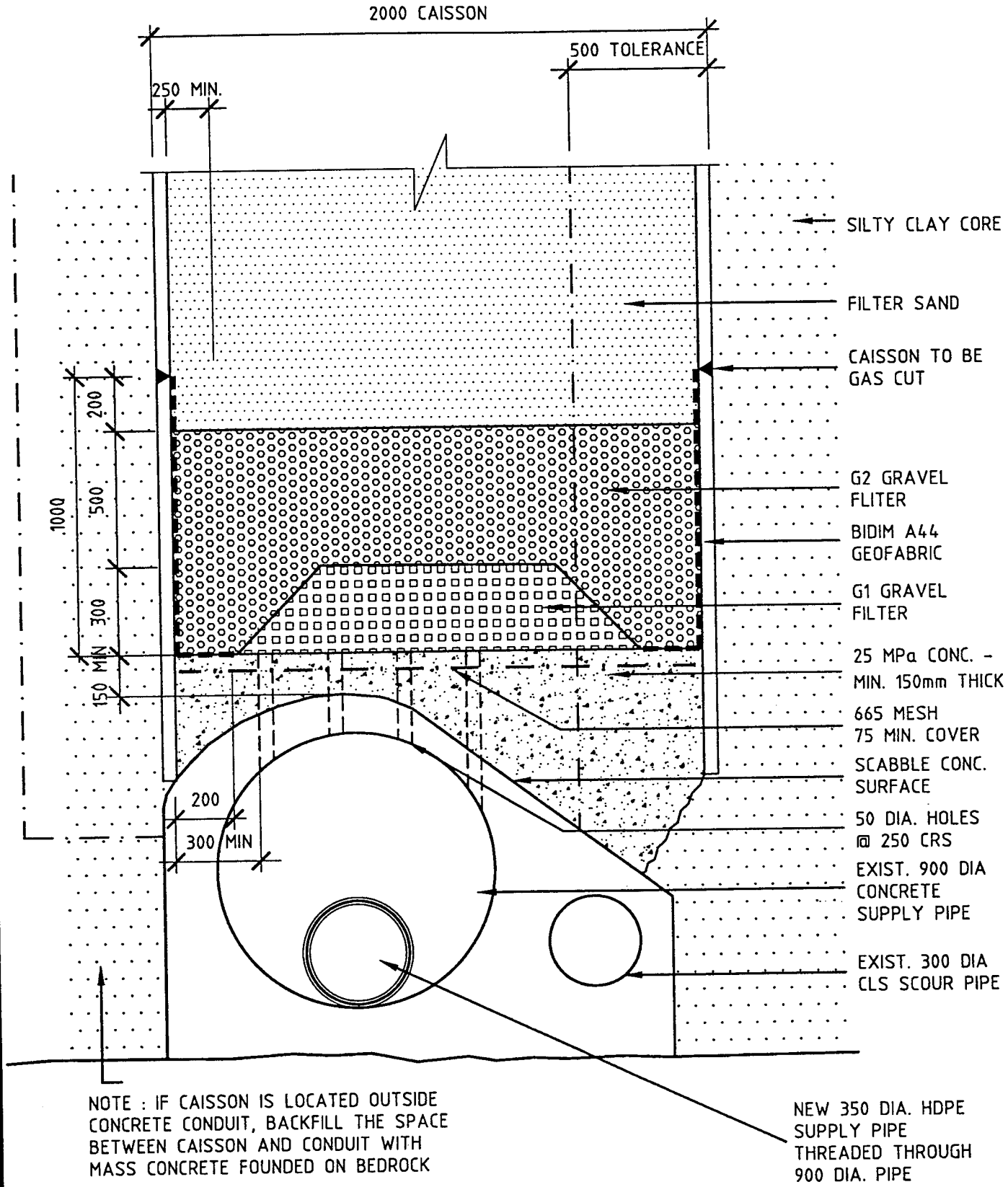
CROSS SECTION SHOWING COMPLETED WORKS



CROSS SECTION OF VALLEY A

HAYS CREEK DAM
Papakura, AUCKLAND
DETAILS OF CHIMNEY DRAIN INSTALLATION
Scale 1 : 750

FIG. 4



HAYS CREEK DAM
Papakura, AUCKLAND
DETAIL OF CHIMNEY DRAIN/CONCRETE CONDUIT INTERFACE
Scale 1 : 20

FIG. 5

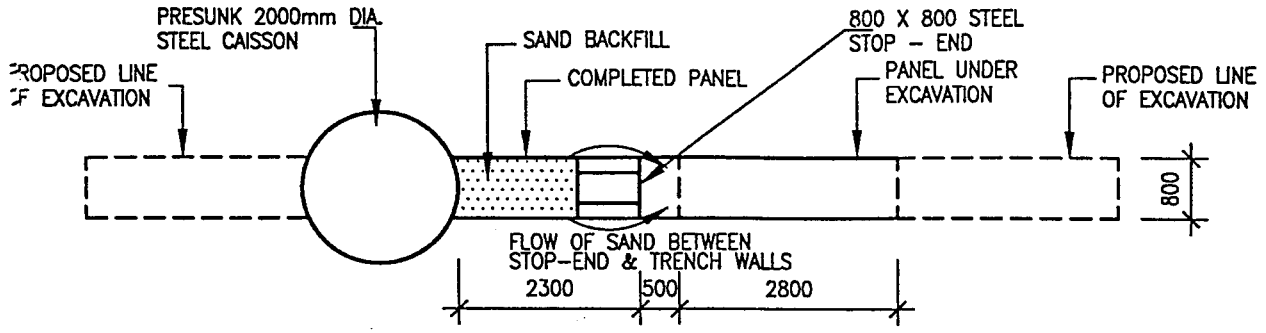


Fig. 6A - Panel Installation with Steel stop - end

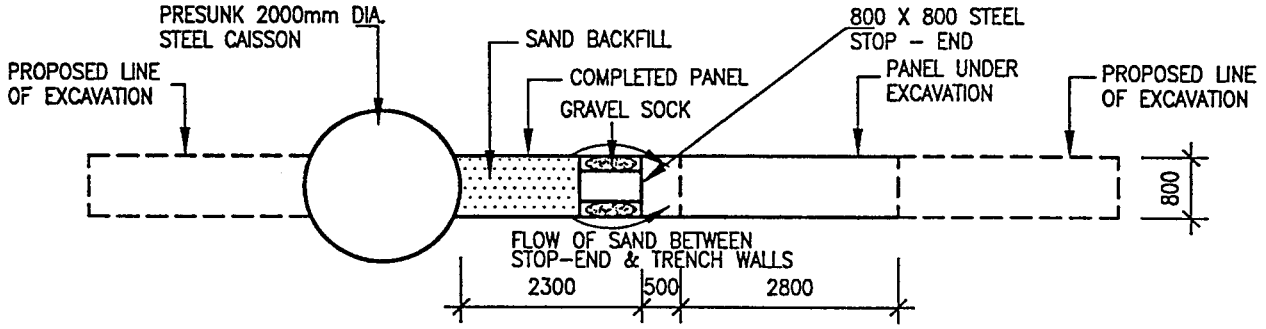


Fig. 6B - Panel Installation with Steel/Gravel sock stop - end

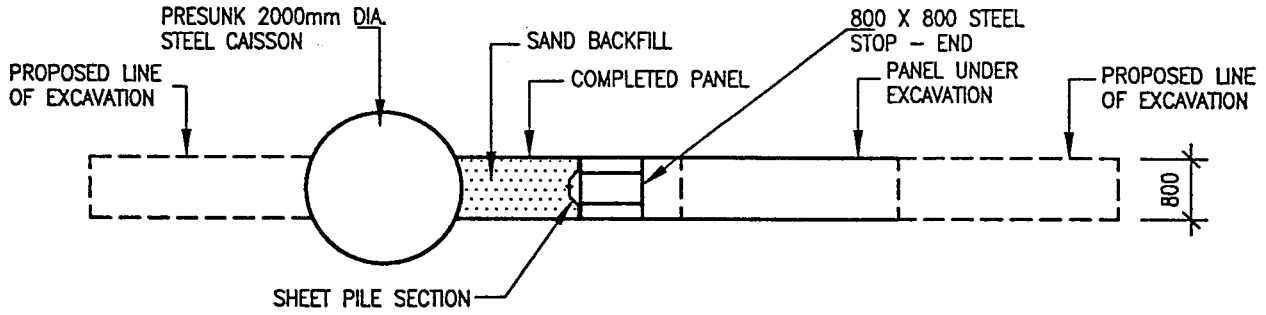


Fig. 6C - Panel Installation with Sheet Pile stop - end

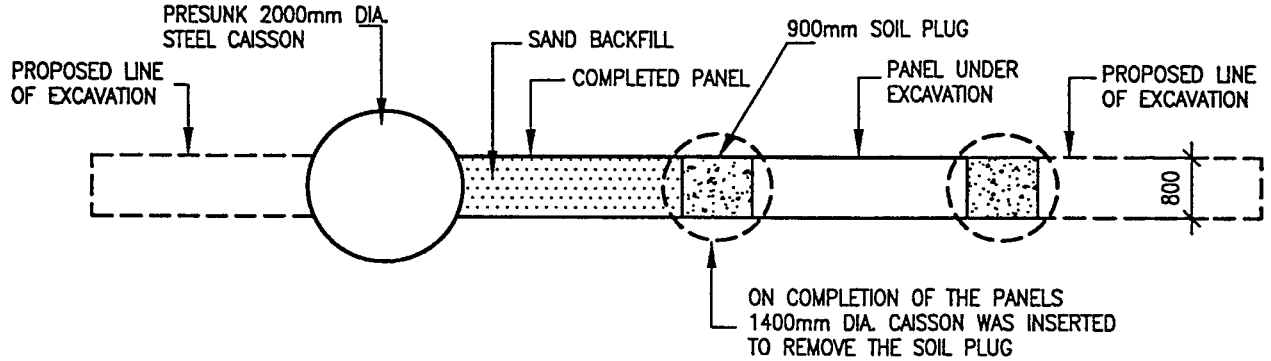
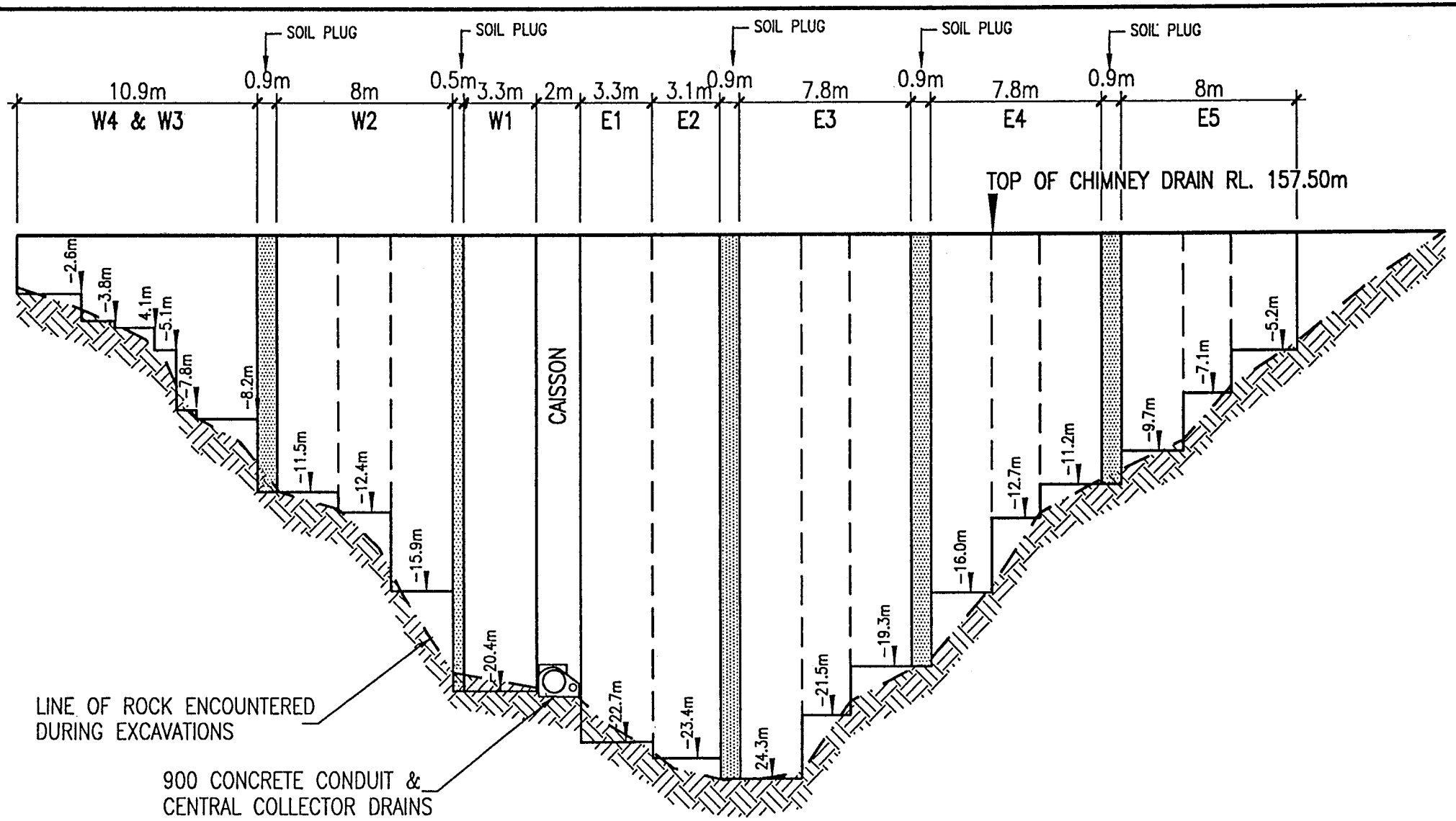


Fig. 6D - Panel Installation with Soil Plug stop - end

HAYS CREEK DAM
Papakura, AUCKLAND
DETAILS OF CHIMNEY DRAIN PANEL INSTALLATION
Scale 1 : 100

FIG. 6



HAYS CREEK DAM
Papakura, AUCKLAND
ELEVATION OF CHIMNEY DRAIN FROM DOWNSTREAM SIDE
Scale 1 : 250

FIG. 7

CPT '95
INTERNATIONAL SYMPOSIUM ON CONE PENETRATION TESTING
LINKOPING, SWEDEN
OCTOBER 1995

The symposium was organised by the Swedish Geotechnical Society in co-operation with the Nordic Geotechnical Societies in Denmark, Norway and Finland. It was attended by about 200 delegates from 33 countries.

The theme of the symposium was **The Solution of Geotechnical Problems by Cone Penetration Testing** with an emphasis of summarising the "state of the art" and outlining future trends and developments. One hundred and ten papers were received and they were grouped into three main sessions:

Equipment and Testing
Interpretation of Test Results
Solutions of Practical Problems

Each session was introduced with a Theme Lecture. This was followed by a Technical Report that outlined the "state of the art" (based on the National Reports from 32 countries) and the technical papers. Five of the technical papers were then presented.

The Theme lecture on Equipment and Testing was given by Mr G Baldi (Italy) and the technical report by Prof. R Larsson (Sweden). Mr R Sandven (Norway) presented the theme lecture on Interpretation and the technical report was given by Mr H Denver (Denmark). The theme lecture on Solutions was given by Prof P Robertson (Canada) and Mr T Lunne the technical report.

While many papers referred to the use of "standard" cone parameters (tip resistance, sleeve friction, pore pressure) some described new parameters that were being measured. Some these were electrical resistivity, temperature, pH, Redox Potential and Laser Induced Fluorescence. Soil gas and water samplers were also described.

A Poster Session was also held where about 30 papers were presented and the authors available to discuss them. A technical exhibition, where a range of CPT equipment was displayed, was held as part of the symposium. On the last day there was a field demonstration where equipment manufacturers were able to display their investigation equipment in action.

The use of Internet was actively encouraged. A News Group for Geotechnology (sci.engr. geomechanics) has been recently created. Also there is a home page for the conference with abstracts of each paper and a list of delegates. It is hoped to continue this page (http://www.ce.kth.se/AOM/SGF/CPT95/CPT95.HTM) as a resource for CPT information.

The closing remarks were given by Prof. P Robertson where he announced that an International Symposium on Site Testing will be held in Atlanta ,USA in June 1998.

Some of the "names" of CPT and field testing also spoke at the Symposium- M. G Sangelerat (France); Prof J Schmertman (USA) and Prof. B Broms (Sweden).

This was a well organised meeting. There were many opportunities to meet with other delegates and exchange ideas and experiences.

Peter Barker
Barker Consulting
PO Box 27 106
Wellington

Cone Penetration Testing in New Zealand

David N Jennings
Works Consultancy Services Ltd, Hamilton, New Zealand

Peter J Waugh
Works Consultancy Services Ltd, Hamilton, New Zealand

International Symposium on Cone Penetration Testing - CPT'95

SYNOPSIS: This paper is a national report on cone penetration testing in New Zealand which has been prepared in response to an invitation from the organising committee for the CPT'95 International Symposium.

Cone penetration testing was first introduced into New Zealand by the then Ministry of Works in 1960. The testing technique is well suited to the soft soils encountered in many parts of the country.

The popularity of the technique has varied with the most use and development being in the upper North Island where there are extensive soft estuarine, alluvial and volcanic soils. In recent years electric systems have been further developed with portable PC data collection and processing and the introduction of the piezocone.

1. INTRODUCTION

This paper is a national report on cone penetration testing in New Zealand which has been prepared in response to an invitation from the organising committee for the CPT'95 International Symposium.

The Cone Penetration Test (CPT) was first introduced into New Zealand by the Ministry of Works in 1960 (MOW, 1961). Dr Begemann of the Delft Soil Mechanics Laboratory visited New Zealand to assist with the investigations for an oil refinery in Northland. Results from the CPT testing were found to be very encouraging and led to the wide spread application of the CPT by the then Ministry of Works.

The testing technique is well suited to the soft soils encountered in many parts of the country.

The popularity of the technique has varied with the most use and development being in the upper North Island where there are extensive soft estuarine, alluvial and volcanic soils. In recent years electric systems have been further developed with portable PC data collection and processing and the introduction of the piezocone.

2. GEOLOGY

New Zealand is a relatively young country in geological terms with a great variety of terrain. Located on the active boundary of the Pacific and the Indian tectonic plates, New Zealand is a country of moderate seismic activity. The geology (Figure 1) is varied and complex with igneous, sedimentary and metamorphic rocks and many land forms associated with recent fault movement and volcanic activity.

Much of the central and upper North Island is soft rock (tertiary mudstone, siltstone and sandstone) with extensive volcanic tephra deposits. The lowland areas and coastal margins comprise alluvial and estuarine soils which are typically fine grained (sand, silt, clay

and peat). In the lower North Island sandstone and argillite rocks are widespread.

The South Island is dominated by the sandstone, argillite and schistose rocks which form Southern Alps. Erosion of these rocks have produced extensive alluvial gravel deposits forming the coastal plains along the eastern and southern parts of the island.

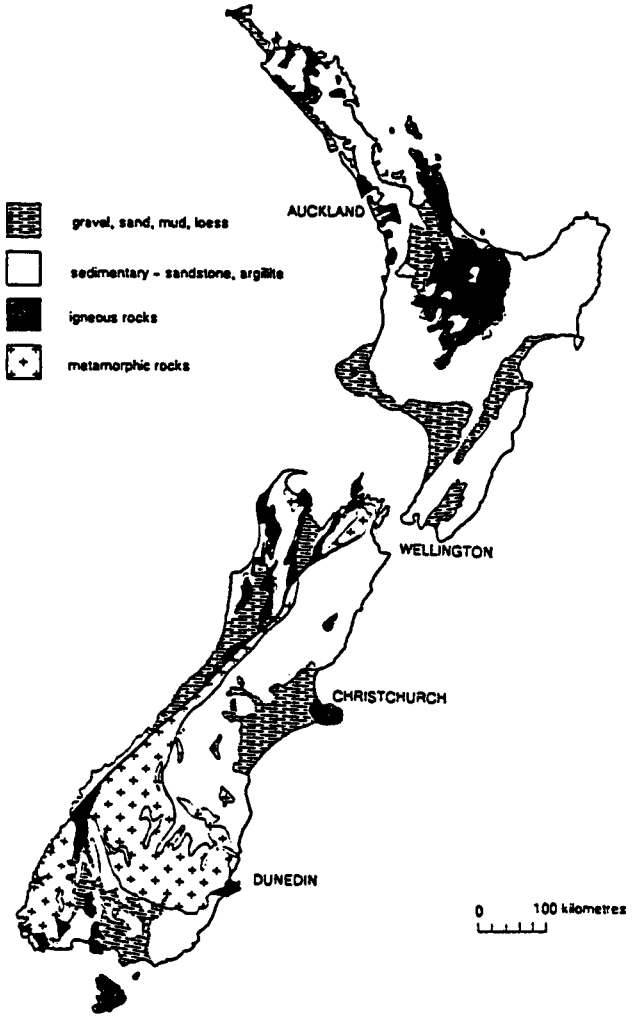


Figure 1 Simplified Geology of New Zealand

3. TESTING AND INVESTIGATION METHODS

Geotechnical site investigation methods utilised in New Zealand range from conventional borehole drilling through to non destructive tests such as ground radar. Site methods commonly used include:

- Scala (dynamic) penetrometer
- auger bore holes
- cored and wash drilled holes
- SPT (standard penetration tests)
- CPT (cone penetration tests)
- geophysical (surface and downhole)

While the Scala penetrometer is a light and convenient method of profiling soils it is limited in depth and in terms of reliability. Drilling, together with SPT testing, is the most common subsurface investigation technique utilised in New Zealand. It is widely recognised that the CPT is a cost effective and useful method for subsurface profiling. Use of the CPT is common in the volcanic, alluvial and estuarine soils in the upper North Island. With increasing emphasis on the seismic performance of foundation soils the CPT is now widely used for the assessment of liquefaction potential.

4. CPT EQUIPMENT

CPT testing was first introduced into New Zealand by the former Ministry of Works in 1960. Test rigs were operated throughout the country by the Ministry of Works. Electronic cone penetration testing was introduced in 1975.

In the past decade a number of test rigs have been converted to perform both manual and electronic CPT tests. Data is now gathered by computer based systems and can involve large volumes of data. Test rigs are operated by:

- Works Consultancy Services Ltd (Six rigs)
- Contractors (Two rigs)
- Universities (Two rigs)

There are only two truck mounted rigs in operation. The largest rig is a 20 tonne rig operated by Works Consultancy Services, Hamilton. Most rigs are 10 tonne units. Mechanical probes are widely used in gravel soils. The CPT is the most economic and effective subsurface field testing technique currently in operation in New Zealand.

Usually test probes extend to about 20m depth but in some situations tests to greater than 50m have been undertaken to prove pile foundation conditions (Figure 2) and soil profiles for liquefaction assessments.

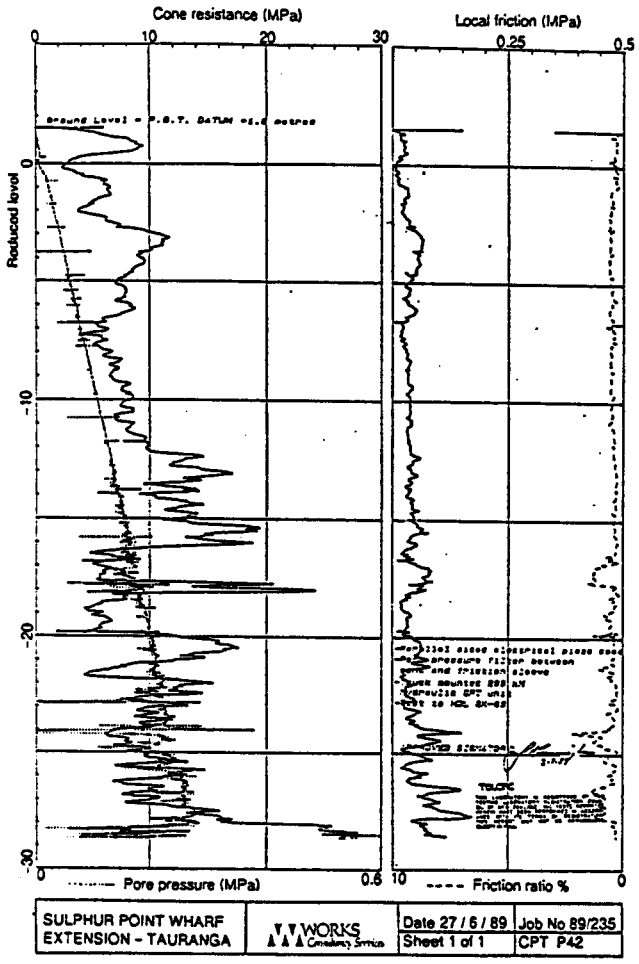


Figure 2 Typical deep CPT probe

Some investigation test methods have been specified in the New Zealand Standard, NZS 4402. The cone penetration test method (NZS 4402:1988) specifies the mechanical and electric CPT equipment and test procedure.

Continued vigilance is required with electronic testing to ensure that test results are calibrated and reliable. This is particularly important when testing soft soils as zero shifts and drifts can significantly influence results. Care is required where changes in ground temperature, eg as found in geothermal areas, can produce unreliable results.

5. INTERPRETATION OF CPT RESULTS

Using correlations between indices of field and laboratory tests and geotechnical model parameters is well established in geotechnical engineering. There have been numerous relationships established and published in the international literature for the CPT test, however there are no correlations that have been specifically developed for New Zealand soils.

In New Zealand, publications from Europe and North America have been adopted. In the 1960's interpretation was based on the work of Begemann (MOW, 1960). Experience in New Zealand led to the publication of local interpretation applications of the CPT (Belshaw, 1973).

One of the first more comprehensive guidelines widely utilised in New Zealand was the FHWA 1978 manual (Schmertmann, 1978). Following this the CIRIA publication on methods and interpretation (Meigh, 1987) provided an excellent update and guidelines which are widely applied.

Subsequently the geotechnical industry has more actively followed international cone penetration testing and interpretation developments. Interpretation techniques have been assessed for local soils and the effectiveness and application of CPT testing continues to be developed. The two university civil engineering schools in New Zealand are actively using the CPT to characterise and assess the performance of soils.

6. DESIGN AND ANALYSIS

The primary design applications for the CPT relate to:

- profiling soil distribution
- assessing settlement potential
- design of embankments
- design of foundations
- pile design in soils
- assessment of liquefaction potential

The cone penetration test is commonly used to investigate and characterise soils. Classification is commonly based on Robertson (1989).

The piezocone has added an important dimension to CPT testing and its application. For example the ability to measure consolidation characteristics with the dissipation test has real benefits in providing direct measurement of soil properties (eg Jones & Rust, 1993).

7. CPT CORRELATIONS

No New Zealand correlations have been established and published to date. A number of geotechnical engineers have wide experience in the use of the CPT and have developed a sound understanding of its applications and limitations. For example settlement estimates in normally consolidated alluvial soils can be reliable (Belshaw, 1973) whereas application of the same technique to highly weathered soils of volcanic tephra origin can provide grossly conservative settlement estimates.

8. MAJOR RESEARCH ACTIVITIES

Research in New Zealand has focussed on the evaluation of assessment techniques for New Zealand conditions. This has particularly related to the assessment of liquefaction potential. Because of the range of soil types, including lightweight volcanic pumice soils common in the North Island, there have been questions regarding the applicability to New Zealand conditions.

In recent years a series of projects have been undertaken by Works Consultancy Services to evaluate the effectiveness of the CPT and published correlations in areas of historical seismic liquefaction of soils. This programme of research has considered a variety of analysis techniques (eg Seed & De Alba, 1986; Shibata & Teparaksa, 1988; Sugawara, 1992). The research has found that the method of Sugawara (1992) has generally provided an effective assessment of liquefaction potential consistent with field observations.

Auckland University is planning a programme to investigate pumiceous sands and weathered soils to establish local correlations for soil properties.

Canterbury University has undertaken a number of projects which have investigated the use of the piezocone to assess liquefaction potential. This has led to more detailed research into layer effects on penetration resistance (Berrill et al, 1995).

9. FUTURE TRENDS AND DEVELOPMENTS

The CPT is widely accepted as an effective and efficient geotechnical investigation technique. It is ideally suited to the fine grained soils found in many parts of New Zealand. With the increasing ability of PC's to manage and manipulate data it is clear that systems will be further developed to enable the mass of data generated to be more effectively processed and analysed.

10. ACKNOWLEDGEMENT

Several New Zealand engineers have assisted with information in the compilation of this paper and the authors acknowledge their assistance including Peter Millar, Professor Michael Pender and Dr John Berrill.

While the paper has been prepared at the request of the New Zealand Geomechanics Society it does not necessarily represent the views of the Society or Works Consultancy Services Ltd.

11. REFERENCES

Belshaw T (1973). Use of the deep-sounding static penetrometer in the Napier District, New Zealand. New Zealand Engineering, May 1973.

Berrill, JB et al (1995). The CPTU test and liquefaction: some New Zealand results.

Paper submitted to the First International Conference on Earthquake Geotechnical Engineering, Tokyo, November 1995.

Jones G and Rust E (1993). Estimating coefficient of consolidation from piezocone tests: Discussion. Canadian Geotechnical Journal, Vol 30, 1993.

Meigh AC (1987). Cone Penetration Testing: Methods and Interpretation. CIRIA Ground Engineering Report: In-situ Testing. Butterworths, London, 1987.

MOW (1961). Foundation Testing: The use of the Penetrometer. Ministry of Works Technical Memorandum No. 84, Wellington, New Zealand, October 1961.

NZS 4402 (1988). Methods of testing soils for engineering purposes: Test 6.5.3. Determination of the penetration resistance of a soil. New Zealand Standards Association, Wellington, 1988.

Robertson PK (1989). Penetration Testing in the UK: Discussion. Thomas Telford, London, 1989.

Seed HB and De Alba P (1986). Use of SPT and CPT tests for evaluating the liquefaction resistance of sands. Proceedings of the Insitu Testing in Geotechnical Engineering Conference, ASCE.

Schmertmann JH (1978). Guidelines for Cone Penetration Test: performance and design. Federal Highways Administration Report FHWA-TS-78-209, US Department of Transportation, Washington, July 1978.

Shibata T and Teparaksa W (1988). Evaluation of Liquefaction potential of soils using cone penetration tests. Soils and Foundations, Vol 28, No 2.

Sugawara N (1984). Emperical correlation of liquefaction potential using CPT. International Conference SM&FE, Vol 12, No.1.

WCS Ltd (1995). Analysis of areas of previous liquefaction. Works Consultancy Services Ltd Central Laboratories Report 95-22320 (Draft), Wellington, April 1995.

DENSITY OF REFUSE - B. HORIDE

There are different understandings of the way to quote the density of refuse. The geotechnical engineer would be interested in **total landfill bulk density** (as tonnes of landfill mass divided by the cubic metres of landfill) for stability and settlement calculations. The landfill owner would be interested in **gate weight / airspace bulk density** (as tonnes of waste across the weighbridge divided by the cubic metres of airspace) for costing purposes. The designer of the compactor would be interested in the **refuse component bulk density** (as tonnes of refuse divided by the volume occupied by that refuse without daily cover). The three values are quite different. An example for a dry landfill soon after closure could be:

Example of a Dry Landfill

Component	Volume (Note 1)	Density (Note 2)	Water (Note 3)	Mass
Daily and final cover	0.25 m^3	1.80 t/m^3	30 %	0.45 t
Refuse	0.75 m^3	0.85 t/m^3	35 %	0.64 t
Total	1.00 m^3			1.09 t

Note 1. The volume of cover in this example is arbitrarily taken as 25 % of total volume but may typically be less than this.

Note 2. The refuse component bulk density in this example is 0.85 t/m^3, and is often in the range of 0.70 to 1.00 t/m^3 for municipal refuse. This range of densities could be confirmed by in situ density tests in the compacted refuse immediately after compaction. However, the range of densities could readily be 1.00 to 1.30 t/m^3 or more if:

- the waste contains a high proportion of heavy construction and demolition debris;
- substantial infiltration of liquid has occurred by rainfall (by not applying daily cover);
- additional waste liquids and sludges have been disposed directly into the landfill.

Note 3. Water content is expressed as a percentage of oven-dry mass as commonly used in soil mechanics. This is not the same as the water content which is determined as the residual of the solids content. For example, if the soil mechanics water content of refuse is 30%, the solids content is 77% (100 g of dry solids in every 130 g of wet sample). If soil mechanics water content of a sludge is 150 %, the solids content is 40% (100 g of dry solids in every 250 g of wet sample).

In the dry landfill example, the total landfill bulk density of interest to the geotechnical engineer is 1.09 t/m^3. The gate weight / airspace bulk density of interest to the landfill owner is 0.64 t/m^3. The refuse component bulk density of interest to the compactor designer is 0.85 t/m^3.

If substantial infiltration of liquid occurred, the densities would be greater. An example for a wet landfill could be:

Example of a Wet Landfill

Component	Volume (Note 1)	Density	Water (Note 3)	Mass
Daily and final cover	0.25 m^3	1.94 t/m^3	30 %	0.49 t
Refuse	0.75 m^3	1.10 t/m^3	75 %	0.83 t
Total	1.00 m^3			1.31 t

This example for a wet landfill could also represent a situation in an initially dry landfill after a period of more than five years, after ongoing rainfall infiltration had partly saturated the refuse and some consolidation had occurred. The total landfill bulk density of interest to the geotechnical engineer would be 1.31 t/m^3. The gate weight / airspace bulk density of interest to the landfill owner would be 0.83 t/m^3. The refuse component bulk density of interest to (and quoted by) the compactor designer would be 1.10 t/m^3.

It is concluded that it is important to clarify the units of any density and water content values quoted for solid waste disposal, i.e. compare apples with apples.

Bruce Horide
REDVALE LANDFILL ENGINEER
WASTE MANAGEMENT NZ LTD
10 October 1995

SECOND AUSTRALIA-NZ YOUNG GEOTECHNICAL PROFESSIONALS CONFERENCE, AUCKLAND, NZ

As we go to print the above conference is underway. A compilation of abstracts is presented here for readers' information. A full set of proceedings for this conference will be available for purchase at $25.00 (members) and $40.00 (non-members) through the Geomechanics Society. The presentation and content of these papers is excellent. A copy of these proceedings is considered to be a valuable addition to your technical library - Ed.

COMPUTER MODELLING AND ROOF SUPPORT DESIGN FOR LARGE DIAMETER ROAD TUNNELS IN SYDNEY HAWKESBURY SANDSTONE

D. C. BEAUMONT
Douglas Partners Pty Ltd, Sydney Australia

This paper looks at the design of the roof support systems for the M2 tollway twin tunnels located at Epping in Sydney, Australia. The tunnels pass through Hawkesbury Sandstone which is subject to high insitu horizontal stresses. Making use of a finite difference computer modelling program, the tunnel excavations were simulated on computer and the results predicted that differential movements could occur along horizontal bedding planes in the sandstone, immediately above the tunnel crown. These movements, caused by the high horizontal stresses became an important factor in the design of roof rock bolts.

GROUNDWATER INVESTIGATIONS FOR AUCKLAND CITY COUNCIL

J. P. BURR
Riley Consultants Ltd, Auckland, New Zealand

The 1994 Auckland region drought prompted an investigation into the groundwater resources of the isthmus. Auckland City Council formed a team to identify and develop these resources for both potable and non-potable supplies. Large volumes of groundwater are potentially available from the volcanic formations on the isthmus during a drought. Following the lifting of the drought the schemes were re-examined under normal economic and environmental constraints. Only those potable supplies able to comply with these parameters were selected to continue. Three schemes were chosen to be taken to the Resource Consent application stage. These schemes propose to supply a total of 15,000 m^3/day of potable water to the council's reticulation network. The applications are currently being reviewed by the Auckland Regional Council.


ABSTRACTS

THE RIVER RODING PROJECT DIFFERENCES IN GEOTECHNICAL ENGINEERING IN AUSTRALIA AND THE UK

G. W. CAMERON
Woodward-Clyde Pty Ltd, Melbourne, Australia

This paper presents a review of the geotechnical site investigation for a tide retention barrage across the River Roding, a tributary of the River Thames, London. An overview of the project is given together with a description of the parties involved and their respective objectives and roles. In particular the inter-relationship between the geotechnical engineer employed by the project Engineer and geotechnical engineer employed by the site investigation Contractor is discussed. Finally the paper discusses the potential pitfalls of the system where the geotechnical engineer carrying out the field works is removed from having a comprehensive knowledge of the project and its objectives.

RIPPABILITY ASSESSMENT FOR THE PROPOSED OPEN PIT GOLD MINE AT GLOBE-PROGRESS, REEFTON, NEW ZEALAND

PHILIP CLARK
University of Canterbury, Christchurch, New Zealand

There are many methods used to predict the rippability of a site, most of which involve using a particular system to rate the rock mass. A preliminary rippability evaluation of a site may be performed by determining the seismic velocity variation within the rock mass. Seismic velocities are used as an estimate of rippability because they are influenced by geological and physical properties of the rock mass. However, a complete rippability evaluation requires rock mass and rock material characterisation as well as data on possible ripping machinery to be used. If the rock mass is rated as being very good rock, then ripping may be difficult. Likewise, if the bulldozer is underpowered, its productivity may be too low and the ripping rate will be slow.

Six seismic refraction traverse lines were surveyed at the proposed open pit gold mine at Globe-Progress, near Reefton using a single channel seismograph, then interpreted using the Generalised Reciprocal Method. Combining the seismic velocities found and data on Komatsu's D575A-2 bulldozer, it is estimated that 85% of the pit is rippable, and a further 7.5% is marginal. This means that 7.5% of the open pit area is unlikely to be rippable. However, further seismic refraction surveys, as well as a complete rock mass classification, need to be done to provide a three-dimensional site model and to clearly identify the rippable, marginal and non-rippable zones.

HARDSTAND LOAD TESTING FOR HEAVY LIFT CRANES

S. J. CLARKE
Coffey Partners International Pty Ltd, Sydney, Australia

Large capacity plate load tests were used to predict settlement of heavy lift cranes. The rear counterweight crawlers of the heavy lift cranes will have a mass of 2200 tonnes, and will apply a track bearing pressure of 490 kPa. The load testing program involved applying a 1000 tonne load over a 6 m long by 2.4 m wide area to result in a maximum applied bearing pressure of 680 kPa. Piezocone penetration testing and magnetic extensometers were used to assess deformation properties of the different soil units encountered at the site. This paper describes the field component of the load test program, the procedure for the assessment of soil deformation properties, and the predicted settlement behaviour for the heavy lift cranes.


ABSTRACTS

WAIKAREMOANA POWER SCHEME - PIRIPAUA ENGINEERING GEOLOGY STUDY AND RISK ASSESSMENT

R. M. DAWSON
Tonkin & Taylor Ltd, Auckland, NZ

ECNZ wished to have an engineering geology and risk assessment study undertaken of the Piripaua penstock slope, part of the Waikaremoana Power Scheme. This paper presents the method used for geological and statistical analysis and the conclusions made. Aerial photograph interpretation as well as field mapping of the geology was carried out to determine the likely failure mechanisms. Three dimensional analysis of wedge failures was performed with variation of input parameters such as strength and earthquake magnitude to allow probabilities of failure to be evaluated.

LIQUEFACTION ANALYSIS FOR FOUNDATIONS FOR MOTORWAY BRIDGES IN HAWKE'S BAY

DAVID DENNISON
Works Consultancy Services Limited, Napier, NZ

The results of insitu Standard Penetration Testing and Cone Penetration Testing were used to assess the soil liquefaction potential at the bridge sites for the proposed extension of the Napier-Hastings motorway. Published correlations between the insitu tests and field performance of sites subjected to earthquake shaking we used to identify liquefiable soil layers and to estimate the intensity of ground shaking that is likely to cause liquefaction.

A seismic hazard study was compared with the results of the liquefaction analysis to produce a quantitative estimate of the risk of soil liquefaction. This data can be used in an economic assessment of the various options to mitigate the effects of soil liquefaction on the performance of bridge structures in earthquakes.

THE APPLICATION OF NATURAL HAZARD MAPPING BY TERRITORIAL REGULATORY AUTHORITIES

N. C. ELDRED
Woodward-Clyde (NZ) Ltd, Auckland, NZ

Natural hazard mapping is a commonly used method for defining land areas prone to processes such as slope instability and subsidence. Recent changes in New Zealand legislation require Regulatory Authorities to control the potential effects of natural hazards. Natural hazard mapping provides one method by which the Regulatory Authorities can meet their responsibilities.

This study developed a natural hazard classification system for Waitakere City, an area located to the west of Auckland City on the North Island of New Zealand. Waitakere City is characterised by a diverse topography and geology and has a history of natural hazard issues. Integral to the development of a natural hazard classification system for the Council was an assessment of how the system could be included as part of the proposed Waitakere City District Plan and assist in the control of natural hazards. A range of proposals were developed as part of the study for the inclusion of the hazard classification system in the Plan.

DESIGN OF DYNAMIC COMPACTION ON LANDFILLS

D. L. FELLOWS
Woodward-Clyde (NZ) Ltd, Auckland, NZ

Dynamic compaction is a ground improvement technique currently used to reduce void space, increase density and reduce long term settlement in soils. It has been used with varying success as a treatment for landfill deposits. Thirteen case studies have been evaluated to assess the success of dynamic compaction on unengineered landfills.

The results suggest that current dynamic compaction design practices tend to overestimate the treatment depth achieved. A damping of input energy due to a cohesive component in the landfill as well as the presence of groundwater in the treatment zone are presented as possible explanations. Based on back analysis of available data, modified design constants are suggested for unengineered landfill deposits.

Relationships between four characteristics associated with dynamic compaction in landfill (i.e. landfill age, depth, input energy, induced settlement) are also explored and alternative design equations are proposed based on these relationships.

THE SHEAR BEHAVIOUR OF ROCK JOINTS

B. FLEUTER
Monash University, Melbourne, Australia

The methods of prediction of rock joint behaviour have traditionally relied on empiricism or over-simplified theoretical approaches. In addition, only limited boundary conditions are considered in many cases. Recent advancements into rock socketed piles have resulted in a theoretically based roughness model for the shear behaviour of concrete-rock interfaces. As there are many similarities between rock joints and the concrete-rock interface of socketed piles it is likely that the new theories are also applicable to rock joints. This paper describes the beginning of a project to expand socketed pile research to rock joints.

GROUND TREATMENT IN RECLAMATION DESIGN & CONSTRUCTION - THREE HONG KONG CASE HISTORIES

STEPHEN L. GAMBLE
Frankipile Australia Pty Limited, Sydney, Australia

Most reclamation projects involve the forming of land over soft or loose near-shore or shallow water sediments, which often require some form of ground treatment to minimise post-construction settlement. Each reclamation project has a unique set of conditions, which will determine which of the available ground treatment techniques are appropriate for achieving the required performance improvement. Three case studies are presented which illustrate some of the different ground treatment techniques used, and the reasons for their choice is discussed.


ABSTRACTS

THE GEOLOGY OF THE QUEEN STREET AREA, AUCKLAND, NEW ZEALAND

A. K. GEORGE
Works Consultancy Services Ltd, Auckland, New Zealand

The geology along Queen St, Auckland, consists of underlying Miocene marine deposited flysch and associated soils. This material is overlain by Quaternary volcanics, alluvium and recent fill, all of variable geotechnical character. Of geological importance is a lava flow which flowed down the paleovalley underlying present day Queen St, from the corner of Victoria St east. The original paleovalley gives clues as to the extent of this flow, however more information is required to determine its terminal extent north and lateral extent east. The course of the Ligar stream last century is useful to determine the extent of reclamation.

GEOTECHNICAL ISSUES ASSOCIATED WITH METHANOL STORAGE TANK DESIGN

K. M. HILLS
Works Consultancy Services Ltd, Hamilton, NZ

When completing a geotechnical assessment of a tank site, the importance of observation and factual data should be realised. Data from adjacent tank sites can give a more representative picture than data from laboratory testing of how the tank will perform, especially when considering tank settlement. One dimensional oedometer test data often gives conservative data for settlement estimation, leading to over conservative foundation design. This is especially true for over consolidated soils.

BEHAVIOUR OF BORED PILES IN EXPANSIVE CLAY

A. G. KILSBY
University of South Australia, Adelaide, Australia

Four reinforced concrete piles, of the same length and shaft diameter, but having different shaft-soil interface conditions, were constructed in late 1993. The test piles were located at an extremely reactive clay site where the potential surface movement exceeds 120 millimetres. Observations were made, with time and changing moisture regimes, of the soil movements, soil properties, pile movements and pile strains.

Computer modelling has commenced in order to simulate and better understand the pile behaviour. The types of numerical analysis being investigated include an elastic thermomechanical model (that is, no pile-soil slip) and a simplified boundary element model which simulates the soil as an elasto-plastic continuum (that is, pile-soil slip is possible). The paper summarises the experimental observations to date and provides preliminary results of the theoretical modelling.

WICK DRAIN APPLICATION FOR ONE DIMENSIONAL CONSOLIDATION, GULF HARBOUR MARINE VILLAGE, WHANGAPARAOA

R. J. KNOWLES
Foundation Engineering Limited, Auckland, NZ

During the summer of 1994/95, approximately 80,000 metres of geosynthetic wick drains (Colbond®EX1000) were installed at the Gulf Harbour Marine Village, Whangaparaoa. This was undertaken to accelerate the consolidation settlement of large areas containing up to 9 metres depth of soft to very soft estuarine and alluvial deposits overlying sandstone/siltstone bedrock at depth. This paper outlines the site geology and geotechnical considerations of the project, together with assessing predicted versus actual performance.

FACTORS INFLUENCING DESIGN OF SLOPES IN RESIDUAL SOILS : AN OVERVIEW

S. KRISHNAN
Tonkin & Taylor Ltd, Auckland, New Zealand

The key to understanding the stability of slopes in residual soils lies in recognising the influence of the weathered profile, relict discontinuities, shear strength parameters, and groundwater conditions. These factors would need to be carefully considered while preparing a site investigation programme to establish the information required for a stability analysis.

EFFECTS OF INTERPARTICLE AND INTRAPARTICLE MATERIAL ON THE GEOMECHANICAL PROPERTIES OF LIMESTONE

GLENN McINTOSH*, VICKI MOON, CAMPBELL NELSON
*Coal Corporation of New Zealand Ltd, Huntly, NZ
University of Waikato, Hamilton, NZ

Interparticle and intraparticle material within limestone is that material deposited between skeletal (and other) grains and within the cavities of skeletal grains, respectively. Combinations of the distribution and quantity of these carbonate materials, and whether they are sparite cement (>0.02 mm) or fine micrite matrix, form important controls on the geomechanical behaviour of limestone.

Interparticle material is correlated with durability/abrasion and dissolution rate parameters. Geomechanically, these involve surficial processes, suggesting that surface degradation is influenced most significantly by the material deposited between grains in limestone. Micrite (muddy) materials are more durable than sparite materials, and intersparite is also responsible for higher rates of dissolution.

Interparticle material is correlated especially with sonic velocity and various strength properties. These areas of geomechanics are concerned primarily with the body of the rock, suggesting an internal breakdown of limestone under stress is controlled particularly by the amount and type of material infilling pore spaces in skeletal grains. An increase in intraparticle material improves the geomechanical performance of limestone. Intramicrite appears to be particularly conducive to higher limestone strengths.

ABSTRACTS

GEOLOGICAL HAZARD ZONATION AND LAND USE PLANNING ASSESSMENT IN THE SOUTH EASTERN MARLBOROUGH SOUNDS, NEW ZEALAND

SONIA T. McMANUS
University of Canterbury, Christchurch, NZ

The Marlborough Sounds, located at the top of the South Island, New Zealand is well known for its scenic beauty. However, the area is less well known for the high degree of weathering and instability associated with the steep slopes. There is a high demand for land in the south eastern Marlborough Sounds due to urban expansion from Picton and Waikawa. Increasingly, the land being selected for house sites is on steeper and potentially more unstable land.

Quaternary climatic influences saw the beginning of the deep weathering profile typical of the Marlborough Sounds today. Periglacial and interglacial periods assisted in the preferential weathering of shear zones and the development of significant amounts of regolith and colluvial material overlying the schistose and greywacke bedrock.

USING BENDER ELEMENTS TO DETERMINE ELASTIC SOIL PARAMETERS

V.M. MEYER AND M.J. PENDER
The University of Auckland, New Zealand

This paper presents results from several bender element tests performed on undisturbed samples of differing soil type. The bender elements 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 ν for the soil samples were evaluated. These parameters showed general agreement with soil type.

PIEZOCONE PENETROMETER TESTING AND DIMENSIONLESS EXCESS PORE PRESSURE

ADAM B. MILLIGAN
University of Canterbury, Christchurch, NZ

The use of the piezocone (CPTU) probe has become increasingly popular and is currently one of the most widely used *in situ* investigation devices. The addition of a pore pressure measuring system to the cone penetration test (CPT) provides much more information about the *in situ* soil and thus enables a much clearer picture of the subsurface soil conditions to be obtained.

PRECONSOLIDATION EFFECT IN NORMALLY CONSOLIDATED AGED CLAYS

A. K. MURASHEV
Beca Carter Hollings & Ferner Ltd, Wellington, NZ

This paper provides evidence from research and practice that most of natural normally consolidated clays are in fact preconsolidated due to aging. Examples of normally consolidated aged clays, including a clay investigated by the author at the site for the proposed Seaview Sewage Treatment Plant (New Zealand) are presented. Test procedures specifically designed to detect preconsolidation due to aging are described.

ABSTRACTS

SLOPE RISK ASSESSMENT OF NEAR VERTICAL CUTS IN HAWKESBURY SANDSTONE, F3 FREEWAY, WAHROONGA TO HAWKESBURY RIVER, NSW

D. E. MURRAY
Douglas Partners Pty Ltd, Sydney, Australia

A slope risk assessment analysis was undertaken on a total of 83 high angle road cuts in Hawkesbury Sandstone along a 20 km length of the F3 Freeway, north of Sydney.

Details of individual cut features and methods used to prioritise cuts for remedial works are given, together with a discussion on risk assessment as part of the design process for future freeway works.

RESIDENTIAL DEVELOPMENT ON COASTAL CLIFFLINES

C. K. OLDHAM
Harrison Grierson Consultants Ltd, Auckland, NZ

The threshold criteria for determining when a detailed stability analysis is required is dependent on a number of factors but primarily the geology of the site. Where previous studies have been undertaken guidelines may be present to determine when detailed studies are required. A case study of a detailed stability analysis of a redevelopment located on a cliffline is given.

LIME STABILISATION OF ROAD SUBGRADES BENEFITS AND RECEPTIVE SOIL TYPES

R. M. OSBORNE
Wood & Partners Consultants Ltd, Auckland, NZ

Soil stabilisation is not new in New Zealand having been practised some thirty years or more. Lime stabilisation, however, is only now being considered as a primary option in the process of road construction.

Lime reacts with clay to varying degrees depending on the mineral composition of the clay. Plastic soils whether they are fine grained clay or gravel-clay in nature are responsive to lime, whereas organic soils and soils with a low Plasticity Index (P.I.) are generally not.

The advantage of lime treatment is that it leads to a reduction in the construction time and cost if carried out correctly. It thus makes it imperative to recognise when it is a viable option. Simple tests can identify lime responsive soils, but further laboratory tests are required to enable a cost efficient result to be achieved.


WELLINGTON REGIONAL STADIUM SITE ASSESSMENT

S. J. PALMER
Beca Carter Hollings & Ferner Ltd, Wellington, NZ

The Wellington Regional Stadium is one of a number of projects planned or under construction along Wellington's reclaimed waterfront. Each of these projects has had to consider ground stability with respect of liquefaction and lateral spreading, taking into account Wellington's relatively high seismic activity and the weak and variable nature of the reclaimed land.

The proposed stadium site straddles two distinct areas of reclamation; one of hydraulic fill and the other of end tipped gravel fill. The potential for liquefaction and lateral spreading of the site has been assessed. A relatively high potential for liquefaction of the hydraulic fill sands has been concluded. On the basis of an approach proposed by Newmark a potential for up to 1 m of lateral movement of the site has been predicted under the design earthquake (600 to 800 year return period). Ground improvement options have been considered to mitigate these predicted movements. The formation of gravel columns by vibro-replacement has been concluded to be an appropriate form of ground improvement.

SOME ENGINEERING PROPERTIES OF A VOLCANIC SAND

S. PRANJOTO[1], T.J. LARKIN[2]
University of Auckland, NZ

Pumice sand is widespread over the central part of the North Island due to frequent past volcanic activity. The pumice has distinct properties different from that of quartz sands. The index and engineering properties are reviewed. The most significant difference from typical quartizitic sands is the grain softness of pumice. The particles are easily crushed by a finger nail. The other major difference is the void ratio, which is about twice that of typical quartz sands. These two factors are suggested as being substantially responsible for its different behaviour, as found in a series of consolidated drained triaxial tests on specimens with free end platens.

DESIGN AND CONSTRUCTION OF CASTLEMAINE LANDFILL

DON RICHARDSON
Golder Associates Pty Ltd, Melbourne, Australia

In 1994 a new landfill was designed and constructed in accordance with strict environmental and regulatory requirements on a former alluvial gold mining site in Castlemaine, central Victoria. The landfill includes staged filling in specially constructed cells, leachate management and progressive rehabilitation. A major geotechnical aspect of the project was lining the base of the landfill cells with a low permeability liner constructed by ripping, breaking down, moisture conditioning and compacting the on site weathered sedimentary rock. The liner construction works were generally performed in accordance with specified relative compaction, moisture and particle size requirements to achieve a median permeability of between 4.0×10^{-9} and 9.4×10^{-9} m/s.


ABSTRACTS

BIO REMEDIATION OF HYDROCARBON CONTAMINATED SOILS: EXPERIENCES FROM AUSTRALIA

W.M. TROTTER
Groundsearch EES, Auckland, New Zealand

Bioremediation is an effective way of remediating hydrocarbon contaminated soils and is a widely used technique in Europe, the US and Australia. The landfarming technique involves the application of nitrogen and phosphate to the soil, monitoring the soil pile to ensure optimum moisture and pH conditions are met along with ongoing aeration to ensure an adequate supply of oxygen is available to ensure maximum micro-organism population growth. A landfarming bioremediaton facility needs to be adequately managed to ensure the community and surrounding environment are not affected by the remediation process. On site management practices include: dust suppression, noise and odour control, stormwater runoff control, sediment and erosion control, groundwater monitoring and regular sampling to monitor the progress of the remediating soil.

SLOPE MOVEMENTS AROUND THE TUTAMOE PLATEAU (CENTRAL NORTHLAND, NEW ZEALAND)

S. J. TYSON
University of Auckland, Auckland, NZ

The Tutamoe Plateau consists of a prominent upstanding tableland of resistant well jointed basaltic rock and regolith. Underlying sediments are highly to extremely weathered, eroded, and very weak, with subdued topographic expression. Stream superposition and erosion of these sediments by slope movement results in oversteepened slopes which maintain the edge of the Plateau in a state of disequilibrium. Continued and successive undercutting of the Plateau creates large and varied slope movements. Degradation and retreat of the Plateau edge is continuous and ongoing.

DRAINAGE OF THE CAIRNMUIR LANDSLIDE, NEW ZEALAND

C. R. WATTS
Electricity Corporation of New Zealand, Clyde

The 20 million m^3 Cairnmuir Landslide is located on the right bank of Lake Dunstan about 15 the Clyde Dam. Investigations and remedial works concentrated on the 8 million m^3 active segment, a 40-70 m thick translational slide composed of schist debris. The groundwater model is a relatively simple stepped watertable below the slide but a highly compartmentalised system of aquifers within the debris. Groundwater below the slide was easily drained by drainage drives and drainholes. However, the thin compartmentalised aquifer system within the debris was difficult to drain. Prior to remedial works the active segment was moving at rates of up to 100 mm/yr. Since the completion of the underground drainage and surface infiltration protection works the slide velocity has reduced to approximately 5 mm/yr.


THE SECOND AUSTRALIA-NEW ZEALAND YOUNG GEOTECHNICAL PROFESSIONALS CONFERENCE

REFLECTIONS

CONFERENCE COMMENTS

While captured on a bus tour of the "sites" of Auckland, conference attendees were asked to comment on the conference and provide impressions on the quality of presentations. Time restrictions did not allow for all members of the 30 strong audience to have a say but here are some of the responses to the editor/journalist's microphone:

- *Stephen Gamble (Frankipile, Sydney, Australia) meeting people of a similar age group doing similar sorts of work, its very valuable.*

  Editor - What have you thought of the standards so far of the papers that have been presented?

  Stephen Gamble: Excellent. It makes you feel proud that we can do such good work in this area, both in Aussie and in New Zealand.

- *Charlie Watts (Electricity Corporation of NZ, Clyde, South Island, NZ). Well, it's been an enjoyable experience. The highlight's been flogging the Australians, but meeting the other people of similar age has been a worthwhile experience for me, up from the South Island. The variety of work that people are doing is quite interesting.*

  Editor - Did you go to the conference last time, in Sydney?

  Charlie Watts: No, this is the first one I've been to. From what I understand, very few have doubled up, so to speak.

- *Stuart Palmer (Beca Carter Hollings & Ferner, Wellington, NZ)*
  The conference has been really worthwhile so far. It's good to meet up with a lot of people all working in a similar field. There's also a good mix between geotechnical engineering and engineering geology - good to see so many geologists along here at the conference.

  Editor - And you are a geologist or an engineer?

  Stuart: I'm a geotechnical engineer

- *Wendy Trotter - Environmental Scientist, Groundsearch EES, Auckland, NZ: Aha, you've picked the only environmental scientist here, so I'm baffled -some of the content has been a bit beyond my field. However, it's been interesting as I do some geotech. work.*

  Editor - Do you think other environmental people would benefit from coming to the conference - do you think there should be more "environmental" input?

  Wendy: If Maurice (Fraser) could "con" a few more. There would have to be perhaps a bit more of a section for us, and perhaps a little bit more of inter-relating the two fields.

  Editor - You'll be keen to organise the next one, will you?
  (Nervous response)

Editor's Note: I managed to catch a morning session at the Conference on Saturday and was impressed with the standard of presentation and technical content of papers. I understand the other papers were equally as impressive. S.A. Crawford

1996 NZ GEOMECHANICS SOCIETY SYMPOSIUM

Geotechnical Issues in Land Development

Hamilton, New Zealand

Friday 16 to Sunday 18 February 1996

INTRODUCTION

A topical area currently facing the engineering profession is the issue of land development. This symposium hopes to address the issue, and provide a forum for discussion.

The last Geomechanics Society symposium dealing with land development was 14 years ago (Geomechanics in Urban Development, 1981). Significant changes to the legal system in New Zealand, particularly the introduction of the Resource Management Act, have been made since 1981. The impact of this Act on geotechnical practice will be discussed.

Technology has advanced considerably, particularly the use of personal computers. Many local authorities now use a geographic information system (GIS) to monitor and track resources and developments in their areas. This symposium will address how this technology and other applications are being applied by the geotechnical profession.

Identification and management of hazards has become an important aspect of geotechnical engineering which will be addressed during the symposium. There is also increasing pressure to develop marginal land which creates concern for geotechnical engineers. Should we recommend construction on dormant landslides and what are the implications of developing sites on contaminated land ? Risk needs to be assessed and hazards mitigated.

Some organisations are now generating approved lists of consultants. The symposium will discuss the appropriateness and implications of this approach for the profession.

PRELIMINARY PROGRAMME

Speakers are coming from throughout New Zealand to present over 20 papers. The full programme will be sent to registrants.

Speakers The keynote speaker is Don Taylor. Other speakers include Vernon Pickett, David Bell, Peter Kingsbury, Peter Wood, John Blakeley and Bruno Petrenas.

Papers Topics include:

- Legal and Planning Framework
- Planning and Development Guidelines
- Regional Hazard Identification and Risk Assessment
- Development on Marginal Land
- GIS in Land Development

EXHIBITION

An exhibition will be held concurrently with this symposium covering a wide range of products and services. Please contact the Conference Centre for further information.

REGISTRATION

See the last three pages of this issue of Geomechanics News for the registration forms.

1996 IPENZ CONFERENCE
"ENGINEERING : PROVIDING THE FOUNDATIONS FOR SOCIETY"
Dunedin 9-13 February 1996

The theme of the conference is "Engineering - providing the foundations for society". Engineers and allied professionals have played an integral part in the establishment of society as we know it today be it in infrastructure, services, structures and civil works, industry, manufacturing, agriculture, catchment and flood control, provision of energy or material development. The theme of the 1996 IPENZ Conference will provide the opportunity to review the activities of the past, study the actions of the present and to explore the exciting opportunities and challenges of the future.

The Institution is made up of members from a wide range of groups involved in every aspect of engineering and allied disciplines. The Annual IPENZ Conference provides an ideal opportunity for your group to conduct sessions which enable those in other fields of activity to see and hear what are the key issues, developments, challenges and exciting advancements in the future in your field. Participation in the conference will give each group an opportunity to provide a "window" on the activities of its members which will be of interest and benefit to others.

Papers must be submitted in the format and to the timetable required by the conference committee and the papers must be presented personally on Sunday 12 February, Monday, 12 February or Tuesday, 13 February. All papers presented will be published in the Conference Proceedings prior to the conference and these will be supplied to all delegates as part of their registration fee. Paper format details will be provided to all authors accepted for the Conference. The papers should be submitted to your technical group secretary.
/

All enquiries to: Colin Newton
NZGS Secretary
C/o Works Consultancy Services Ltd

Tel: (04) 471 7088
Fax: (04) 473 1296

The following geotechnical papers are to be presented at the 1996 IPENZ Conference.

A GIS-Based Hazard Information System: Dunedin Pilot Project
- P.J. Forsyth, P.J. Glassey & I.M. Turnbull

A GIS-based Hazards Information System (HIS) has been developed by the Institute of Geological and Nuclear Sciences in partnership with local territorial authorities and University of Otago. The system is designed to assimilate data on natural hazards from a wide range of sources in different formats, to integrate these data with location information (topographic and cadastral), and to make the information readily accessible. The HIS consists of two sub-systems: a site-specific register of natural hazards, and zonations of hazard risk. The system is intended to help local and regional authorities to supply hazard information, as required under the Resource Management Act and the Building Act, as well as meet planning needs. The HIS has been developed using the software package Arc/Info, and was tested using data from part of Dunedin City.

Geotechnical Guidelines for Residential Land Development
- D.H. Bell, S.A. Crawford, G.G. Grocott & D.K. Taylor

This paper presents draft geotechnical guidelines prepared by the New Zealand Geomechanics Society for the planning and development of residential land. They incorporate recommended procedures for hazard evaluation and mitigation to satisfy the requirements of both the Resource Management Act 1991 and the Building Act 1991, and site-specific examples and included to illustrate the range of geotechnical constraints that exist to residential land use throughout the country. It is anticipated that following peer review of the document, the guidelines will become the standard for use by geotechnical practitioners and territorial authorities within New Zealand.

"GEOMECHANICS IN A CHANGING WORLD"

Adelaide, Australia, July 1-6, 1996

Organized by the Australian Geomechanics Society in association with the New Zealand Geomechanics Society and endorsed by the International Society for Soil Mechanics and Foundation Engineering (ISSMFE), the International Association of Engineering Geology (IAEG) and the International Society of Rock Mechanics (ISRM).

INFORMATION

Object
This four-yearly meeting of the Australian and New Zealand Geomechanics Societies is aimed at providing a forum for geotechnical engineers and geologists, active in the field through research and practice, to present and discuss their work.

Venue
The Conference will be held at the Adelaide Convention Centre, in the heart of Adelaide, the capital city of South Australia.

Keynote Speaker
The keynote speaker will be Prof. M. Jamilkowski, President ISSMFE, and Chairman of the Committee currently assessing rehabilitation works to the Leaning Tower of Pisa.

Technical Program
The technical program will consist of the keynote address, the John Jaeger Memorial Lecture, to be given by D. H. Stapledon, the NZ Geomechanics Society Lecture, to be given by M. J. Pender, 3 theme addresses on the topics of Analytical and Numerical Modelling.

Paper Presentation
To maximize the number of papers which can be accepted, theme session reporters will summarize papers for general discussion. A small selection of papers will be presented in each session. Poster sessions will be available for the authors of the remaining papers.

Technical Exhibits and Sponsorship Opportunities
A technical exhibition will be run at the conference and will allow either single day exhibiting or continuous exhibits throughout the week. In addition, opportunities exist to sponsor various aspects of the conference at a number of different levels.

Field Trip
A day has been set aside for technical visits which will provide delegates with the chance to see South Australian developments and the State's local attractions.

Deadlines

Submission of papers	12 January 1996
Early registration	31 May 1996

CONFERENCE SECRETARIAT
Ms Angela Schaeffer
Conference Manager
ICMS Pty. Ltd.
Adelaide Convention Centre
North Terrace
Adelaide, South Australia, 5000
Telephone: 08 210 6776
International: +618 210 6776
Fax: 08 212 5101
International: +618 212 5101

Mr Mark Jaksa
Chairperson of the Organizing Committee
7th ANZ Conference on Geomechanics
Dept. of Civil and Environmental Engineering
The University of Adelaide
Adelaide, South Australia, 5005
Telephone: 08 303 4317
International: +618 303 4317
Fax: 08 303 4359
International: +618 303 4359
Email: mjaksa@aelmg.adelaide.edu.au

JUNE 17-21, 1996
Trondheim, Norway
7TH INTERNATIONAL SYMPOSIUM ON LANDSLIDES
Topics: Analysis of landslides inventories; Landslide investigations; Monitoring and instrumentation; Stability analyses and geotechnical parameters; Shoreline stability and submarine slides; Assessments of landslide risk and hazards; Stabilisation and remedial works; Open-pit mine slopes and mine tailings; Slope instability in tropical and seismic areas; Landslides in sensitive soils. Language: English and French

JULY 1-6, 1996
Adelaide, South Australia
7TH AUSTRALIA-NEW ZEALAND CONFERENCE ON GEOMECHANICS - GEOMECHANICS IN A CHANGING WORLD
Call for papers: April 1995 with synopses required by July 1995 and final papers by January 1996. (See article earlier in this issue of Geomechanics News).

AUGUST 4-14, 1996
Beijing, China
30th INTERNATIONAL GEOLOGICAL CONGRESS
Topics: Wide ranging programme includes symposia on structural geology and geomechanics; Engineering geology; Hydrogeology and environmental geology.

AUGUST 27-29 1996
Sydney
IX AUSTRALIAN TUNNELLING CONFERENCE: "BREAKING NEW GROUND"
The Conference will focus on key issues confronting the development of underground space in Australia and the Asian region. Of interest to planners, builders, developers, financial institutions and specialists in underground construction and mining.

SEPTEMBER 3-6, 1996
Torino, Italy
EUROCK '96, ISRM INTERNATIONAL SYMPOSIUM - PREDICTION AND PERFORMANCE IN ROCK MECHANICS & ROCK ENGINEERING
Topics: Foundation of dams, bridges, oil field platforms and other large structures; Natural and excavated slopes; Tunnels, oil wells and caverns; Mining structures; Environmental engineering (including fluid-rock interaction, prediction of contamination radioactive waste repositories, subsidence above oil and gas fields, etc.), Historical sites and monuments.

SEPTEMBER 11-13, 1996
Orlando, USA
FIFTH INTERNATIONAL CONFERENCE ON THE APPLICATION OF STRESS-WAVE THEORY TO PILES
Themes: Wave mechanics and application to pile driving analysis; stress wave analysis, high and low strain dynamic pile testing; NDT methods applied to deep foundations; testing equipment and methodologies; and case histories.
Language: English.

SEPTEMBER 23-26, 1996
Gol, Norway
2ND INTERNATIONAL SYMPOSIUM ON SPRAYED CONCRETE - UNDERGROUND SUPPORT
Topics: Design of Support; Construction Aspects, Durability; Frost Loading; Case Histories
Language: English
Abstracts by 1 April 1996

SEPTEMBER 30 - OCTOBER 2, 1996
Maastricht, The Netherlands
EUROGEO 1. GEOSYNTHETICS CONFERENCE
Topics: Erosion control/Bank protection; Filter applications; Liners and landfill covers; Monitoring; Embankments/walls.

OCTOBER 16-18, 1996
Xuzhou, China
INTERNATIONAL SYMPOSIUM ON MINING SCIENCE AND TECHNOLOGY
Aims to provide a forum for experts to exchange information on pioneering research into mining and to promote scientific and technological co-operation.

OCTOBER 16-18, 1996
Santiago, Chile
INTERNATIONAL SYMPOSIUM ON SEISMIC AND ENVIRONMENTAL ASPECTS OF DAMS DESIGN.
Topics: Tailings dams - environmental aspects, monitoring and abandonment, seismic design and behaviour; Concrete and embankment dams - seismic aspects.
Papers: by April 1, 1996
Languages: English, French, Spanish

1997

OCTOBER (2 days), 1996
Naples, Italy
INTERNATIONAL SYMPOSIUM ON GEOTECHNICAL ENGINEERING FOR THE PRESERVATION OF MONUMENTS AND HISTORIC SITES
Topics: Investigations - history of the monument/ site, structure, materials, buried remains and foundations soils; Monitoring; Intervention Techniques; Case histories - illustrating interplay between preservation and geotechnical engineering.
Abstracts: by 31 December 1995
Papers: by 30 June 1996

NOVEMBER 5-8, 1996
Osaka, Japan
2nd INTERNATIONAL CONGRESS ON ENVIRONMENTAL GEOTECHNICS
Themes: Site Investigation, Speciation and Characterisation; Modelling and Numerical Analysis; Geotechnics of Mines Waste Management; Geotechnics of Municipal Waste Management; Waste Disposal and Containment; Geotechnical Recycle or Reuse of Waste Materials; Remediation of Contaminated Ground; Dredging and Sediments; Geo-Environmental Risks: Assessment and Mitigation; Regulations: Trends and Vision for the Future.
Language: English

NOVEMBER 12-14, 1996
Fukuoka, Japan
2ND INTERNATIONAL SYMPOSIUM ON EARTH REINFORCEMENT (IS KYUSHU '96)
Topics: Construction practice on embankments, wall structures, foundations, slopes and excavations; Standardisation of testing methods; Standardisation of design methods; Numerical methods for design; Case histories; Monitoring systems.
Language: English

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
Abstracts: by 30 December 1995
Papers: by 28 February 1996

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
Registration by 30 June 1996

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.

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

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		REDUCED PRICE TO MEMBERS
	MEMBERS	NON	
Australia-NZ Conferences on Geomechanics Proceedings of the Sixth Australia-NZ Conference on Geomechanics, Christchurch, February 1992	$100.00	$100.00	$50.00
Proceedings of the Third Australia-NZ Conference on Geomechanics, Wellington, May 1980	$ 20.00	$ 30.00	$10.00
Proceedings of the Second Australia-NZ Conference on Geomechanics, Brisbane, July 1975	$ 25.00	$ 25.00	N/A
NZ Geomechanics Society Symposia Proceedings of the Wellington Symposium "Geotechnical Aspects of Waste Management", May 1994	$ 25.00	$ 35.00	N/A
Proceedings of the Auckland Symposium "Groundwater and Seepage", May 1990	$ 25.00	$ 45.00	$10.00
Proceedings of the Hamilton Symposium "Piled Foundations", September 1986	$ 20.00	$ 25.00	$10.00
Proceedings of the Alexandra Symposium "Engineering for Dams and Canals", November 1983 (a joint Symposia with NZSOLD)	$ 40.00	$ 50.00	$10.00
Proceedings of the Palmerston North Symposium "Geomechanics in Urban Planning", May 1981	$ 20.00	$ 20.00	N/A
Proceedings of the Wanganui Symposium "Using Geomechanics in Foundation Engineering", September 1972 (xerox copy)	$ 8.00	$ 10.00	N/A
Other Publications Guidelines for the Field Description of Soils and Rocks in Engineering Use	$ 10.00	$ 13.00	N/A
"Stability of House Sites and Foundations - Advice to Prospective House and Section Owners"	$ 1.00	$ 1.00	N/A
IEA Guidelines for Provision of Geotechnical Information, etc.	$ 10.00	$ 10.00	N/A
Back dated issues of Geomechanics News	$ 0.50	$ 0.50	N/A

GEOMECHANICS SOCIETY PUBLICATIONS ORDER FORM

NAME:

.....

ADDRESS:

.....

.....

.....

ORDER NO.:

.....

TITLE(S) OF PUBLICATIONS REQUESTED:

.....

.....

.....

.....

POST TO: The Secretary
IPENZ
P.O. Box 12241
WELLINGTON NORTH

PAPERS PUBLISHED BY SOCIETY MEMBERS

The Society regularly updates a list of papers published by Society Members. The updated list is to be published in Geomechanics News once per year and used to assist in selecting a paper for the Geomechanics Award.

To assist in updating this list, if you have recently published a paper please complete the following form and post it to:

The Publications Officer
Stuart Palmer
C/- Beca Carter Hollings & Ferner Ltd
P.O. Box 3942 Phone: (04) 473 7551
WELLINGTON Fax: (04) 473 7911

GEOMECHANICS SOCIETY LIST OF PAPERS PUBLISHED BY MEMBERS

AUTHOR(S) _____

TITLE _____

_____

WHERE PUBLISHED _____

WHEN PUBLISHED _____

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 1995)

Members	*(IPENZ members)*	*$25.00*
	(others)	*$40.00*
Students	*(IPENZ members)*	*$15.00*
	(others)	*$20.00*

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

International Society for Soil Mechanics and Foundation Engineering (ISSMFE)		*$16.00*
International Society for Rock Mechanics (ISRM)		*$16.00*
International Association of Engineering Geology	*(IAEG)*	*$10.00*
	(with bulletin)	*$37.00*

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

NZ Geomechanics Society
P O Box 12 241
WELLINGTON

GEO-SYSTEMS

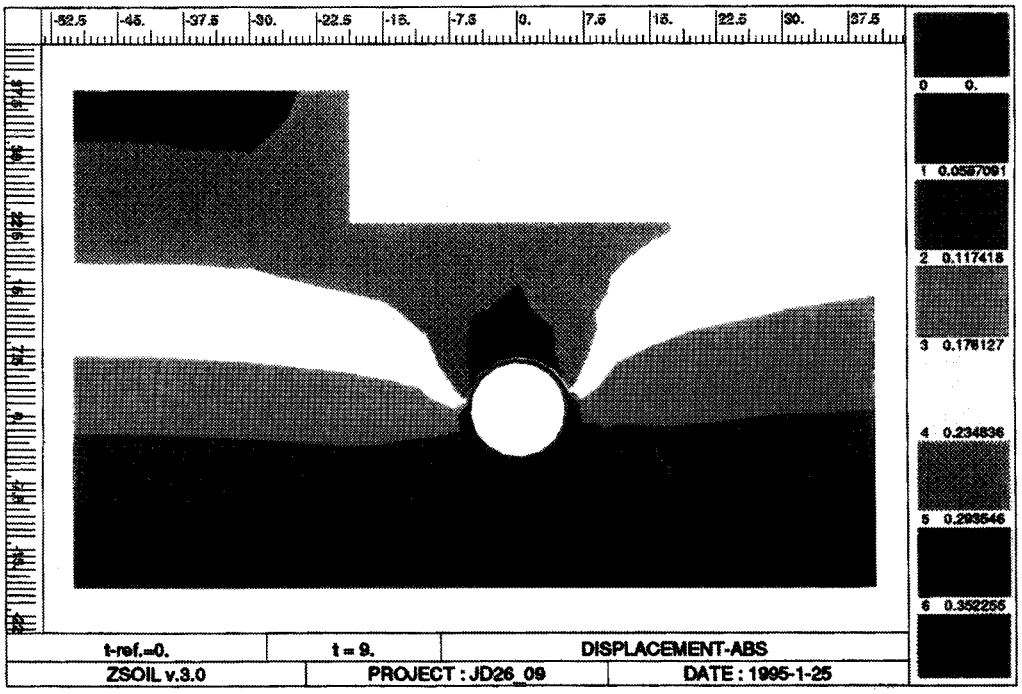
Technical Software, Data Capture & GPS Specialists

New Z-Soil.PC3 under Windows 3

NEW!

- Load carrying capacity, stability analysis
- Plane strain and axysimmetry
- NEW! • Flow – steady, transient, fully coupled 2-phase media
- Deformation consolidation creep
- NEW! • Materials: Mohr-Coulomb, Drucker-Prager, Multilaminate

A MAJOR ADVANCE IN SOIL MECHANICS ON PC'S USING PLASTICITY THEORY



THE BENEFITS TO YOU ARE:–

- More comprehensive tools
- Easier user interface
- Greater quality of output
- Faster analysis

Contact us for friendly, knowledgeable advice and efficient service

GEO-SYSTEMS LTD

Contact Martin, Dave or Zig
39 Leslie Hills Drive
Riccarton, Christchurch
Ph 0-3-343 2333
Fax 0-3-343 2444

Or Mark Green
11 Huron Street
Takapuna, Auckland
Ph 0-9-489 2225
Fax 0-9-489 2226

Agents:

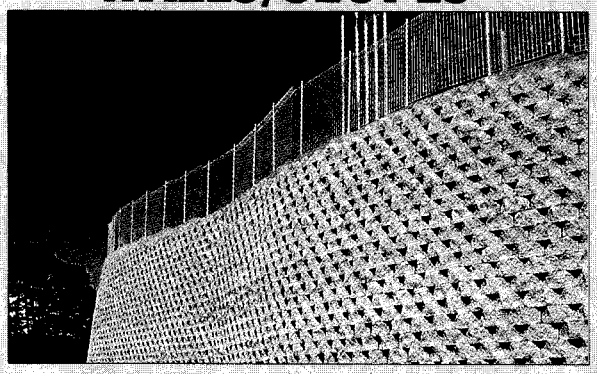
Trimble
Survey & Mapping Products

Agents for Hewlett Packard, Schonstedt, Sokkia, Laser Atlanta

SUPERIOR REINFORCEMENT SYSTEMS

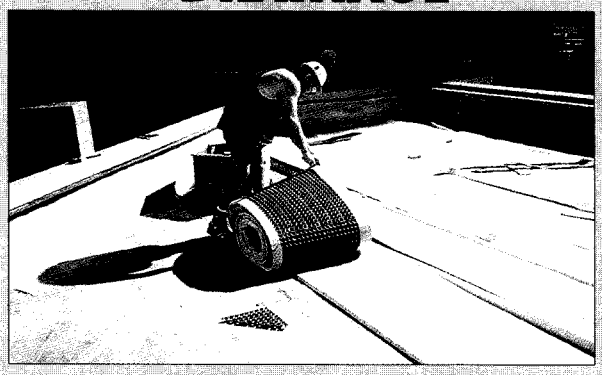
For over 20 years we have provided a specialist technical service and a wide variety of superior products to ensure ground stabilisation.

WALLS/SLOPES



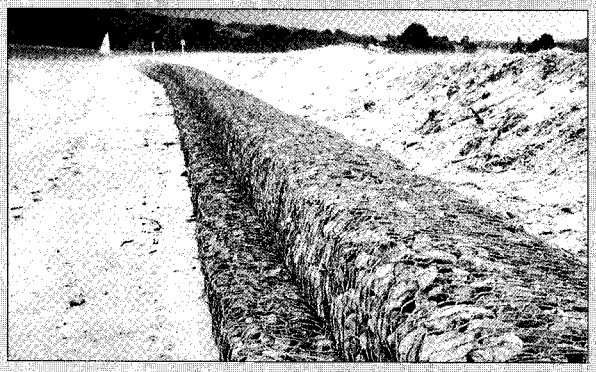
When the need is to hold the ground, we have a range of products for every situation from large scale hillside reinforcement to decorative retaining walls.

DRAINAGE



We specialise in a broad range of sophisticated drainage products which are economical and easy to install. The emphasis of these products is to be user friendly with features such as minimum excavation and backfill requirements in addition to high flow rates.

EROSION CONTROL



We have numerous products to achieve ground holding and erosion control - from biodegradeable protection blankets and permanent grass reinforcement systems, to the rugged, heavy duty gabions.

ROADING

Our roading products are at the forefront of geosynthetic technology. These technically proven products are designed to extend the life of the road and increase the load bearing capacity.

A New Zealand Company.

GROUND ENGINEERING

Superior Reinforcement Systems

AUCKLAND
PH: 09 579 8215
FAX: 09 579 4698

CHRISTCHURCH
PH: 03 349 2268
FAX: 03 349 3031

Please supply further information on the benefits of Ground Engineering's Superior Reinforcement Systems

Name: _____

Address: _____

Phone: _____

Post coupon to:
GROUND ENGINEERING LTD
FREEPOST 1439
AUCKLAND
FREEPHONE: 0800 659 000

GE8