

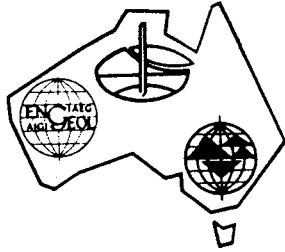
Australian Geomechanics



News Journal of the Australian Geomechanics Society

ISSN 0818 - 9110

No. 17, JUNE 1989



AUSTRALIAN GEOMECHANICS

News Journal of the Australian Geomechanics Society

ISSN 0818 - 9110

No. 17, JUNE 1989

Front and Back Cover - The Briseis (Cascade) Dam failure - see page 19.

PUBLISHED FOR THE AUSTRALIAN GEOMECHANICS SOCIETY BY
THE INSTITUTION OF ENGINEERS, AUSTRALIA
National Headquarters: 11 National Circuit, Barton ACT 2600
Telephone: (062) 70 6555 Facsimile: (062) 73 1488 Telex: AA62758

SUBSCRIPTION:
\$16.00 per year for members
\$20.00 per year for non-members

Overseas orders must include an additional \$10.00 per year to cover airmail postage.

Responsibility for the content of this publication rests upon the authors and not The Institution of Engineers, Australia nor the Australian Geomechanics Society. Data presented and conclusions developed by the authors are for information only and are not intended for use without independent substantiating investigation on the part of the potential user.

© 1989 - The Institution of Engineers, Australia



The
Institution
of
Engineers.
Australia

The Australian Geomechanics Society is jointly sponsored by:

The Institution of Engineers, Australia

The Australasian Institute of Mining and Metallurgy



INCORPORATED BY ROYAL CHARTER 1953

EDITOR'S NOTES

The Editorial Committee of Australian Geomechanics seeks technical contributions for future editions. The following comments are offered to assist would-be contributors.

Technical contributions can include any of the following:-

- Papers, not necessarily of standard or content required for acceptance in, say, the Transactions of the I.E.Aust. State groups might consider submitting selected addresses.
- Technical notes.
- Comments on papers published in Australian Geomechanics.
- Brief notes on "wrinkles" encountered in the practice of geotechnical engineering which contributors may be willing to share with readers.
- Descriptions of geotechnical projects of special interest.
- Failures or 'partial successes'. Share your experience with others.

Submission of material in camera ready format is not absolutely necessary. However, so that justice can be done to contributors, it will be appreciated if the following guidelines are observed.

- Text: The material should be submitted in typed form and preferably in the following format (i.e. based on word processing standards):-
 - * Character quality - double density letter quality
 - * Character size - 12 characters to the inch (column width 110mm)
 - * Line length - 52 characters (left/right justified)
 - * Line spacing - single
 - * Paragraph spacing - double
 - * Main headings - numbered 1 to n, 10 characters per inch
 - * Formulae - typed or clearly hand written
 - * Lines per page - say 55 (editors will fit material to format)
- Diagrams: These should be sharp black on white and of the correct size for mounting on format sheets (ie 100 mm wide for single column or 220mm wide for double column layout). Please do not submit computer print out material because this does not reproduce to an acceptable standard. Original ink drawings may be submitted, these will be photographically reproduced and the originals will be returned if required. Photocopies of drawings are not acceptable.
- Photographs: These should preferably be good contrast black and white gloss prints and of the correct size for mounting on format sheets. However, negatives, colour prints and transparencies can be accepted. They must be clearly labelled to indicate their position in the paper.
- Tables: As for diagrams. Contributors are urged to use only standard size print characters.
- Responsibility: Authors will be responsible for the integrity of their material and for permission to publish.

Contributors are reminded that the deadlines for submission of material are 1 Nov. '89 for issue No. 18 and 1 May 1990 for issue No. 19. Contributions should be forwarded to the Editorial Committee, Australian Geomechanics, C/- H.E.C. G.P.O. Box 355D, HOBART, TAS 7001.

Editorial Committee: Bram Knoop, Richard Barnett, Larry Polglase.

Ph: 002 305397, 305480, 305645.

Advertising: Roy Bushnell

C/- I.E.Aust. 11 National Circuit, BARTON ACT 2600. Ph: 062 70 6555

LIBRARY FACILITIES

All publications received by the Society are placed in the CSIRO Division of Geomechanics Library, PO Box 54, MT. WAVERLEY, VIC 3149. Telephone: (03) 235 1355, Telex: 32363, Fax: (03) 233 2052. The library will include details of such publications in its Current Awareness Bulletin. Copies of this bulletin will be sent to the Secretaries of Geomechanics Groups in each state. Books are available for loan to Society members and photocopies of papers or extracts may be obtained on request. Photocopies of articles are available at the rate of \$6.00 per item. Members will be invoiced on a quarterly basis.

AUSTRALIAN GEOMECHANICS SOCIETY SUPPORTING MEMBERS

ARUP GEOTECHNICS
PO BOX Q116
QUEEN VICTORIA BUILDING
SYDNEY NSW 2000

BARRETT, FULLER & PARTNERS
407-416 Riversdale Road
HAWTHORN EAST VIC 3123

CENTRE FOR GEOTECHNICAL RESEARCH
School of Civil & Mining Engineering
University of Sydney
SYDNEY NSW 2006

CIVIL TEST P/L
PO BOX 537
MORNINGTON VIC 3931

CSIRO DIVISION OF GEOMECHANICS
PO BOX 54
MOUNT WAVERLEY VIC 3149

D. J. DOUGLAS & PARTNERS P/L
8 South Street
RYDALMERE NSW 2116

FRANKPILE AUSTRALIA P/L
PO BOX 3366
PARRAMATTA NSW 23150

GEOLAB SYSTEMS
77-79 Anzac Parade
KENSINGTON NSW 2033

GEOTECHNICS P/L
41 Dunn Road
ROCKLEA BRISBANE QLD 4106

GFWA P/L
1 Vantor Avenue
WEST PERTH WA 6005

GOLDER McCONNELL
72 Kelvin Grove Road
NORMANBY QLD 4059

HOLLINGSWORTH CONSULTANTS
PO BOX 251
SPRINGHILL QLD 4000

HUNTER DISTRICT WATER BOARD
PO BOX 5171B
NEWCASTLE WEST NSW 2302

JEFFERY & KATAUSKAS P/L
39 Buffalo Road
GLADESVILLE NSW 2111

KUMAGAI - CONCRETE JOINT VENTURE
PO BOX 1304
CROWS NEST NSW 2065

MACDONALD WAGNER P/L
PO BOX 538
NORTH SYDNEY NSW 2060

MAUNSELL & PARTNERS P/L
6 Claremont Street
SOUTH YARRA VIC 3141

PAK-POY & KNEEBONE P/L
100 North Terrace
ADELAIDE SA 5000

ROCK ENGINEERING P/L
731 Heidelberg Road
ALPHINGTON VIC 3078

SOUTH AUSTRALIAN HIGHWAYS DEPT.
33 - 37 Warwick Street
WALKERVILLE SA 5081

TURNER, CLARKE GEOTECHNICS P/L
117 Magowar Road
GIRRAWEE NSW 2145

AUSTRALIAN GEOMECHANICS SOCIETY

STATE GROUP	CHAIRMAN	SECRETARY	NEW MEMBERS
SYDNEY	Mr G Mostyn 129 Darling Street BALMAIN. 2041	Dr A B Phillips Arup Geotechnics PO Box Q116 Queen Victoria Bldg SYDNEY, 2001	Mr N Balgunan Mr K A Boddie Mr M M Chapman Mr D B Edwards Professor G Hocking Mr S D F Jackson Mr S R Jones Mr A Leventhal Dr K J McManus Mr C J Parker Mr M D Riley Mr P Stubbs Mr S I Summerell
NEWCASTLE	Mr R J Carr 4 The Quarter Deck CAREY BAY, 2283	Mr J R Gleeson 22 Aldyth Street NEW LAMBTON, 2305	
QUEENSLAND	Mr G W Eades c/- QWRC Planning Division GPO Box 2454 BRISBANE, 4001	Mr D K Nolan c/- Golder Assoc 72 Kelvin Road NORMANBY, 4059	Mr P Armstrong Professor E T Brown Mr S Buffington Dr Choi Sing Ki Mr M N Easton Dr L Gonano Mr M B Schult Mr D M Stewart Dr Tan Chee Phuat
SOUTH AUSTRALIA	Mr B G Richards CSIRO Division of Soils Private Bag No. 2 GLEN OSMOND, 5064	Mr R Newman E&WS Department GPO Box 1751 ADELAIDE, 5001	Mr P E Whitehead
WESTERN AUSTRALIA	Mr C A O Waterton c/- Dames & Moore 26 Lyall Street SOUTH PERTH, 6151	Mr T Osborne GFWA Pty Ltd 1 Vantor Avenue WEST PERTH, 6005	Mr M O Hillman Mr R B Lamont-Smith Dr H E Speight
TASMANIA	Mr B P Knoop c/- HEC Elizabeth Street HOBART, 7000	Mr A J Dowling c/- HEC Elizabeth Street HOBART, 7000	Mr T J Davies Mr R K Tarvydas
VICTORIA	Mr W T Flintoff 7 Scott Street CANTERBURY, 3126	Mr R Smith Aus. Construct. Services 3rd Floor Tivoli Court 239 Bourke Street MELBOURNE, 3000	Mr G W Cameron Mr D M Fotakis Mr B J Grayson Dr C M Haberfield Mr P A Morris Mr S Sekaran Mr S I Woodroffe
OVERSEAS			Mr M K Dreschler Mr J P King

AUSTRALIAN GEOMECHANICS SOCIETY

NATIONAL COMMITTEE

Chairman	Dr. Neil Mattes	Coffey & Partners (02) 888 7444
Deputy Chairman	Mr Max Ervin	Coffey Partners International (03) 429 1555
Immediate Past Chairman	Dr Peter Mitchell	Pak Poy & Kneebone (08) 212 5733

Australasian Vice Presidents

ISSMFE	Prof. Harry Poulos	Coffey & Partners (02) 888 7444
ISRM	Dr Ian Johnston	Monash University (03) 565 4963
IAEG	Mr John Trudinger	Dames & Moore (09) 367 8055

IEAust Nominees

Dr Bill Bamford	Melbourne University (03) 344 6638
Mr Michael Thom	D.J. Douglas & Partners (02) 638 7322

AusIMM Nominees

Mr Dennis McMahon	AM&S Mining (02) 95 7412
Mr Frank Kaesehagen	MIM Holdings (07) 228 1317

Elected Members

Victoria and Overseas	Mr Tom Flintoff	RCA (03) 860 2054
	Mr Brett Thomas	GHD (03) 665 0222
NSW and ACT	Mr Bob Carr	D.J. Douglas & Partners (049) 26 2766
	Mr Garry Mostyn	UNSW (02) 697 5038
Queensland	Mr Russ McConnell	QWRC (07) 224 7336
SA and NT	Mr Brian Richards	CSIRO (08) 274 9283
Tasmania	Mr Tom Bowling	HEC (002) 30 5642
Western Australia	Mr Charles Waterton	Dames & Moore (09) 367 8055

Secretary

Mr Roy Bushnell	IEAust (062) 70 6555
-----------------	----------------------

Australian Geomechanics

Number 17

June 1989

CONTENTS

	Page
State Groups and New Members	3
National Committee	4
Editorial	6
Guest Editorial - John K. Wilkins	7
Report on International Conference on Calcareous Sediments	9
Secondary Compression of Silty Clay Adjacent to the Swan River S. Wagner and A. Cray	17
The Briseis (Cascade) Dam Failure - Editor	19
Rock Discontinuity Spacing Statistics: Log-normal Distribution versus Exponential A. Mohajerani	20
The Hellyer Project - P. K. Wrigley	22
A Few Days in the Life of an Engineering Geophysicist - R. Gordon	24
Book Reviews	29
'Guide to Rock and Soil Descriptions' Ed	
'Guidelines for the Field Description of Soils and Rocks in Engineering Use' Ed	
Geonews, People & Organisations	31
AGS Draft Five Year Plan 1990 - 94	35
Gladstone's Bag	36
Gravelrash	39
Geodiary	40
State Group Reports	44

EDITORIAL

First a brief comment about the special edition of 'Australian Geomechanics' covering the 5th Australia New Zealand Geomechanics Conference. This edition was prepared by the conference organizing committee chaired by Prof. Harry Poulos and saved the current editorial committee many hours of painstaking work. Thank you Harry, John and Garry.

The task of drawing suitable material together for this issue of 'Australian Geomechanics' proved more difficult than anticipated. Striking a balance on what to publish is often complicated when material arrives which is considered borderline or which is not in accordance with our adopted 52 character column width. Even though the publication policy of 'Australian Geomechanics' has been enunciated regularly, submissions are still received which are too detailed and heavy - going for a 'news' type publication like this.

A request for more articles on mining and related matters is slowly starting to bear fruit. As our mining colleagues form a very significant proportion of our Society, their interests should be catered for more regularly.

The cover of this issue shows some aspects of the 'Briseis' (Cascade) Dam, in Northern Tasmania, which failed 60 years ago, resulting in the loss of fourteen lives. This dam failure provides a forceful reminder of the dangers associated with designing and building Geotechnical Structures. This is especially so when designs are, or have to be, based on 'insufficient' or 'limited' knowledge and understanding. This can often be the case when large structures such as dams are built in environments which can not be considered to be fully defined. Perhaps the only lower limit of a parameter that we can really be sure of is zero for the saturated cohesion intercept.

This brings us to the issue of professional liability which is currently being debated in many quarters. Dr Peter Miller, in his regular column in 'Engineers Australia' constantly reminds his readers of the implications of current legal 'opinion' on the application of the laws of liability. Many of his recent contributions to this debate should come as disturbing news to those engaged in the design, construction or maintenance of geotechnical structures. Miller concludes one of his recent columns "Engineers do not know it all" with the words: 'Engineering decision making is facing a crisis, and we are moving towards a dialogue which has been looming for some time. It will go to the root of the relationship between the profession and the community. Before we embark upon it, let's take a deep look at ourselves'.

The above words are most pertinent to Geomechanical experts, be they Engineers or Geologists, as we almost daily evaluate uncertainties of design and

probabilities of failure. Although advances in our knowledge and understanding of structural behaviour of materials may have led to considerable improvements in performance and safety, this does not mean that the risk of failure can be completely eliminated. This is of course generally recognized within the profession and is often expressed in concepts such as 'State of the Art' 'Failure Criteria' and 'Acceptable Risk'. Unfortunately such concepts are often difficult to quantify and are also subject to continual change. This is reflected for example in the fact that many water authorities both in Australia and overseas have during this decade been very much preoccupied with the issues of Dam Safety and spillway capacity. In this process many structures have now been identified which are considered to be unsafe and in particular to have inadequate spillway capacities. The process of bringing such structures to a currently 'acceptable' standard often requires considerable time in planning, design and construction. Any questions regarding liability in the event of a mishap occurring before the completion of an upgrading programme are likely to be complex.

News items and articles describing 'mishaps' and 'foul-ups' appear quite regularly in technical journals and form a constant reminder of how things can and do go seriously wrong. Some of these 'failures' such as Malpasset, Vajont and Teton, to name but a few, are permanently engrained in our minds. Many others may not be so well known but all form part of a pool of bitter experience. With the aid of hindsight the flaws in the original design decisions may be obvious. However in many instances the original design decisions appeared to be quite reasonable, when judged by the standards of the day. Then there are areas where the standards of design for some structures have changed to such an extent that it is hard to believe that those structures could have stood the test of time. In other cases disaster may appear to have been averted more by luck than good design.

Besides continually reminding ourselves of the 'failures' and 'incidents' in our specific fields of endeavour, we should perhaps also keep in mind the following dictums:

"Redundant structures can generally only accommodate one under-designed component" and "the expansion of liability is probable, for deep pockets attract litigation."

In closing this editorial we thank the Hydro-Electric Commission for its assistance in producing this issue.

Bram Knoop, Richard Barnett, Larry Polglase



GUEST EDITORIAL

John K. Wilkins F.I.E. Aust., F.I.C.E.*

ROCKFILL - A BRIEF HISTORY

A well known quotation from Karl Terzaghi runs, "on a waterless planet the science of soil mechanics would not exist."

This could be taken as a warning to those aspiring to employment on the first moon colony, but actually reflects the enormous part that water plays in the properties of soils.

As grain sizes increase the importance of water decreases, which may account for the lack of interest in rockfill taken by soil mechanics experts for a long time. Indeed it was not until the late 1950's that anything really significant appeared in print on the subject.

Common sense in engineering is very useful as it is in all aspects of life, but it can be very misleading. We have all admired the immense piles of rocks forming the pyramids or the soaring walls of the great cathedrals. They have stayed there convincing us of their stability and permanence for hundreds of years. It was common sense, therefore, to assume that rock is a hard, virtually incompressible material and that when piled up in a heap to form a dam, would be stable for hundreds of years.

For dams up to 30m in height this was not far from the truth. Faith in it dominated the engineer's thinking right up to the mid 60's, but from 1930 onwards dam heights had been increasing rapidly. The Pacific Gas and Electricity Company (P.G. & E.) California embarked on the construction of a number of dams with heights of 100m or so, using a fill of large clean rocks dumped in great layers up to 60m high, confident that they would never move. Compaction was aided by water-sluicing the fines into the fill. The watertight membrane was constructed of reinforced concrete of a thickness equal to rather more than 1% of the water depth at any point. It was generally placed as the dam rose in height, on a bed of placed rock on the surface of the fill.

What happened is history. The P.G. & E. kept a record of variations in crest levels and movements of the faces of these dams which has proved of great value to other engineers. The movements were considerable and continued for a long time - so far as I know they are still going on. Although they did not affect the stability of the dams, the concrete faces were distorted and joints fractured, so that losses of water were both large and expensive. What was happening within the fill is quite clear. High contact stresses caused fracture of the rock points

and slight movements of individual stones, which redistributed the load to other points within the rock fabric. The process then repeated itself and continued indefinitely.

As a result of these troubles the Hydro Electric Commission (H.E.C.) of Tasmania decided to restrict the height of dams of this type at 30m. This decision became a challenge and we set to work to find a solution.

The solution was not a stroke of genius on our part but rather an accumulation of the correct processes.

Casagrande said in 1965 in a lecture delivered in Vienna that "Prof. Terzaghi many years ago half jokingly stated that an ideal rockfill shall consist of rock material crushed to the size of a well graded stone of maximum size 3 inches (75mm) after which it should be strongly compacted in thin layers." This was really the basis of the solution. The number of contacts between stone and stone increases as the void ratio decreases. The more contacts there are, the more stable is the stone, and the lower is the load on each contact.

A maximum density mix of crushed rock compacted by vibration rollers was what was required. As one cannot compact effectively a layer deeper than 500mm, this dictated the ideal maximum rock size although in practice some latitude was taken with layer thickness and rock sizes. Luckily it proved quite easy to obtain a suitable mix, as it came almost naturally from a quarry run rock.

Confirmation of the correctness of this theory came from the records of settlements of the Quoich Dam in Scotland which was built in 1958 of crushed rock rolled in 2 foot (600mm) layers.

In 1966 I went on a tour for the H.E.C. to study rockfill dams, mainly in the United States and France, and on my return we set about assembling all the good features and discarding all the bad features of world practice. We backed this up with the development of a reasonable theory, with laboratory tests of materials and careful design of face joints. Construction techniques were as important as anything else and finally it all came together in the design and construction of Cethana Dam in Tasmania, a dam so successful that it served as a prototype for similar dams in many parts of the world.

The main differences between Cethana and P.G. and E. dams were the use of crushed rock in layers, the completion of virtually the full height of the dam before the concrete face was cast, and the smoothing of the face of the fill, by rolling the thin layer of crushed rock on it, before placing the concrete.

It was realised that the concrete thickness was only required to keep out water, so savings were made by reducing it to 0.3m + 0.002 times the head.

Joints in the face were improved and in particular the peripheral joints were made so that they could open a little and slide without waterstop fracture.

In 1973 I was invited to form part of the expert panel on 'Impervious elements and slope protection of earth and rockfill dams' for the Large Dams Congress (ICOLD) in Madrid.

I spoke enthusiastically of the 'decked' rockfill dams and in my address said that "whenever I went onto the construction site I felt that this was the way to build a dam." In the discussion that followed I was heavily criticised by a young engineer who mistakenly thought that I was advocating the exclusion of all other types of dam. Moreover, in the panel meeting to prepare our report, I found that I was the only engineer in favour of this type of dam. All the others were sceptical.

The years have proved concrete decked rockfill dams even more successful than I had expected and in Tasmania they have almost taken over from all other types. Even at sites in the Pieman schemes where the depth of overburden required the removal of large volumes of material from the river bed before the rockfill placing could commence, they have proved more economical than earth fill and at one site which looked a natural concrete arch damsite the rockfill won.

Not all rockfill is suitable for dam construction. Scotts Peak Dam, with a maximum height of only 34m, was constructed at the upstream end of Lake Pedder to close off the Huon River. It was constructed of hard mudstone quarried in the vicinity, sources of other better types of rock having proved illusory. Although laboratory tests showed that the argillite would give settlements almost an order higher than would have been expected from Cethana's rock, it was decided to go ahead using a flexible bituminous concrete face. The dam was also given a camber of some 250mm to allow for crest settlement.

Despite all our care in construction, the dam sprang a leak about a year after filling. The bituminous concrete may be more flexible than cement but it still fractures in tension and this is what happened. The leakage rose to about 4.5 cusecs (130 l/s) and the water accelerated the settlement as it does with all such rockfill. Despite some public alarm over safety, which was partly whipped up by ardent conservationists who had objected to the flooding of the lake, we knew there was no danger. The sealing of the leak is a story of its own, but eventually it was achieved by placing a blanket of impervious gravel over part of the face, which has permanently cut off the leakage flow.

Although Scotts Peak Dam has taught us a lesson which should not be forgotten, I think that Karl Terzaghi would be very pleased if he could see how well his advice on rolled rock has worked.

John K. Wilkins

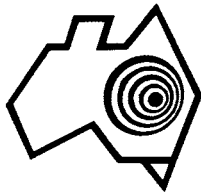
*John Wilkins is a former Chief Civil Engineer of the Hydro-Electric Commission of Tasmania. He is a fellow of both the Institution of Civil Engineers and the Institution of Engineers, Australia.

During his time with the H.E.C. he has published eight papers dealing with various aspects of rock mechanics and the design of large dams.

In 1968 he was awarded the Warren Prize and the Chapman Medal for his paper "Decked Rockfill Dams" which was presented at the I.E. Aust. Engineering Conference in Brisbane that year.

This paper was recently re-published in the Australian Geomechanics Society's Commemorative Volume marking the Golden Jubilee of the International Society for Soil Mechanics and Foundation Engineering (1985).

During his career he has taken an active interest in the affairs of professional bodies such as the I.E. Aust., the A.G.S. and ANCOLD.



AUSTRALIAN UNDERGROUND CONSTRUCTION & TUNNELLING ASSOCIATION

SECRETARIAT:

11 National Circuit,
BARTON ACT 2600

Tel: (062) 70 6555
Fax: (062) 73 1488
Telex: AA 72 6548

The Australian Underground Construction and Tunnelling Association was formed in 1972 and is jointly sponsored by The Institution of Engineers, Australia and the Australasian Institute of Mining and Metallurgy. It is a non-profit making organisation uniting engineers, tunnellers and miners in its membership with the aims of:

- * encouraging the use of the subsurface to meet social, environmental and economic demands for facilities.
- * promoting advances in research, investigation, design, construction and maintenance of tunnels and subsurface openings and structures.
- * acting as a focal point for the collection and dissemination of information on all aspects of tunnelling and underground construction.

The Association membership includes both the engineering and mining fraternities and extends to contractors, consultants, owners, public authorities, town planners, equipment and material suppliers and all individuals interested in tunnelling and underground construction.

The Association encourages member participation in activities which include:

- * organised talks on topics of interest to the members, usually in the form of lunchtime meetings
- * tunnelling and underground excavation conferences, which are held triennially
- * seminars on particular aspects of tunnelling and underground construction
- * site visits to underground works
- * presentation of the "Tunnelling Achievement Award" usually in conjunction with the triennial conference to an individual for outstanding achievements in the tunnelling industry
- * assisting with seminars and conference sessions organised by other mining and engineering groups

REPORT ON INTERNATIONAL CONFERENCE ON CALCAREOUS SEDIMENTS

This conference was jointly organised by the Institution of Engineers, Australia and the International Society for Soil Mechanics and Foundation Engineering and was held at the Sheraton Hotel in Perth from 15 to 18 March 1988.

The catalyst for the Conference was the decision by Woodside Offshore Petroleum Pty Ltd to make available the experience gained on the North West Shelf of Western Australia.

The Conference proceedings comprise seventy six papers. These include 38 papers relating to various aspects of investigation, analysis, design and construction of foundations for the North Rankin 'A' Platform. The balance of the papers relate to a variety of projects throughout the world.

Included in the Conference were four sessions in which State of the Art reports were presented followed by selected presentations and general discussions. The following session reports summarise these discussions.

Session Report: - Lateral Loadings and Shallow Foundations

Reporter: Dr. M Allman

This session was to have consisted of state of the art presentations by Prof. L Reese on Lateral Loads and by Dr. K Hoeg on Shallow Foundations, followed by selected short presentations and a general discussion. Unfortunately Dr. Hoeg was unable to present his State-of-the-Art report and the only consideration given to shallow foundations during the session was in short presentations by R N Dutt and Prof. J Burland.

State of the Art Report: The Response of Piles in Calcareous Soils to Lateral Loading by Prof. L C Reese

The report began by discussing the general background to the analysis and design of laterally loaded piles. The characteristics of calcareous soils which influence the lateral loading behaviour, and research that has been conducted on this problem were then discussed, followed by recommendations for further research and conclusions.

The analysis of laterally loaded piles requires the selection of appropriate models for the pile and for the soil. The method that has been used most widely to date for modelling the soil, particularly for the design of piles for offshore foundations, is the p-y method. In general, full-scale experiments are still critical to obtaining data on which to base recommendations for p-y curves. The p-y method was concentrated upon during the discussion of the response of calcareous soils.

The unusual nature of calcareous soils and problems with classification lead to some difficulties in modelling the response of the soil. Three fundamental characteristics of calcareous sediments were cited as significantly affecting p-y curves i.e. CaCO₃ content, cementation and crushing. The model described by Price (1988), principally related to monotonic loading for cemented calcareous soils, is very interesting and would suggest a highly non-linear p-y curve. With regard to cyclic loading, models such as that presented by Dobry et al (1988) may be useful although consideration of the permeability of calcareous soils is important.

Suggestions for further research were;

- improved near surface sampling;
- improved methods for obtaining engineering properties of calcareous soils;
- opportunities for full-scale testing should be taken; and
- further analytical work is needed.

The report was concluded with the following remarks:

- major difficulties exist in developing a rational method for predicting the response of calcareous soils to lateral loading;
- the Abbs (1983) model for p-y curves for calcareous soils provides the framework for design, and
- comprehensive site-specific testing, both laboratory and in-situ, are required for major structures, as well as conservative design.

Special Presentations

Lateral Loading - J D Murff

Murff discussed the foundation design for external struts for strengthening the first generation platforms in Bass Strait. To aid in the design of the pile to withstand lateral load, large scale tests were conducted in a pit of reconstituted calcareous sand, as well as centrifuge tests. Details of these test series can be found in Williams et al (1988) and Wesselink et al (1988), respectively. From the test results p-y curves were developed and good agreement was obtained between calculations from the p-y curves and the results of the pit tests.

Shallow Foundations - R N Dutt

Dutt discussed the behaviour of such foundation elements as jack-up footings, mud mats and gravity anchors in calcareous sands. For jack-up footings, general shear and local shear bearing capacity solutions generally overpredict the end bearing capacity in calcareous soil, mainly because of the effects of soil compressibility and scale. Spherical cavity expansion approaches have also been found to overpredict, although giving an improved prediction, with scale effects still not accounted for. Difficulties arise in predictions as important parameters such as E , ν , and the volumetric strain δ show poor repeatability in laboratory tests, and the selection of the elastic parameters is very subjective. Dutt has found that using

$$\phi' = \tan^{-1}(0.33 \tan \phi)$$

in the general shear solution provides a good prediction of end bearing capacity in calcareous soils.

For mud mats the same considerations as for jack-up footings apply, although scale effects are less severe.

For gravity anchors the sliding resistance is best approximated by using ϕ' from direct shear tests or direct simple shear tests conducted at constant volume.

Shallow Foundations - J Burland

Burland briefly discussed the results of long-term observations made on the foundations of some 20m diameter by 50m high silos founded on deeply weathered carbonate material. The pressure-settlement curves showed a classical form with a very linear portion at small strains then a break followed by a steeper curve.

Cycled over 20 years, maximum settlements were 20mm, and when the load was less than the previous maximum pressure there is virtually no irrecoverable settlement. There was a shakedown with no brittle, "run-away" type situation.

Burland believes there are tremendous advantages to be made by making measurements from local displacements remote from the loaded area, as well as at the loaded area.

General Discussion

The chairman, I W Johnston (Monash University) opened the floor for discussion and suggested that four problem areas were apparent from the previous presentations and could form the basis of the discussion. The four problem areas were:

- (i) cementation;
- (ii) pore pressure generation;
- (iii) soil compressibility; and
- (iv) scale effects.

Unfortunately time only permitted the first two to be addressed.

Cementation

L C Reese (University of Texas, Austin) - it is difficult to be specific about the effect of cementation on lateral load behaviour as it is variable. Models must allow variations with both depth and distance from the pile. At the pile, cementation can breakdown, while further away the soil remains in a pre-peak condition. Most importantly, the presence of cementation can be detrimental, particularly with respect to gap formation.

J D Murff (EPRCO) - from my experience cementation generally gives a high monotonic stiffness and if there is no breakdown of cementation then there is little concern. However, there is a dearth of information on the effect of cyclic loading and the pressures at which cementation is likely to breakdown. Tests are needed to enlighten us in this respect and work in artificially cemented soil is providing valuable information.

A F Abbs (Dames and Moore) - using our model (Abbs, 1983), if you reach the peak of the p-y curve you can get an "unzipping" action. This is alarming, however, I have never seen it happen or be reproduced in tests.

L C Reese - (in response to a question on the applicability of the pressuremeter expansion curve for deriving p-y curves). Any insitu tests which provides information on the soil is useful. Regarding the pressuremeter, it expands equally in all directions, whereas a pile moves in one direction only, so you cannot expect a one-to-one relationship. Design methods prepared at Texas A & M are useful for developing p-y curves from pressuremeter results. The self-boring pressuremeter is particularly useful, and it can be used to obtain fundamental stress-strain information and then be utilised to develop p-y curves.

L C Reese - (in response to a question on the effect of gapping). Gapping can be remedied by placing pea gravel at the surface, and offshore this may have potential, particularly where scouring protection is being provided. You could grade the scour protection from fine below to coarse at the surface. There are possibilities here for remedial action.

H G Poulos (University of Sydney) - gapping in uncemented calcareous soil was observed in model tests and this suggests there is potential for gapping to several meters depth in the North Rankin case. He enquired whether gapping was observed in the Bass Strait pit tests.

J D Murff - no gapping was observed in the pit or centrifuge tests in Bass Strait, just a conical depression.

Pore Pressure Generation

Chairman - what about the effects at pore pressure generation during cyclic lateral loading; does it affect stability?

T W Dunnavant (EXXON) - in the Bass Strait pit tests pore pressure generation was very minor under cyclic loading until the load level approached the monotonic capacity. Under working loads or 100 year loads, in uncemented material pore pressure generation is not a problem. Permeabilities from tests were variable but were as low as 10^{-5} cm/sec.

A F Williams (CSIRO) - there was a measureable effect on the stiffness of the response due to the small pore pressure generated during the pit tests, but it was minor.

T W Dunnavant - the pore pressure tended to reach a stable regime.

At this point the Chairman thanked all participants and closed the session.

Session Report: - The Behaviour of Deep Foundations

Reporter: Dr. D Airey

This section of the conference was dedicated to the axial response of deep foundations in calcareous soils. A state of the art paper was presented by Dr. M F Randolph which is briefly summarised below. This was followed by two prepared discussions. The first by Adrian Hyde looked at a method for estimating the axial capacity of piles from the results of triaxial tests, the second presented by Guy Houlsby looked at the effect on the end bearing response of layers of cemented material. Discussion was then opened to the floor.

State of the Art Report:
The Axial Capacity of Deep Foundations in Calcareous Sands
by
Dr. M F Randolph

Using data presented at the conference the principal engineering properties affecting pile capacity were restated; these are the high friction angle, the high voids ratio and resulting compressibility, and the fact that they are, typically, at least lightly cemented. The paper then went on to review the published data on the shaft capacity of driven, drilled and grouted, and driven and grouted piles. The data were compared with the design guidelines used in current practice. For driven piles, the low skin frictions were noted and particular emphasis was given to the difficulties associated with estimating the shaft capacity from pile driving records, and from the interpretation of cone penetrometer tests. Grouted section tests relevant to the behaviour of drilled and grouted piles were reported in several papers submitted to the conference. It is evident from the results of these tests that, unlike driven piles, partial cementation has a beneficial effect leading to higher lateral stresses and higher skin frictions. Again the

difficulty of predicting the performance of these piles from cone penetration data was highlighted. Finally, grouted driven piles were mentioned as these appear to offer the advantages of drilled and grouted piles without their high cost.

The variable nature of the calcareous deposits was emphasised. This makes it difficult to develop analytical models that can adequately describe the stress-strain response. In such a situation it is essential to try and understand the mechanisms involved, and to try and formulate guidelines that have a rational basis as opposed to being entirely empirical. Nevertheless, a model is essential to explore the load deformation response of axially loaded piles, particularly under cyclic loading. A model was described that captured the main features of the soil response, and was used to predict the response of a typical drilled and grouted pile under cyclic loading.

The end bearing response of piles in calcareous soils was considered. This can be a significant portion of the overall capacity, especially for driven piles. Consideration was also given to the ability of open ended piles to form soil plugs and thus govern the ability of such piles to develop their full end bearing capacity.

G Mostyn (University of New South Wales) expressed concern regarding the way in which Dr. Randolph had fitted a straight line through the data from the grouted section tests performed in the Bass Strait. Any one of a number of lines could be fitted through the data and could be made to fit a number of a priori assumptions regarding the behaviour of the tests.

M F Randolph (University of Western Australia) - In field tests it is not possible to vary all the parameters that one would like to, which in this case would have included the grout pressure and pile size, because of cost restrictions. As a result it is necessary to interpret the field tests within the framework built up from numerical and laboratory experiments. In the case of grouted sections, many laboratory tests have been performed, particularly at the University of Sydney, which show a clear effect of confining stress. Unfortunately, only a small range of grout pressures have been used so that a variety of interpretations of the data are possible. However, when producing design guidelines it is necessary to consider all the available data from a range of sources. If field data are obtained then it is possible to check that the design approach is consistent with them.

T Hyden (ESSO) - The grouted section tests in the Bass Strait were performed to develop a revised design approach for the particular materials existing in that location. As such the exercise was successful and it was possible to construct a lower bound curve to the data which was used for design.

D Murff (EPRCO) I would like to add some additional comments on the grouted section tests performed in the Bass Strait. The tests were all performed from existing operating platforms and as a result there were limits on time and accessibility which meant that a very tight schedule had to be kept to. Numerous decisions had to be taken on site using one's best judgement of how the tests were going at the time. Later when one looks at the data in more detail it is always possible to determine more information that it would have been good to have obtained.

When the tests were performed we did not have any particular model in mind. Our aim was to obtain an appropriate design model for the soil at the test site which was very weak to very strong layers. The production of a suitable design model required very careful interpretation of the data and certainly a great deal of attention was given to the scale effects mentioned by M Randolph in his state of the art paper.

P G Fookes (Consulting Engineering Geologist, Winchester, U.K.) - I would like to expand on the statement of Dr. Randolph's that calcareous sands are angular. Uncemented carbonate sands can be broadly classed into three main groups; rounded oolites, fragmented, and bioclastic or corraline. These sands can be either loose or dense. With time these sands can become cemented. At first a light micrite cement will bond the particles together and at this stage the sands will still be highly porous. Eventually a heavier cement will be formed that will close up the pores and this cement will be comprised of sparry calcite. The point at which these cemented sands can be considered to change from soil to rock lies somewhere between the light and heavy cementation. The chemistry of the cementing process is highly complex, but it is possible for the properties of the soil to change in engineering time. For instance, with the high pressures under the bells at North Rankin the light cement may dissolve, and then, perhaps as a result of the pore pressure dissipating, re-cementation may occur blocking the pores and possibly creating a much stronger material.

A Noorany (University of San Diego) I would like to caution against extrapolating the experience from Rankin to other sites of calcareous soils. Many particles from other sites contain internal cavities and I would like to ask how one would characterise the void ratio in these soils and what would the effect of the internal voids be on the stress, strain, strength response?

A Hyde (University of Bradford) Tests have been performed on a range of carbonate sands and a standard siliceous sand, the results of which are described in the paper by Golightly and Hyde (1988). In agreement with the data for carbonate sands reported in several papers submitted to this conference, our carbonate sands exhibited negative dilatancy and lower shear moduli at all stress levels than the siliceous sand.

Using Rowe's stress dilatancy theory and the pile skin friction load transfer relations of Frank and Randolph, theoretical predictions of skin friction mobilisation for the sands tested have been obtained. The predictions show that, as expected, the pile skin frictions mobilised by carbonate sands are much lower than for the siliceous sand.

The analysis set out in this presentation is still at an early stage of development; it assumes a rigid pile and a linear elastic soil. Improvements are required to account for material non-linearity, pile compressibility and to determine a more appropriate transfer function.

G Houlsby (University of Oxford) The variability of calcareous soils has been mentioned several times during this conference. In this discussion the importance of the layering will be emphasised, in particular the effects of having a strong layer amongst weaker layers and its effect on the end bearing pressure of piles.

A series of model pile tests have been carried out at Oxford University and have been described in the paper by Houlsby, Evans and Sweeney (1988). In these tests artificially cemented layers of sand have been embedded at the mid-depth of a calibration chamber containing uncemented sand. The stress level in the chamber is controlled through rubber pressure bags. The very small scale of the laboratory tests when compared to the full scale situation should be noted, the calibration chamber was 450mm diameter by 700mm high.

The principal variables studied were the effects of stress level, layer strength and layer thickness. From these tests a distinct pattern emerged in which the end bearing capacity in uncemented sand is controlled by the stress level, and in thick layers of cemented material is controlled by the layer strength. Failure of the layer was ductile at lower layer strengths and high stress levels, and brittle for high layer strengths and low stress levels. It is the pattern of behaviour with varying layer thickness which is, however, particularly interesting.

Houlsby et al (1988) discuss the results of five tests, one in purely uncemented sand and the others with cemented layers of thickness 0.5, 1.5, 3.0, and 5.0 times the pile diameter. A low confining stress was used and the cemented layers all failed in a brittle manner. In these tests the pile is continuously jacked into the specimen, so that the resulting curves are somewhat analogous to CPT profiles. Two important features emerge. Firstly the load begins to increase when the pile is within about 2.0 to 2.5 diameters of the top of the layer. Secondly, failure of the layer occurs when the pile is within 3.5 diameters (rather less for thinner layers) of the base of the layer. The load then reduces very rapidly towards the value in uncemented sand.

A result of this pattern is that the maximum load developed in thin layers is much less than that achieved in thick layers. For a layer of only 0.5 pile diameters thick, even a very strong layer causes only a minimal increase in load. Another feature is that the maximum load is developed when the pile tip is a short distance above the layer, not when it is at the surface of the layer. This means that to gain benefit from a thin strong layer the pile tip should be placed 2 to 3 pile diameters above the layer, and not directly on the strong layer.

The above results were obtained for continuously penetrating piles. Houlsby et al (1988) discuss a similar set of results for piles initially built in at the top of the cemented layer. These results are relevant to cast in-situ piles, or open ended piles which are grout plugged after driving. The tests show a very rapid build up of load, but again much lower maximum loads in thin layers, with virtually no benefit being derived from a strong layer 0.5 pile diameters thick.

In the context of the North Rankin A platform the "pile diameter" should be equated with either the bell diameter, or because of the close proximity of the bells, with the bell group diameter. The implication of the small scale model tests is that any layer of less than about 6m in thickness would have minimal impact on the foundation capacity (although it may of course influence the small displacement stiffness).

M Khorshid (Woodside) Could Dr. Houlsby give us more information about the modelling of the North Rankin profile and how the model results compared with the theoretical analyses.

G Houlsby We did not attempt to model the precise Rankin profile, but rather we attempted to model the model of the profile adopted in the finite element analyses. In practice, we had to further simplify the profile for the small scale model tests, and only drained tests could be performed. The following observations were made:

1. The model test gave a significantly stiffer response at small displacements than the finite element analyses.
2. A sudden failure occurred in the model test at a lower bearing pressure than in the finite element analyses. The model drained test looked like the undrained finite element analysis but with a higher capacity.
3. A second model test was performed in which the boundaries were adjusted to be identical to those used in the finite element analyses. This meant that the boundaries were much closer to the pile in this test. There were appreciable differences in the two test results, particularly at large pile deformations, suggesting that the boundaries used in the finite element analyses were not chosen sufficiently far away from the pile.

D Murff I have a question regarding the effectiveness of thin hard layers. Surely the response will depend on the strength of a layer relative to the surrounding layers. Will this not govern whether the behaviour is brittle or ductile?

G Houlsby In our tests the stress and strength levels were appropriate to the Rankin site, they were not identical but covered the range of values found there. From the evidence of these small scale tests it appears that a layer of less than half the diameter of the bell or bell group, would have no effect on the response. But, it is of course very dangerous, and often inappropriate, in soil mechanics to extrapolate from the results of small scale laboratory tests to the field situation.

D Murff Our experience in the Gulf of Suez with a layer of calcified limestone rock 1m to 2m thick, with piles of 1.5m diameter is worthy of note. The material both above and below this layer was very weak. During installation of the driven pile it was found that some of the piles could not penetrate through this hard layer. We were not happy with the piles resting on this thin hard layer and in some places were able to drive them through. This was achieved by having a full head of steam on the hammer we were using to drive the piles, and by ensuring we were going as fast as possible, when we reached the hard layer.

M Fahey (University of Western Australia) - The "free falling" piles at North Rankin were held up on relatively thin cemented layers. Can this be explained from the results of the work presented by Houlsby et al?

J Dolwin (Earl and Wright) The strong layers at 40m and 60m depth were both approximately 4m thick and the layer at 90m was somewhat thicker. However, the thicknesses of the individual layers were highly variable over the site.

G Houlsby If indeed, the layers were 4 metres thick then I would expect them to have a significant effect as this would be approximately 2 pile diameters.

M Sweeney (BP) The thickness effects described in the paper by Houlsby et al were obtained from tests with piles that had closed ends. For an open pile being driven without plugging it is likely that it will be the wall thickness, not the pile diameter, which will be relevant. Thus a layer of more than 2 or 3 wall thicknesses in depth would be expected to have an appreciable influence on the ease of driving.

J Cuckson (SIPM) I would like to make some observations regarding the Rankin story.

The first task was to define the problem. Initially it was felt that as the stress level was high under the foundation the problem was one of estimating the settlement. We wanted to know what the appropriate load displacement curve was. Then a new ingredient was introduced, namely, did we have a drained or an undrained problem? If we had the latter then it appeared that there was a capacity problem. This shows the importance of determining the nature of the loading, an aspect of the story that apparently received little attention early on.

Classification was also a problem. At first it was felt that the North Rankin site was unique in Australia, but it has since become clear that this was not so. Nevertheless, it proved possible to fit all the samples into one of five categories on the basis of simple index tests. Subsequently a sixth category, the eposanded material was added.

Another difficulty lay in selecting appropriately conservative numbers. The model failed to duplicate the very brittle response of much of the test data and it was not clear if this was necessarily a safe assumption. For instance, the case of a footing punching through a strong layer above a weak layer is not necessarily a brittle problem. It is important to distinguish the behaviour of a small element from that of the overall structure.

A model was selected with a deviatoric and a volumetric yield surface. A large number of tests were performed to evaluate this model. It turned out that the deviatoric surface was of far greater importance although as many tests were performed to investigate the volumetric response. It is necessary to think about the stress path that will be applied in practice and concentrate on performing the most appropriate tests.

M F Randolph I would like to comment on the point made by John Cuckson regarding the assumption that ignoring the cementation is necessarily conservative. Plasticity theory states that if one ignores part of the strength then one should be on the safe side as regards capacity. However, the same is not true for the settlements required to reach that capacity. Under the working loads and owing to the effect of cyclic loading one leg could break through a relatively weak layer while the neighbouring legs are held up on the cemented layer. As a result of the cyclic loading this leg may accumulate displacement and this may give rise to a problem of differential settlement. In such a case it would clearly be necessary to consider the effects of variable cementation under the different legs.

J Cuckson I agree with the comments Mark Randolph has made regarding the assumption that a lower strength is a safe assumption. However, the situation at North Rankin was rather different because of the effects of the variable layering with depth. Not only did the different layers have different strengths but they also had different states of drainage so that in some layers the behaviour was drained and in others undrained. Also, under different bells there were different patterns of layering and different degrees of hardening within these layers. Even within a plasticity sense, therefore, one cannot make general statements because different layers behave differently.

On the possibility of differential settlement within a group, this is unlikely because the piles are physically joined together so that one cannot advance ahead of the others. There is some possibility for some slight differential settlement but not for gross movement.

M F Randolph In that case instead of differential settlement one will get load concentration which could be just as damaging for the structure.

G Houlsby I would like to add that it can, indeed, be unsafe to ignore part of the strength. Within plasticity theory generally ignoring strength is going to be safe, but in some cases it can be unsafe. These cases are when one has a highly frictional material and when one is dealing with materials that exhibit brittle failure.

I Smith (University of Manchester) I would like to make a number of remarks concerning my involvement in the fascinating Rankin story.

Computing: I would like to emphasise that the Rankin remedial measures were computer designed. This was because there was no alternative, indeed if there had been one it would undoubtedly have been implemented because engineers are, in my view, wrongly suspicious of computer solutions.

Classification: We did have a viable classification of the Rankin material into 5 categories. Speakers at this conference have made many references to the infinite complexity of calcareous soils. This complexity is certainly not confined to calcareous soils. I am reminded of Rowe's Rankine lecture in which he said that most of the sites I have examined could be broken down into 3 or 4 horizons or materials at which point the behaviour could be comprehended and some analyses could be performed. It is disappointing to see that many of the papers submitted to the conference make no mention of the categorisation, based on the results of hundreds of drained and undrained tests, that we spent many hours developing.

The drained/undrained problem: In performing analyses of the plate load tests conducted at Rankin we initially assumed drained behaviour and found that the results were relatively insensitive to parameter variation, and they indicated adequate foundation strengths. An undrained analysis was then performed. This caused a major re-assessment of what we were doing because the analysis indicated we might have a capacity problem. To determine whether we had a drained or an undrained problem we, had to perform further analyses. From this we found that there were two orders of magnitude of permeability between the drained and undrained solutions.

However, it was not possible to accurately determine the permeability and we therefore had to take the worst case and assume that we had an undrained problem.

Conservativeness: To be conservative we took low ϕ' values and generated high pore pressures in all our analyses. However, we were worried that it could be unconservative to be conservative in situations where there was a strong layer overlying a weak layer as the strong layer could shield the material below and lead to a lack of pre-loading.

Punch through: We do not appear to have the conventional jack-up punch through problem where you plunge at great geometric variations into a lower weaker material but rather a problem where the lower layer has already sensed the load and the total response does not show a dramatic decrease in load.

Session Report: - Geology, Fabric and Classification Systems

Reporter: J P Trudinger

This section of the conference, chaired by Prof. Van Weele, addressed geological aspects of calcareous sediments including their origin, composition, texture, diagenesis and classification systems. The state of the art paper was presented by Prof. P Fookes, and is briefly summarised below. This was followed by two prepared discussions. The first by Dr. G Price presented the results of fabric studies carried out on calcareous sediments; the second by Mr. F Bullen discussed the use of coralline materials as engineered fill.

State of the Art Report: Geology, Fabric and Classification Systems by Prof. P G Fookes

Prof. Fookes commenced his address with a review of the compositions and origins of carbonate sediments including calcareous sediments. He showed the various textures and fabrics that resulted from a range of clastic grains and precipitates and illustrated the mineralogical changes that typically follow deposition - from aragonite to calcite and, ultimately, dolomite.

He then described and illustrated the various types of sediments that accumulate in the various onshore and offshore depositional environments including the beach zone, lagoons, reefs and continental shelf. Changes in the depositional environment over short distances and fluctuating sea levels explain the extreme variation in sediment types which have been observed over short lateral and vertical intervals.

Prof. Fookes went on to discuss diagenesis - the changes that take place after deposition which, in the case of calcareous sediments includes cementing, solution, mineralogical changes and micritisation. He pointed out that some of these changes can develop in "engineering time". He stressed the value of having specialised sedimentologists carry out detailed geological studies as these commonly lead to insights that are highly significant in terms of engineering response of the sediments. He also mentioned the value of chemical analyses of pore fluids.

Finally Prof. Fookes introduced the subject of classification of carbonate sediments. Geological classification systems are based on grain size, grain shape, constituent material types and type of cementation. Engineering classification systems have added consideration of the strength of the substance.

Special Presentations

Dr. Price (CSIRO) presented a talk which was based on the fabric studies that he had carried out on calcareous sediments from the N.W. Shelf and elsewhere. He presented a series of photomicrograph slides to illustrate the wide differences in texture and fabric that occur within one group of calcareous sediments - the calcarenites. These slides clearly showed both the variation in the nature of detrital grains of differing origins and the nature and degree of cementation and recrystallisation in a range of sediments.

Dr Price recommended fabric studies to assist in classifying calcareous sediments when existing broad classification categories do not provide sufficient distinction between sediments with significant differences in engineering behaviour. He also demonstrated, again by means of photomicrographs, that fabric studies can provide insights into the nature of deformation that occurs in laboratory tests.

Mr F Bullen (Queensland Institute of Technology) spoke about the use of calcareous materials, specifically coralline materials, as engineered fill in the Pacific Islands to the north of Australia. In many cases these materials represent the only readily available sources of fill in the islands. He also mentioned the variability of the deposits and the phenomenon by which the compacted coralline materials increase in strength with time. The suitability of these sediments for engineering purposes was found to depend largely on the presence of plastic fines.

General Discussion

In the very brief discussion period that followed these three talks, Asij Noorany (University of San Diego) introduced the classification system that he had developed for marine sediments and offered copies of a paper describing the system. Marjorie Apthorpe (Consulting Palaeontologist, Perth), following a question by Prof. Fookes, reported that on the N.W. Shelf in the North Rankin area, aragonite is the predominant carbonate mineral to a depth of 95m.

Session Report: - State of the Art Review - The Mechanical Properties of Carbonate Soils

Reporter: P A Hefer

Understanding of the mechanical properties of carbonate soils has progressed since the first offshore platforms were installed in these materials in the Bass Strait during the late 1960's. Initial designs based on quartz sand characteristics were later proven to be optimistic when open ended pipe piles were driven more easily than expected. Much research has since been performed on these materials and this session was intended to provide an update of current findings on their mechanical properties.

The session comprised a state of the art review, four selected presentations on the topic and a forum for limited discussion at the end.

State of the Art Report by Dr. R M Semple

The report focused on bioclastic sands and silts with a carbonate content of greater than 90% and formed on continental shelf areas. These materials were selected due to the foundation problems which are so often associated with them. Materials of this type are characterised by highly angular grains and are generally highly porous and variably cemented. The few intergranular contact points led to high intergranular contact stresses and consequently failure of these contact points may occur at relatively low applied stress levels. Reorganisation of the particle structure then occurs which results in irrecoverable strains. The phenomenon can be seen in the high unload stiffness generally displayed by these materials. Foundation response is governed by the compressibility of the soil.

Dr. Semple clearly demonstrated that the dominant characteristic of bioclastic soils is the high void ratio or porosity and suggested that the performance of these materials may be anticipated after consideration of the initial void ratio together with the cementation characteristics. After a review of test data, it was suggested that compressibility, strength, cyclic degradation, bearing capacity and pile skin friction of quartz and bioclastic sands are comparable when these soils have the same void ratio. Unlike granular silicate soils which generally exhibit a tendency to dilate, bioclastic materials contract on shear. Therefore, conventional soil mechanic theory and empiricism do not, as a rule, apply. However, design methods incorporating compressibility effects, based on appropriate test data, can provide reasonable predictions for these materials.

Special Presentations

Professor K Knight (KDM Consultants, South Africa) presented results of a cyclic triaxial testing programme carried out on samples of calcareous sands recovered from Richards Bay in South Africa. The programme was undertaken to establish whether rational geotechnical principles could be used to formulate a design approach for large diameter pipe piles driven in these materials.

Dr. M R Coop (City University, London) presented some interesting results and observations from a triaxial testing programme carried out for BP International on biogenic carbonate sand from Dog's Bay, Ireland. Samples were isotropically consolidated at cell pressures of up to 8 MPa and subsequently sheared using a variety of stress paths. Some of the major observations made from the results of the consolidation phase of these tests were that particle crushing occurred at relatively low stresses and that the exceedingly high unload stiffnesses recorded are indicative of the irrecoverable strains that results from a re-organisation of the particle structure. It was further observed that the critical state could not be reached in the drained tests and it is therefore likely that routine triaxial tests on these materials are generally terminated prematurely.

A presentation by **Dr. P K Currie** (Koninklijke/Shell E & P laboratory, The Netherlands) served to further highlight some of the aspects discussed in his paper entitled "Testing of Chemically Stabilised Calcareous Materials" published in volume 2 of the General Proceedings of this Conference. Selected results of tests carried out on North Rankin cores treated by injection of a two-component epoxy resin system (EPOSAND) developed by Shell were presented. The impregnation process was clearly demonstrated using images obtained from microphotography taken at different stages during the process. Independent laboratory testing carried out in Australia and The Netherlands produced consistent results. The unconfined compressive strength of the treated core showed an increase of up to four times over that of the untreated core.

The final presentation by **S McKean** (James Cook University, North Queensland) consisted of an outline of an interesting research programme together with CSIRO in which pile driving performance in a harsh coral reef environment may be predicted from site investigation results. The methods being investigated involve heavy dynamic probing and instrumented rotary core drilling. These techniques are being applied alongside existing piled foundations where pile driving records are available. The research programme also includes testing in a disused quarry near Geelong in Victoria where calibrations for the equipment will be carried out.

General Discussion

Limited time was available at the end of this session for discussion. Those contributions to the discussion are, however, presented below:

Dr. A Norany, (University of San Diego) expressed an interest in **Dr. Semple's** observation that at comparable void ratios, the behaviour of quartz and carbonate sands might be the same and suggested that this phenomenon would simplify geotechnical procedures in the future. A question was then directed at **Dr. Semple** in which he was asked whether a sample of carbonate sand and a sample of quartz sand both reduced to smaller particles by grinding and tested at the same void ratio under the same mean confining stress would display similar friction values.

Dr. R Semple (Dames and Moore) replied that although in some regards certain materials properties could end up being the same, there would always be a difference in the friction angle as the mineral sliding friction is different for quartz and carbonate sands.

Dr. G Price, (CSIRO) congratulated **Dr. Semple** on his premise that the initial void ratio was the critical factor regarding the mechanical properties of calcareous material. He pointed out that observational evidence obtained from fabric studies carried out on North Rankin samples which contained a large proportion of quartz sand grains and which were tested under high pressure, indicated fracturing of both the quartz and carbonate grains at a similar frequency. It was therefore concluded that there is no real difference in terms of grain strength between the two materials. **Dr. Price** also suggested that the models put forward by **Dr. Semple**, although well suited for the angular calcareous materials which are predominant in the vicinity of the North Rankin platform, were not necessarily applicable to other sites where these materials can be dominated by well rounded particles with low void ratios and where the individual carbonate grains can have very low strengths. Examples of such materials are calcarenites which are dominated by faecal pellets.

Dr R Semple reiterated that grain crushing is an important characteristic in any granular soil. This is the mechanism whereby a granular soil yields whether it be a quartz or a carbonate sand. It is an intrinsic characteristic that the reduction in friction angle and the yield behaviour is a grain crush phenomenon.

Dr. J Cuckson, (SIPM) pointed out that as one of the technical advisers to Woodside Offshore Petroleum on the North Rankin platform project, the subject of void ratio was raised as early as 1982 and followed through to about 1986 when it became a hotly contested issue during the upgrading of the platform foundations. **Dr. Semple** was therefore commended for his presentation in which new light was thrown on the subject and for paving the way to a simple perspective when dealing with these materials in the future.



AUSTRALIAN GEOSCIENCE COUNCIL

(Continued from page 33)

CURRENT ACTIVITIES

Report on Australian Geoscience 1988

One of the regular activities of the AGC Executive is to plan and compile the annual report on Australian Geoscience, which is published in the BMR Report series. Contributions are sought each year from appropriate people throughout the geoscience community. Australian Geoscience 1988 has been published, and copies will be available for distribution to all AusIMM Branches. Copies will be sent for display and distribution at the next International Geological Congress in Washington.

Conference on Crisis in Science for Primary Industries

A one day Conference was held in Canberra on 30 May 1989 to address the crisis in science education, training and careers now facing the Australian mining and agriculture industries. Objectives of the Conference were:

- to identify the needs of the mining and agriculture industries for R & D to meet the challenge of sustained technological advancement into the 21st Century;
- to confront Government with the need for sustained support for primary industry R & D, irrespective of the difficulties confronting manufacturing; and
- to alert Government that R & D for mining and agriculture requires an assured number of quality scientists and technologists trained in Australia.

CONCLUSION

This summary of the activities of AGC and FASTS is designed to show that these umbrella organisations are fulfilling a vital, if perhaps not always obvious, role in promoting science in general, and geoscience in particular, in today's fairly hostile community and political environment. I hope that individual AusIMM members will support the endeavours of these organisations whenever the opportunity arises. ■

SECONDARY COMPRESSION OF SILTY CLAY ADJACENT TO THE SWAN RIVER

S. Wagner & A. Cray*

1. INTRODUCTION

The Narrows Interchange is constructed on land reclaimed from the Swan River Estuary in Perth, Western Australia. Preconsolidation techniques were used to eliminate primary consolidation and some secondary compression with subsequent settlement resulting from secondary compression.

For projects of this nature, postconstruction settlement can be estimated from the laboratory determined value of C_α , the coefficient of secondary compression. Postconstruction settlements of the pavements within the interchange have been monitored since the opening in 1973. An analysis of this settlement data has provided field values of C_α for comparison with the laboratory determined values.

2. HISTORY OF SITE

An area of 36 hectares was required for the Narrows Interchange (Fig 1) and associated works. This area was reclaimed from the Swan River in two stages: 28 hectares reclaimed in conjunction with the construction of the Narrows Bridge in the late 1950's and the remaining 8 hectares in 1965. The reclamation in each case was achieved by pumping silty clay from the river bed to comprise the bulk of the filling. This was subsequently topped with a layer of sand approximately 1m thick.

Subsoil investigations of the site after reclamation revealed alluvial deposits of very soft organic silty clay varying in thickness from 12m to 21 m. This is underlain by 6m of sandy clay, which is further underlain by limestone.

In order to improve the poor founding conditions, preconsolidation of the compressible stratum was necessary. This was attained by installing sand drains and applying a sand surcharge. 43 000 sand drains were installed by the displacement method and approximately 3 million m³ of sand fill was imported for the embankments and surcharge. The rate of loading was controlled by the use of stability analysis based on vane shear strength tests.

The surcharge was in place for a minimum period of 2 years and settlements up to 7 m were recorded.

3. POSTCONSTRUCTION SETTLEMENT

The embankment design allowed a period of three years for construction of embankments and achievement of the desired degree of consolidation. At the end of this period excess pore water pressures had effectively returned to zero implying primary consolidation was complete.

In 1988 postconstruction settlement data for 110 stations within the interchange was plotted against the logarithm of time (typical plots are shown in Fig 2). These plots show a linear relationship and, except for 11 stations, indicate that primary consolidation was complete at the commencement of monitoring.

As with any project of this nature these postconstruction settlements have varied across the site and values in excess of 600 mm have been recorded with the average being 290 mm over a period of 19 years.

4. COEFFICIENT OF SECONDARY COMPRESSION

For most fine grained soils the magnitude of secondary compression is essentially directly proportional to the thickness of the compressible stratum at the completion of primary consolidation. Secondary compression appears to result from shear stresses since isotropic consolidation in triaxial compression tests causes very little secondary compression, whereas one-dimensional consolidation causes a significant amount. The coefficient of secondary compression is determined for complete lateral confinement such as is found in a laboratory consolidation test and assumed beneath the central portion of wide fills. It can be computed (Johnson 1970) as

$$C_\alpha = \frac{\Delta H_{\text{sec}}}{H_p \log \frac{t}{t_p}}$$

where

ΔH_{sec} = settlement as a result of secondary compression

H_p = thickness of compressible stratum at time t_p

t_p = time corresponding to completion of primary consolidation

t = time at which secondary compression settlement is computed

By computing the secondary settlement over a single logarithmic cycle of time this reduces to

$$C_\alpha = \frac{\Delta H}{H_p}$$

where

ΔH = settlement corresponding to one log cycle of time

* S WAGNER, Research Officer, A CRAY, Engineer, Main Roads Department, Western Australia

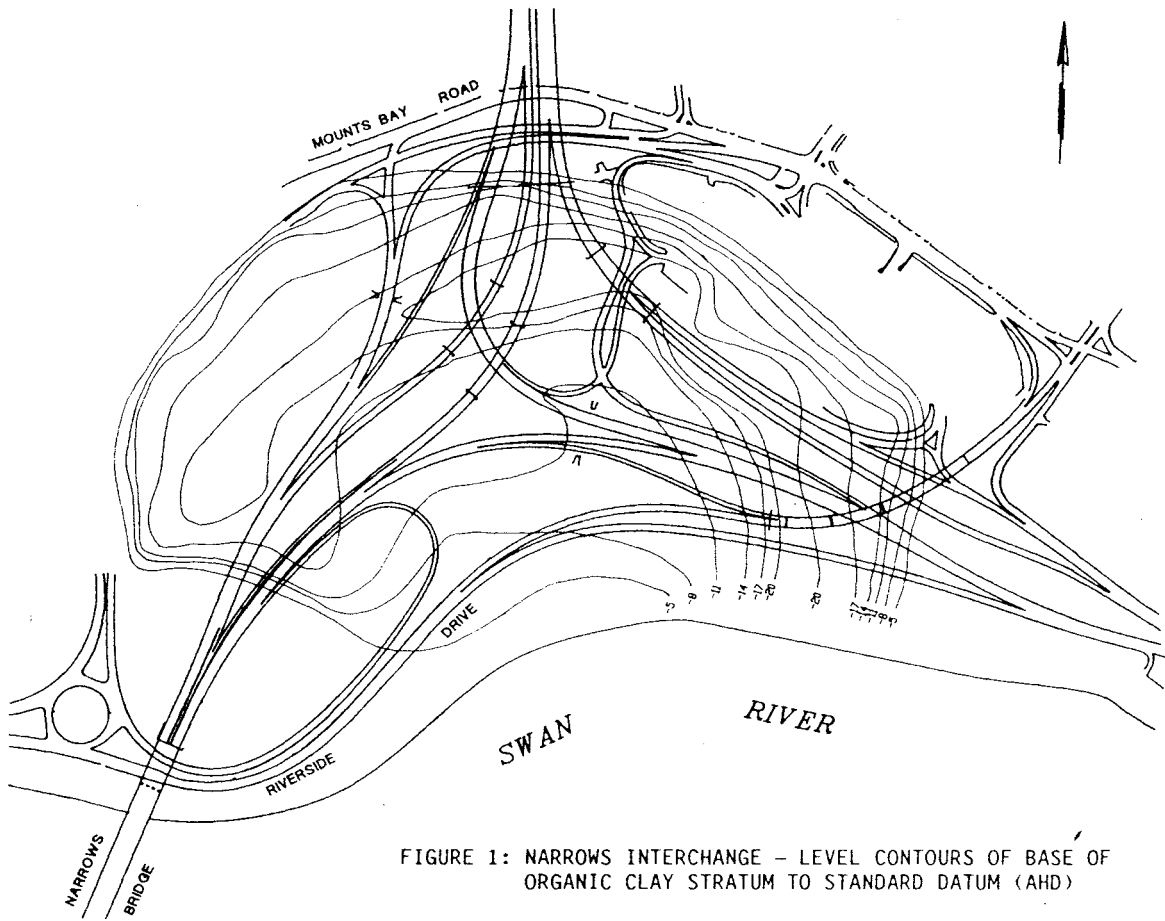


FIGURE 1: NARROWS INTERCHANGE - LEVEL CONTOURS OF BASE OF ORGANIC CLAY STRATUM TO STANDARD DATUM (AHD)

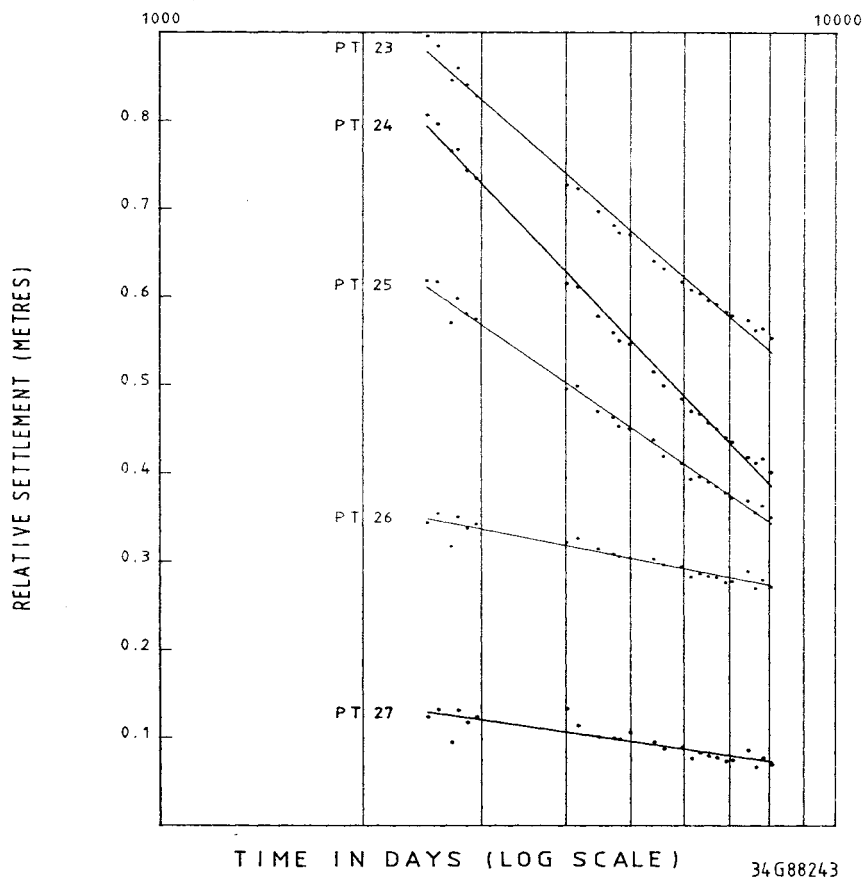


FIGURE 2: TYPICAL NARROWS INTERCHANGE SETTLEMENT STATION PLOTS - POSTCONSTRUCTION SECONDARY SETTLEMENT OF THE ORGANIC CLAY STRATUM. POINT 23, 24, 25, 26, 27

Back analysis of the post construction settlement enabled the determination of a field value for C_{α} . This was determined for all 110 settlement stations and had an average value of 0.024 with a standard deviation of 0.020

5. DISCUSSION

Laboratory tests performed on the silty clay by Soil Mechanics Ltd in London and Main Roads Department in Perth during 1965 indicate a C_{α} range of 0.014 to 0.025 (Soil Mechanics Ltd, 1968). These results were obtained from six disturbed and six undisturbed samples taken at various depths from two boreholes at the interchange. The laboratory tests were carried out at $\Delta P/P$ ratios (load increment to previous load) of 1 approximating that expected in the field after the completion of works. The relationship between moisture content and C_{α} was determined and the C_{α} range cited above was for the average natural moisture content of the silty clay (130%).

The laboratory determined values were thought to be high and it was hoped that a major portion of the secondary compression settlement would occur during primary consolidation. However secondary

compression of the silty clay stratum has resulted in postconstruction settlements within the range predicted by laboratory determined values of C_{α} at the design stage of the project.

6. REFERENCES

JOHNSON S J (1970) : Precompression for Improving Foundation Soils. ASCE Vol 96, SM1

MARSH J G (1967) : Planning of Projects - Earthworks. Permanent International Association of Road Congresses, XIIIth Congress, Tokyo.

SOIL MECHANICS LTD (1968) : Prediction of Residual Vertical and Horizontal Movements at Bridge Foundations, Narrows Interchange Earthworks, Perth WA. Report No 4542/2, London (unpublished).

WAGNER S D (1988) : Narrows interchange Settlement Predictions. MEB Report No 88/97 M. Main Roads Department, WA.

Acknowledgement: The approval of the Commissioner of Main Roads, Western Australia, for the publication of this paper is gratefully acknowledged. Opinions expressed are those of the authors and are not necessarily those of the Department.



The Briseis (Cascade) Dam Failure

FRONT COVER

This shows the remains of the Briseis (Cascade) Dam which failed sixty years ago on the 4th April 1929 and resulted in the loss of 14 lives plus extensive flood damage.

The dam had been constructed by the Briseis Tin and General Mining Co. Ltd. Its purpose was to provide sluicing water at the open cut tin mine in the Ringarooma riverbed at Derby 5km downstream.

The dam was an early example of the concrete face rockfill (CFR) dam type. Its principal dimensions were:-

maximum height	24m
crest length	137m
crest width	1.5m ₃
volume	28 400m ₃
upstream slope	1:1 at lower levels to 0.5 (H): 1(V) near the crest.
downstream slope	1:1

The rockfill consisted of granite boulders, with an approximate mass of 3-8 tonnes each, placed to a void ratio of ~ 0.46 . The foundations were of massive granite.

The upstream face consisted of a 0.3m thick reinforced concrete slab. The crest was capped with a 0.15m thick slab with 0.5m high parapets near each of the abutments. The spillway occupied the central 70m portion of the crest and discharged directly on the downstream face of the dam. Its estimated maximum capacity was 200m³/sec.

At the time of failure the flow over the spillway was estimated at 600m³/s. The failure commenced when stones and boulders were dislodged by waves of water impacting on the downstream face.

The main causes of the failure were an under estimate of the design flood, the consequent lack of spillway capacity and the inability of the dumped rockfill boulders in the downstream face to withstand the flood discharge.

The dam was re-built some years later, again as a CFR dam; however the downstream face was flattened to 1.75 (H) : 1(V) and the spillway capacity was increased.

At the inquest into the death of the 14 victims of the dam burst the verdict of the jury was: "....."....they came to the conclusion that the bursting of the dam was the result of an abnormal and unprecedented volume of water which may have been caused by a cloud burst, or by an extraordinary rainfall in the catchment area of the dam, and they advised that no blame was attachable to anyone....."

One can only wonder what the judicial outcome would be under similar circumstances today.

The failure of the Briseis dam is the only failure of a large dam in Australia for which a loss of life has been recorded. Hopefully it will also remain the last.

Ed.

ROCK DISCONTINUITY SPACING STATISTICS: LOG-NORMAL DISTRIBUTION VERSUS EXPONENTIAL

A. Mohajerani, M.I.E. Aust. *

1. INTRODUCTION

The load - deformation behaviour and seepage characteristics of a rock mass are directly related to the geometric characteristics of its discontinuities (spacing, trace length and orientation). In order to take account of the distributive character of these properties and to allow for the fact that field sampling is a statistical problem, it is essential to use statistical descriptions of these properties.

2. DISCONTINUITY SURVEY METHOD

Different techniques have been used to survey discontinuity characteristics. The most common and generally accepted method involves the use of a series of scanlines (e.g. Piteau 1970, Attewell et al. 1976, ISRM 1981).

The scanline technique which is used on rock surface exposures involves extending a measuring tape along the face of an exposure and measuring all discontinuity spacings, lengths and orientations along the tape. Discontinuity spacing can also be determined from analysis of drill cores.

Biases in discontinuity spacing and length are numerous. These have been described by Attewell & Farmer (1976), Priest & Hudson (1981), and, Rouleau & Gale (1985), for example.

3. DISCONTINUITY SPACING DISTRIBUTION

Different statistical techniques have been recommended for analysing and describing discontinuity survey data (e.g. Bridges 1975; Priest & Hudson 1976; Baecher, Lanney & Einstein 1977; Meritt & Baecher 1981; ISRM 1981 and Rouleau & Gale 1985). However, the statistical distributions of discontinuity spacing, length and orientation fitted to the results obtained by these and other investigators are not strictly consistent. For example, both exponential and log-normal distributions have frequently been fitted for discontinuity spacing. Analysis of field results obtained from scanline measurements carried out on a mudstone, a sandstone and two chinks, by Priest and Hudson (1976 and 1981), have indicated that a negative exponential distribution of discontinuity spacing values is a good approximation to the true distribution pattern. On the other hand Sen & Kazi (1984), in a discontinuity spacing study on a schist, using scanline measurements, have concluded that, "The log-normal probability density function provides flexibility in the sense that, in addition

to the average discontinuity spacing value, the variance of the discontinuity spacings is also taken into consideration in any scanline evaluations. Increase in the standard deviation gives rise to greater errors in estimations". It should be noted that in an exponential form of distribution, standard deviation and mean are equal.

Similarly, Rouleau and Gale (1985), analysing an extensive fracture data base, collected from drill cores of granite, indicated that the exponential distribution did not fit their data at all but the log-normal distribution fitted their data very well. They evaluated the goodness-of-fit of three statistical models, exponential, log-normal and Weibull, with quantile plots, and their results showed, quite clearly, that the log-normal distribution fitted the data very well. However, it is interesting to note that all the data points which did not fit the exponential distribution had spacing values about one metre or larger.

The discontinuity spacing distributions reported by Priest & Hudson (1976) show good agreement with exponential distributions for three different discontinuity sets and for each set the value of the mean spacing is approximately equal to the standard deviation (this is a characteristic of the exponential distribution). However, their results show that, for all scanlines taken together, their spacing values are smaller than one metre.

Similarly, deviation of actual spacing values from the exponential distribution, when some of the spacing values are larger than one metre, can be seen in results reported by other workers (e.g. Bridges 1976, Baecher & Lanney 1977, Wallis & King 1980 and Sen & Kazi 1984). This could be an indication that the distribution of spacing values may be assumed to be either exponential or log-normal, depending on the rock type and spacing range (between the maximum and minimum values). Apparently the spacing distribution patterns of sedimentary rocks are different from those of igneous and metamorphic rocks. It appears that spacings are randomly distributed in sedimentary rocks, but they are not randomly distributed in crystalline rocks. Furthermore, it appears that discontinuities with spacing values larger than about one metre are not randomly distributed along the scanline or borehole.

4. CONCLUSIONS

The distribution of spacing values may be assumed to be either exponential or log-normal, depending on the rock type and the range of spacing size (between the maximum and minimum). It appears that discontinuities with spacing values larger than about one metre are not randomly distributed.

* A. Mohajerani, M.I.E. Aust.,
Lecturer, School of Engineering
Capricornia Institute

As a consequence of this investigation, the writer makes the following suggestions:

- (i) Discontinuities could be classified as finely-spaced if less than 10 per cent of the spacing values are larger than one metre and as coarsely-spaced if 10 per cent or more of the spacing values are larger than one metre;
- (ii) Exponential and log-normal distributions could be fitted for finely-spaced and coarsely-spaced discontinuities respectively;
- (iii) To estimate RQD, from field discontinuity spacing measurements, Priest & Hudson's equations (Priest & Hudson 1976) and Sen & Kazi's curves (Sen & Kazi 1984) could be used for finely-spaced and coarsely-spaced discontinuities, respectively.

5. ACKNOWLEDGEMENTS

The author would like to thank Mr. Garry Mostyn, Department of Civil Engineering, The University of New South Wales, for providing the majority of references used in this study.

6. REFERENCES

Attewell P.B. and Farmer I.W. Principles of Engineering Geology. Wiley, 336-345, (1976).

Baecher G.B., Lanney N.A. and Einstein H.H. Statistical Description of rock properties and sampling. Proceedings of the 18th US Symposium on Rock Mechanics. 5c1-1 - 5c1-8 (1977).

Bridges M.C. Presentation of fracture data for rock mechanics. 2nd Australian New Zealand Conference in Geomechanics, Brisbane, 144-148 (1975).

Deere D.U. Technical description of rock cores for engineering purposes. Rock Mech. Eng. Geol. 1, 17-22 (1964).

ISRM (International Society for Rock Mechanics Commission on Standardization of Laboratory and Field Tests) Suggested Methods for the Quantitative Description of Discontinuities in Rock Masses, Int. J. Rock Mech. Min. Sci. 15 319-368 (1978).

Merritt A.H. and Baecher G.B. Site characterisation in rock engineering. Proc. 22nd US Symposium on Rock Mech. 49-66 (1981).

Piteau D.R. Geological factors significant to the stability of slopes cut in rock. South African Inst. Min. Met., Symposium on Planning Open Pit Mines, Johannesburg (1970).

Priest S.D. and Hudson J. A. Estimation of discontinuity spacing and trace length using scanline surveys. Int. J. Rock Mech. Min. Sci. & Geomech. Abstr. 18, 183-197 (1981).

Priest S.D. and Hudson J. A. Discontinuity spacings in rock. Int. J. Rock Mech. Min. Sci. & Geomech. Abstr. 13, 135-148 (1976).

Rouleau A. and Gale Statistical characterisation of the fracture system in the stripa granite, Sweden. Int. J. Rock Mech. min. Sci. & Geomech. Abstr. 22, 353-367 (1985).

Sen Z. and Kazi Discontinuity spacing and RQD estimates from finite length scanlines. Int. J. Rock Mech. Min. Sci. & Geomech. Abstr. 21, 203-212 (1984).

Wallis P.F. and King M.S. Discontinuity spacings in a crystalline rock. Int. J. Rock Mech. Min. Sci. & Geomech. Abstr. 17, 66-67 (1980).



GEOTEST INSTRUMENTATION

INSTRUMENTATION FOR CIVIL ENGINEERING AND MINING APPLICATIONS

Australian Agents for:

- * GLOETZL of West Germany - hydraulic & pneumatic measuring systems, tunnel monitoring instrumentation.
- * SOL EXPERTS of Switzerland - sliding micrometers, clinometers.
- * CAMBRIDGE INSITU of U.K. - high pressure dilatometers, self boring pressure meters.
- * SOIL INSTRUMENTS of UK - piezometers, pressure cells, settlement cells & inclinometers.
- * RICO of West Germany - borehole & pipeline TV inspection system.

11 Ebeli Close
Narre Warren North
Victoria, 3804

Telephone: (03) 700 5252
Fax: (03) 700 4009

THE HELLYER PROJECT

P.K. Wrigley, BSc.*

Introduction

The Hellyer deposit is one of the biggest mineral discoveries in Tasmania this century. The deposit is situated approximately 70 km south of Burnie and 3 km north of the Que River Mine in a relatively unexplored northern portion of the Cambrian Mt Read Volcanics.

Aberfoyle has a 90% interest in the Hellyer deposit, with Paringa Mining and Exploration Company PLC holding the balance.

Exploration History

Aberfoyle secured exploration rights over the area in 1970 and conducted regional geological mapping, stream sediment surveys, airborne electromagnetics and a comprehensive literature review to delineate targets for ground electromagnetics and soil geochemical surveys.

These methods, and subsequent drilling led to the discovery of the Que River deposit in 1974. A diluted indicated mineable ore reserve of 3.6 million tonnes of 0.35% Cu, 6.97% Pb, 12.51% Zn, 171 g/t Ag and 3.36 g/t Au was established.

At Que River the available ground electromagnetic systems failed to identify the main ore lens due to its poor conductivity. A good response to induced polarisation led to extensive use of this method over the area for several years in conjunction with geological mapping, stream and soil geochemistry, and drilling. However, by 1982 it was concluded that no substantial massive sulphide deposits existed less than 50 metres below surface and during 1983 a substantial part of the prospective volcanics were surveyed using UTEM. This method, a large-loop, broadband time-domain electromagnetic system, had demonstrated that the main ore lens at Que River was moderately conductive, during orientation surveys over the mine, but the response was too weak for earlier systems which were unable to detect poor conductors at depth.

A UTEM survey to the north of the Que River Mine was conducted to determine the response of some disseminated sulphides encountered in 1982 when drilling an IP/geochemical anomaly. The UTEM survey revealed part of a deep linear conductor to the north of the drill hole, with a detectable strike extent of 400 metres.

By the end of 1984, 94 diamond drill holes totalling 27,368 metres were completed. Continuity of mineralisation was defined over 600 metres of strike and ore body limits were established everywhere except the northern end. Indicated in-situ resources

are considered to be 20 million tonnes averaging approximately 0.4% Cu, 7% Pb, 13% Zn, 160 g/t Ag and 2.3 g/t Au.

Geology

The Hellyer copper-lead-zinc-silver-gold ore body was emplaced penecontemporaneously with a prominent north-south fault within the Cambrian Mt Read Volcanics. A diagrammatic plan and cross sections are detailed in the accompanying figures. A stringer zone has pervasively intruded and altered porphyritic dacite ridges in an Andesitic Lapilli Tuff Sequence and have provided a locus for fold development around the base metal core. A Feldspar Phyrlic Sequence overlies these rocks and underlies volcanoclastics which host the mineralisation. Stratigraphically overlying the volcanoclastics are andesites, pillow lavas, black shale and an epiclastic sequence containing rhyolitic tuffs and shale.

The geological environment in the Que River-Hellyer area is considered to be similar to the Kuroko deposits of Japan in which ore bodies tend to occur in clusters.

Mining

The ore body is accessed via 1.3 km adit from the floor of the Southwell River Valley. The ore body was intercepted at about mid-height and up to 5 km of incline and decline ramps will be used to access its full vertical extent (which is over 500 m).

The majority of ore will be obtained by open stoping, followed by mass firing of pillars and extraction under caving conditions. Mining will commence in large primary stopes with arched roofs to provide stability. When the primary stoping is complete in an area, the surrounding pillars will be mass-blasted into them. At this stage the openings will be so large that surrounding waste rock will subsequently cave. The ore from the pillars will be extracted from below the caved material.

The mine will have an underground workforce of 40 miners, working on a three shift, five-day week roster. Some of the mechanised equipment employed is the largest used underground in Australia.

Mineral Processing

Initially, production totalled 250,000 tonnes per year, with the ore being treated at the converted Cleveland (tin) concentrator during commissioning of a new mill which was opened in April, 1989. The Hellyer concentrator has a capacity of 1 million tonnes of ore per annum. It produces four types of base metal concentrates: zinc, copper, silver and bulk concentrates.

* P.K. Wrigley BSc
Administrative Geologist Department of Mines Tasmania

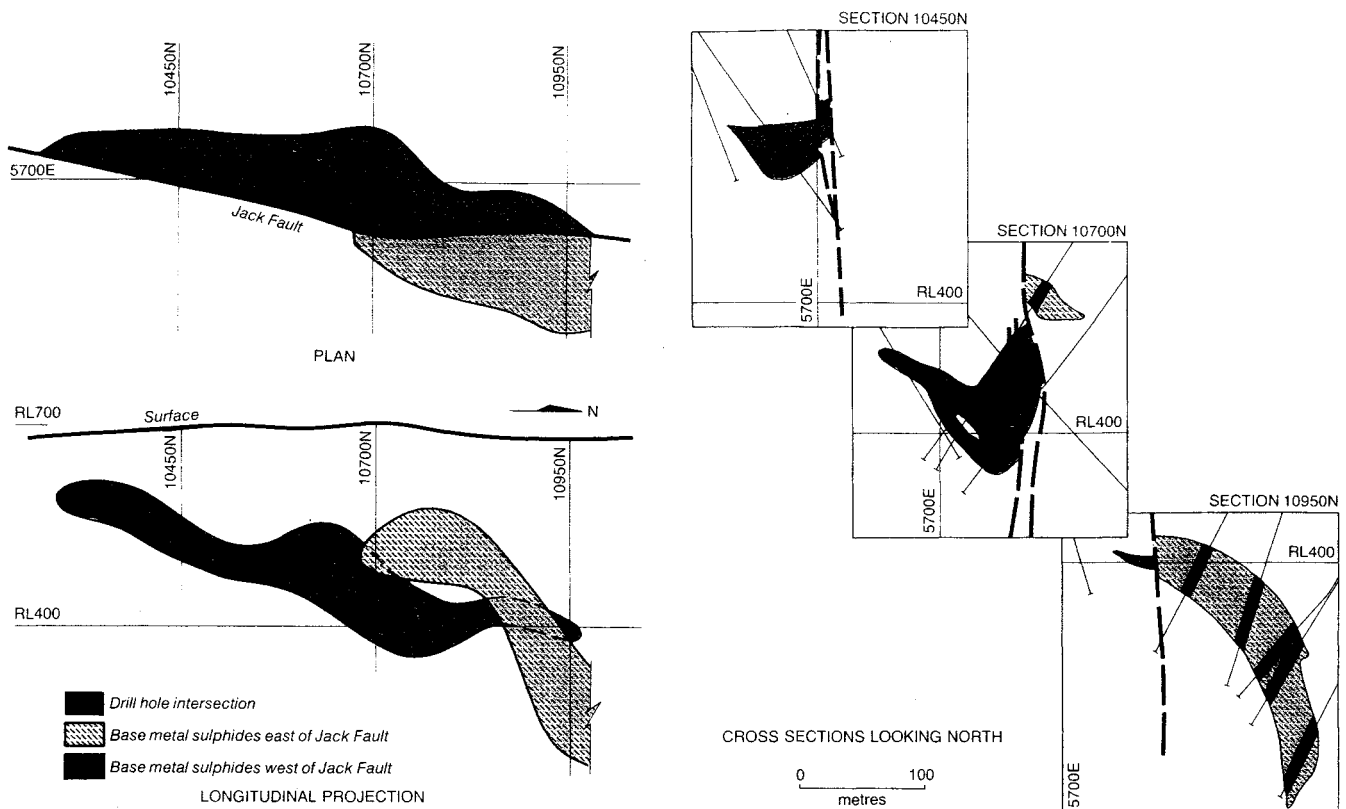
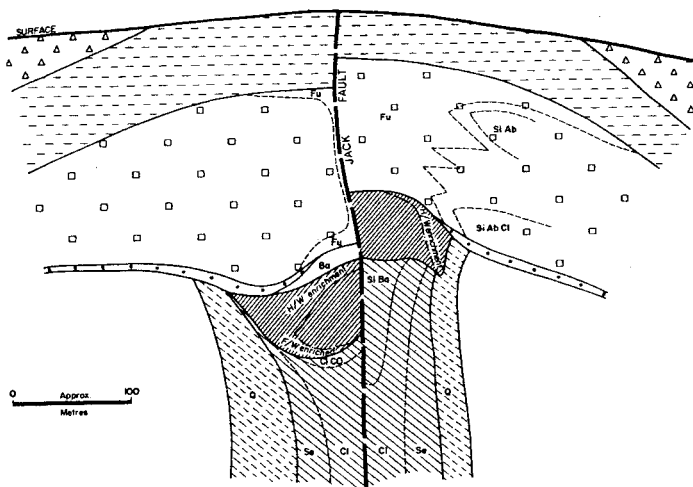


Figure 1 - Hellyer Project - plan and typical cross sections of ore body.



STRATIGRAPHIC UNITS	
	Upper Rhyolitic Sequence
	Que River Shale
	Pillow Lava Sequence
	Hanging Wall Volcaniclastic Sequence
	Barrie
	Base Metal Sulphides
	Feldspar Phytic Sequence
	Stringer Zone
	Stringer Envelope Zone
ALTERATION MINERALOGY	
Fu	Fuchsite
Si	Silica
Ab	Albite
Cl	Chlorite
CO	Carbonate
Se	Sericite
Q	Quartz (Sericite-Silica-Pyrite)

Figure 2 - Hellyer Project - schematic cross section.

The mill utilises a number of innovative features that place it on the front line of mineral processing technology in Australia, these include:

- . production of four separate concentrates
- . second largest flotation machines ever installed (and the World's largest for lead-zinc)
- . first Tower Mills installed in Australia

- . total plant design for lowest capital cost and energy efficiency
- . centralised control room for overview of all sections.

Concentrates are transported from the mill to Burnie via the Emu Bay Railway. From there, a substantial tonnage of the zinc concentrate is shipped to the Electrolytic Zinc Company's Risdon plant where metallic zinc and saleable by-products are produced. Other concentrates are sent to mainland Australian smelters and to Japan, Korea and Europe.

Acknowledgement

The mining and mineral processing sections in this article have been summarised/paraphrased from Pringle-Jones (1989). This informative publication is available from the Tasmanian Chamber of Mines.

References

Aberfoyle Pty Ltd Annual Report 1984.

Jack, D.J.; Sise, J.R. Report on Exploration on the Mackintosh E.L. 2/70 during the period January, 1983 to April, 1984, October, 1984.

Pringle-Jones, J. (1989) Minesreport special edition: Aberfoyle Limited, The Hellyer Project, Opening, Tasmanian Chamber of Mines Pubs.

Sise, J.R.; Jack, D.J. Exploration Case History of the Hellyer Deposit, Mineral Exploration and Tectonic Processes in Tasmania, Burnie Nov. 1984.

The Examiner, Tasmania, 20 August 1985 and 25 May 1985.

The Advocate, Tasmania, 20 September 1985. △

A FEW DAYS IN THE LIFE OF AN ENGINEERING GEOPHYSICIST

Ray Gordon

I appreciated the recent serious discussion between Messrs Stapledon and Fell on the value of engineering geophysics. My own experience when trying to utilize geophysics in an integrated site investigation has been generally one of despair. For the education of readers I attach an actual TRIP LOG made during a recent geophysical survey of a port site. There have been bigger disaster areas in this potent field but not many as this state of affairs is often the lot of a contractor using other peoples gear from seismic equipment to survey vessels. Names in the TRIPLOG have been changed to protect the innocent. How can geophysicists remain SANE under conditions like these - oh yes, well, maybe they don't?

Ray Gordon.

MONDAY - 30 NOVEMBER 1987

- 08:30 Able proceeds to Port to mobilise vessel, power supplies and transducer bracket being arranged. Ten boxes of equipment from PWD in Port store.
- Equipment unpacked and installed on vessel with assistance from Port staff. Documentation on PWD manufactured interface boxes and amplifiers missing, and some cables apparently missing. Some cables extra to requirement.
- 12:45 Baker arrived on vessel with computer and interface notes from PWD.
- 15:00 Line filter obtained from Port. Awaiting Pinger bracket fabrication.
- 16:00 Geophysical equipment mobilization completed as far as possible, computer not reading bathymetric data. Power cable for trigger amplifier manufactured.
- 16:30 Departed vessel.

TUESDAY - 1 DECEMBER 1987

- 07:00 Arrived at vessel, prepared Boomer for sea trials.
- 08:00 Purchased additional power distribution board, Pinger transducer assembly arrived.
- 09:45 Slip for trials using Boomer; system giving records and required final tuning. Baker setting up computer.
- 11:45 Computer not operational, returned to suppliers for checking.
- 13:00 Computer returned but apparently not 'talking' to Micro-fix or Sounder. Tests with Pinger show system runs intermittently.
- 16:00 Computer working, but not logging bathymetry.
- 16:15 Departed vessel.

WEDNESDAY - 2 DECEMBER 1987

05:55 Arrived at vessel.
06:00 Port staff arrived and unlocked gate.
06:10 Port surveyors on board then setting up batteries at shore stations.
07:05 Tests with Boomer prior to running lines. Base Station No.3 installed.
07:15 Station running however problem with computer.
07:30 Returned to jetty.
08:30 System apparently operational, standing by for return to boat crew from hospital (eye damage).
09:30 Leave for trials.
10:00 Returned to jetty, problem with continuous fixing on analogue data. Problem with continuous fixing, 'locking-up' of computer and expanded display on helmsman display.
12:00 Replacement computer sourced.
13:00 Computer arrived, however, 10 volts found on earth line between Geophysics (tied to sea-earth) and Micro-Fix so computer returned.
14:00 Further investigations showed 10 volts on earth between Micro-Fix and Helm Monitor.
15:00 Boat returned to pen for modifications to Micro-Fix/Monitor.
15:30 Port obtained replacement monitor.
18:00 Staff leave.

THURSDAY - 3 DECEMBER 1987

05:50 Arrived at vessel, gate locked.
06:00 Port staff arrived.
06:10 Surveyor at vessel, other Port surveyor setting up base stations.
06:40 Stations installed.
07:00 Testing system at sea; working, then computer 'locked-up' again.
08:05 Back alongside to work on computer.
12:00 Still interface problem with computer, apparently the output from Micro-Fix too low. Port staff to Racal for replacement Micro-Fix.
13:15 Replacement Micro-Fix arrived, 240 volts and no power lead.
15:10 Power lead arrived. Micro-Fix output apparently insufficient for computer.
16:00 Decision to use manual fixing. Port installing logging unit to use with Port Micro-Fix.
16:30 Proceeded to river.
17:00 Boomer output power lead shorted to earth, checked Boomer plate and found earth plug off. Plug reconnected and held in place. System run up again, still short circuit and sparking at power unit. Examined power lead and found damaged insulation.

18:30 Completed attempts for days work.

FRIDAY - 4 DECEMBER 1987

06:45 Standby for Port staff due at 08:00.
08:00 Surveyors installing stations.
08:45 Leave harbour.
08:44 Boomer running.
08:58 Turn on SOL. On line 1 but no fixing due to bad ranges.
09:02 Fix 13, EPC recorder dropping out.
09:21 Abort work, EPC problem. Port surveyor to office to calculate line co-ords. New stylus belt installed on EPC.
09:34 Running to line 2.
09:37 Interference from ship's radio seen to stop EPC.
09:56 Line ended, bad fixation, problem with Micro-Fix ranges. Returned to jetty to install alternative Micro-Fix unit.
10:00 Gear control on ship's engine failed and hit bridge. Pinger transducer hit but no apparent damage. Pinger and EPC recorder run for 1 hour. EPC ran without failing once, and Pinger transducer fired continuously.
14:27 Vessel repaired and preparing to survey.
14:34 Surveying, primary lines Inner Harbour.
15:40 EPC recorder failed.
17:05 EPC fault rectified.
18:40 Completed surveying for day. Base stations being retrieved using vessel. Apparent problem with position of precalculated lines - wrong grid parameters in Micro-Fix; Port surveyors to rectify.
19:00 Vessel alongside.

SATURDAY - 5 DECEMBER 1987

05:40 Arrived at vessel.
07:30 Vessel in survey area, Port setting up stations.
07:57 Start of survey in Outer area, data affected by noise from seastate or the large number of vessels in the area.
08:10 Lost navigation, lost ranges.
08:34 SOL 2, data poor. Retrieved equipment and found Boomer joy plug burnt out.
10:46 Boomer plug repaired. Small generator failed to start.
11:00 Generator running and although the supply was suspect the equipment was operational.
11:18 Line conditioner installed.
11:20 Boomer system run up, no power from Boomer supply unit.
12:25 Pinger system run up and operated on internal trigger for approximately 1 hour. Reflection from seabed obtained; however, only very weak and discontinuous

penetration recommended that use of Pinger would not achieve useful data in the prevailing soil conditions.

13:25 Boomer checked for open circuit. Boomer cable/plate has resistance 0.7 ohms. Dummy load (sparker) made and confirms that original ignitron and Boomer cable OK. Attempted to locate spare Boomer plate.

SUNDAY - 6 DECEMBER 1987

06:00 Decision made to decommission vessel until replacement parts can be sourced.

08:45 Equipment packed in Port store.

FRIDAY - 11 DECEMBER 1987

08:30 Status meeting.

10:00 Departed for Port.

11:00 Meeting at Port.

13:00 Departed.

FRIDAY - 18 DECEMBER 1987

08:40 Able at Port.

09:30 Equipment unpacked and ready to load.

11:30 Survey vessel apparently unserviceable.

17:30 Departed Port office.

MONDAY - 21 DECEMBER 1987

07:30 Able and Baker at vessel picked up Atlas Deso 20 transducer and overside mounting bracket.

08:15 All small equipment loaded, waiting on crane to lift generator, shiprights and welder. Port staff located their own Deso 20 transducer and overside bracket.

10:00 Bench installed and instruments set up ready for testing, waited for completion of welding prior to test.

11:10 Transducer bracket welded and earth attached.

12:00 High voltage (Boomer source) tested. Low voltage/instruments run using shore power due to loose carburetor on generator.

12:30 Generator repaired and seismic equipment ready for 'sea trials'.

15:45 Sea trials and equipment operational after tuning, however, no echo sounder or Micro-Fix operational at this time.

17:00 Tied up alongside.

17:15 Departed.

TUESDAY - 22 DECEMBER 1987

06:00 Arrived, waiting on surveyors to set up base stations.

06:25 Slipped berth, problems with Micro-Fix monitor.

07:20 Alongside for Micro-Fix.

07:40 Slipped berth, no helmsman monitor on Micro-Fix.

08:00 Boomer deployed, data marginal due to seastate. Returned to sheltered waters and noted gradual weakening of signal (seismic).

08:20 Complete failure of hydrophone, dismantled unit and found to be low in oil, returned to berth to source oil.

13:15 Sea trials using repaired hydrophone, signal still weak.

14:00 Operational system obtained.

14:39 Surveying, seastate marginal.

15:29 Commenced surveying in relative shelter, unable to survey in harbour due to lack of suitable base stations. Some Outer primary lines and diagonal tie lines surveyed.

16:47 Abandoned work for the day due to the seastate.

17:05 Alongside.

WEDNESDAY - 23 DECEMBER 1987

05:00 Arrived at vessel, standby for surveyors to install base stations.

05:20 Slipped berth.

05:40 Boomer equipment deployed and ready to survey. Surveyed outer primary lines, outer tie lines and diagonal tie lines.

10:50 Break off survey for coxswain rest spell and adjustment of base station configuration.

12:30 Resume survey, Inner Harbour tie lines.

14:20 Break of survey for coxswain replacement, continue Inner Harbour tie lines.

16:25 Completed days survey.

17:00 Boat returned to pen in time for coxswain relief.

THURSDAY - 24 DECEMBER 1987

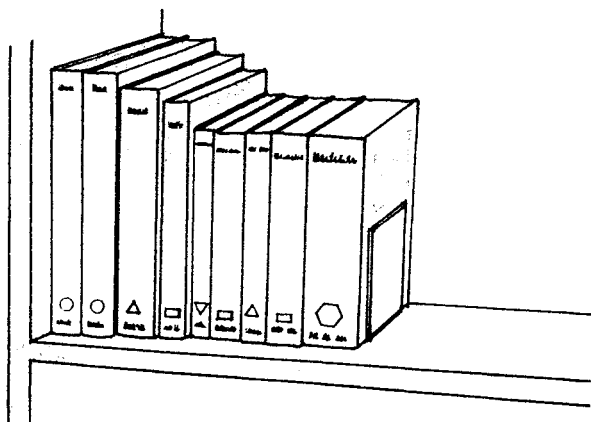
07:36 Slipped berth.

08:00 Equipment deployed and operational, survey in Beach area.

09:00 Returned to berth.

10:00 Equipment unloaded and placed into store.





BOOK REVIEWS

"Guide to Rock and Soil Descriptions"

Geoguide 3 - Geotechnical Control Office,
Civil Engineering Services Department.
First Published July 1988.
HONG KONG.

189 pages, Price in Hong Kong: HK \$40.00
Price overseas : US \$ 9.00
(Including surface postage).

This guide is a companion volume to Geoguide 2 which was reviewed by Tom Bowling in Australian Geomechanics issue no. 15. This document is aimed primarily at the practising civil and/or geotechnical engineer and associated professionals working in the earth sciences field.

The structure of the guide is based on Section 8 of the British Code of Practice for site Investigations, BS5930:1981, and emphasises geological conditions pertaining to Hong Kong and its immediate surrounding territories.

The geoguide was prepared in the Geotechnical Control Office, Hong Kong, under the direction of Mr. J.B. Massey. The main contributors included Drs. R.P. Martin and R.L. Langford.

The contents of the guide are arranged in five main sections i.e. introduction, description of rocks, description of soils, engineering classification of rocks and soils and legend for maps, plans and diagrams. Also included are references, tables, figures, colour plates, an appendix and a glossary.

The sections on descriptions of rocks and soils are well set out. The evaluation of specific rock and soil parameters are dealt with in a concise manner. In general this geoguide provides advise and numerous hints on how the task of describing rocks and soils should be approached.

This volume should be a useful source document for geotechnical engineers and geologists especially those who are involved in projects in and around Hong Kong.

"GUIDELINES FOR THE FIELD DESCRIPTION OF SOILS AND ROCKS IN ENGINEERING USE".

First published November 1988.
New Zealand Geomechanics Society, Wellington.

42 Pages, Price not stated.

This guideline is the result of an extensive process of evaluation of a series of draft documents. The

original guideline was produced by the Geomechanics Society in 1980. A revised draft document, completed in 1985, was circulated to all society members for comment. The current document can be said to represent the collective thoughts of a wide range of geotechnical practitioners in New Zealand. The committee responsible for putting this guideline together, i.e. Messrs. S.A.L. Read, P.J. Millar, N.S. Luxford and A.J. Olsen, have produced a brief loose leaf manual which should provide a ready reference on how to describe soils and rocks in situ.

The document is in four parts, introduction, description of soils, description of rock and abbreviated charts and example logs, plus a bibliography.

The description of soils is largely based on the USBR "Earth Manual" and includes a (reduced in size) copy of its unified soil classification chart. The guideline for the description of rock is based mainly on the method originally put forward in the 1972 Report of the Engineering Group of the Geological Society Working Party.

Part four provides several examples of abbreviated charts obtained from various New Zealand organizations.

The guideline provides a concise office reference and can be obtained from the Institution of Professional Engineers, New Zealand, P.O. Box 12241, Wellington North, New Zealand.

Ed.

ROCK ENGINEERING

By John A. Franklin and Maurice B. Dusseault.
Published by McGraw-Hill Publishing Company.
600 pages (hard back), price A\$150.00

This book was received recently from McGraw-Hill Australia. The book follows the rock engineering syllabus taught to fourth-year civil engineering and earth sciences undergraduates at the University of Waterloo in Ontario, Canada. A comprehensive review will be published in the next issue of Australian Geomechanics.

Business Directory

Ph (07) 369 6889

John Beal
Engineering Geologist

J.C. BEAL
43 Armstrong Terrace
Paddington Qld. 4064



MINCAD Systems

Australia's GEOMECHANICS SOFTWARE SPECIALISTS

- * Leading Civil Engineering Design Programs:
 - * CIRCLY - Pavements
 - * FOCALS - Raft Foundations
- * **State-of-the-Art Software for Rock Mechanics**
 - * Pillar Design * Slope Interaction
 - * Extraction Sequence * Subsidence
- * User-friendly, interactive graphics
- * Runs on IBM compatible micros
- * Software installation * Training
- * Professional support * Consulting services

- * **Contact us for free demo disks**

MINCAD Systems Pty. Ltd.
PO Box 408, Canterbury, VIC 3126
Tel: (03) 830 4362 Fax: (03) 836 0608



The University of
New South Wales

CENTRE FOR
POSTGRADUATE
STUDIES IN
CIVIL ENGINEERING

SHORT COURSE ON EMBANKMENT DAM ENGINEERING Including Earth, Earth and Rockfill and Tailings Dams

25th - 29th September 1989

The course is designed for Civil Engineers, Engineering Geologists and Mining Engineers who are involved in the investigation, design, construction and operation of earth, earth and rockfill and tailings dams.

The course will be practically based, but will present the state of the art and discuss shortcomings in present practice. It will be of value to experienced as well as inexperienced practitioners. Attendees will be encouraged to discuss their own dam problems.

The course lecturers include:

Professor R Fell, University of NSW;
Professor D Stapledon, South Australian
Institute of Technology; Mr P Macgregor,
Coffey & Partners Pty Ltd;

The course fee is \$850

For further information please contact:

Ms L. Lim Ph: (02) 697 5080

Fax: (02) 663 2188

Centre for Postgraduate Studies
School of Civil Engineering
The University of New South Wales
PO Box 1, Kensington NSW 2033

Access to the best

The HEC Enterprises Corporation has been created to market the facilities and expertise of Tasmania's highly-credentialed Hydro-Electric Commission.

The Commission is one of the relatively few organisations which undertakes, inhouse, all aspects of electricity supply from initial site investigations, through to detailed design, construction, operation and marketing.

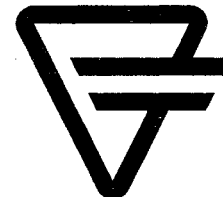
From the drawing boards to commissioning have come 26 individual hydro power schemes including all the civil and electrical engineering structures and installations: More than 800km of roads have been built, mostly in ruggedly remote terrain, 34 major dams and 172km of tunnels and pipelines.

In 1987 the Hydro-Electric Commission finished the massive Pieman River Power Development, resulting in the Commission receiving the Australian award for Engineering Excellence.

The wealth of accumulated skill and knowledge and a depth of modern engineering equipment and facilities is available through the HEC Enterprises Corporation.

The HEC Enterprises Corporation - Engineering Excellence of the Highest Order - a Corporation equipped to take on the world with that same engineering excellence.

HEC ENTERPRISES CORPORATION



Manager: Mr Alan Davison

Postal Address:

*HEC Enterprises Corporation
GPO Box 355D*

HOBART TAS AUST 7001

Telephone: (002) 305174

Telex: 58091

Facsimile: (002) 305823

GEONEWS, PEOPLE & ORGANISATIONS

DRAFT CODE OF PRACTICE FOR EARTHWORKS

Committee CE27 of the Standards Association has now agreed a draft of the proposed Code of Practice for Earthworks for Residential and Commercial Development. This Standard is being prepared to provide guidance and recommendations with respect to the performance and control testing of earthworks for residential, industrial and commercial development, and associated site preparation works. It is intended to provide a basis upon which site works for such projects can be specified and to provide guidance in interpretation and applications of the test procedures presented in AS 1289.

This draft is currently being prepared in SAA format and is expected to be available for public review in August 1989. The Committee would welcome constructive review and comment and urges all with an interest in this important and often controversial issue to obtain a copy of the draft from their local SAA office when it becomes available.

Max Ervin

RECENT APPOINTMENTS

Dr Ian W. Johnston has been appointed as an Associate Professor in the Department of Civil Engineering at Monash University. Dr Johnston is currently Vice-President for the Australasian region of the International Society for Rock Mechanics.

Professor Harry Poulos of Sydney University has joined Coffey Partners International in Sydney whilst retaining a part time commitment with Sydney University.

ERRATA

In the last issue of Australian Geomechanics (Special Issue - 5th ANZ Conference on Geomechanics) some errors occurred in the Session Summary for Session B1. The text 6 lines from the top of page 115 which says "Rock mass indices are" should be replaced by "RQD alone is" and on pages 113 to 116 "Mr Barrett" should be replaced by "Dr Barrett".

As editor of the issue I offer my apologies to Dr John Barrett for these mistakes.

ERRATA

John Small

In the last issue of Australian Geomechanics (Special Issue - 5th ANZ Conference on Geomechanics) some errors occurred in the Session Summary for Session B1. The text 6 lines from the top of page 115 which says "Rock mass indices are" should be replaced by "RQD alone is" and on pages 113 to 116 "Mr Barrett" should be replaced by "Dr Barrett".

As editor of the issue I offer my apologies to Dr. Jack Barrett for these mistakes.

John Small

NEW GEOMECHANICS GROUP IS FORMED

A new international group has been formed to foster research in geomechanics, an interdisciplinary area that involves the study of natural and man-made systems with emphasis on the mechanics of various interacting phenomena. To be known as the Association for Computer Methods and Advances in Geomechanics, the group springs from a series of highly successful international conferences on the subject that began in 1976 and is held every three years.

In addition to encouraging and seeking funds for basic and applied research, the new group will also advocate industrial applications related to computer methods and other advances in geomechanics. It will also undertake efforts to introduce the subject into undergraduate and post graduate engineering curricula. A major avenue of communications will continue to be through its conferences, the next of which is set for 1991 in Australia. For more information contact: Secretariat, International Association for Computer Methods and Advances in Geomechanics, Dept of Civil Engineering and Engineering Mechanics, University of Arizona, Tucson, AZ 857 21 USA.

ISRM COMMISSION OF TESTING METHODS

SUGGESTED METHODS FOR SEISMIC TESTING WITHIN AND BETWEEN BOREHOLES.

This document has been received recently and will be available from the CSIRO Library.

The document is in four parts and comprises 25 pages. It was co-ordinated by K. Sassa of Japan.

The topics covered in the document are: seismic testing within bore holes, seismic testing between bore holes and seismic tomography.

The document contains a number of illustrations including some computer generated graphics in colour, and concludes with a list of 21 references.

The quoted price is \$3 from Pergamon Press Plc. Great Britain.

THE AUSTRALIAN GEOSCIENCE COUNCIL

The following article describing the structure and activities of the Australian Geoscience Council was published in the AusIMM Bulletin and Proceedings, Vol. 294, No. 4, June 1989. It is reproduced by kind permission of the Australasian Institute of Mining and Metallurgy. The Australasian Geomechanics Society is also a member of the Australian Geoscience Council. The author, Eric Best, is a longstanding member of the Australian Geomechanics Society.

Structure and recent activities of the Australian Geoscience Council

by ERIC BEST

The AusIMM's Representative on AGC
and AGC Treasurer
Canberra College of Advanced Education
PO Box 1 Belconnen ACT 2616

The Australian Geoscience Council (AGC) is a forum of representatives of Australian geoscientific societies and organisations, co-operatively working together to encourage the development of the earth sciences in the best interests of the Nation and of the members of the geoscientific profession

Collectively the Council represents over 7000 professional members of the geoscientific community including geologists, geophysicists, geochemists, palaeontologists, soil scientists, geographers and many other specialists in earth science involved in the exploration, development and conservation of national resources, and in teaching and research in earth science disciplines.

The Council consists of the Member Societies, whose nominated Representatives elect six of their number to form the Executive Committee. Additionally, the constitution provides for related geoscientific organisations (eg Governmental bodies, Research Institutes) to be invited to join the Council as non-voting Associate Members and Observers.

The composition of the AGC is currently as follows:

Council Members: Association of Exploration Geochemists, The Australasian Institute of Mining and Metallurgy, Australian Geomechanics Society, Australian Society of Exploration Geophysicists, Australian Society of Soil Science, Geological Society of Australia, Institute of Australian Geographers, and Petroleum Exploration Society of Australia.

Associate Members: Australian Clay Minerals Society, Australian Council of Chairmen of Earth Science Departments, Australian Geoscience Information Association, Australian Institute of Geoscientists, Australian Mineral Foundation, Australian Mining and Petroleum Law Association Ltd, Bureau of Mineral Resources, Commonwealth Scientific & Industrial Research Organisation, Consortium of Ocean Geosciences, Government Geologists' Conference, International Association of Hydrogeologists, Soil Conservation Service of NSW, and Statistical Society of Australia.

Observers: Australian Academy of Science, Australian Academy of Technological Sciences and Engineering, and Australian Mineral Industries Research Association.

OBJECTIVES

The objectives of the Council are as follows:

- 1 To promote co-ordination and co-operation in the activities of Australian geoscientific societies.
- 2 To develop and disseminate to governments, industry and other bodies informed and collective opinions on matters of science policy involving earth sciences and their practical application, without political or industrial bias.
- 3 To promote the development of earth science education in Australia at all levels.
- 4 To provide an informed opinion to the people of Australia on matters of public concern relating to the earth sciences by developing channels of communication with the news and other information services.

- 5 To provide liaison with other scientific and professional societies in Australia and internationally.
- 6 To serve the community of earth scientists in Australia in whatever other ways the Council shall determine to be expedient, but excluding regulatory roles.

RELATIONSHIP WITH THE FEDERATION OF AUSTRALIAN SCIENTIFIC AND TECHNOLOGICAL SOCIETIES (FASTS)

FASTS was formed in 1985, following an attack on science and technology funding in the preceding Commonwealth Budget. It has a full-time executive Director (David Widdup) and a Council and a Board made up of representatives from member Societies. FASTS has about 70 Member Societies, representing 60,000 scientists and technologists working in industry, government, research, administration and education. It has become a fully operational lobby for science and technology, and has been doing a tremendous job, both behind the scenes and in the media, in trying to counter the science and research bashing that has been so evident in the political environment in recent years.

The geoscience community are members of FASTS through the Australian Geoscience Council, rather than through the individual Member Societies. Membership of FASTS currently costs \$3.50 per individual member. However, because the geoscience community is represented through the AGC, rather than the individual Societies, and because of the significant overlap of membership of the individual geoscience Societies, the AGC subscription to FASTS is based on an estimated total of 3,000 geoscientists to be represented. The FASTS subscription is then divided up proportionately among the AGC Member Societies. This means that the individual Societies are paying for FASTS membership, through AGC, at a rate of about \$1.50 per geoscience member.

In the early days of FASTS, there were some concerns about its operation being too political, but these were just teething problems. An earlier criticism that FASTS was not responsive to geoscience needs is certainly not true now. For the past two years David Widdup has attended all AGC Executive and Council meetings, with great benefit to both parties. The last AGC Council meeting was unanimous in its support of FASTS, as the geoscience community has a responsibility to support the only body which exists solely to promote the essential value of science and technology research and education to Australia's present and future wellbeing.

ACTIVITIES OF AGC DURING 1988

Murray Basin Conference

The AGC gave financial and organisational support to the Murray Basin Conference held in Canberra 23-26 May 1988. The co-sponsor was the Groundwater Working Group of the Murray-Darling Basin Ministerial Group of the Murray-Darling Basin Ministerial Council. Representatives of government agencies from Victoria, New South Wales and South Australia as well as the Commonwealth were all actively involved. The wide representation of organisations and disciplines ensured that the problems of water quality and soil degradation were examined from the widest possible perspective. About 170 delegates attended the Conference, a report of which has been published as Bureau of Mineral Resources Record 1988/43.

The Executive has set aside \$4000 to support future broadly-based ventures that will bring together geoscientists and other scientists to examine problems of wider community interest. Advances from this fund will be in the nature of seed money, and would normally be reimbursed from the proceeds of the meeting.

Member organisations of the AGC are invited to apply for assistance for similar ventures.

ANZAAS

The ANZAAS Committee requested the Executive of the AGC to organise a half day Symposium on 'The contribution of geoscience to the national economy'. Dr Neville Markham of the NSW Geological Survey convened the Symposium on behalf of the Council. The program was greatly appreciated by those who attended but numbers were smaller than expected.

The AGC Executive seeks views on whether or not if its efforts would be better rewarded by supporting specific inter-disciplinary projects such as the Murray Basin Conference mentioned above, rather than generalist ones at ANZAAS. The Executive would welcome your comments.

BMR Review

Because of its size and breadth, BMR must play a leading role in Australian geoscience. With the present Government's record of reducing the resources available to science through funding cuts in the CSIRO and tertiary education sectors, Council felt it was important to make a submission to the BMR Review. The members of the Executive who are not directly associated with BMR, undertook the task of informing the Minister for Resources, Senator Cook, and the reviewer, Mr Alan Woods AO, of the importance of BMR, the means by which it fulfils its role, and some ways in which its scientific effort could be improved.

A submission was written, and discussions were held with Senator Cook's staff. After the report of the review was published, the AGC took advantage of the opportunity to comment by preparing a response, which was sent to both Senator Cook and Mr Kerin.

Ocean Drilling Program

The AGC has given its support to the raising of Australian funds to join the ODP through a consortium arrangement with Canada. A sum of \$1.15 million has been obtained from BMR, the Australian Research Council, the Australian Vice-Chancellors' Committee, and the Antarctic Division. A national ODP committee has been set up, and it has selected the University of Tasmania to be the site of the Program office.

'Green Paper' on Tertiary Education

The Green Paper's recommendations and its special implications for geoscience were summarised. This summary was circulated at the Geological Society of Australia Convention in Brisbane in February, and it also received wide circulation through FASTS. A submission to the Minister, Mr Dawkins, was acknowledged, but led to no recognisable changes in government policy as set out in the final 'White Paper'.

FASTS

The AGC maintains membership of FASTS for a number of reasons:

- At a time of persistent attack on the funding and the character of science done in this country, it is necessary for scientists to present a united front. Our input is needed to support science as a whole;

- Earth scientists form a relatively small group in comparison with biologists, chemists and physicists, and our interests are better secured if we form part of a large body;
- FASTS has established a strong lobbying role with the Federal government and has succeeded in having scientists appointed to bodies previously dominated by economists, lawyers or trade unionists;
- FASTS is acting as a focus for submission on secondary teacher training in science and mathematics, and geoscience must be well represented in that effort.

It is the view of the AGC Executive that any reduction of support for FASTS activities would leave Australian science weaker, and geoscience exposed to attack by an unsympathetic and largely uninformed community and government.

Geoscience Awareness Program (GAP)

This program was founded by Professor Bob Carter of James Cook University, and is centrally administered from the Earth Resources Foundation by Ms Robyn Stutchbury. It has set itself the task of informing the community of the importance of geoscience for understanding the environment and the economy of the country. It seeks to do this by influencing teachers, lobbying for changes in school curricula, and issuing press releases on issues of public concern.

AGC has agreed to support GAP wherever possible, and the AGC Executive is collaborating with Ms Stutchbury as opportunity offers. She attends AGC Council meetings as an observer.

Overseas Shares of Skilled Immigrants

The Department of Employment, Education and Training prepares recommendations to government on the need to recruit personnel overseas for various professions and skilled trades. The Executive has offered advice to that department on the geoscience profession. It has stressed the need for more secure employment for geologists and geophysicists in certain areas of industry, and has pointed out the effects on tertiary educational institutions of fluctuations in employment.

Creation Science

In response to requests from several quarters, the Executive wrote to all Ministers for Education pointing out the disastrous effects of teaching 'creation science' as an alternative to real science in schools. Responses supporting the Council's view were received from all States except Queensland. A second letter was then sent to the minister in that State who has sent a more subtle, casuistic reply. It has been decided to let the matter drop. Invincible ignorance is invincible ignorance.

Research Priorities

The profession will soon be asked by the Australian Research Council (ARC) to indicate two or three areas of geoscience research which are considered to be major national priorities. These may be broadly defined, as demonstrated by the biological sciences where genetics and molecular biology, and Australian ecosystems have been suggested as its priority areas.

The Executive of AGC intends responding to this request by the ARC and seeks input from member societies. This could be through the holding of a workshop to identify research priorities. Please send your thoughts on this suggestion, or any other ideas, to Peter Smith, Secretary, AGC, c/-Bureau of Mineral Resources.

It is important to note that marine geoscience has been declared a national priority for 1989, and the Ocean Drilling Program benefited by a grant of \$600,000 from ARC as a result. This field may not be so considered in 1990 and beyond. Clearly it is important that we respond imaginatively and responsibly.

(Continued on page 16)



SEVENTH AUSTRALIAN TUNNELLING CONFERENCE AND TRADE EXHIBITION

11-13 SEPTEMBER 1990

"THE UNDERGROUND DOMAIN"

SYDNEY.

The Seventh Australian Tunnelling Conference continues a series of regular conferences for those persons interested in the productive or creative use of underground space. The Conference is organised by the Australian Underground Construction and Tunnelling Association and by The Institution of Engineers, Australia in co-operation with the Australasian Institute of Mining and Metallurgy.

The aim of the Conference is to provide a forum for discussion of the broad economic, social and technical factors that bear upon our community's use of underground space. This will be achieved by bringing together, perhaps for the first time, interested entrepreneurial, urban planning, technical, construction, regulatory and environmental specialists.

Contributions addressing the aims of this Conference are invited from engineering personnel, researchers, equipment suppliers, architects and property owners or developers who are interested in underground space. Papers are invited in the following broad areas of interest:

- The financing of underground projects
- Urban planning and commercial development of underground space
- Innovative use of underground space
- Environmental and regulatory aspects of underground activity
- Industrial relations and industry matters
- Permanent and temporary services for underground structures
- Case studies
- Recent research
- Ground support
- Equipment development
- Project Management
- Underground construction in mining
- Investigation, planning and design
- Contractual issues

DEADLINES

Receipt of synopses **25 September 1989**
 Notification of acceptance of synopses **11 December 1989**
 Receipt of papers for final review **12 March 1990**

ENQUIRIES

The Conference Manager,
 The Institution of Engineers, Australia
 11 National Circuit, BARTON ACT 2600
 Telephone: (062) 70 6549
 Facsimile: (062) 70 6530

MINE GEOLOGISTS' CONFERENCE

MOUNT ISA QUEENSLAND

2 - 5 OCTOBER 1990



The North West Queensland Branch of The Australasian Institute of Mining and Metallurgy is to conduct a conference designed specifically for mine geologists. It is the first of its kind to be held in Australia.

The Conference will provide the venue for the presentation and discussion of practical aspects of mining geology. It is anticipated that the following categories will provide the majority of interest:

- Collection and Manipulation of Raw Data;
- Geology Input into Mine Planning, Drilling and Blasting;
- Ore Reserve Estimation (Computerised and Manual);
- Diamond Drilling;
- Computer Applications;
- Grade Control;
- Ground Conditions and Support;
- Ore Accounting.

Particular emphasis on recent development, innovative ideas and cost reduction methods is desirable. Papers with a bias towards practical aspects of mining geology are preferred. The Conference is expected to attract mining geologists from underground and open-cut operations worldwide.

UNDERGROUND TOURS

Half-day tours to the mining operations in the Mount Isa region will be conducted during the Conference. These tours will include visits to the underground operations at the Mount Isa and Hilton Mines.

VENUE

The venue for the Conference will be the Mount Isa Civic Centre which is ideally situated in the centre of the city on the east bank of the Leichhardt River. The Civic Centre is suitably designed and equipped for technical sessions with a large auditorium, extensive balconies and a main entrance foyer.

TRADE EXHIBITIONS

It is proposed to hold trade exhibitions in the Civic Centre foyer featuring suppliers, services and equipment. Intended exhibitors are invited to indicate their interest so that space can be allocated and guidelines established.

CONFERENCE VOLUME

Papers to be presented will be published in a Conference volume. Copies will be distributed at the Conference.

LANGUAGE

Please note the language of the Conference is English.

CALL FOR PAPERS

Intended contributors interested in submitting papers are requested to forward a one page abstract to the Organising Committee by 30 September 1989. Advice of acceptance will be given by the end of November 1989. Final manuscripts will be required by 31 May 1990.

MOUNT ISA

Mount Isa city is located in North West Queensland, Australia. It has a population of approximately 25 000 people. The city has developed primarily due to the operation of Mount Isa Mines Limited which currently produces 5.4 million tonnes of copper ore and 4.6 million tonnes of lead-zinc ore per year from the Isa and Hilton Mines.

ORGANISER

The Conference is being organised by the North West Queensland Branch of The Australasian Institute of Mining and Metallurgy.



THE AusIMM 1990 ANNUAL CONFERENCE

New Zealand 1990

Sheraton Hotel, Rotorua New Zealand

18-21 March 1990

1990 is the 150th Anniversary of New Zealand and this makes it very appropriate that the 1990 Annual Conference of The Institute is to be held there. New Zealand has a long history of mining activity commencing with the gold rush of the 1860's. While major gold dredging and more recently iron sand operations are well known most operations both surface and underground have been small in scale. These include the recovery not only of gold but of a wide variety of minerals for example many industrials and energy related resources.

Conference Topics

While papers are invited on exploration, mining, mineral processing, economics, new technology, environmental controls, rehabilitation and resource management papers more specifically addressing the topics outlined below would be preferred.

The conference will place emphasis on these topics - of particular interest in New Zealand - and field visits and conference tours both technical and scenic will highlight both past and current operations in these general areas.

Small Scale Mining

Operations producing less than 500 tonnes per day contribute significantly to the mineral output of most countries. Small scale mining has always been a feature of mineral production in New Zealand and Australia. Papers are expected to cover the special features pertaining to the assessment, development and technology of smaller mineral deposits.

Alluvial Mining

The sustained gold price has resulted in a major growth in the number of alluvial gold operations world wide. These together with sand mining involve unique technology and papers will include aspects of resource evaluation, mining and associated processing and recovery where many innovative developments have recently been demonstrated.

Industrial Minerals

While attracting less attention the industrial minerals industry yields substantial tonnages of products for the construction,

agricultural, manufacturing and metallurgical industries. These commodities represent a branch of the mineral industry which has distinctive evaluation, beneficiation and marketing characteristics and which provides the opportunity for sophisticated added value processing.

Gold Geology and Technology

Considerable attention has been focused on the history of gold mining and on the future potential for discovery in New Zealand as part of the Pacific Rim system. Interesting research and exploration developments will be addressed together with an update on the application of processing technology.

Energy - Oil, Natural Gas, Coal and Geothermal

The planned development and utilization of energy resources is of great national importance. The definition of resources and strategies for future use with particular reference to coal will form the basis for technical sessions in this broad area.

KEYNOTE ADDRESSES

It is expected in Keynote Lectures will address the role of the Mineral Industry in New Zealand, and its development and closer association with Australia.

EXHIBITION

A trade exhibition will be held in conjunction with the Annual Conference. Potential exhibitors are asked to contact those person

FOR FURTHER INFORMATION

M H Buckenham or W E Vance
 Department of Mining Engineering
 University of Auckland
 Private Bag AUCKLAND
 NEW ZEALAND
 Telephone : +64 9 73 7804
 Telex: UNILIB 21480
 Facsimile: +64 9 366 0702

PRE AND POST CONFERENCE TOURS

Pre and Post Conference tours will be arranged in both the North and South Islands of New Zealand covering areas of mining, historical and scenic attraction

ACCOMPANYING PERSONS PROGRAM

A full and interesting program will be arranged for persons accompanying delegates to the Conference

Mrs J M Webber
 Conventions & Marketing Coordinator
 The Australasian Institute of Mining and Metallurgy
 PO Box 122 Parkville Victoria 3052
 Telephone: +61 3 347 3166
 Facsimile: +61 3 347 8525

**AUSTRALIAN GEOMECHANICS SOCIETY
DRAFT FIVE YEAR PLAN, 1990-1994.**

Dr. Neil Mattes, the current Chairman of the Society, has released a draft report which was prepared by a three man sub-committee consisting of Max Ervin, Charles Waterton and Garry Mostyn.

The sub-committee's draft report as shown below is set out in two parts, "Aims and Objectives" and "Suggested Action Plan".

The report has been forwarded to all local groups of the Society for consideration so that National Committee delegates will be able to discuss this matter at the next National Committee meeting in October.

AIMS AND OBJECTIVES

The aims and objectives of the Society during the period 1990-1994 will be as follows:-

1. To work with its sponsoring bodies, the Institution of Engineers, Australia and the Australasian Institute of Mining and Metallurgy, to create greater public awareness of the Geomechanics profession and its contribution to society.
2. To maintain and improve standards and to promote professional conduct in the practice of Geomechanics.
3. To promote (i) the evaluation and consolidation of existing knowledge and its relevance to practical geomechanics, (ii) the assessment of the reliability of various analytical and design procedures, and (iii) research and investigation into geotechnical problems which are relevant to Australian conditions.
4. To increase membership of the Society and, in particular, to encourage wider participation in the Society by persons involved in the Mining, Construction and Engineering Geology sectors.
5. To increase the numbers of organizations involved in the Society as Supporting Members.
6. To promote Australian Geomechanics by hosting appropriate local and international seminars and conferences.

SUGGESTED ACTION PLAN

Many of the proposed actions address more than one of the aims of the Society.

1. Each of the Society's Groups should hold regular meetings with invited speakers addressing topics of interest to geomechanics. At least some of these meetings should be targetted at non geotechnical personnel; thus other engineers, architects, planners, etc should be invited to attend.
Continuing.
2. Where appropriate the content of the above meetings should be more widely disseminated by publication in general civil engineering and other broader based publications. Technical meetings should be recorded, where possible, for wider distribution and speakers encouraged to submit short technical notes or papers to Australian Geomechanics.
Continuing.

3. Articles regarding broad based geotechnical issues should be submitted to the sponsoring bodies annual conferences. At each such conference the Chairman should organize an invited paper addresssing a topic of wider interest which would increase awareness of geomechanics. Society members should be encouraged to attend these conferences.
Annually.

4. The Institution's Code of Ethics and Dr. Peter Mitchell's notes should be published at least once every two years in Australian Geomechanics, members attention should be drawn to these documents. Guest editorials on ethics and liability issues should be published in Australian Geomechanics.
Two Yearly.

5. The Society should, as national body, hold a National Conference every four years, and organization for this conference should be rotated between State and New Zealand groups, as appropriate. The organizing committee for the A.N.Z. Conference should ensure that at least some sessions are targetted at the Mining and Engineering Geology sectors. The Regional Vice-Presidents of the I.S.R.M. and the I.A.E.G. should work actively to ensure that these sectors are involved in the Society's activities and that there is no conflict of themes between conferences nationally and internationally.
1992.

6. The Regional Vice-president of the I.A.E.G. should investigate the current situation of the Engineering Specialty Group of the Geological Society of Australia and see if any headway can be made in ensuring a unified voice for engineering geologists.
1990.

7. Supporting membership should be promoted by a general mailing of the publicity dodger and accompanying invitation to join. The chairman to follow up selected targets or delegate such targets to committee members.
1990.

8. The National Committee and each State Group should formally report on specific issues relevant to aim 3(iii). This may best be achieved by each group reporting every two years on progress with respect to these aims and objectives; the National Committee should then consolidate this into a short position paper to be published in Australian Geomechanics.
1990.

9. Government and private organizations should be encouraged to contribute, support or undertake research in geomechanics. Local participation should be encouraged.
Continuing.

10. Depending on its size each Group should endeavour to organize, say every two to three years, a workshop/seminar on an issue of local geotechnical interest.
Continuing.

12. Each group should encourage the active participation of young professionals in its activities. Thus young members should be encouraged to address technical meetings and to nominate for group committees.
Continuing.

13. Every committee and sub-committee should report annually to its parent regarding its past and future performance. The membership of all committees should also be reviewed annually.
Continuing.

GLADSTONE'S BAG



CHINESE GEOLOGICAL ABSTRACTS AND LITERATURE.

The abstracts are published quarterly by the National Geological Library of the People's Republic of China with the aim to provide bibliographic information on Chinese geological literature. Each issue may contain up to approximately 500 citations. References to more than one hundred Chinese magazines on geology and related sciences are quoted. An index of authors and magazines, appropriately indexed, is included with each issue.

The English edition of the quarterly comprises approximately 100 pages and costs:-

US\$ 20.00 per issue,

US\$ 60.00 per year,

US\$104.00 per 2 years.

Postage per copy costs US\$ 6.70 surface mail,
US\$19.00 airmail.

The distributors are:

Export Department of China National Publications
Import and Export Co.

P.O. Box 88,
137 Chao Nei Street,
BEIJING, CHINA.

Telephone: 444625,
Telex: 22313 CPC CN.

Some typical titles quoted in the geological literature catalogue (G) 88-1 and 89-1 include:

GE-17

Stratigraphy and Palaeontology of Systemic Boundaries in China, Cambrian - Ordovician Boundary (1) - (2).
18 papers, 36 authors, 840 pages, 114 plates, English
US\$56.00 (surface mail), US\$70.00 (airmail).

GE-18

A Research on Cenozoic Tectonology of the Longjing Structural Area in the Shelf Basin of the East China Sea Region.

209 pages, 55 plates, English ed. 1985.
US\$14.00 (surface mail), US\$20.00 (airmail).

GE-22

Developments in Geoscience.
63 papers, 677 pages, 200 figures, English ed. 1984.
US\$53.00 (paperback) plus US\$5.80 (surface mail) or
US\$23.69 (airmail).

GE-25

Engineering Geological Problems in Asia.
30 papers, 500 pages, 150 figures, English ed. 1986.
US\$48.00 (paperback) plus US\$5.80 (surface mail) or
US\$18.52 (airmail).

GE-27

Introduction to Geomechanics.
234 pages, 50 figures, 9 plates, 1984 ed.
US\$60.00 (paperback) (includes surfacemail).

GE-28

Cambrian Trilobites of North China.
459 pages, 125 plates, 1987 ed.
US\$74.00 (paperback) plus US\$5.80 (surface mail) or
US\$22.62 (airmail).

GE-36

The Reconstruction of Climate in China for Historical Times.
174 pages, 1988 English ed.
US\$56.00 (paperback) plus US\$3.40 (surface mail) or
US\$13.13 (airmail).

For further details please check with the CSIRO Geomechanics Library.

The Australasian Institute of Mining and Metallurgy has announced the publication of:

GEOLOGY OF THE MINERAL DEPOSITS OF AUSTRALIA AND PAPUA NEW GUINEA (Two Volume Set)

This publication has been edited by Frank Hughes, a successful exploration geologist and a group of specialist advisers and will be available in the third quarter of 1989. This Monograph will cover the major mines and mineral prospects of this area and comprises 240 papers set out on 1400 pages and is illustrated with colour plates. Two folded geological maps are included with the publication.

Contents include:

General papers;
Precambrian Orogenic Domains and Cover Sequences of Western, Northern and Southern Australia;
Late Proterozoic and Phanerozoic Epicratonic Sedimentary Basins;
The East Australian Orogenic Province;
The New Guinea Orogenic Province;
Surficial Deposits.

Price \$150.00 (Members).
Enquiries: The A.I.M.M.
P.O. Box 122
Parkville,
VIC. 3052.

SOIL SLOPE STABILITY PROGRAMS REVIEW

An ACADS meeting was held in Melbourne during April to discuss the findings of the ACADS-Monash University Review of Slope Stability Computer Programs. The organizers of this project, Professor Ian Donald and Mr. Peter Giam, had arranged for a series of slope stability problems to be solved by various organizations each using their own slope stability computer program packages. The aim of the review was to test the different computer programs in use rather than the experts who normally operate such facilities.

The results obtained from participants in the review were compared against referee solutions which had been prepared by five different experts, three from overseas, using different methods of analysis.

Except for a few discrepancies the referee solutions agreed closely and were adopted as the correct solutions for the review.

The review covered five typical slope stability problems and called for solutions to ten distinct load cases. In the review 42 computer programs are listed and 236 solutions are summarised.

The findings surprised the organizers in that the spread of results obtained varied considerably more than had been anticipated. Considering that the slope stability problems used in the review had been fairly tightly defined, one would have expected that the results obtained for the minimum factor of safety, F , should have been within ± 0.05 of the referee value in each case. However the variations for the values of F obtained were found to range from -0.06 to $+0.04$ for the first case to -0.37 to $+0.51$ for one of the last cases examined. Generally there were also considerable differences in the plotted positions of the critical failure surfaces. The authors indicate that some of the slope stability programs still in use are based on fairly simple analysis and employ poor searching techniques to find minimum value solutions. They conclude '...that the local state-of-the-art is not as good as it could or should be...'

GWEDGEM

Professor Ian Donald and Mr. Peter Giam have also released three civil engineering research reports dealing with various aspects of slope stability analysis. The reports are;

Report No.1/1989.
IMPROVED COMPREHENSIVE LIMIT EQUILIBRIUM STABILITY ANALYSIS.

Report No.2/1989.
SOIL STABILITY ANALYSIS BY AN UPPER BOUND PLASTICITY METHOD.

Report No.4/1989.
EQUIVALENCE OF LIMIT EQUILIBRIUM AND UPPER BOUND PLASTICITY METHODS IN SOIL STABILITY ANALYSIS.

In these reports the authors set out details of the Generalised Wedge Method (GWEDGEM) for stability analysis.

For further information regarding these publications one should contact the authors at Monash University, Clayton, Vic. 3168.

INTERNATIONAL SOCIETY FOR ROCK MECHANICS

The I.S.R.M. will be producing an annual directory which is planned as a major reference book for all those who are involved in the field of geomechanics. An important feature of the directory will be advertisements for professional services. It is anticipated that the directory will be published by Pergamon Press. Persons or organisations requiring detailed information on the I.S.R.M. Directory are advised to contact the I.S.R.M. Secretariat:

c/o Laboratorio Nacional de Engenharia Civil
101 Ave. Brasil,
P-1799 LISBOA Codex, PORTUGAL.
Phone: 351 1 882131 - Ext 2419.
Fax: 351 1 897698.
Telex: 16760 LNEC P.

or Dr. Ian W. Johnston,

c/o Department of Civil Engineering,
Monash University,
CLAYTON, VIC. 3168, AUSTRALIA.
Phone: 03 565 4963.
Fax: 03 565 3409.
Telex: AA 32691.

FOREIGN PUBLICATIONS RECEIVED

Since the publication of the issue no 16 of Australian Geomechanics the editors have received three copies of the newsletter put out by the Dutch Engineering Geology Group.

Their November 1988 publication contains a summary of results of a doctoral-thesis on 'The Influence of Discontinuities with Respect to the Groundwater Flow in the Limestone Aquifers of South Limburg' by Ir. R.G. de Wit of Delft University. (in English).

The December 1988 issue contains articles on, engineering geology in Finland, the influence of natural discontinuities and material strength on the safety of calcarenite mine pillars, slope stability calculations, and a review on penetration testing.

The April 1989 issue contains reports on, the Sixth International Conference on Numerical Methods in Geomechanics, and the Conference on Underground Spaces and Earth Sheltered Buildings, Shanghai.

The above publications also contain book reviews and articles on topics of local interest plus conference notices. Ingeokring Nieuwsbrief is published approximately 50-50 in Dutch and English.

**TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
WASHINGTON, D.C., U.S.A.**

The following Transportation Research Records have been received by The Institution of Engineers, Aust. and are available from their Library in Canberra.

**RECORD 1153
REINFORCED LAYERED SYSTEMS**

Contents:

- 1 Reinforced Elastic Layered Systems.
C.A. Vokas, R.D. Stoll.
- 8 Geogrid Reinforcement of Ballasted Track.
R.J. Bathurst, G.P. Raymond.
- 15 Design and Performance of a Reinforced Embankment for Mohicanville Dike No. 2 in Ohio.
J.M. Duncan, V.R. Schaefer,
L.W. Franks, S.A. Collins.
- 26 Design and Construction of Reinforced Embankments over Weak Foundations.
R. Bonaparte, B.R. Christopher.
- 40 Model Tests for Strip Foundation on Clay Reinforced with Geotextile Layers
J.P. Sakti, B.M. Das.

RECORD 1169

Contents:

GEOTECHNICAL INSTRUMENTATION

- 1 Deformation Measurements with Inclinometers.
G.E. Green, P.E. Mikkelsen.
- 16 Dilatometer Experience in Washington DC and Vicinity.
P.W. Mayne, D.D. Frost.
- 24 Ground Vibration Monitoring Instrumentation and Computerised Surveillance.
C.H. Dowding, D. Jessen.
- 33 Instrumentation for Tests of Piles Subjected to Axial Loading.
L.C. Reese, K.H. Stokoe II.

- 43 Use of the Wave Equation by the North Carolina Department of Transportation.
J.F. Ledbetter, Jr.
- 49 NYSDOT's Construction Control of Pile Foundations with Dynamic Pile Testing.
P.F. Bailey, S.E. Sweeney.
- 54 Discussion of Procedures for the Determination of Pile Capacity.
R.L. Engel.
- 62 Modern Specification of Driven Pile Work.
R.S. Cheney.
- 70 Analysis of Laterally Loaded Piles with Nonlinear Bending Behavior.
S.L. Kramer, E.J. Heavey.
- 75 Unified Design of Piles and Pile Groups
B.H. Fellenius.
- 83 LTBASE: A Computer Program for the Analysis of Laterally Loaded Piers Including Base and Slope Effects.
M.A. Gabr, R.H. Borden.

AUSTRALIAN GEOSCIENCE COUNCIL

GEOSCIENCE NEWS

The Council for Earth Science Societies in Australia now produces a Newsletter for distribution to its member organisations.

The Editor for this publication is Paul Shelley who can be contacted;

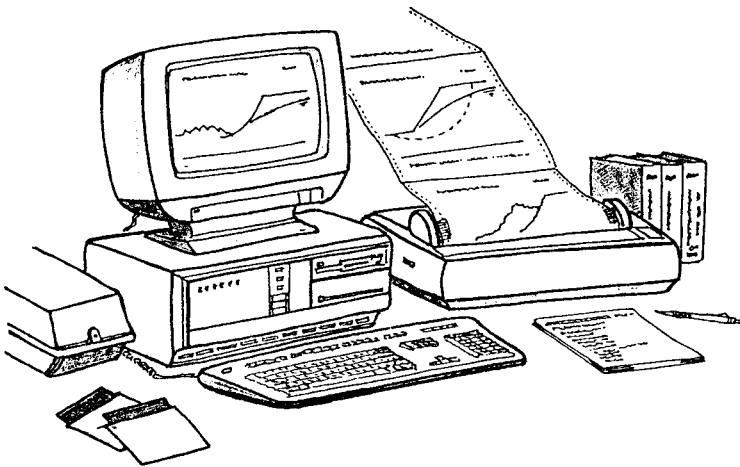
c/o Bureau of Mineral Resources,
G.P.O. Box 378,
CANBERRA CITY, ACT 2601.
Phone: 062 499602.

Copies of Geoscience News are available from A.G.S. Group Secretaries.



ISRM PUBLICATIONS AVAILABLE

TITLE	Unit Price (USD)	No. of Copies
Characterization of Swelling Rock	\$ 5.00	630
Recommendations on Site Investigation Techniques	\$ 5.00	115
Report on ISRM Fields of Activities	\$ 5.00	725
Report on the Teaching of Rock Mechanics	\$ 5.00	120
SMS for Deformability Determination Using a Flexible Dilatometer	\$ 5.00	175
SMS for Deformability Determination Using a Large Flat Jack Technique	\$ 5.00	150
SMS for Determining Point Load Strength	\$ 5.00	197
SMS for Determining Shear Strength	\$ 5.00	188
SMS for Determining the Fracture Toughness of Rock	\$ 8.00	150
SMS for Rock Anchorage Testing	\$ 5.00	180
SMS for Rockbolt Testing	\$ 5.00	192
SMS for Rock Stress Determination	\$ 8.00	187
SMS for Seismic Testing within and between Boreholes	\$ 8.00	220
SMS for Surface Monitoring of Movements across Discontinuities	\$ 5.00	175
Terminology	\$ 5.00	100



GRAVEL RASH

GRAVELRASH & THE PC BLUES

Some time ago the topic of home computers raised its head at the dinner conversation. Our eldest, who has just started in her first year at university, mentioned that staff these days appreciated assignments produced on a word processor in preference to the hand written product. Number two, who is currently in his first year of a two year matriculation course, felt he could put a P.C. to everyday use producing school projects in physics and chemistry. My wife identified a need to model quilting patterns whilst I could use a home P.C. for editing issues of Australian Geomechanics and yachting material to mention but a few.

With four participants in the debate and four 'experts' the question as to what would be a suitable system was not likely to be answered overnight. However the price of office style P.C. equipment brought everyone quickly back to earth. So after protracted consultations with various experts at the office an I.B.M. P.C. clone was decided upon as appropriate to our needs.

Of course the equipment arrived just when the cut-and-paste work for Australian Geomechanics was getting into full swing. Although installing a P.C. may according to all the glossy pictures seem quite straight forward in actual practice there are many hurdles to be crossed before the system can be said to be fully functional.

In the office environment the P.C. is these days taken for granted, ie. it is part of the furniture which gets used if not daily at least once a week for either handling technical data or word processing. Under these conditions the P.C. system is usually maintained by the office computer whiz who is also available most hours of the day to advise on any curly problems should they arise.

At home this is quite an other matter. One can hardly ring up the supplier of the equipment late in the evening to question him about a compatability problem between the word processing software and the printer. However of necessity one soon learns to cope with the jargon in the various manuals and guides and after a period of time one starts to become quite familiar with the 'user friendly' messages which beam from the video screen.

With the system now generally operational I feel I can reflect more objectively on the pros and cons of presenting material for publication using a wordprocessing system. Having the equipment in the study at home is very helpful however it still takes a lot of time to prepare typed material in the appropriate format. Also with three other users, or potential users, the equipment is not always available on demand. Furthermore considerable time can be spent sorting out problems as they arise such as encouraging a physics program on satellite motion to function properly so that the device does not crash after half an orbit or flies off into outer space.

So on reflection it may be that expecting contributors to Australian Geomechanics to present their material in 'paste' ready format is a tall order. Hence in this issue some none format material from the Western Australians has been published more or less as is. No doubt they will find out exactly what I mean when they take on the task of publishing Australian Geomechanics next year.

For a closing comment it may be worth noting that computer systems appear to conform to WYSZKOWSKI'S SECOND LAW: which states that - Anything can be made to work if you fiddle with it long enough. This truism comes from that well known publication- 'MURPHY'S LAW and other reasons why things go W & O N G' - by Arthur Bloch. The copy I have was picked up at a School Fair and used to belong to the Officers of the 'ZINCMaster' a vessel which comes into Hobart from time to time.

Finally in respect of the suggestion that contributors should send their material on a floppy disk, so that the editors can format it to their specific requirements, please don't. The practicalities of reformatting material prepared with different wordprocessing packages is akin to the problems experienced with the building of the tower of Babel.

Bram Kuost



GEODIARY

CONFERENCES, COURSES, SEMINARS, SYMPOSIA, WORKSHOPS, ETC

Brief details of conferences, courses, seminars, symposia, workshops, etc will be entered in Geodiary without charge to the organiser as a service to members of the Society. Advertisements giving more prominence and carrying greater detail may be inserted in any issue of Australian Geomechanics.

AUGUST 8-10 1989.
FIRST SOUTH-AMERICAN SYMPOSIUM ON LANDSLIDES.
Topics: Methods for detection, analysis, prevention and research of landslides.
Bogota, COLUMBIA.
Enquiries:
Juan Montero Olarte, Sociedad Colombia de Geotecnia,
Apartado Aereo 057045,
BOGOTA, D.E. COLUMBIA.
Telephone: 57 1 2223896, 2924695.
Telex: 41263 SIKA.

AUGUST 13-18 1989.
XII INTERNATIONAL CONFERENCE ON SOIL MECHANICS AND FOUNDATION ENGINEERING.
Topics: include environmental impact in geotechnical engineering, offshore exploration and foundations, excavation in soft rock, environmental control of toxic wastes, earthquake geotechnical engineering, SPT, CPT pressure testing.
Rio De Janeiro, BRAZIL.
Enquiries:
Mr. Francis Bogossian, Secretary General,
C.P. 1559, BR-20001 RIO DE JANEIRO, RJ, BRAZIL.
Telephone: 55-21-2246080.
Telex: 2132891 CERT.

AUGUST 28-31 1989.
INTERNATIONAL SYMPOSIUM - ROCK AT GREAT DEPTH.
Rock mechanics and rock physics at great depth.
Topics: include stability of excavations, role of fluids, properties of rock mass discontinuities, stress field evaluation.
Pau, FRANCE.
Enquiries:
Vincent Maury, Honorary Chairman,
Symposium 'Rock at Great Depth'
Elf Aquitaine, CSTCS - Bat. L5,
F-64018 PAU CEDEX, FRANCE.
Telephone: 33 59 834318.

SEPTEMBER 3-9 1989.
2nd INTERNATIONAL CONFERENCE ON GEOMORPHOLOGY.
Frankfurt am Main, GERMANY FR.
Enquiries:
Prof. Arno Semmel, Institut f. Physische Geographie,
University Frankfurt, Senckenberganlage 36,
Postfach 111932, D-6000 FRANKFURT/MAIN, GERMANY FR.

SEPTEMBER 4-7 1989.
INTERNATIONAL CHALK SYMPOSIUM.
Brighton, ENGLAND.
Topics: General, Construction, Hydrogeology, Petroleum Engineering.
Enquiries:
Dr. R.N. Mortimore, Department of Civil Engineering,
Brighton Polytechnic, Moulsecoomb,
BRIGHTON BN2 4GJ, ENGLAND.

SEPTEMBER 4-8 1989.
INTERNATIONAL CONFERENCE ON MICROMECHANICS OF GRANULAR MEDIA.
Clermont-Ferrand, FRANCE.
Topics: Geometry, Mechanical properties, Mechanics of grain assemblies, Fictive continuum, Relationship between fundamental approach and practical experience.
Enquiries:
Mr. P. Gourves, C.S.U.T., Laboratoire de Genie Civil,
Universite Blaise Pascal de Clermont-Ferrand II,
Rue des Meuniers,
63170 AUBIERE, FRANCE.
Telephone: 73 26 41 10.

SEPTEMBER 9-14 1989.
INTERNATIONAL CONGRESS ON PROGRESS AND INNOVATION IN TUNNELLING.
Topics: include investigation and testing, design and construction, seepage control, case histories, research and development, support, lining.
Toronto, CANADA.
Enquiries:
Technical Secretariat,
Prof. K.Y. Lo,
Faculty of Engineering Science,
University of Western Ontario,
LONDON, ONTARIO, B6A 5B9, CANADA.
Telephone: 1 519 6612125.
Telex: 0647134.
Organizing Secretariat,
Mr. Laurier Forget,
National Research Council Canada,
OTTAWA, ONTARIO, K1A 0R6, CANADA.
Telephone: 1 613 9939009.
Telex: 0533145.

SEPTEMBER 10-14 1989.
QUATERNARY ENGINEERING GEOLOGY.
25th Annual Conference of the Geological Society
Heriot-Watt University, Edinburgh SCOTLAND.
Enquiries:
Dr. J. A. Little,
Department of Civil Engineering,
Heriot-Watt University,
EDINBURGH, EH14 4AS, SCOTLAND.

SEPTEMBER 11-13 1989
SEMINAR ON ROCK FRAGMENTATION MECHANICS
CSIRO Division of Geomechanics, Queensland
Course Co-ordinator:
Dr. G. Beer, CSIRO Div. of Geomechanics,
Ritchie Building, Research Road, University
of Queensland, St. Lucia, Qld. 4067.
Tel (07) 377 7822; Fax (07) 371 7435

SEPTEMBER 17-21 1989
NON-FERROUS SMELTING SYMPOSIUM
Port Pirie, SA

Enquiries:
The AusIMM, PO Box 122, PARKVILLE, VIC 3052
Telephone (03) 347 3166; Fax (03) 347 8525

SEPTEMBER 25-29 1989.
NEW AUSTRIAN TUNNELLING METHOD (NATM) SEMINAR.
Topics: principles, tunnel geology, rockmechanics,
excavation, support, design, numerical analysis,
measurements.
Technical University of Graz, AUSTRIA.
Enquiries:
Technische Univ. Graz,
Rechbauerstrasse 12,
A-8010 GRAZ, AUSTRIA.
Telephone: 43 316 7061231.
Telex: 311221.

SEPTEMBER 28-29 1989.
SUOLOSOTTOSUOLO, INTERNATIONAL CONGRESS ON
GEOENGINEERING.
Topics: environment and land, non-energetic mineral
resources, energetic mineral resources, underground
water resources.
Turin, ITALY.
Enquiries:
Associazione Mineraria Subalpina,
c/- Dip.o di Georisorse e Territorio del Politecnico
Corso Duca degli Abruzzi 24,
I-10129 TORINO, ITALY.
Telephone: 39 11 5567681.
Telex: 220646 POLITO.

OCTOBER 2-4 1989.
FOURTH INTERNATIONAL SYMPOSIUM ON MINING WITH
BACKFILL.
Inovations in Mining Backfill Technology.
Topics: in-situ testing, laboratory testing, rock
support, system design, economics.
Montreal, CANADA.
Enquiries:
Dr. F.P. Hasani, Chairman, Organizing Committee,
Department of Mining & Metallurgical Engineering,
McGill University,
3480 University Street,
MONTREAL, PQ H3A 2A7, CANADA.
Telephone: 1 514 3984377.
Telex: 05268510.

OCTOBER 9-11 1989
DEWATERING TECHNOLOGY AND PRACTICE CONFERENCE
The Sheraton Hotel, Brisbane
Enquiries:
The AusIMM, PO Box 122, PARKVILLE, VIC 3052
Telephone (03) 347 3166 Fax (03) 347 8525

OCTOBER 12-13 1989
HARALD LAUFFER COLLOQUY
(38th Geomechanics Colloquy 1989)
Themes: Pressure tunnels and pressure shafts -
recent developments; rock mechanics in mining
practice; tests in geomechanics; control of high
rock pressure in tunnelling.
Languages: English and German
Enquiries:
Austrian Society for Geomechanics,
Paracelsusstrasse 2, 5020 SALZBURG, AUSTRIA

OCTOBER 18-20 1989.
IABSE COLLOQUIM ON EXPERT SYSTEMS IN CIVIL
ENGINEERING.
Bergamo, ITALY.
Enquiries:
ISMES,
Viale Giulio Cesare 29,
I-24100, BERGAMO, ITALY.
Telephone: 035 358 301.

OCTOBER 23-26 1989.
FOURTH INTERNATIONAL CONFERENCE ON SOIL DYNAMICS AND
EARTHQUAKE ENGINEERING.
Mexico City, MEXICO.
Enquiries:
Prof. A.S. Cakmak,
Department of Civil Engineering,
Princeton University,
PRINCETON, NJ 08544, USA.
Telephone: 609 452 4601.
or
Prof. I. Herrera,
Instituto de Geofisica,
Universidad Nacional,
Autonomo de Mexico,
Apartado Postal 22-582,
14000 MEXICO, D.F.
Telephone: 905 548 5892.

NOVEMBER 6-8 1989.
INTERNATIONAL SYMPOSIUM ON TRIAL EMBANKMENTS ON
MALAYSIAN MARINE CLAYS - PREDICTIONS AND
PERFORMANCE.
Kuala Lumpur, MALAYSIA.
Enquiries:
Ir. Chua Lee Boon,
Hon. Secretary, International Symposium on Trial
Embankments,
c/- Institution of Engineers, Malaysia,
Bangunan Insengieur, 60/62, Jalan 52/4,
Peti Surat 223, 46720 Petaling Jaya,
Seangor Darul Ehsan, MALAYSIA.
Telephone: 03 7569173, 7569575.
Telex: MA 37299 IEM.

APRIL 3-7 1990
TUNNEL CONSTRUCTION '90 DRILLEX '90
Wembley Stadium, London, England
Enquiries:
The Conference Office, The Institute of Mining
and Metallurgy, 44 Portland Place
London W1N 4BR, England Tel. 01-580-3802
Fax 01-436 5388; Telex 261410 IMM

APRIL 16-20 1990.
TENTH SOUTHEAST ASIAN CONFERENCE ON GEOTECHNICAL
ENGINEERING.
Topics: include tunnelling and underground
construction, environmental geotechnology, mapping,
slope stability, engineering geology, rock
mechanics.
Taipei, TAIWAN.
Enquiries:
Dr. C.D. Ou, Secretary-General,
Organizing Committee, 10th SEAGC,
c/- Ret-Ser Engineering Agency,
11th Floor, No. 207, Sung-Chiang Rd.,
TAIPEI, TAIWAN, REPUBLIC OF CHINA.
Telephone: (02) 503-2233
Facsimili: (02) 503-1113
Telex: 21531 RSEA.

APRIL 18-20 1990.
INTERNATIONAL CONFERENCE ON MECHANICS OF JOINTED AND
FAULTED ROCK

Topics: include structural geology and formation of
joints and faults, failure criteria, time dependent
deformation, hydromechanics, performance and
stability.

Vienna, AUSTRIA.

Call for papers. Abstracts required by 30-7-89.

Deadline for papers 31-1-90.

Enquiries:

Doz. Dr. H.P. Rossmannith,

Institute of Mechanics,

Technical University Vienna,

Wiedner Hauptstrasse 8-10/325,

A-1040 VIENNA, AUSTRIA.

Telephone: 0222 58801 5514, 5519.

Telex: 61 3222467 = TUW.

MAY 14-18 1990.

14th WORLD MINING CONGRESS AND EXHIBITION.

Beijing, CHINA.

Enquiries:

Chinese Organizing Committee of the 14th World

Mining Congress,

54 Sanlihe Road,

BEIJING, CHINA.

Telephone: 868981 Extension 264 or 863880

Telex: 222633 CSTEC.

MAY 28 - JUNE 1 1990.

FOURTH INTERNATIONAL CONFERENCE ON GEOTEXTILES AND
GEOMEMBRANES.

Topics: include bank and bed protection, soil
reinforcement, properties and testing, drainage,
environmental control.

The Hague, THE NETHERLANDS.

Enquiries:

The Secretariat of the Fourth Geotextile Conference,

c/- Holland Organizing Centre,

16, Lange Voorhout,

NL 2514EE THE HAGUE, THE NETHERLANDS.

Telephone: 31 70 65 78 50

Telex: 33111 HOC NL

Facsimili: 31 70 65 58 07.

JUNE 4-6 1990.

ISRM REGIONAL SYMPOSIUM ON ROCK JOINTS.

Topics: characterization of joints, mechanical,
hydraulic, dynamic and coupled behaviour,
constitutive models.

Loen, NORWAY.

Abstracts: 300 (words max. + 3 fig.) by 1 10 1989,
papers by 1 2 1990.

Enquiries:

Norwegian Geotechnical Institute,

Attention Dr. Nick Barton,

P.O. Box 40,

TAASEN, N-0801, OSLO 8, NORWAY.

JUNE 7-8 1990.

ISRM WORKSHOP ON SCALE EFFECTS IN ROCK MASSES.

Topics:

Loen, NORWAY.

Abstracts: 300 (words max. + 3 fig.) by 1 10 1989,
papers by 1 2 1990..

Enquiries:

Mr. Antonio Pinta da Cunha,

Laboratorio Nacional de Engenharia Civil,

101 Av. do Brasil,

P-1799 LISBOA CODEX, PORTUGAL.

JUNE 10-13 1990.

SECOND SYMPOSIUM ON STRAIT CROSSINGS.

Topics:

Trondheim, NORWAY.

Abstracts: (200 words max.) by 1 10 1989, papers by
1 3 1990.

Enquiries:

Vidar E. Storvik,

Norwegian Society of Chartered Engineers,

Kronprinsensgt 17,

N-0251 OSLO 2, NORWAY.

JUNE 12-15 1990.

FIRST INTERNATIONAL SYMPOSIUM ON UNIQUE UNDERGROUND
STRUCTURES.

Denver, COLORADO, USA.

Abstracts: (500-1000 words) by 31 8 89.

Enquiries:

Abstracts and Papers.

Dr. R.S. Sinma,

U.S. Bureau of Reclamation,

D3120 P.O. Box 25007,

DENVER, COLORADO, 80225, USA.

Phone 303 236 3994.

Authors' Registration.

Dr. G.L. Braughman,

Director Office of Special Programs and Continuing

Education, Colorado School of Mines.

GOLDEN, COLORADO, 80401 USA.

Phone 303 273 3321.

JUNE 18-21 1990.

ASCE SPECIALTY CONFERENCE ON DESIGN AND PERFORMANCE
OF EARTH RETAINING STRUCTURES.

Topics: wall selection and performance, mechanically
stabilised systems, in-situ walls, waterfront
retaining structures.

Ithaca, NY, USA.

Enquiries:

Dr. Phillip Lambe,

Department of Civil Engineering,

North Carolina State University,

Campus Box 7908,

RALEIGH, NC 27695, USA.

AUGUST 6-10 1990.

6th INTERNATIONAL CONGRESS OF THE IAEG.

Topics: include engineering geology mapping, site
investigation, hydro engineering geology etc.

Amsterdam, NETHERLANDS.

Enquiries:

Dr. L. Primet, Secretary General IEAG,

LCPC, 58, Boulevard Lefebvre, F-75732

PARIS Cedex 15, FRANCE.

Telex: 200361 LCPARI.

AUGUST 26-31 1990

'FRAGBLAST 90'

Third international symposium on rock fragmentation
by blasting

Brisbane, Queensland

State of the art in explosives and blasting
technology

Enquiries:

The AusIMM, PO Box 122, PARKVILLE, VIC 3052

Telephone (03) 347 3166; Fax (03) 347 8525



SEPTEMBER 3-7 1990.
INTERNATIONAL SYMPOSIUM - TUNNELS AND UNDERGROUND
WORKS.
Chengdu, CHINA.
Enquiries:
Secretariate CCES,
P.O. Box 2500,
Bai Wan Zhuang,
FELJING, CHINA.

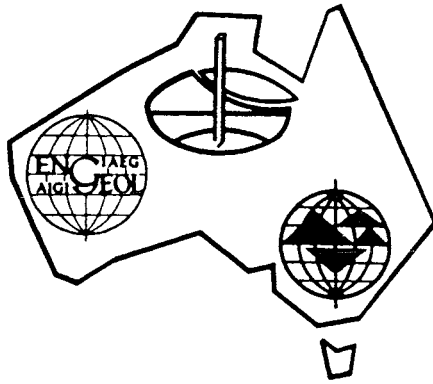
SEPTEMBER 11-13 1990
SEVENTH AUSTRALIAN TUNNELLING CONFERENCE AND TRADE
EXHIBITION
"The Underground Domain"
Hilton International Hotel, Sydney
Enquiries:
The Conference Manager, IEAust., 11 National Ct.,
Barton, ACT 2600 Tel (062) 706 549; Fax (062)
706530

OCTOBER 2-5 1990
MINE GEOLOGISTS CONFERENCE
Mount Isa, Queensland
Enquiries:
The AusIMM, PO Box 122, PARKVILLE, VIC 3052
Telephone (03) 347 3166; Fax (03) 347 8525

OCTOBER 11-13 1990.
IX NATIONAL CONFERENCE ON SOIL MECHANICS AND
FOUNDATION ENGINEERING.
Cracow, POLAND.
Call for papers. 200 word abstracts by 15-7-89.
Enquiries:
Komitet Organizacyjny IX Krajowej Konferencji
Mechanikow Gruntow i Fundamentowania.
Biuro RW Not, Dzial Org. Prezydialny,
ul Straszewskiego 28,
31-113 KRAKOW, POLAND.

MARCH 11-15 1991.
SECOND INTERNATIONAL CONFERENCE ON RECENT ADVANCES
IN GEOTECHNICAL EARTHQUAKE ENGINEERING AND SOIL
DYNAMICS.
St. Louis, Missouri, U.S.A.
Topics: include Static and Dynamic Engineering Soil
Parameters and Constitutive Relations of Soils;
Model Testing in Cyclic Loading; Deformation and
Liquifaction of Sands, Silts, Gravels, and Clays;
Dynamic Earth Pressure and Seismic Design of Earth
Retaining Structures; Soil Structure Interaction
under Dynamic Loading; Earthquake Geotechnolgy in
Off-shore Structures; Stability of Slopes and Earth
Dams under Earthquakes; Soil Amplification during
Earthquakes and Microzonation; Seismology,
Predicting Strong Ground Motion for Design; Wave
Propagation in Soils; and Dynamic Characteristics of
Vibration Sources other than Earthquakes.
Call for papers. Abstracts of 500 words by 1-11-1989
Enquiries:
Shamsher Prakash,
Conference Chairman,
Department of Civil Engineering,
University of Missouri-Rolla,
Rolla, MO 65401 U.S.A.
Telephone: 314 341 4489 or 341 4461.
Facsimili: 314 341 4729.

APRIL 14-18 1991
TUNNELLING '91
Sixth international symposium, London England
Enquiries:
The Conference Office, The Institute of Mining
and Metallurgy, 44 Portland Place
London W1N 4BR, England Tel. 01-580-3802
Fax 01-436 5388; Telex 261410 IMM



STATE GROUP REPORTS

SYDNEY GROUP REPORT

The Sydney Group Committee for 1989 was elected at the Annual General Meeting in November 1988 and consists of the following members.

CONTINUING MEMBERS

Mr Garry Mostyn Chairman	University of NSW 607 5038/810 5760
Dr Tony Phillips Secretary	Arup Geotechnics 261 1633
Dr John Small Past Chairman	University of Sydney 692 2128
Dr Neil Mattes National Comm.	Coffey and Partners 888 7444
Prof Harry Poulos National Comm.	University of Sydney 692 2109
Mr Bruce Walker	Jeffery & Kautaskas
Mr Jack Hodgson	J.D. Hodgson Consultants
Mr Michael Thom	D.J. Douglas & Partners
Mrs Margaret McMahon	McMahon Associates
Mr Malcolm Dale	Burgess & Associates
Mr John Braybrooke	D.J. Douglas & Partners
Prof Robin Fell	University of NSW
Mr Peter Burgess	Burgess & Associates
Mr Peter Andrews	D.J. Douglas & Partners
Mr Ian Hoskins	Coffey & Partners Resigned December 1988

NEWLY ELECTED MEMBERS

Mr John Adamiec	Frankipile
Mr Colin Thorne	Coffey & Partners
Mr Geoff Young	Arup Geotechnics

THE FOLLOWING MEMBERS OF THE OUTGOING COMMITTEE RETIRED

Dr Terry Wiesner, Mr Bruce Rodway, Mr Mike Adler, Mr Rod Jeffrey, Mr Slav Tchepak and Mr Ron Coleman.

TECHNICAL MEETINGS

The February to May meetings advised in the last issue have been held with continuing good attendances.

Technical meetings programmed for the rest of 1989 are listed below.

June 14th 1989 DEEP EXCAVATIONS IN SYDNEY ROCK EXTENDED TECHNICAL MEETING

C.R. Windsor - CSIRO
P. Hilleard - State Rail Authority
P. Wong - Coffey & Partners
J Braybrooke - D.J. Douglas & Partners

Sydney is entering a particularly challenging phase of varied underground and deep foundation development. The extended meeting will cover developments in rock stress measurement, rock reinforcement, excavation design and analysis and performance monitoring. Current case studies will be used to illustrate the topics discussed.

July 12th 1989 NEW DEVELOPMENTS IN GEOSYNTHETICS

Dr Manfred Hausmann - University of Technology, Sydney

The growing number of books, conference papers, design manuals and testing standards on the use of synthetics in geotechnical engineering is evidence of the rapid advances made in this field. The functional approach to the design of soil-geosynthetic systems is now fairly well developed for solving problems with embankments, foundations, railways, steep slopes, pavements, landfills and more. Now types of fabrics and composites are widening the scope of applications. In Australia, interesting research results have become available on fabric reinforced clay walls, composites in railway tracks, fabrics and membranes as formwork, and more. Progress is also being made in standardizing basic test procedures for geotextiles.

August 9th 1989 DESIGN OF STRUCTURES FOR SUBSIDENCE

Dr Laurie de Ambrosis - Longworth & McKenzie

The issue of mining subsidence and its effect on surface structures has been receiving much attention in the recent past. The issue is particularly relevant to the Sydney Coal Measures where coal is largely mined by underground techniques. Increasingly, because of the limited extent to the allowable workable mining areas, underground mining is being forced into developed areas (urban as well as rural). The need to maximise extraction exacerbates the effects of subsidence.

Many structures which could previously be "protected" by sterilisation are now not capable of protection because of the increasing use of longwall mining techniques which involve the mining of large continuous panels of underground coal. In most instan-

ces provision now has to be made for such structures to withstand the effects of future subsidence and the geotechnical engineer is being asked to provide input information into the design of these structures.

This talk will aim to briefly describe the currently available methods for subsidence prediction which incorporate the results of monitoring to give relevant "local" subsidence parameters. Some time will also be given to reviewing some techniques which have been used in the design of a wide variety of structures to cater for subsidence. The talk will also be illustrated by case studies.

September 13th 1989
EXPERIENCE WITH THE FOOTING CODE A.S.2870

L.D. Appleyard - Appleyard, Forrest & Assoc
A Maltby - Sinclair, Knight & Partners

The "Residential Slabs and Footing Code" (AS 2870) was published in 1986 after much discussion of the draft document. Implementation of the code initially caused some "buyer resistance" but is now accepted and indeed required by most Councils. Within the Sydney area, further geotechnical research seems limited as a result of site classification, in many cases, by determination of the clay profile thickness. As a result, structural engineers have become the main users of the code, often with minimal input from geotechnical engineers.

The discussion will present comments on implementation of the code, primarily from the viewpoint of the structural engineer either when designing the footings or when checking building applications to Council. Contributions and discussion will be sought from the audience regarding problems with application of the code, adequacy of the designs nominated by the code, future developments in footing design and construction, and further geotechnical research in the Sydney area.

October 11th 1989
THE GEOTECHNICAL INVESTIGATION AND CONSTRUCTION SUPERVISION OF THE BURWOOD BEACH SEWER OCEAN OUTFALL PROJECT

Margaret McMahon - Dames & Moore

This project involved the construction of a 90m deep shaft 4.5m in diameter, a 1.8km long 2.7m diameter TBM driven tunnel, 10 vertical 1m diameter diffuser shafts, and associated works. The excavations were completed in 1988. The project was complicated by the presence of old, water or gas filled coal mines which extend out under the sea over most of the site. This talk will describe the investigations to explore the subsurface geological and mine conditions for the contract documents, and throughout the project for design modifications which were made during construction. It also reviews the TBM performance.

November 8th 1989 - AGM
GEOTECHNICAL EXPERIENCE ON THE NORTH WEST SHELF

THE THIRD E.H. DAVIS MEMORIAL LECTURE

Dr Mohamid Khorshid - Woodside Offshore Petroleum

It is proposed that the lecture will present the following material. The North Rankine A Platform was installed in 1982 on the North West Shelf of Australia, is located in a water depth of 125m and was designed to resist cyclonic weather conditions. The proposed Goodwyn A Platform will be installed in 1992 and is 23km to the south west of North Rankin A but in a similar depth of water and over similar foundation materials.

This presentation will discuss the geotechnical programme undertaken for both North Rankin A and the proposed Goodwyn A platforms which will include:

1. The experience with the initial design of North Rankin A including measures which were to be implemented if the design assumptions could not be verified during installation, the realization that following the implementation of these remedial measures the capacity was still insufficient, the development of an extensive field and laboratory test programme to enable the design of further primary and secondary remedial measures and the implementation of the selected option which consisted of an end bearing solution.
2. The selection of drilled and grouted piles for the proposed Goodwyn A Platform foundations, the site investigations both offshore and onshore, the development and results of the large scale pile load testing programme and the modification to the design codes which included effects of long term cycling.

The presentation will conclude with the lessons learnt from these investigations and areas for possible future development.

VICTORIA GROUP STATE REPORT

Report of Meetings

The Lochiel Trial Pit

8 Feb 1989

Tim Sullivan of Coffey & Partners described the Trial Pit which was part of the evaluation of the mining efficiency of the Lochiel coal deposit. The pit project entailed site selection, investigation, design, instrumentation, monitoring, dewatering, depressurisation, excavation and trial dump construction. Intensive monitoring included 385 separate instruments.

The geotechnical & hydrogeological aspects described included

- * depressurisation drains to improve mining condition in fine grained soil strength materials,
- * vacuum dewatering of aquifers,
- * evaluation of depressurisation of fine grained soils due to unloading,
- * intensive monitoring of pit movements,
- * large scale evaluation of the shear strength of loosely dumped soil and
- * back analysis of planned failures.

Modulus of Subgrade Reaction - Its Use & Abuse

14 March 1989

A joint meeting with Institution of Engineers, Victoria Division Structural Branch. Speakers included Peter Moore of University of Melbourne outlining the background to the use of the Winkler method and the methods of correcting the modulus for width and depth effects.

Keith Seddon of Pak Poy & Kneebone described 3 case histories which showed how some engineers had misunderstood the correct use of the modulus in design of rafts.

Chris Tattersall of B J O'Neill & Partners presented examples of its successful use from a structural engineers viewpoint.

Chris Haberfield of Monash University described the use of elastic theory, and in particular CSIRO Division of Geomechanics FOCALS program to model raft footings.

A lively discussion followed. It would appear that geotechnical engineers prefer to use Youngs modulus while structural engineers frequently use modulus of subgrade reaction in programs for raft design. It is proposed to publish the proceedings in a forthcoming I E Aust Civil College Report as an insert in Engineers Aust.

Review of Slope Stability Programs.

19 April 1989.

Prof Ian Donald & Peter Giam of Monash University presented a review of slope stability programs carried out for ACADS based on contributions from various sources. The 5 basic problems with 5 variants were compared against 4 "referee" sources from a worldwide selection. The problems tested the ability of the programs and users to handle a full range of situations expected in practice including complex soil profiles and slope geometries, pore water pressures, seismic effects, earth and rock dams, surcharges and non-circular failure surfaces. Calculated safety factor and positions of critical surfaces were presented by 24 respondents using a total of 27 different programs. The results cover a surprisingly wide range with the mean sometimes agreeing with "referee" values.

Two programs GWEDGEM and EMU developed at Monash were described and are detailed in the University's Civil Eng Research Reports 1, 2 and 4 of 1989.

The ACADS report Soil Slope Stability Programs Review was launched and is available from ACADS, 576 St Kilda Road, Melbourne, 3004 for \$45 for ACADS members & \$90 for non-members.

Dam Surveillance and Safety in Victoria -

17 May 1989

Ranji Casinader, consulting engineer, described the history and present situation of the proposed Victorian Water Bill which includes provision for dam safety. The major issues included in the Bill are

- liability for dam failure
- limited legislative controls
- definition of applicable dams
- administrative arrangements

The main implication is the requirement of strict liability of dams owners for which reasonable care is not a defence in the

case of damage to third parties. This will have significance for dam owners, public service and consulting engineers and liability insurers.

The aim of the legislation is to encourage dam surveillance by owners.

The technology of surveillance and monitoring was outlined.

Future meetings

Wed 21 June Nuclear Densometers in compaction control
K York RCA

Wed 19 July Site Investigation in Practice
R Olds of Coffey & Partners. A meeting with students & new graduate members

Wed 16 Aug Workshop - Update of Melbourne City Geology Map
J Neilson Geological Survey

Wed 20 Sept Seminar on Lateral Earth Pressures 4 - 8 pm
J Morgan, A Bridges, J Peyton

Wed 18 Oct Predicting Failure in Rock Mechanics E T Brown

Wed 9 Nov E H Davis Memorial Lecturer Dr M Khorshid

The Victoria Group, through Max Ervin, is continuing its bid for the XIV ICSMF in 1997. The next opportunity to present our case will be at the International Society's Council Meeting in August. The bid has been with the considerable support of I E Aust. An approach has been made to the Australian Tourist Commission.

TASMANIA

The Tasmanian Group have held two meetings so far this year. At the first meeting on the 20th March Mr Max Ervin presented the paper that he had presented at the fifth ANZ Conference on Geomechanics in 1988, a paper entitled "The Evaluation of Geotechnical Performance". The presentation was well received by the twenty members and guests who attended.

The second meeting was a combined meeting with the Tasmanian Division of the Institution of Engineers, Australia. Dr Patrick Quilty, Assistant Director Science with the Commonwealth Antarctic Division in Hobart, presented a talk on "Geotechnology in Antarctica". Although the area of exposed soil and rock in Antarctica is only a small fraction of the continent's total area, Dr Quilty described some of the problems associated with the foundations of buildings at Antarctic bases and excavations in frozen ground and also gave a fascinating account of the deep sea drilling operations with which he has recently been involved.

Three more meetings are planned for the remainder of this year. On the 10th July Mr Barry Weldon of the Tasmanian Mines Department will talk about his involvement with the recently resurrected gold mine at Beaconsfield in the North of Tasmania. On the 11th September a Workshop on "The Role of Personal Values in Geomechanics" will be held. This Workshop will investigate the effect of interpersonal relationships and attitudes on the transmission of geological and geotechnical information to the

design or construction engineer. The final meeting for the year will be the Group's Annual General Meeting to be held on Monday 20th November. At this meeting Mr Peter Bailey of the Tasmanian Mines Department will talk about "Geology and Hydrocarbon Potential of Tasmania's Offshore Areas".

The current membership of the Group is 23 with the following members forming the Committee:

Bram Knoop (Chairman)	H.E.C.
Brian Cousings (Deputy Chairman)	University
Tom Bowling (Secretary)	H.E.C.
Dick Barnett	H.E.C.
Fred Baynes	H.E.C.
David Brett	Consultant
Rick Donaldson	Mines
Larry Polglase	H.E.C.
Ralph Rallings	D.M.R.
Peter Stevenson	Ex Mines

Tom Bowling is the Group's representative on the AGS National Committee and Bram Knoop is the representative on the Committee of the Tasmanian Division of the IEAust.

QUEENSLAND GROUP NEWS

Summary of meetings held so far.

February

Engineering Evaluation of Compressible, Underslab Void Forms; presented by Miss Sue Henderson and Professor Keith Wallace. This paper was a review of research work undertaken by Sue Henderson into the behaviour of cardboard void formers used in certain circumstances under concrete floor slabs to relieve expansive uplift forces. The investigation considered the interaction of the soil expansion rate with the moisture uptake and the rate of strength loss of the void former under typical covered conditions.

March

This was a joint meeting with the Geological Society at which Dr. Cliff Mallett, of the C.S.I.R.O. Division of Geomechanics, presented a paper on New Energy Sources and their Geotechnical Challenge. Two possible energy sources were discussed, coal seam methane extraction and thermal energy from deep artesian waters of western Queensland. Projects in the U.S.A. were compared with Australian possibilities. The major problems for methane extraction appeared to be finding suitable coal seams having sufficiently high permeabilities, and the availability of a pipeline infrastructure.

April

A Mini Symposium was held on the Geotechnical Problems of Coastal Resort Developments which attracted a large audience to hear a panel of six speakers outlining problems such as, investigations for reclamation design, design and construction difficulties on dune sand, coastal protection structures, and finally the developers viewpoint.

June

Mr. Jim Miller from Frankpile presented a talk on new techniques and equipment being applied to the design, installation and testing of piles, and on new types of piles such as the Atlas pile.

Meetings on the agenda include the July dinner meeting which will be addressed by the distinguished Austrian philosopher Dr. Friedrich Felskop on 'The Early Life and Times of Karl Terzaghi'; in September a Mini Symposium on Soil and Groundwater Pollution Control; and in October a field visit; and the Group's A.G.M. in November.

SOUTH AUSTRALIAN GROUP

Office Bearers for 1989:

Brian Richards, Chairman,	CSIRO Soils Div SA	274 9283
John Morris, Deputy Chairman,	Department Mines and Energy	274 7688
Bob Newman, Honorary Secretary	E&S Department	226 2299

Committee:

Derek Avalue	212 5733
Lindsay Ballentyne	31 6356
Peter Bayetto	363 0022
Richard Cavagnaro	272 0777
Ed Collingham	226 2279
Michael Doherty	223 7011
Dr Peter Mitchell	212 5733
Paul Peter	274 9209
Dr Stephen Priest	228 5333
Ian Hosking	352 1744

The South Australian Group meets monthly at the Institution of Engineers Building, Chapman Hall, 11 Bagot Street, North Adelaide. Meetings are generally held on the third Monday of each month and commence with a light tea at 5.30 pm.

Technical meetings held in the first half of 1989 were:

Feb 20 Void Formers for Footings on Expansive Sites

Sue Henderson of the CSIRO discussed the use and application of various compressible materials used to avoid the impact of soil movement beneath floor slabs.

March 20 Overseas Study Leave Experience

Dr Neil Kay of the University of Adelaide presented his experience into research of static core testing, application of probability to geotechnical design which he gained during visits to Berkely California, Cornell and Hong Kong.

April 17 Post Graduate Studies in Adelaide

Students from the University of Adelaide and the South Australian Institute of Technology, Richard Herriman, Mark Jaksa, Narajana Somaratne, Chris Rigg, Li Hong Yu and Tony Meyers presented the basis of their studies.

June 19 The Sydney Harbour Tunnel

Ian Hosking of Coffey Partners International presented an address on the new road tunnel for Sydney Harbour.

Meetings for the remainder of the year include a Seminar on Earthworks: design construction and quality control which will be held on September 18.

To date this year our technical programme has been fairly busy with some eminent overseas visitors passing through Perth.

- ** On 7 March 1989 Dr. Guy Houlsby of Oxford University spoke on "Recent Developments in Cone and Pressuremeter Testing".

Guy was able to provide first hand reports of the recent developmental work underway at Oxford University in the fields of Insitu-Testing.

Of particular interest was the discussion based upon testing in relation to the influence of horizontal stress on the cone test and its interpretation.

Also of interest was the description of the cone pressuremeter which is presently under development.

- ** Our other Overseas visitor was Dr. Richard Jewell also of Oxford University who came to Perth to be part of the team presenting a short course at University of Western Australia on Soil Reinforcement.

On 20 April 1989 the final session of this course took the form of a technical meeting of the Geomechanics Society when Richard presented a talk entitled : "Reinforced Soil - Selected Developments Worldwide". This talk was amply illustrated by slides and descriptions and was well received by a large audience.

The interest shown in the topic and the course seems indicative of the current trend toward soil reinforcement be it for insitu soils by soil nailing techniques or for fill structures as in reinforced soil applications.

- ** On 8 April 1989 a small group of members visited the Harris Dam Site where construction is underway on a new dam to supplement the water supply to the Great Southern areas of W.A.

The dam is to be located on the Harris River, a few kilometres upstream from its confluence with the Collie River. The embankment will be earth fill and some 35 metres high.

Because the site is underlain by up to 25 metres of decomposed granitic materials (in places highly permeable) a slurry trench is required as part of the dam foundations.

Visitors were able to see the slurry trenching operation and the associated curtain grouting. Also of particular interest was the construction detail of the articulated outlet culvert which has been designed to accommodate the significant foundation settlement anticipated.

The spillway channel excavation had recently been completed mainly through rock so there was also something of interest for the "Geologists" in the group.

- ** Of special interest to country members was a joint meeting with the Geraldton Group of the Institution of Engineers of Australia held on 24 May 1989 when Geoff Cocks of the Main Roads Department spoke on "Laterite Gravel for Road Construction". Western Australia has an extensive network of lightly trafficked rural roads. The extent of this network and the sparsity of population has meant that low cost of construction is an important aspect in considering appropriate materials. In this regard Lateritic gravels have been used extensively and it has been found that performance has been some what better than may have been predicted on the basis of particle size distribution and plasticity tests alone.

Geoff presented details of characteristics of some lateritic materials which have been used.

One interesting feature which emerged from the talk is the realisation that very little research has gone into the selection of materials suitable for unsealed roads since the days of Macadam in the 19th Century. When one considers that Australia has more unsealed roads than sealed roads this becomes significant.

ADVERTISING RATES

Rates are as follows for black and white camera ready copy:

		One entry	Two entries
Full page	(165mm x 245mm)	\$300	\$540
Half page	(165mm x 120mm or 80mm x 245mm)	\$150	\$270
One third page	(165mm x 80mm or 80mm x 165mm)	\$100	\$180
One quarter page	(165mm x 60mm or 80mm x 120mm)	\$75	\$135
Professional directory	(business card) (80mm x 60mm)	\$60	\$108

Loadings:	Outside back cover	+	20%
	Inside back cover	+	10%
	Inside front cover	+	15%

Front Cover: The Editorial panel will consider a sponsored front cover showing a geomechanics project, machinery or equipment worthy of being brought to the attention of the profession. The sponsorship fee is \$500; this will also cover space for a short article describing the project.

Colour:	Full colour	-	per page or part with colour negatives supplied	+	\$300
			without colour negatives	+	\$500

Camera ready copy should be delivered to:

The Secretary, Australian Geomechanics Society
11 National Circuit
BARTON ACT 2600

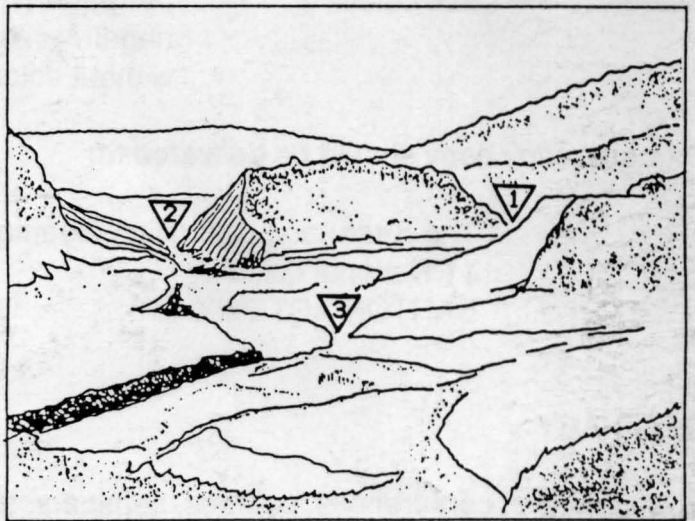
GEODIARY

Brief details of conferences, courses, seminars, symposia, workshops, etc will be entered in Geodiary without charge to the organiser as a service to members of the Society. Advertisements giving more prominence and carrying greater detail may be inserted in any issue of Australian Geomechanics at the above rates.



The above photo shows some of the devastation downstream near the Briseis Mine. The flood wave actually cut through the ridge which ran from left to right as shown diagrammatically.

The photos are part of a set of about 11 taken by the late Fred Smithies and which are now kept in the Tasmanian Archives.



- 1 - Old river course ran around Ridge in the middle distance
- 2 - Flood from dam burst cut through the ridge here
- 3 - Devastation in the foreground