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N.Z. GEOMECHANICS NEWS

No. 30

JULY 1985

A NEWSLETTER OF THE N.Z. GEOMECHANICS SOCIETY

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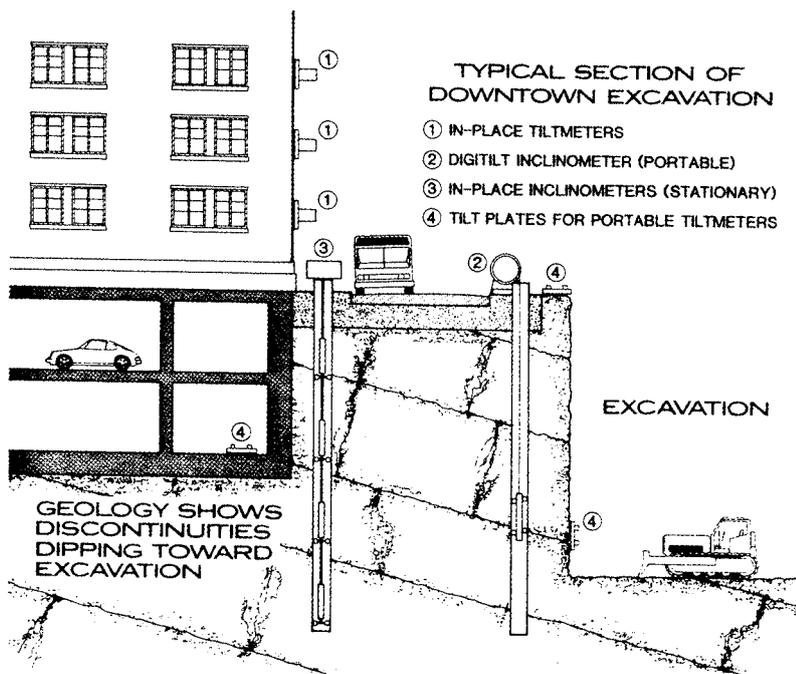
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NO. 30, JULY 1985

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THIS IS A RESTRICTED PUBLICATION

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

Persons interested in applying for membership of the Society are invited to complete the application form at the back of this newsletter. The basic annual subscription rate is \$20.00 and is supplemented according to which of the International Societies, namely Soil Mechanics (\$10.00), Rock Mechanics (\$13.00), or Engineering Geology (\$6.00) the member wishes to be affiliated. Members of the Society are required to affiliate to at least one International Society.

Editor: Peter Millar
P.O.Box 30-845
LOWER HUTT

(04) 683-119

Advertising: Graham Ramsay
P.O.Box 12-041
WELLINGTON NORTH

(04) 729 929

EDITOR'S NOTES

There has been considerable activity in the geomechanics technical group recently with particular interest in technical standards and the appropriate representation of members within professional groups.

An Auckland based subcommittee has been seeking ways of providing guidelines for Local Authorities seeking advice on stability assessments. Other groups have considered the wider question of the professional status of engineering geologists. To date these discussions have centred on the appropriate type of professional body and whether associate membership of IPENZ should be considered to provide recognition of the experience of practicing engineering geologists. However, it will also be necessary to address the required levels of academic qualification particularly in applied geomechanics for any such group if it is to gain acceptance.

The Society is sponsoring a symposium on Pile Foundations for Engineering Structures to be held in Hamilton in May 1986 and will also be presenting two technical sessions during the IPENZ Conference in Auckland in February 1986.

The draft method of soil and rock description has been reviewed with a large number of contributions and comments being received by the committee. The final document is expected to be available in August and a summary of the major revisions is included in this issue.

The Geomechanics Society is the largest and oldest technical sub group of IPENZ and the management committee has decided to establish a separate award for geotechnical papers published by members. A life membership category in recognition of services to the Society is also proposed.

Several of the Societies members have been prominent in the past year with Dr Northey being made Honorary Fellow of the Institution of Professional Engineers, John Galloway being Australasian Vice President elect and Prof M. Pender receiving the Fulton/Downer Award at the 1985 IPENZ Conference.

Two feature articles appear in this issue, the first outlining the role of geomechanics in the proposed Longwall mining at Huntly East.

The second article is by J.K. Hill and is one of a group of papers presented at the Port Hills symposium sponsored by the Society. A number of these papers will be published in following issues of the Geomechanics News.

The Editor would also welcome other contributions in the form of letters and technical notes.

P. Millar
Editor

PUBLICATIONS OF THE SOCIETY

The following publications of the Society are available:

(a) From the Secretary, IPENZ, P.O.Box 12-241, Wellington North:

- Proceedings of the Palmerston North Symposium "*Geomechanics in Urban Planning*", April 1981. Price \$20.00.
- "*Stability of House Sites and Foundations - Advice to Prospective House and Section Owners*". (Published for the Earthquake and War Damage Commission). Price \$0.50.
- Proceedings of the Third Australia-New Zealand Conference on Geomechanics, Wellington, May 1980. Price \$20.00 for the three volume set to members, \$30.00 to non-members.
- Proceedings of the Hamilton Symposium "*Tunnelling in New Zealand*", November 1977. Price \$18.00 to members, \$20.00 to non-members.
- Proceedings of the Second Australia-New Zealand Conference on Geomechanics, Brisbane, July 1975. Price \$25.00.
- Proceedings of the Wanganui Symposium "*Using Geomechanics in Foundation Engineering*", September 1972. Price \$8.00 to members, \$10.00 to non-members.
- Proceedings of the Christchurch Symposium "*New Zealand Practices in Site Investigations for Building Foundations*", August 1969. The last copies of a limited reprinting are available at \$8.00 to members, \$10.00 to non-members.
- Proceedings of the Alexandra Symposium "*Engineering for Dams and Canals*", November 1983. Price \$40.00 to members, \$50.00 to non-members.
- Copies of all back-issues of "*New Zealand Geomechanics News*" are available to members at a nominal price of 50cents per copy plus 50cents post and packaging per order.
- The following back-issues of the IAEG Bulletin are available. Price \$3.00 to members: Volumes 15, 24, 26 / 27.

(b) From Government Bookshops and the Secretary IPENZ:

- "*Slope Stability in Urban Development*" (DSIR Information Series No.122). Price \$2.00. (Also available from Government Bookshops).

The following publications of the Society have been sold out:

- Proceedings of the Nelson Symposium "*Stability of Slopes in Natural Ground*", 1974.
- Proceedings of the Wellington Workshop "*Lateral Earth Pressures and Retaining Wall Design*", 1974.

G.RAMSAY.
Publications Officer

NEWS FROM THE MANAGEMENT SECRETARY

1. MANAGEMENT COMMITTEE

The Management Committee for 1985 is:

| | | |
|----------------|--------------------------------------|--------------|
| T J Kayes | (Chairman) | Wellington |
| S A L Read | (Management Secretary) | Wellington |
| D H Bell | (Australasian Vice-President IAEG) | Christchurch |
| J H H Galloway | (IPENZ Appointee) | Wellington |
| J W Henderson | | Dunedin |
| D N Jennings | (Vice-Chairman, Rock Mechanics) | Hamilton |
| N S Luxford | (IPENZ Appointee) | Auckland |
| P J Millar | (Editor, Geomechanics News) | Wellington |
| R D Northey | (Australasian Vice-President ISSMFE) | Wellington |
| A J Olsen | (Vice-Chairman, Soil Mechanics) | Tauranga |
| B R Paterson | (Vice-Chairman, Engineering Geology) | Christchurch |
| G Ramsay | (Publications Officer) | Wellington |
| Y Thorp | | Auckland |

2. LOCAL GROUP ACTIVITIES CONVENORS

| | | | |
|-----------------|------------------|---|--------------|
| Auckland | Ms Y Thorp | c/- Beca Carter Hollings and Ferner P.O.Box 6345 AUCKLAND | Phone 773410 |
| Wellington | Dr I R Brown | P.O.Box 44168 LOWER HUTT | Phone 651946 |
| Christchurch | Mr D H Bell | Geology Department University of Canterbury Private Bag CHRISTCHURCH | Phone 482009 |
| Otago/Southland | Mr J W Henderson | City Engineers Office P.O.Box 5045 DUNEDIN | Phone 743899 |

3. NEW MEMBERS

The following new members are welcomed to the Society:

| | | |
|-----------------|--------------|--------------|
| R Adlam | K P Horide | T P McCarthy |
| Ms M O'Halloran | S Sekaran | D L Stewart |
| M W G Duddings | F Huppert | J H Murphy |
| D R Preston | D R Schubert | D J Waters |

The membership of the Society currently stands at:

| | |
|----------------------|-----|
| Membership | 328 |
| Affiliated to ISSMFE | 228 |
| ISRM | 54 |
| IAEG | 118 |

4. IPENZ 1986 CONFERENCE

The 1986 IPENZ Conference is to be held in Auckland from 10-14 February 1986. As in past years the Geomechanics Society will contribute to the Conference which this year has the theme "*Engineering - The Human Factor*".

The Conference will cover a wide scope of engineering with emphasis on aspects such as interaction with the public. Papers are required for presentation during the two Geomechanics Society sessions at the Conference.

Intending authors should submit synopses of their papers to the Management Secretary at the Society address by 31 August.

The address is: N.Z. Geomechanics Society
c/- Institution of Professional Engineers (NZ) Inc.,
P.O.Box 12-241
WELLINGTON.

The deadline for submission of draft papers for pre-printing is 30 November 1985.

The Annual General Meeting of the Society will take place during the Conference.

5. IPENZ AWARDS

The Institution of Professional Engineers New Zealand Inc.(IPENZ) annually makes a number of awards for papers presented by members. Nominations are being sought from Society members for the following awards:

- (a) Fulton/Downer Award - for papers presented at the Institution Conference.
- (b) Furkert Award - for papers in Civil Engineering, particularly relating to the interaction of water on the faces of nature.
- (c) Rabone Award - general nature subject not qualifying for one of the other awards.
- (d) Environmental Award - for predominantly engineering work which best exemplifies care for and consideration of environmental values.

Further information on the above awards is outlined in a brochure issued by the IPENZ Secretariat. Nominations should be forwarded to the Management Secretary at the Society address by 30 September.

The Otto Glogau Award sponsored by the New Zealand National Society for Earthquake Engineering will again be awarded this year. Further details may be obtained from the Secretary of that Society via the IPENZ address.

Congratulations are extended to Professor M Pender, firstly on his appointment to Professor at the School of Engineering, University of Auckland, and secondly for being awarded the Fulton/Downer Award during the 1985 IPENZ Conference. His paper was "*Stability of Slopes in Closely Jointed Rock*". It is also heartening that this is the second time a Society member has gained this top IPENZ award in 5 years.

6. DRAFT METHOD OF SOIL AND ROCK DESCRIPTION

Since the draft method was circulated to all members in March comments have been received from more than 10 members. A local group meeting was also held in Auckland to discuss the method. The subcommittee has met to consider all the comments received and will meet again in early July to make appropriate changes to the draft. Notes prepared by the subcommittee on the major points raised by members are given in this issue.

7. NEW ZEALAND GEOMECHANICS SOCIETY AWARD

As papers for nomination for IPENZ awards need to be written by author(s) who are all members of IPENZ, a large part of the Society membership is ineligible for an award in the field of geomechanics. The Management Committee has decided to instigate an award to fill this gap. The award, to be known as the "*New Zealand Geomechanics Society Award*" may be awarded annually to the Society member or members producing the best published paper during the three years ending 31 July preceeding the date of the award. The award will be a sum of money for the purchase of books, plus a certificate. Presentation of the award will be during the course of the IPENZ Conference.

All Society members who are authors or co-authors of any nominated paper are eligible for the award. Papers need to be nominated in writing by a Society member during the current year.

It is planned that the first award will be presented during the 1986 IPENZ Conference. Nominations are open for the inaugural award and will close on the 31 October. Members who require further information should contact the Secretary or another member of the Management Committee.

8. SOCIETY LIFE MEMBERSHIP

The Management Committee has decided to introduce a category of life membership as an honour in recognition of service to the Society. The necessary changes to the Society rules will be made at the 1986 AGM and further information will be given in the November issue of Geomechanics News.

9. NEW ZEALAND STANDARDS

The Standards Committee of IPENZ is being disbanded. This is likely to result in a greater Society involvement in the preparation of, comments on drafts, and revision of standards.

Current New Zealand standards under review include:

NZS 4402 Part 1: 1980 and NZS 4402 Part 2P: 1981
Methods of Testing Soils for Civil Engineering Purposes.

Part 1 is being revised and Part 2 will be issued as a full standard.

The subcommittee reviewing the standards (Dr R D Northey is the Society Representative) has met several times.

The standards when reissued will become available for sale as whole standards with provision for replacing individual methods as they are updated in the future. Additional overseas standards are to be included into the method - e.g. SPT, field vane, nuclear densometer.

The date for the reissue has not been finalised. Further information may be obtained from either Dr Northey or the Management Secretary.

NZS 4431 : 1978

Earthfill for Residential Development.

Views are being sought by the Standards Association on NZS 4431 : 1978. If the standard is satisfactory in its current form it will be revalidated for a further 5 years. If members consider that changes are necessary could they forward their comments in writing to Mr A J Olsen, Mr N S Luxford or the Management Secretary prior to 31 August 1985.

10. EXPERIENCE IN GEOMECHANICS

The Management Committee formed a subcommittee to investigate possible criteria of use to Local Authorities as guidelines for determining the suitability of consultants undertaking slope stability assessments, particularly with regard to residential development.

The subcommittee's report (Chairman Dr P Goldsmith, Secretary Mr G G Grocott, Messrs N S Luxford, N Rogers, K Shores, M Wesseldine, G Woodward) has been submitted to the Management Committee. Further information will be given in the November issue of Geomechanics News. Other information may be obtained by contacting Mr N S Luxford.

11. LAND RECONTOURING

In the Tauranga area land has commonly levelled and/or recontoured before its sale for horticultural usage. Cases subsequently arose in which the land did not perform to expectation. This prompted the formation of a subcommittee to investigate the procedures and practices in recontouring and they have now completed their report. Members who wish to obtain further information may write to the Bay of Plenty Catchment Commission or the Tauranga County Council.

12. GEOTECHNICAL DATA IN CONTRACT DOCUMENTS

The Australian Geomechanics Society has formed a subcommittee to investigate the guidelines for the provision of geotechnical data in contract documents. Issues being investigated also include the use of exclusionary clauses to limit or exclude liability with respect to site information provided by the client, and latent condition clauses to provide contractual relief when unexpected ground conditions are encountered.

Members who wish to contribute to the activities of the subcommittee should forward their comments in writing to the Management Secretary of the New Zealand Society prior to 31 August 1985.

S A L Read
MANAGEMENT SECRETARY

FORTHCOMING CONFERENCES

| | | | |
|-----------------|-----------|------|---|
| 11-15 | August | 1985 | XI ICSMFE. ISSMFE Jubilee International Congress. San Francisco, USA. |
| 26-27 | August | 1985 | Geotextiles Seminar, Department of Extension Studies, University of Canterbury. |
| - | | | |
| 31 Aug-01 | Sept. | 1985 | 11th General Assembly. International Tunnelling Association " <i>Underground Structures in Urban Areas</i> " Prague, CSSR. |
| 02-04 | September | 1985 | The Role of Rock Mechanics in Excavations for Mining and Civil Works. Zacatecas, Mexico. |
| 15-21 | September | 1985 | First International Conference on Geomorphology, Manchester, England. |
| 15-20 | September | 1985 | Fundamentals of Rock Joints. Bjorkliden, Sweden. |
| 09-10 | October | 1985 | International Symposium on Management of Hazardous Chemical Waste Sites. Winston - Salem, USA. |
| 09-13 | December | 1985 | Geological Society of New Zealand Conference. Christchurch |
| 17-22 | February | 1986 | Australia & New Zealand Geomorphology Group - Third Conference. Theme - Geomorphology of plate boundaries and Continental Margins. Also sections on fluvial geomorphology and general geomorphology. Information from Prof.P.Williams, ANZGG Conf.Dept.Geology, University of Auckland. |
| 14-19 | April | 1986 | Engineering Geology Problems in Seismic Areas. Bari, Italy. |
| 08-12 | June | 1986 | 12th General Assembly International Tunnelling Association. " <i>Large Underground Openings</i> ". Florence, Italy. |
| 22-25 | June | 1986 | Use of In-Situ Tests in Geotechnical Engineering. Blacksburg, Virginia, USA. |
| 25-28 | August | 1986 | Large Rock Caverns 1986. Helsinki, Finland. |
| + 20-25 | October | 1986 | 5th International Congress of IAEG. Buenos Aires, Argentina. |
| | November | 1986 | Engineering in Complex Rock Formations Beijing or Wuham, China. |
| + 30Aug-03Sept. | | 1987 | ISRM 6th International Congress on Rock Mechanics, Montreal, Canada. |
| 31Aug-03Sept. | | 1987 | Groundwater Effects in Geotechnical Engineering, Dublin, Ireland. |

+ Council Executive Committee Meeting of ISSMFE, ISRM or IAEG . It would be appreciated if members contemplating attending these conferences contact the Management Secretary or Vice-Chairman of the appropriate discipline, so that New Zealand may be represented.

Further information on the conferences may be obtained by writing to the Management Secretary or the Vice-Chairman of the appropriate discipline.

S A L Read
Management Secretary

I P E N Z CONFERENCE - FEBRUARY 10 - 14 1986

THEME : THE HUMAN FACTOR

Papers are now being called for next years IPENZ conference which is being held in Auckland. Your support is needed to make the Geomechanics Society's contribution to the conference a success.

If you wish to submit a paper for consideration for presentation at the conference please send an abstract to the Geomechanics Society Management Committee c/- P.O.Box 12-241 Wellington

before the end of August 1985

FROM THE INTERNATIONAL VICE-CHAIRMAN

1. ROCK MECHANICS

1.1 I S R M Working Groups

In the December 1983 issue of Geomechanics News an invitation was first issued to the membership to contribute to the '*Commission on Testing Methods*' Working Groups. The main task of the Commission is the drafting of '*Suggested Methods*' for rock testing.

Currently 23 Working Groups are active, and contributions are invited, in the following areas:

Aggregate Tests
Borehole Dilatometers (Flexible)
Borehole Dilatometers (Rigid)
Borehole Probe Extensometers & Strain Gauges
Convergence Monitoring
Deformability Measurement using Flat Jacks
Drilling & Boring Tests
Dynamic Elastic Tests
Fracture Toughness Testing
Hydrogeologic Tests (additions and revisions)
Large Scale Sampling & Triaxial Testing
Mesh Testing
Publication and Dissemination
Rock Anchor Monitoring
Seismic Testing Within and Between Boreholes
Shear Testing (Revisions)
Shotcrete Testing
Stress Measurements
Surface Seismic Methods
Survey Methods of Movement Monitoring
Swelling Tests
Thermal Tests
Uniaxial Tests (In Situ)
Uniaxial Tests (Laboratory, Revision)
Vibration and Blast Monitoring

1.2 6th I S R M Congress

This 6th Congress will be held in Montreal from 30 August - 3 September 1987.

A call for papers will be made soon.

1.3 7th I S R M Congress

Proposals have been received from four national groups to host the 7th I S R M Congress in 1991 - France (Paris), Germany FR (Aachen), India (Delhi) and South Africa (Cape Town). The venue is to be decided at the next I S R M Council meeting in Mexico in September 1985.

Venues for previous congresses have been:

| | | | |
|------|-----|---|-----------|
| 1966 | 1st | - | Madrid |
| 1970 | 2nd | - | Belgrade |
| 1974 | 3rd | - | Denver |
| 1979 | 4th | - | Geneva |
| 1983 | 5th | - | Melbourne |
| 1987 | 6th | - | Montreal |

D N Jennings

Vice Chairman I S R M

31 May 1985

2. ENGINEERING GEOLOGY

2.1 I A E Bulletins and Newsletters

IAEG have publicised the following programme for the issue of Bulletins and Newsletters:-

February 1985 - Bulletin No.30 + Newsletter No.11

July 1985 - Bulletin No.31 (June 1985 issue)

December 1985 - Bulletin No.32 (December 1985 issue) + Newsletter No.12.

If this programme is adhered to, receipt of the documents in N Z is likely to be at least two months after the dated indicated because of delivery by surface mail. The recommencement of IAEG Newsletters after a period of two years since the issue of No.10 is gratifying.

N Z Members should have recently received personal copies of Newsletter No.11, which should be accompanied by Bulletin No.30 for those who subscribe. If you have not received your copy please contact the Engineering Geology Vice-Chairman.

Bulletin No.30 is another thick volume of 482 pages which contains papers from themes 4, 5 and 6 of the International Symposium on Aggregates held in Nice, in May 1984. Papers from themes 1, 2 and 3 were published in Bulletin No.29.

2.2 I A E G Membership List

The last IAEG membership list was published in 1978 and an updated list is currently being prepared which should be available late this year. Because of high printing costs it is unlikely that members will receive free copies. However, to ensure that each member affiliated to IAEG receives a copy it will be necessary to raise the affiliation fee slightly to cover the cost. It would also be beneficial if new members affiliated to IAEG could receive a membership list when they join the Society so that they can identify with others members in the N Z Group as well as overseas.

2.3 Engineering Geology Manual

An engineering geology manual has been in preparation for several years and is proving to be a huge task. The content and format of the manual has been decided, but to facilitate quicker publication of the data, it has been decided to issue the manual as seven volumes, the first of which should be printed by the end of this year. This decision has been taken by the IAEG Council and the Chief Editor W R Dearman.

It is expected that the cost of volume 1 will be approximately \$30. Copies will be available from the N Z Geomechanics Society. Further information on the contents and cost of volume 1 will be published in the Geomechanics News. In the meantime orders are being taken by the Vice-Chairman for members wishing to obtain a copy. This will give an indication of the number of copies that should be ordered from IAEG.

2.4 5th International Congress of IAEG, Buenos Aires, Argentina, 20-25 October 1986

Copies of the Second Circular are available from the Vice-Chairman or the Management Secretary. Abstracts from intending authors should be submitted by 30 June 1985, and papers received by 31 January 1986.

2.5 Future Conferences / Symposia

The following conferences are being sponsored by IAEG:-

- | | | | |
|-------|----------|------|--|
| 9-10 | October | 1985 | International Symposium on Management of Hazardous Chemical Waste Sites. Winston-Salem, U S A. (preceded by IAEG Executive Council Meeting) |
| 25-29 | November | 1985 | First Latin American Symposium on Natural Disasters, Quito, Ecuador. |
| 14-19 | April | 1986 | International Symposium on Engineering Geology Problems in Seismic Areas, Bari, Italy. |

Further information is available in the IAEG Newsletter No.11 or from the Vice-Chairman or Management Secretary.

B R Paterson
Engineering Geology Vice-Chairman

3. SOIL MECHANICS

3.1 XI ICSMFE - ISSMFE Jubilee International Congress, San Francisco, U S A
August 1985.

- 6 N Z sponsored papers have been accepted
- John Galloway has been nominated for the position of Australasian Vice-President for a 3 year term from August 1985.

3.2 Technical Committees

Draft Reports are available - prepared by the following committees on the state of the art

- Constitutive Laws of Soils (copy held by the Secretary)
- Sampling and Testing of Residual Soils
19 papers including a N Z contribution by Dr Ian Brown
Available from

Scorpion Press
G P O Box 90674
Tsimshatsu Post Office
HONG KONG
(US 19.00)

A.01sen

LOCAL GROUP ACTIVITIES

AUCKLAND BRANCH ACTIVITIES

Three well attended meetings have been held so far this year in Auckland. Our program commenced with a meeting in April designed to stimulate discussion and comment on the Draft Method of Soil and Rock Description. Messrs. P Luxford and A Olsen (both members of the committee preparing the draft) gave a brief description of the drafts contents, highlighting potential contentious issues. A lively discussion followed with both engineering and geological viewpoints raised, particularly on the questions of soil description by particle size vs properties, rock strength terminology and borelog descriptions. A summary of the meeting was forwarded to the committee and encouragement was given to individuals to also send their comments. We look forward to the publication of this document, which is obviously of considerable interest to our members.

Our second meeting in May followed the general theme of retention methods. Dr D V Toan of Beca Carter Hollings and Ferner discussed a number of high cost retention schemes for difficult sites. Mr B Hadfield of Gilbert Hadfield Pile Co., gave illustrations of past and present methods of construction of retaining walls and anchorage systems, temporary and permanent and Mr R Irwin of Foundation Techniques Ltd., discussed the latest techniques in corrosion protection of anchors.

A joint meeting in June was held with Auckland Branch of IPENZ entitled "Landslides". With over a hundred attending, this meeting was our most successful this year. Mr Milton Allwood, Secretary of the Earthquake and War Damage Commission explained the details and implementation of the Earthquake and War Damage 1984 Regulations. Following the recent record rainfall in Auckland and its ensuing numerous slips, this topic was of great interest to many.

The evening was completed with a viewing of the unique and fascinating film of the massive Rissa landslide and its "floating mobile homes" - recommended viewing for all geotechnical and structural engineers.

Three further meetings are planned for the remainder of the year commencing on July 25 with a discussion of the use of geotextiles in roading and hydroschemes presented by Mr G R W East and Dr D V Toan.

Y. Thorpe

WELLINGTON BRANCH ACTIVITIES

The Wellington branch has had one meeting this year on 11 April. This was presented by Dr Graham Ramsay, Special Projects, MWD on the Design of a High Wall at Ohai Number 16 Open Cast Mine. Outlining the theme of the paper presented at the 4th Australia-N Z Geomechanics Conference, Dr Ramsay discussed the development stages and design of the 100m high batters. Of particular concern was the nature of the overburden where old underground workings were recorded as having been pillared out. Careful consideration was given to selection of representative strength parameters, piezometric conditions and appropriate factors of safety.

A further meeting is planned at which Murray Gillon, MWD Power Directorate will outline current methods of analysis used in the USA for design of large earth embankments.

I. Brown

LETTERS TO THE EDITOR

The following item of correspondence has been received by the Editor:-

Sir,

The question of a change of name for the Geomechanics Society appears to have widened, quite properly perhaps, to include the relationship between geotechnical engineers and engineering geologists. It is in the area of the interaction between the engineered structure and the earth materials on or in which it rests that a substantial overlap exists between the work of the engineer, generally civil, and the geologist. The geologists most concerned with those overlap generally describe themselves as engineering geologists.

The engineer, because of his training and experience, is best qualified to deal with the engineered structure. The engineering geologist, on the other hand, because of his training in the characteristics of earth materials and their distribution in a three dimensional space, should be the best qualified to deal with these materials. I should say because undoubtedly **there are** geologists whose training has been directed towards other aspects of geology who now consult as engineering geologists or, as Ian Brown points out, as geotechnical engineers.

In Britain and possibly elsewhere in the world a wider view of what constitutes engineering is common in contrast to the more restricted view prevailing in New Zealand. Elsewhere there seems to be a greater acceptance of the view that engineering is the application of physical science and mathematics to the practical solution, in a cost effective manner, of day to day material problems. Few would disagree that there are a number of individuals, trained as engineers who, because of the research nature of their work might properly be described as scientists. There are also individuals, formally trained as scientists, who by applying their science to the solution of problems are, in fact, working as engineers.

It appears to me that the difficulties that engineers face in dealing with earth materials would be diminished if they accepted that the individuals specialising in this field, the engineering geologists, should be engineers also in the sense of being registered professionals. Leaving for a moment the question of whether the engineering geologists should be members of IPENZ or another body of similar legal status, all the legal responsibilities, at present carried by engineers, for the stability and adequacy of the earth materials on or in which a structure might be founded should devolve on the registered engineering geologist advising the designer of the structure.

There is, at the moment, no professional body for the engineering geologist in New Zealand. There has been much debate among the various applied geologists in New Zealand regarding professional bodies and professional status. The question is difficult to resolve because of the differing needs and aspirations of academic geologists, exploration geologists, engineering geologists and groundwater geologists. The second group have their professional bodies, The Institution of Mining and Metallurgy and The Australasian Institute of Mining and Metallurgy. The difficulties inherent in setting up a professional, as opposed to graduate, body of engineering geologists and obtaining for this body the legal and other status of IPENZ, with the consequent responsibilities in law, are probably insuperable. My view is that these difficulties could best be resolved by the admission, into IPENZ as corporate members, of suitably trained engineering geologists.

As corporate members of IPENZ, and thus or in some other way eligible to be registered as engineers, it would be incumbent on the admitted engineering geologists to do only that which they are professionally capable. IPENZ would be able to ensure that only adequately trained and experienced engineering geologists would be able to describe themselves as registered engineers.

My view, which I believe is widely held among private sector geologists and other geoscientists, is that registration is desirable for geological consultants and those geologists contributing to company prospectus and environmental impact reports or otherwise active in situations commensurate with those where there would be a requirement for an engineer to be registered. I envisage three divisions in which geologists might be registered:-

1. Engineering geology
2. Mineral exploration
3. Groundwater exploration

The Australasian Institute of Mining and Metallurgy and The Institution of Mining and Metallurgy should be, by registration linked to corporate membership, the approving bodies for mineral exploration. Similarly IPENZ should be the approving body for engineering geologists. All three bodies should be able to approve for groundwater exploration on evidence of suitable experience.

R H Dewhurst

Hauraki Catchment Board.

SYMPOSIUM ON PILE FOUNDATIONS FOR ENGINEERING STRUCTURES

MAY 1986

Arrangements have commenced for a Symposium on Pile Foundations for Engineering Structures. The Symposium is to be held at the University of Waikato, Hamilton on 23-24 May 1986.

The emphasis for the symposium is on practical aspects of piled foundations and will include several case histories. Speakers will be invited by the Symposium Steering Committee to contribute to the Symposium.

It is intended to include a form discussion on aspects of pile design. This has potential to be a lively and constructive discussion with the opportunity for involvement of all participants.

Details of the programme and arrangements for the Symposium will be presented in the November issue of Geomechanics News.

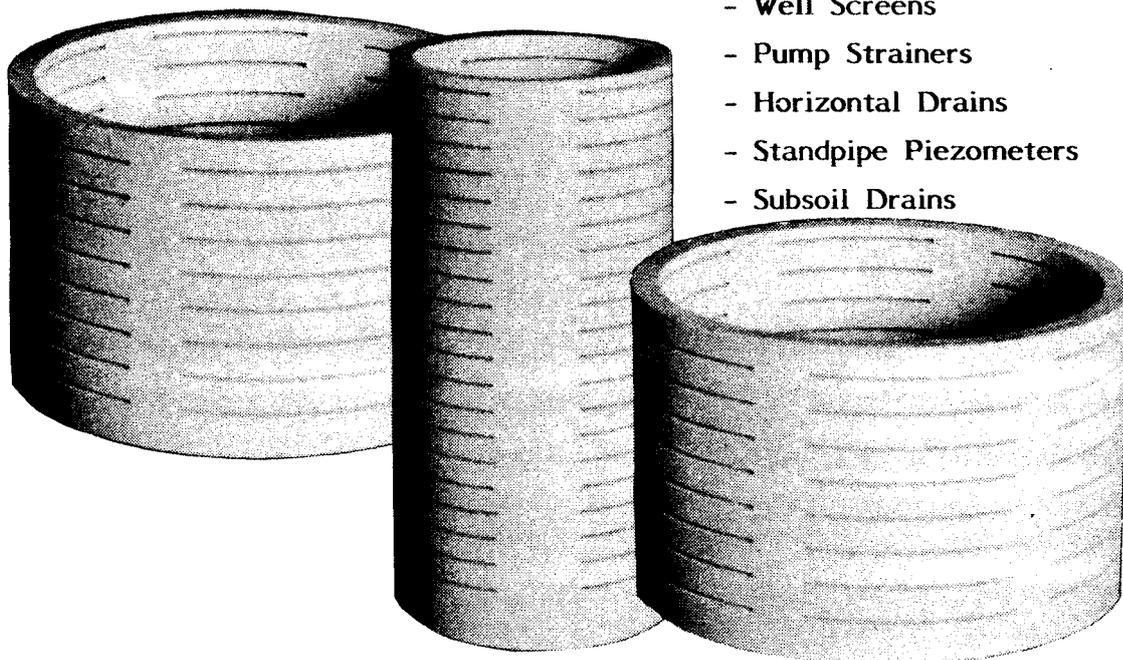


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ROY NORTHEY MADE HONORARY FELLOW OF INSTITUTION OF PROFESSIONAL ENGINEERS

The Institution of Professional Engineers New Zealand has elected Dr Roy Northey, recently retired Deputy-Director of the Soil Bureau, as an Honorary Fellow of the Institution.

Dr Northey is only the third Honorary Fellow currently on the roll of the 6000 strong Institution. The others are Dr W H Pickering (recently retired as Director of the Jet Propulsion Laboratory at Caltech) and Professor C M Segedin, Professor Emeritus of Theoretical and Applied Mechanics at the University of Auckland.

Dr Northey, in his work in soil mechanics and foundation engineering, has been closely associated throughout his career with professional engineers and with the Institution's technical group, the N Z Geomechanics Society for Soil Mechanics and Foundation Engineering, to which the Geomechanics Society is affiliated.

After completing his Ph D in 1950 at Imperial College, London, Dr Northey returned to New Zealand and was in charge of the soil engineering section of the Soil Bureau from 1950 to 1981, when he was appointed Deputy Director. During this period he introduced new methods of sampling, testing and analysis of soils. His advice and services have been used extensively by government agencies, local bodies, consulting engineers and others. He established such a reputation for knowledge, practical skill, experience and judgement in soil engineering that he became the ultimate resource person in New Zealand for a generation of engineers.

In the field, Dr Northey has taken part in investigations of notable and catastrophic failures of slopes, embankments and foundations. In these investigations his observation, knowledge, analysis and reasoning have often been conclusive in establishing causes and identifying remedial action. He has published over 40 pages in national and international journals and proceedings. He has a very extensive knowledge of international literature, and has been able to draw on this to assist him in investigations. He has the ability to see the wider implications of situations and to suggest creative solutions to problems.

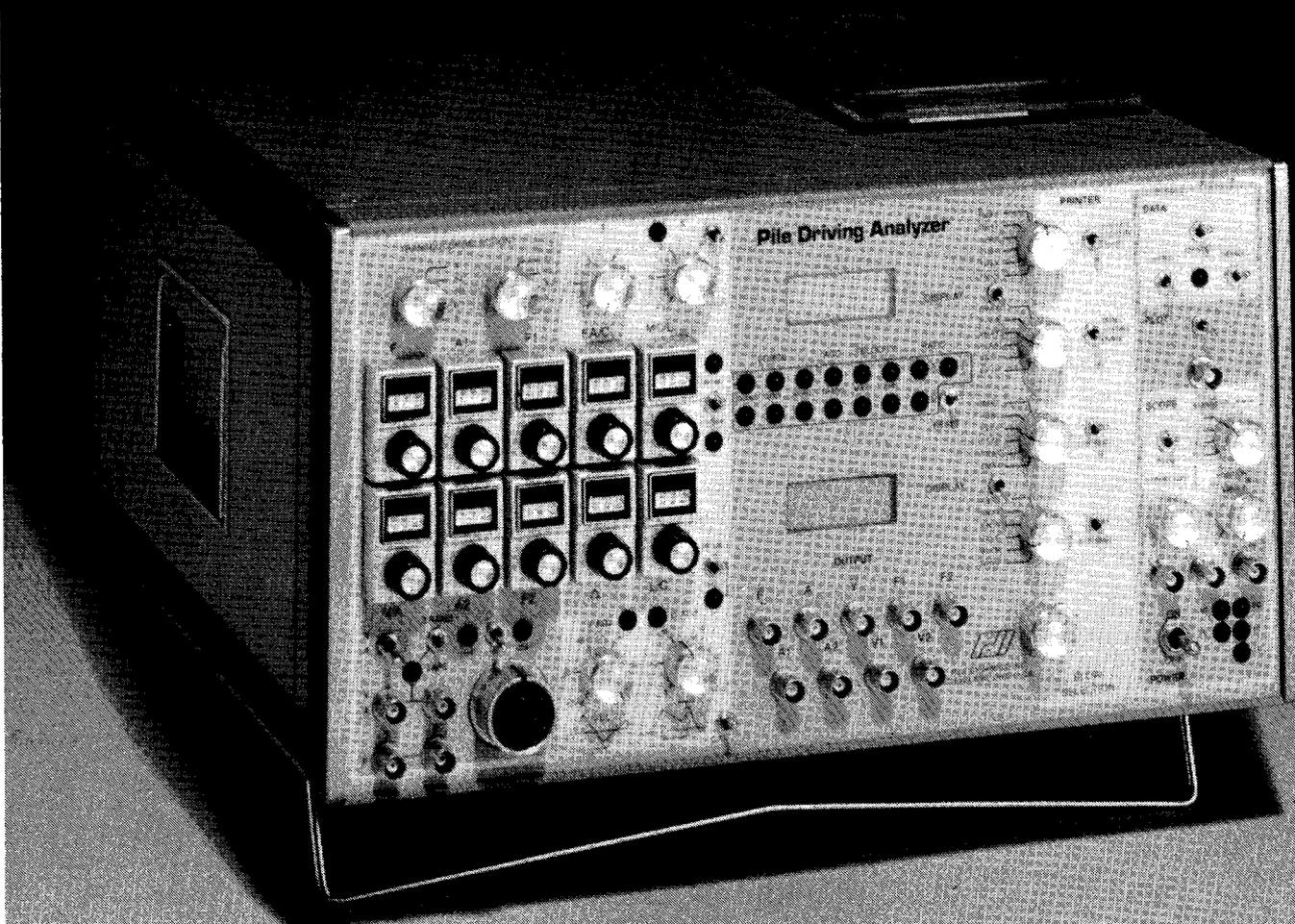
Dr Northey's reputation extends far beyond New Zealand. He has been asked to provide expert opinion and give evidence in tribunal hearings, both here and overseas. He has been an invited participant in a number of international conferences.

Dr Northey has also contributed to the work of the Institution of Professional Engineers New Zealand, being a co-author of the Institution's recent publication, Engineering Risk.

Dr Northey's certificate of membership as an Honorary Fellow was presented to him at the Institution's annual conference in Wellington in February 1985.

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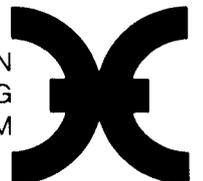


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SOIL AND ROCK DESCRIPTION MANUAL

The subcommittee has met to review comments made by members on the draft document circulated in March. These comments provided the basis for the resolution of several of the more contentious sections of the draft viz. description of the fine grained soil fractions, plasticity definitions, terminology used for rocks with unconfined compressive strength $< 1 \text{ MPa}$ and weathering of soils.

A brief summary of the main conclusions is included.

1. Fine grained soil fractions.

There is general agreement that the description of fine grained soil should clearly identify the behavioural characteristics of these fractions. Two systems have been proposed which provide this information and on examination by the committee both alternatives were shown to be clearly distinguishable and unambiguous. These are:

(a) Soil classification systems USCS and BSCS.

The Unified Soil Classification system (USCS) method is the most widely used classification system and has been included, but it is noted that the most recent revision of ASTM 2487 : 1983 recommends the use of additional descriptive terms to be used in conjunction with this classification system. The British Soil Classification System (BSCS), BS 5930 : 1981 has also included additional subgroups. In these methods the terms used are SILT or CLAY with the descriptive terms lean, fatty or elastic optional. The additional plasticity terms of the BSCS system can also be used if desired.

(b) Particle Size Terms for soil names with Upper Case letters used to identify Behavioural Characteristics.

This system is similar to the British field description method BS 5930 : 1981 and provides for soil name descriptions based on particle size estimates but with the dominant fraction affecting engineering behaviour identified by upper case letters. The system uses the principal, subordinate and other terms as set out in the draft document. e.g. CLAYEY silt. The principal fraction in this material is silt ($>30\%$). Clay forms the subordinate fraction (20-30%) but is considered to dominate the engineering behaviour of the material. The USCS system would most likely describe this material as a lean CLAY (CL). (no subordinate terms being permitted in the USCS system).

The full list of alternative terms for both systems shows that they are easily distinguishable but both provide a clear indication of the engineering behaviour.

2. Plasticity Definitions.

It is clear that the USCS system initially defined the plasticity of soils in terms of the plasticity index. However, the general relationship between increasing plasticity index and liquid limit has lead to the more common definition of plasticity in terms of liquid limit. e.g. BSCS. The latter allows plasticity to be correlated with undrained shear strength and shrinkage / swelling characteristics.

3. Soil Weathering.

Soil weathering is to remain in the sequence of terms primarily for coarse grained soils which have weathered after deposition.

4. Density of Cohesionless Soils.

The system used to describe density of cohesionless soils will be consistent for all methods of determination and will use the terms currently applied to relative density tests. Where information is obtained by testing the results should be clearly shown on the logs.

5. Soil / Rock Division.

The use of rock description terms for extremely low strength rocks which have weathered in situ and have a strength $<1\text{MPa}$ may not provide adequate engineering information and soil description terms should also be given. Alternatively the material may be described as a soil but the weathering grade and the parent rock name must then be included in square brackets at the end of the descriptions.

Where the strength of the material is greater than 1MPa it should be described as a rock.

6. Rock Description.

The document will be expanded to include an improved description of defects. Consideration is also being given to guidelines for estimating excavation requirements e.g. rippability.

Engineering Geology for Local Government

- An Input for Planning & Development

A 2-day seminar on the above subject was held at Canterbury University, 27-28 May, organised by the University's Department of Extension Studies. The main contributors were David Bell and Jarg Pettinga of the Department of Geology. Thirty-three participants, a majority of whom represented local government bodies throughout New Zealand, took part in a programme of lectures, discussion and film on the following topics:-

Geological processes, hazards and disasters
Engineering geology and land use planning
"Abbotsford landslip in retrospect"
Engineering geology methods and data presentation
Planning for hazard mitigation
Planning for disaster preparedness

In addition to the main contributors, Dr J.G. Gibb (MWD Water & Soil Directorate) presented a very interesting talk on coastal erosion with particular reference to recent work on the West Coast (South Island).

Throughout the 2 days numerous examples of the use of engineering geological methods were illustrated and discussed and by the end of the seminar participants appeared to be in no doubt concerning the relevance of engineering geological input to land use planning, hazard mitigation and disaster preparedness.

During discussion several recurring key questions were raised, in particular

1. The professional status of the engineering geologist in New Zealand and the possible community benefits were he to be professionally registered (compare the registration by Act of Parliament of practising engineers and surveyors);
2. The desirability (or otherwise) of a statutory engineering geology input into land use planning and
3. The need to establish technical expert teams (including engineering

geologists) to assist with civil emergencies.

A table illustrating the role of engineering geology within the existing legislative framework is reprinted from the seminar notes.

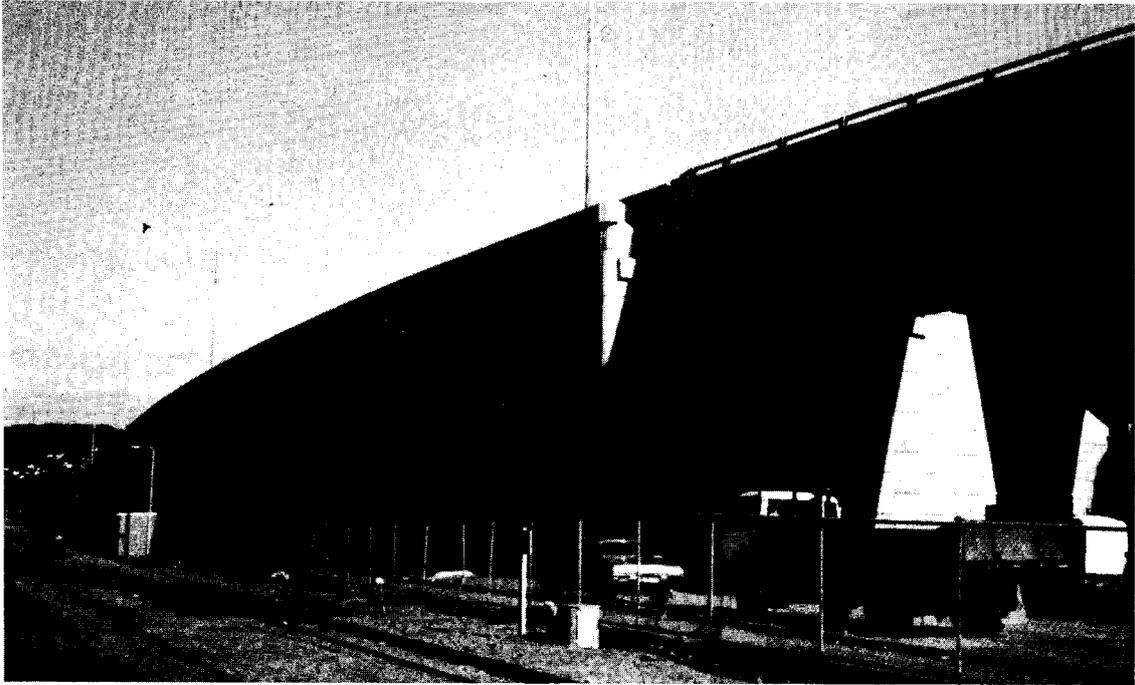
J.D. McLean

TABLE
ENGINEERING GEOLOGY DATA INPUT FOR URBAN DEVELOPMENT IN NEW ZEALAND

| Planning Stage ⁽¹⁾ | Engineering Geology ⁽²⁾ Investigation Objectives | Typical Map Scales | Geotechnical Data ⁽³⁾ |
|---|---|--------------------------|--|
| A. REGIONAL SCHEME  | 1. Identification of "regional" hazards such as floodplains and "active" fault traces | 1:100,000 | Characterisation of lithologies and identification of "problem" soil types; assessment of resources (e.g. aggregate availability and long-term requirements) |
| | 2. Mapping of bedrock and surficial geology | 1:25,000 | |
| B. DISTRICT SCHEME  | 1. Engineering geological and/or pedological mapping, with limited excavation logging | 1:10,000 | Geotechnical characterisation of mapping units as required for land-use zoning decisions; specific evaluation of tectonic and hydrologic hazards |
| | 2. Identification and investigation of "local" hazards (e.g. landslides) | 1:5,000 | |
| C. SUBDIVISION CONCEPT PLAN  | 1. Engineering geological site mapping and subsurface investigations | 1:2,000 | Limited testing (e.g. plasticity/grainsize) to indicate general characteristics of site materials; hazard avoidance or mitigation measures |
| | 2. Interpretative risk assessment and/or planning guidelines | 1:1,000 | |
| D. SUBDIVISION SCHEME PLANS  | 1. Detailed site investigation of specific areas identified at Concept Plan stage | 1:1,000 | Additional geotechnical testing to verify design and/or construction feasibility as required; investigation of specific features to facilitate stage E |
| | 2. Engineering geological mapping and logging to meet any "local" authority requirements | 1:500 | |
| E. SUBDIVISION DESIGN AND CONSTRUCTION  | 1. Confirmation of mapped geology | 1:500 | Detailed investigations for design of cut and fill batters if required; control of earthworks |
| | 2. Additional investigation as required | 1:50 | |
| F. SECTION DEVELOPMENT AND HOUSE CONSTRUCTION | Engineering geological investigations only if required (A + E should prevent site "problems") | 1:200 | Site specific testing for foundations if required; control of earthworks, drainage, etc |
| | | 1:50 | |

- NOTES: 1) Planning stages follow from existing legislative framework (Table 5).
- 2) Engineering geology investigation methods include air-photo interpretation and relevant mapping and logging techniques.
- 3) Geotechnical design investigation requirements may vary considerably within individual urban areas.

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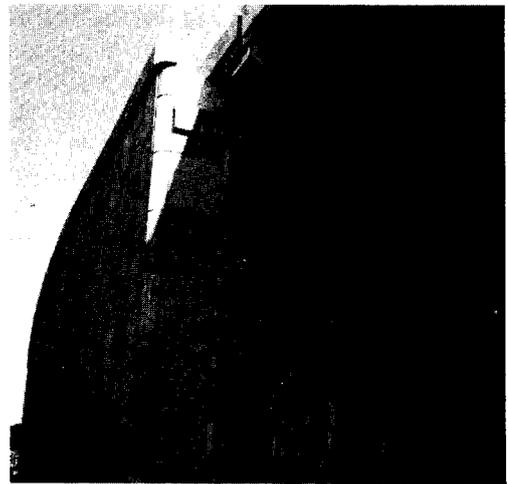


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Longwall Mining at Huntly East Mine

Iain S McIntosh, Mining Engineer (Methods), State Coal Mines.

The purpose of this article is to briefly outline the role geomechanics has to play in longwall mining. The term longwall is meaningless to most people outside of the mining fraternity so a description of the Huntly East Mine project is included.

State Coal Mines is presently seeking tenders for the purchase of equipment for the first fully mechanised longwall face in New Zealand. This however will not be the first longwall to be operated in this country. A hand loaded, machine cut longwall face with sand stowage was used to mine coal at the Mangapehi Mine in the mid 1950s.

Longwall Mining is an underground mining method in which a rectangular block of coal 1 to 5 metres thick between two parallel roads 50 to 300 metres apart and 500 to 4000 metres long is mined by cutting coal from a face on the short side of the block. The face is the full width of the block and at Huntly East will be 125 metres wide. On each pass along this face the coal shearer cuts off a slice of coal 0.6 to 1.0 metres thick and the full height and width of the face. As the coal is cut the face equipment is moved forward ready to take the next cut and the roof strata are allowed to collapse. Figures 1 and 2 show a plan and cross-section of the longwall layout and equipment.

The main elements of a mechanised face are the shearer to cut the coal, an armoured conveyor onto which the cut coal falls and is transported away, and self advancing hydraulic supports which support the roof strata in the vicinity of the face and provide protection for the miners.

The longwall method which originated in Wales in the 1700s is used to produce most of the "deep mined" coal around the world from deep coal seams and conditions where other methods are unsafe, uneconomic or technically not feasible. The main benefits are the positive ground control afforded by the supports, the fact that the supports are continually reused and not lost as with other systems of ground support and the continuous production cycle.

At Huntly East Mine there are two mineable seams, the Renown and the Kupakupa which have varying thicknesses from 2 to 6 metres and 2 to 12 metres respectively. The Renown seam is 5 to 20 metres above the Kupakupa seam and both are 140 to 290 metres below the ground surface. While this is very shallow by world standards for the use of longwall methods the very weak coal and roof strata mean that alternative methods such as bord and pillar are not suitable.

A feasibility study completed in June 1984 by British Mining Consultants (Australia) Pty Ltd., proposed to recover these seams using longwall mining methods. For this a nominal face operating height of 1.75 to 3.2 metres was selected. Equipment is available for faces up to 5.5 metres but at these heights it is considered that the face would be unsafe. As face height increases the stability of the face deteriorates causing operational problems and the equipment becomes too heavy and large to transport underground. Also, because there is no experience of longwall mining in the conditions at Huntly a conservative approach has been adopted to minimise the risk always present in mining operations in difficult conditions.

Where the seam is thicker than 6 metres it is proposed to take two slices to increase recovery rates. In this situation the top 2 to 3 metres of the seam is mined and the collapsed strata allowed to consolidate for 2 to 3 years. After this time the lower 2 to 3 metres of the seam is mined with the face moving under previously collapsed strata.

In all 17 rectangular blocks (or panels) were defined : 5 are in the Renown seam, 4 are single slice panels in the Kupakupa seam and 4 are double slice panels in the Kupakupa seam. To minimise adverse stress conditions on the face the panels in the two seams are located exactly over one another. This effectively results in 8 panels which will be mined 1 to 3 times.

In addition to the longwall at Huntly East it is also proposed to operate 3 longwall faces at the Huntly West No 1 mine and a similar number at the proposed Huntly West No 2 mine at depths of up to 550 metres. These longwall faces which will be installed from 1989 onwards will all be in thick coal and therefore will either use multiple slice or sublevel caving techniques to maximise coal recovery. The Huntly East mine will provide much of the design information for these faces especially for multiple slicing operations.

Having described the proposal it is time to get to the point of this article and that is to outline the role geomechanics can play in longwall mining.

There are several areas requiring geomechanical input of which the most important from a mining point of view is the selection of the hydraulic supports. The design criteria for supports is usually derived by one of three methods:-

a) rule of thumb:-

usually what other mines in the vicinity have done.

b) empirical methods:-

usually a relationship between several parameters such as seam thickness, bulking factor, caving height, convergence, cantilever beam length, uniaxial compressive strength but also relying on experience nearby or in similar conditions.

c) modelling:-

this has had limited application because of the need for large quantities of geomechanical data which is usually not available in mining situations.

In addition most mining countries or nationalised mining industries have adopted empirical relationships that have general local acceptance for defining support capacity. Given that there is no longwall history in New Zealand it has been necessary to use one of these empirical relationships as a starting point.

To overcome this lack of data a monitoring program is to be put in place prior to the start of longwall mining programmed for mid 1987. The objective is to derive local design criteria and determine the mechanics of caving to enable extrapolation to deeper seams at the other mines. This will include determination of the caving height from surface boreholes, bed separation by underground extensometers, continuous measurement of support loading by monitoring hydraulic pressures, measuring of face convergence, logging roof strata and roadways and correlating this with observed face conditions and production cycles to determine the relevant parameters. The type of design parameters required for supports include support yield load, optimum setting load, canopy configuration, leg configuration, face sprag size, position and load, and operating parameters such as the need for face reinforcement. The first stage of this program was recently started with a contract let to review suitable techniques and equipment that are permitted in gassy coal mines, this being a major constraint on any monitoring system planned.

Having selected a support capacity the support base configuration and lifting rams have to be considered. The Geomechanics Section, Central Laboratories, MWD have conducted a series of plate bearing tests on a variety of floor materials to enable support manufacturers to design a base that will not sink too far into the floor strata before the support is advanced. The base performance of the Huntly East supports will be monitored primarily by observation. There is limited opportunity to do too much more than this because, with the exception of weekends or when there are problems, the face will move forward 8 to 10 metres per day. It will be possible to relate support load with penetration and floor strata.

Between each panel of coal extracted a coal pillar is left to enable the area to be sealed in event of flooding or fire. As the longwall moves forward an abutment stress on the face and these pillars increases to several times the overburden stress resulting from strata bridging across the area from which the coal has been extracted. It is essential that the pillars withstand this stress and retain structural integrity if they are to function as desired. As with the support design empirical formulae from overseas are used to design pillars. The design and stability of the pillars becomes more critical with multiple slicing where the height : width ratio moves away from that experienced to date. On the other hand pillars of excessive size can significantly reduce coal recovery rates so a balance has to be achieved.

A monitoring program will be set up to establish design parameters and pillar reinforcement for the conditions at Huntly. This will involve installation of horizontal extensometers to determine the yield zone and stable core of the pillars and the measuring of the change in stress levels as the abutment stress increases.

The success of multiple slice mining depends on the consolidation of the collapsed strata. While in general there will be adequate time between each slice for this to occur it is recognised that at times there will be a need to reduce this time to meet production requirements. It is necessary to establish the rate of consolidation and determine the minimum time required. This will be done by monitoring the rear abutment stress, the reestablishment of overburden stress and from underground drilling into the consolidating strata.

The other main area of concern underground is the stability of the roadways on either side of the block of coal being extracted. It is normal practice to have to put large quantities of temporary supports in this area in addition to steel arches to withstand the front abutment stress, The objective of the monitoring program will be to determine additional support requirements and necessary design changes to minimise the damage to the roads in front of the longwall. This will be achieved by monitoring convergence of the road and bed separation.

Because the strata behind the face is allowed to collapse the surface will subside. A variety of methods for predicting the magnitude and extent of subsidence exist being either empirical or derived from continuum mechanics. All are site specific correlated to the local conditions and geology.

At Huntly East a computer model developed by the National Coal Board based on the measurement of 165 faces in the United Kingdom was used to provide the first estimate. As there is no history of planned subsidence there is no data with which to calibrate the model or verify the results. It is however expected that the actual subsidence will have similar impacts and be of a similar magnitude.

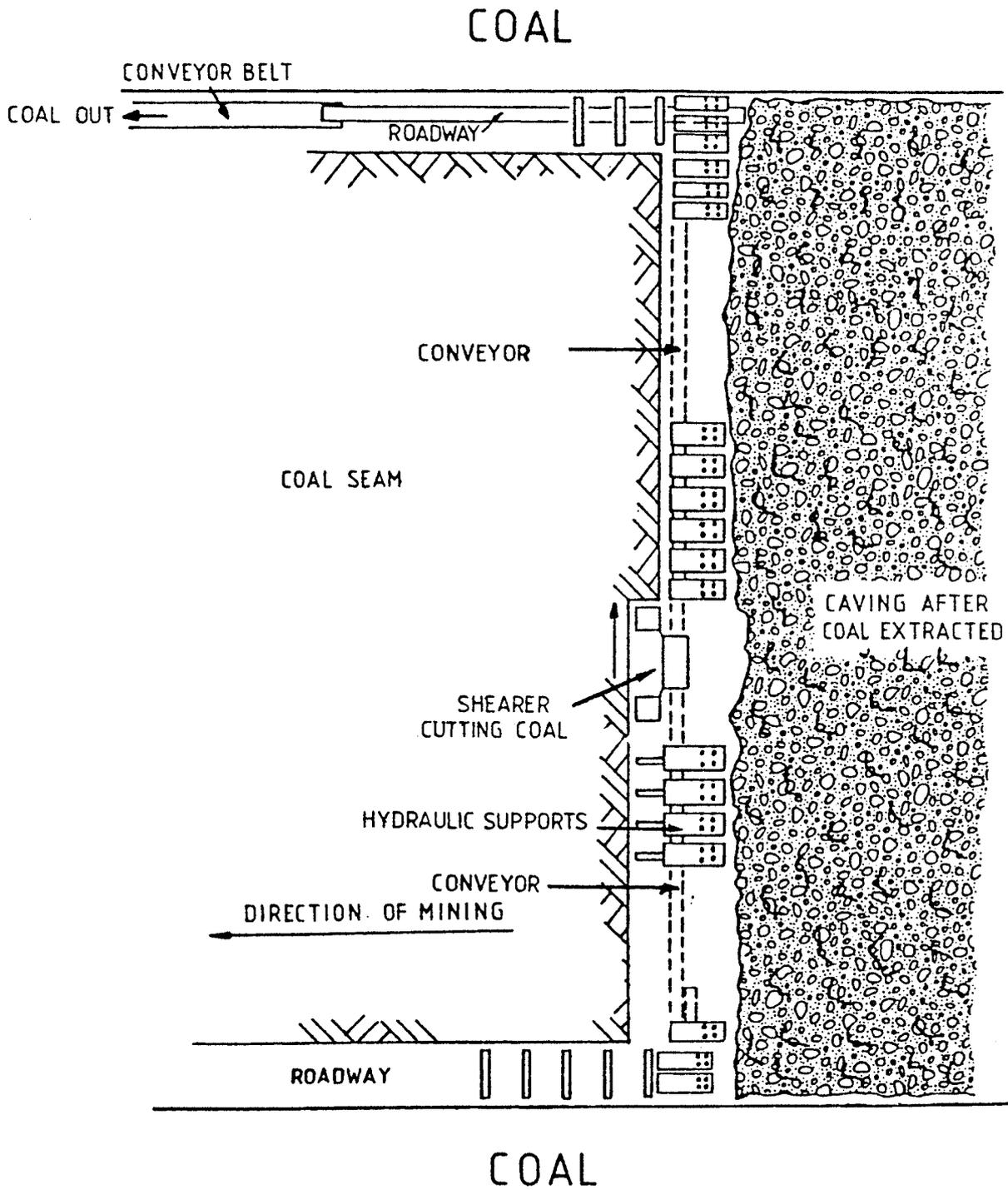
The model predicts maximum subsidence of 4.65 metres where three slices are taken. This will affect roads, railways, houses, pipelines, oxidation ponds, cables and other infrastructure, and cause ponding in the depressions. It is therefore important to be able to predict the subsidence with some degree of accuracy to

enable precautions to be taken or the mine plan modified. To achieve this the surface will be monitored by Lands and Survey Department who have been doing this since the mine started.

A grid of points will be established at 10 to 15 metres and monitored by precise levelling and distance measurement. From this the subsidence, strain and slope can be derived and a subsidence model for Huntly East calibrated.

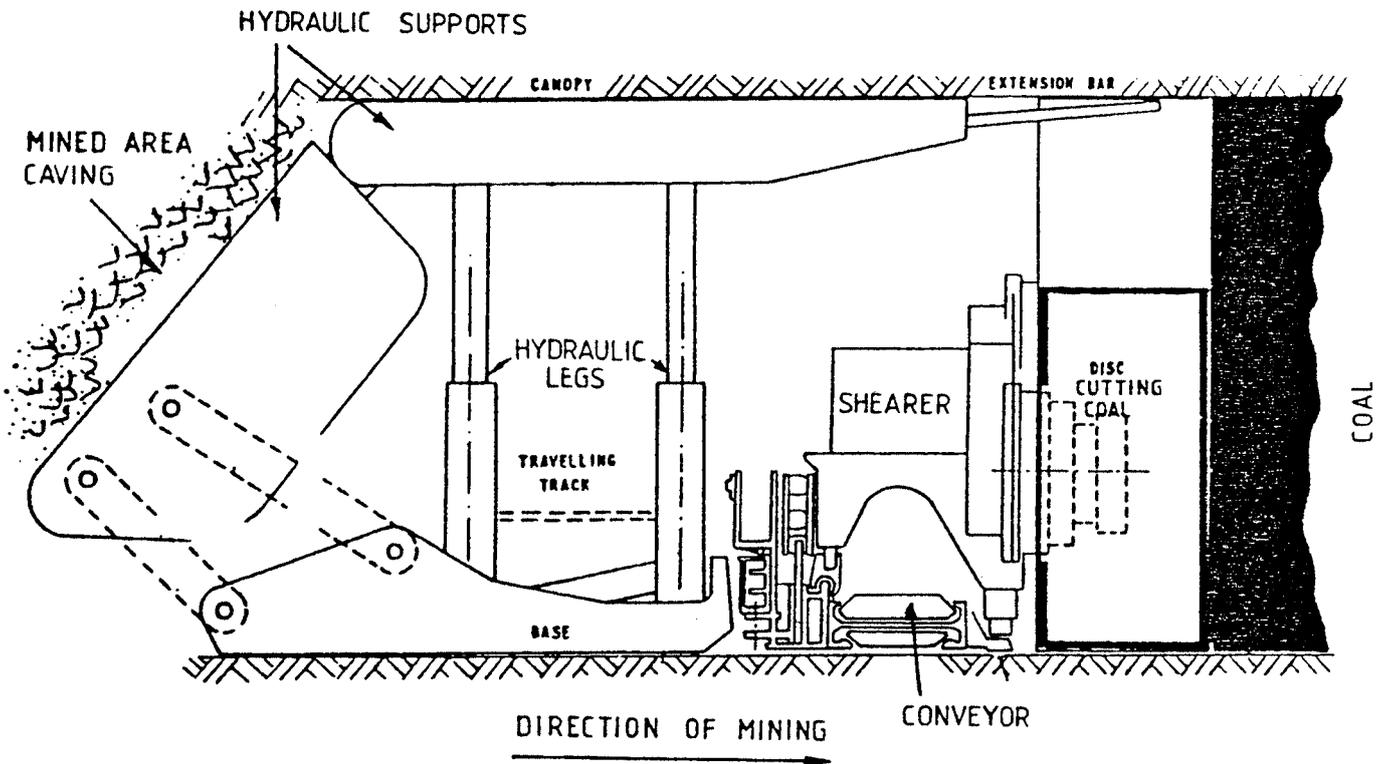
Other areas of concern include groundwater with particular emphasis on the impact the mine might have on the aquifers rather than the flooding of the mine.

In conclusion the bulk of the effort once the longwall starts will be the compilation of a data base of information on how the strata at Huntly reacts to longwall mining. The value of this will be in the factual review of the first longwall and provide the data for the design of the other mines in the area. At present it is not possible to discuss the program in anything other than general terms as has been done here, the detail will have to be addressed in the future once it is known.



LONGWALL EQUIPMENT

Figure 1



LONGWALL FACE EQUIPMENT

SUMMARY. A deep-seated landslide in loess was reactivated by the construction of a large road embankment, which blocked ephemeral springs and surcharged the undermass, the road, underground services, and several houses were damaged. Engineering geological investigations enabled the quasi-rotational nature of the movement to be recognised, and led to removal of part of the road-fill, which unloaded the landslide and brought movement to a halt. Auger holes drilled while the ground was in motion enabled the failure surface to be located and provided the basic data for a stability and drainage analysis. The calculations suggested that a single deep counterfort drain would sufficiently lower the piezometric surface and would remove sufficient water to create reasonable stability before the following winter. The case history points to the need, in the planning and execution of engineering works, to make due allowance for the special problems of loessial ground.

1 INTRODUCTION

This is an account of the history of a 32,000 m³ landslide in redeposited loess which overlies volcanic rocks on the eastern slopes of the Akaroa caldera. The site is a small sheltered valley, not far above the harbour, where an armchair-like hollow offers good building sites, but where mass movements down the flanks of the bordering ridges and from higher slopes had built up a considerable thickness of potentially unstable loessial debris. Near the head of the hollow, three ephemeral springs once flowed into a small stream which passes across the accumulated debris, partly through subcutaneous tunnels. Both the landslide topography and the intermittent underground flow of the stream are evident from inspection of old (1941) aerial photographs and of the site itself.

In late 1972 or early 1973, during earthworks for the La Clare subdivision, several thousand cubic metres of compacted roadfill for Hempleman Drive were placed across the head of the hollow, burying the springs (Figure 1). Some years earlier, during cut-and-fill operations for house sites, the lower courses of the subcutaneous tunnels were blocked off with tree stumps and spoil, thus impeding the drainage of dormant landslides that filled the depression. Minor localised instability problems appeared from time to time in 1973 and 1974, and in 1975 various seemingly unrelated ground movements damaged underground services, roadfill, some kerb and channel, and foundations of the Jeffrey house. Insignificant superficial movements occurred in 1976, but in September 1977 events culminated with a major subsidence of the Hempleman Drive fill, accompanied by extensive ground fracturing down-slope and renewed damage to services and the house (Figure 1). At this stage, the existence of a large landslide was recognised. From then until mid-October 1977, the ground continued to move en masse at a rate of up to 40 mm a day, and six houses were either damaged or threatened with damage.

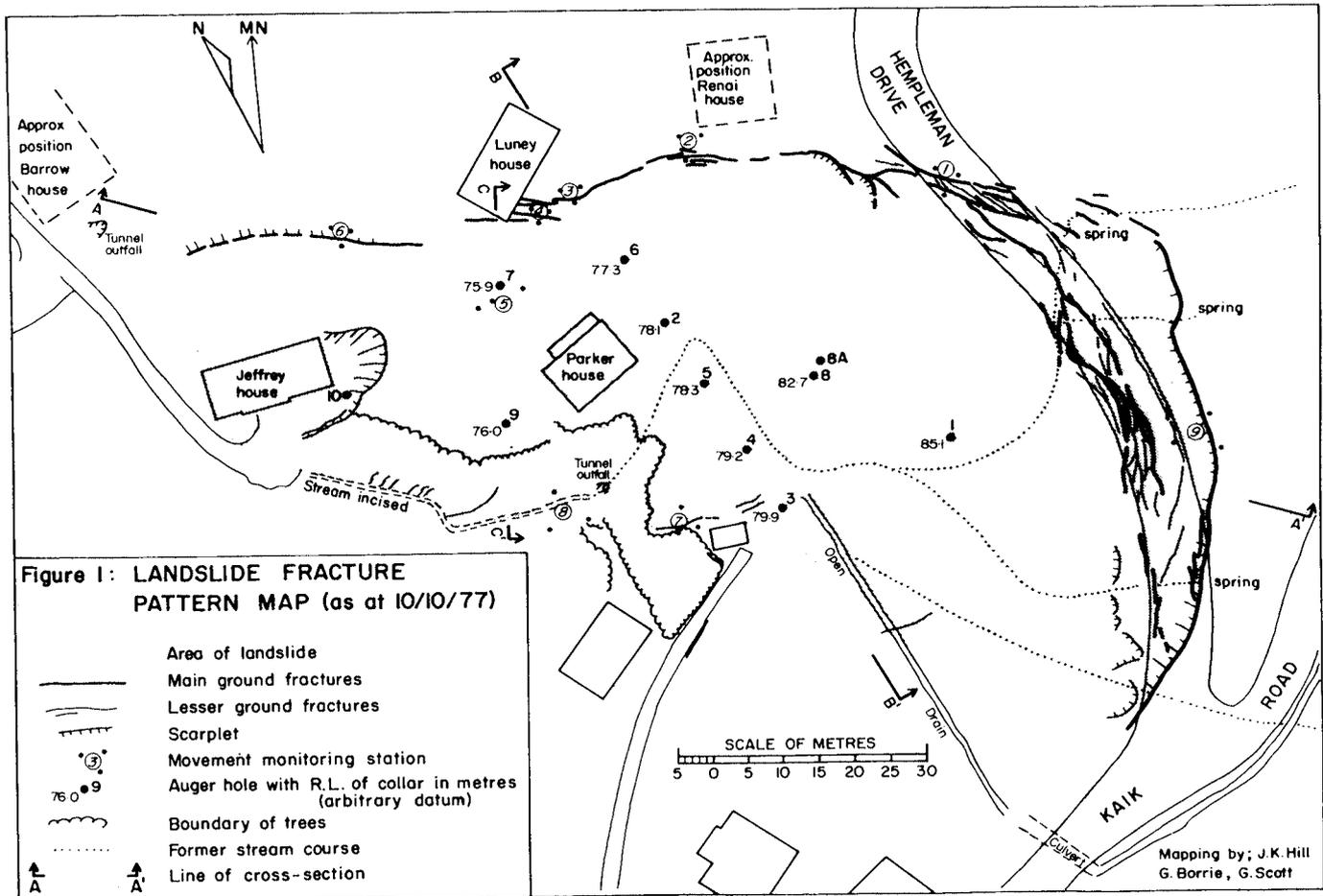
2 ENGINEERING GEOLOGICAL INVESTIGATIONS

2.1 Objectives

Systematic investigations at the landslide began with some urgency on 3 October 1977, and the specific purposes of the work were:

- a) to arrive at an understanding of the landslide's geological and hydrogeological causes and mechanisms, sufficient to provide a rational basis for planning remedial treatment aimed at quickly halting the movement;
- b) in the breathing space gained, to investigate and recommend methods of treatment most likely to be effective both in the short-term (ie before winter 1978) and in the long-term, and which would be both practicable and economical having regard to the limited resources available;
- c) to plan and initiate a simple movement-monitoring system which would measure directions and amounts of movement and allow trends in rates, and cessation or renewal of movement at any time, to be detected as early as possible, and the net effect of rainfall, drainage, and other stability measures to be evaluated;
- d) to plan and initiate a groundwater and drainage monitoring system so that pore pressures, water load, and water-budget of the landslide could be estimated at any time and incorporated in stability analysis or changes in remedial treatment;
- e) to make a permanent record of all significant phenomena associated with the landslide so that, should movement be renewed, a full history of past events would be available, especially since it seems likely that the original landscape and geology will eventually become obscured during subdivision.

The initial investigations consisted of a brief geological examination of the locality, interpretation of aerial photographs, mapping ground fractures, installation of nine temporary movement-monitoring stations, drilling of ten 100 mm diameter auger holes, regular depth and water-level



observations in the holes, and seismic traverses. Subsequent work also included a rainfall analysis, a materials study, and a stability analysis involving a quantitative study of the relationship between drainage and safety factors. In this paper a brief outline is given of the results of this work.

2.2 Rainfall Analysis

A seasonal (three-monthly moving mean) analysis of rainfall (Figure 2) shows that from 1973 there are quite regular and substantial winter departures above, and some summer departures below, the rainfall norm. Whenever the amount of the summer 'deficit' is substantially exceeded by the following winter's 'surplus', major slope movement seems to ensue. When the summer 'deficit' is greater, there is no movement. There is also the possibility that surplus moisture from wet winters is persisting as groundwater storage through normal or wet summers, and is augmenting the moisture content in the succeeding winter, thus enhancing the likelihood of slope movement. Whatever the truth of the matter, from the winter of 1973 onwards there is an accumulating rainfall surplus above the norm, which had become substantial by 1977. All this suggests that in wetter climatic cycles, build-up of excess water in the ground may be a relatively long-term process which, in a landslide situation, may not be easily or quickly reversed in a few months by normal drainage measures.

2.3 Geological Mapping

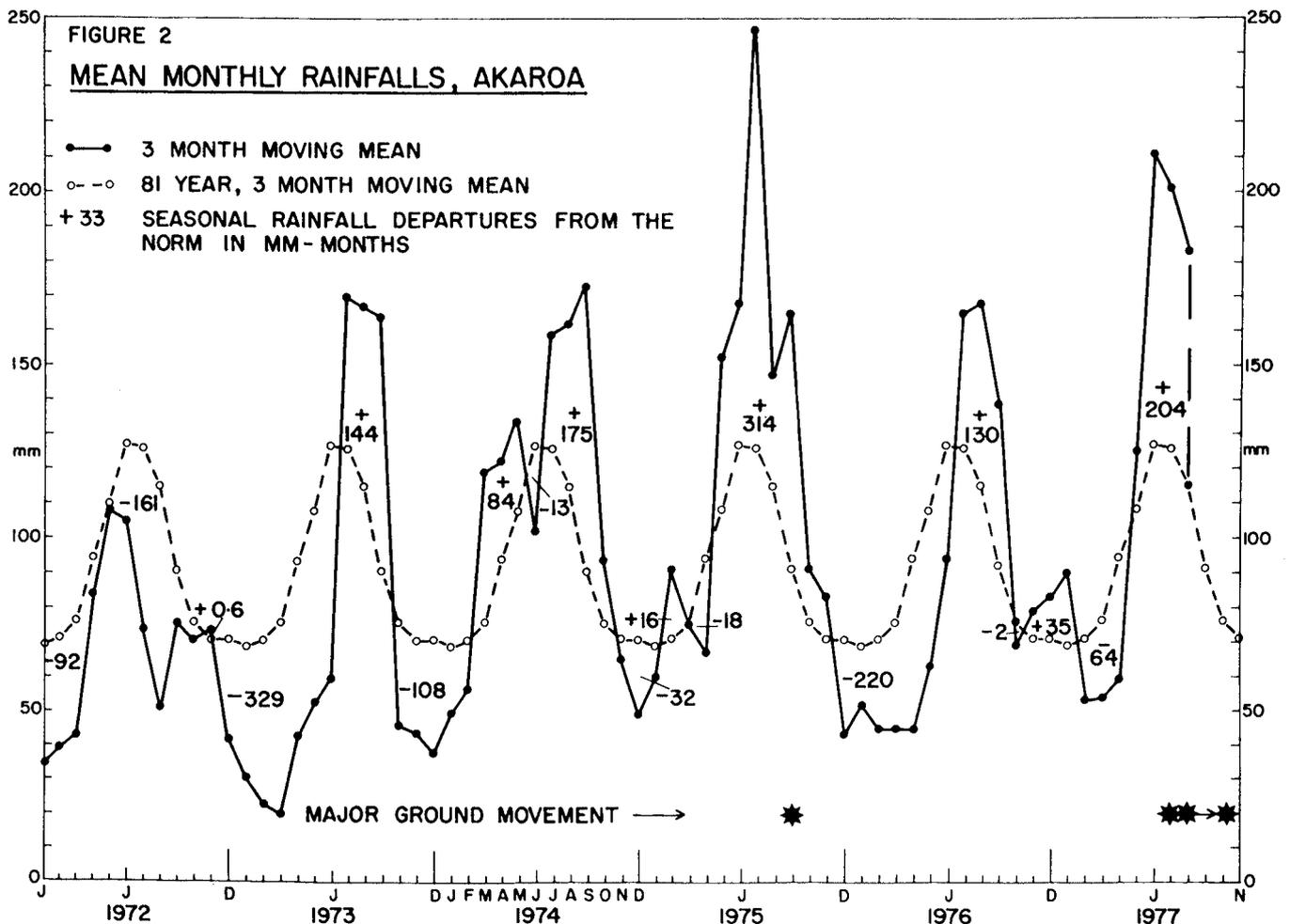
The main result of mapping was the recognition of the geological circumstances of the landslide in their regional context. Then followed detailed recording of all surface phenomena associated with the movement, such as ground fracture-patterns; amounts and directions of relative movement across

fractures; location of excess water; and other features showing evidence of ground movement (turf rumpling, distortion of buildings, tilting of telephone poles, development of soil lobes and scarplets). Appraisal of this information revealed that the failure at the head of the landslide was quasi-rotational, with a dominantly vertical motion. At lower elevations the motion had a stronger horizontal component, which was consistent with rotational failure, but the main bulk of the landslide appeared to be moving by translational block-sliding. In the vicinity of the toe the nature of the movement changed from sliding to flowage, presumably due to increasing water content, with displacements parallel to the slope. Hence it was concluded very early in the investigation that removal of some of the road-fill at the head of the landslide would be very effective in reducing the vertical driving force causing the apical rotational failure - far more effective than if the failure in this critical region was purely a translational one. This recommendation was made to the County Engineer, who immediately arranged for some 1800 m³ of fill to be removed, and the results of this action are discussed below.

Other useful results from the mapping were the establishment of the general dimensions of the slide, the approximate area of the rupture surface, and a realisation of the very wet nature of the ground.

2.4 Interpretation of Aerial Photographs

Stereoscopic examination of aerial photographs, together with information from the ground survey, enabled the stability history of the valley to be inferred. The interpretation is that material moved down from upper source areas by sliding, flowage and sheetwash processes, accumulating on the original loessial deposits of the middle part



of the valley. Subcutaneous tunnels and springs in the source areas probably initiated this mass movement. Eventually, owing to overloading, a large landslide evacuated the middle part of the valley, and came to rest well down the slopes. A series of consequential slides then occurred on the flanks where lateral support had been removed, the last being a fairly large one whose backward-rotated surface forms a flat area on which the Parker house now stands (Figure 1). Two later slides seem to have occurred, and the toe of one (the last major movement until the present day) partly overlaps an earlier slide, forming a bulge above the Parker house. Thus it is evident that the geological environment in the valley is a sensitive one which needs to be treated with care.

2.5 Movement-monitoring Stations

Nine temporary monitoring stations were installed around the perimeter of the landslide and two lines of surveyed pegs were placed across it. This was done on the second day of the investigations. Readings of the former, to a few millimetres accuracy using a triangulation system, were made daily and enabled the direction and magnitude of the relative movements to be plotted (Figure 3). The vectors aided the analysis of the slide's mechanism and revealed a slowing in movement within a day or two of the start of excavation of the road-fill. Movement, which had averaged some 10 mm/day, had virtually ceased at all stations within 10 days, by which time removal of the fill had been completed. Permanent movement stations, capable of being measured to 1 mm accuracy, were later installed so that any resumption of winter movement could be detected early.

2.6 Drilling

Auger drilling of the slide-mass commenced while the slide was still in motion. Crude and cheap hand-auger holes drilled to depths of 8 m or more proved effective, not so much in the information gained from cuttings, but by enabling thin PVC casing to be installed quickly to determine the depth to the surface of shearing movement. This simple and positive means of locating the base of the slide permitted reasonably accurate cross-sections to be drawn (Figure 4) defining the shape of the sole plane and its average inclination (11°), and subsequently allowed the volume of the sliding mass to be estimated (32 000 to 38 000 m³). Later, the holes were used for regular water-level measurements and simple permeability tests. It is very doubtful whether other means, such as coring or trenching, would have enabled the sole plane to be identified more precisely; in similar circumstances the simple auger-casing method is worthy of serious consideration.

2.7 Seismic Refraction Survey

Two seismic surveys were carried out with the aim of defining the depth to bedrock and layering within the landslide. In spite of such difficulties as nearby fences and buried pipes, and the highly plastic, energy-absorbing nature of the ground, three seismic layers were identified. The basal refractor, with a wave speed of 2400 to 2850 m/s, is probably either volcanic bedrock or the rubble layer immediately above it; depth ranged from 9 to 14 metres. The top seismic layer has a wave speed of 330 to 360 m/s and correlates (in most cases) with unconsolidated, partly or wholly saturated soil and landslide debris, mostly above the surface of rupture. The intermediate seismic

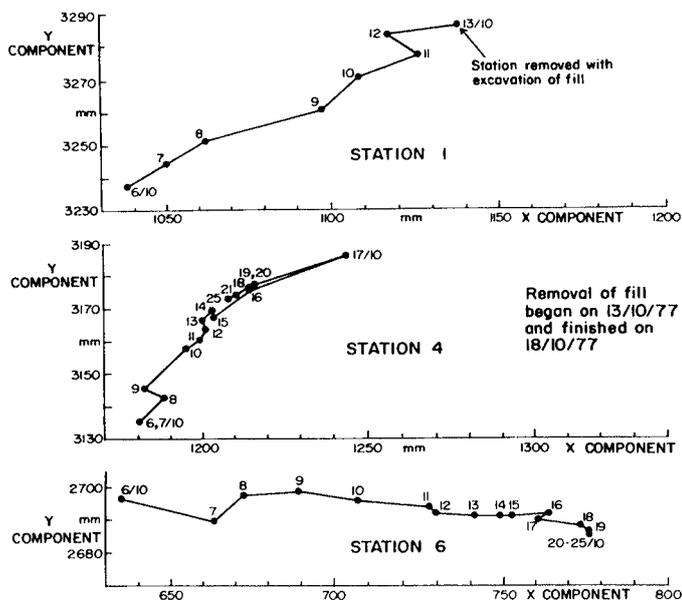


FIGURE 3. PLOTS OF RELATIVE GROUND MOVEMENT

layer at 700 to 890 m/s is thought to be either in situ loess, possibly with a pan, or highly weathered bedrock.

The bedrock surface is of interest in planning remedial treatment because it is a possible seepage and flow boundary; it is a potential failure plane; and it would be the foundation for any structural method (such as a shear key) or stabilizing the slide.

2.8 Groundwater Observations

Daily (and later weekly) water levels measured in auger holes were the only early data available on pore pressures acting at the failure surface, as well as of changes in the landslide's general groundwater regime. When the slide ceased moving towards the end of October 1977, there had been no appreciable change in water levels, all except one of which were within a metre of the ground surface. Shortly after that, levels began to fall slightly with the onset of drier weather.

2.9 Materials Testing

Samples of the landslide debris were taken from one auger hole to the full depth of the slide, but lack of time permitted the determination of only the most basic material properties. The average results from four samples above the failure surface are as follows:

| | |
|---------------------------------------|------------------------|
| Wet mass density | 2040 kg/m ³ |
| Dry mass density | 1570 kg/m ³ |
| Field moisture content (% dry weight) | 30% |
| Liquid limit | 29% |
| Plastic limit | 19% |

These results reflect the very high porosity of loess and its ability to take up water, and confirm the high saturation of the soil mass which was apparent in the field. More normal field moisture contents for loess in the area lie in the range 8 to 18%, whereas the landslide debris was very near its liquid limit and certainly well above its plastic limit. It is therefore scarcely surprising that the slope was unstable.

If it is assumed that a normal moisture content of 15% could be achieved by controlling the water input to the slide and by improving the drainage, the corresponding wet mass density would be reduced to

1.81 t/m³. The excess water content of the landslide may therefore have increased its weight by about 13%, and a reduction of moisture content to 15% gives a specific yield of 24%, which seems reasonable for the fine sand/silt size range involved. If a reduction of this order could be made by drainage operations, the volume of water to be removed would be 230 litres per cubic metre of soil or some 7 million litres of water for the whole landslide.

3 STABILITY ANALYSIS AND DRAINAGE

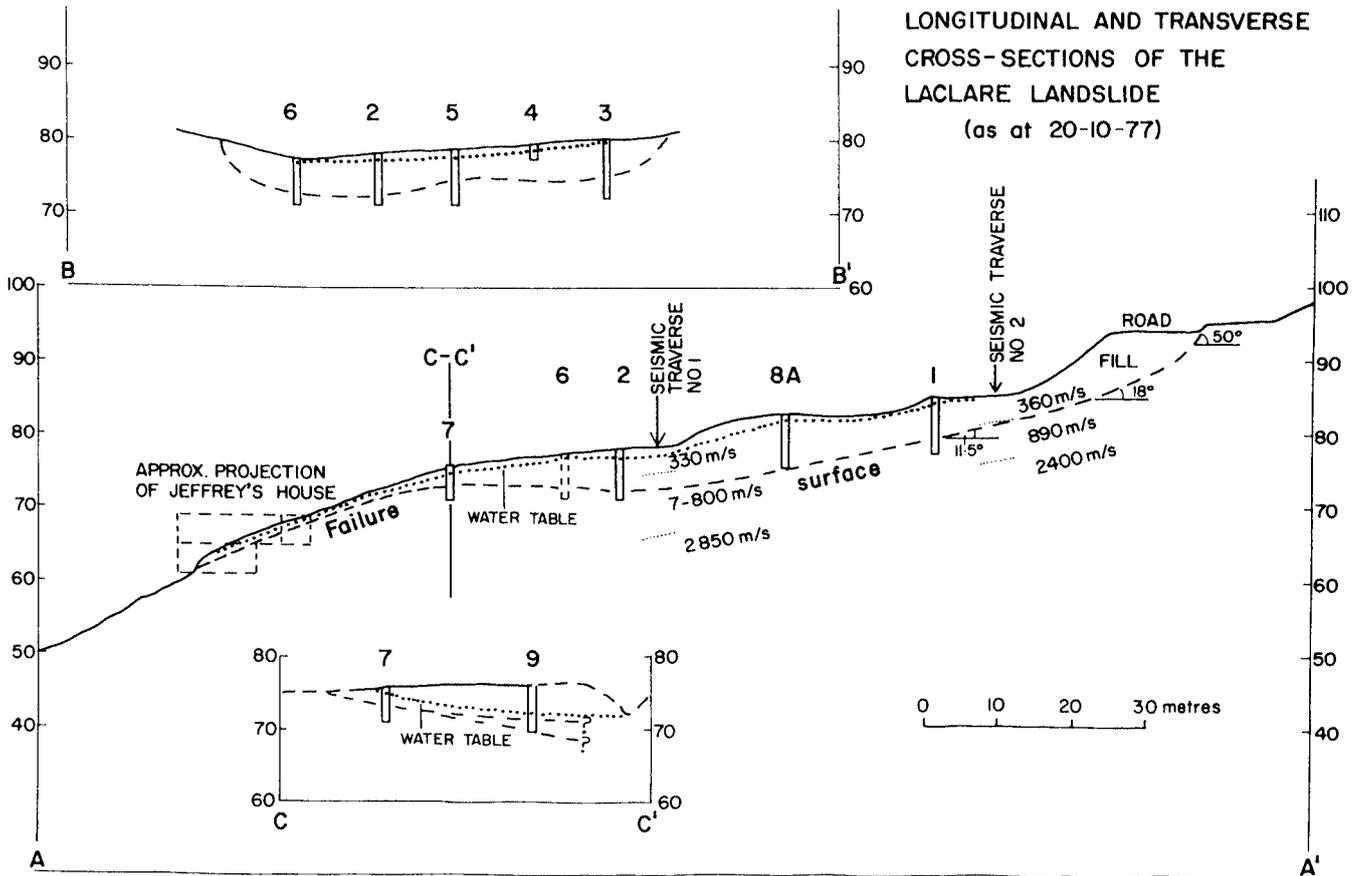
Using the data above, a stability analysis of the landslide was carried out and the stabilizing effects of drainage were assessed - the latter appeared to offer the cheapest, most practical, and potentially most effective method of permanently stabilizing the slope. In the analysis, a crude but quick expedient was adopted of treating the mass movement as wholly translational sliding on a slip plane inclined at 11°; the justification being the rather planar nature of the rupture surface, and the need to obtain a quick answer. Only the driving portion of the landslide - the upper two-thirds was accounted for, the lower tongue being considered a passive, overflow feature.

With these simplifications, in mind and recognising that the removal of 1800 m³ of road-fill from the head of the slide was just sufficient to stabilize it, the residual shear strength of the failure surface was estimated to be about 17.0 kPa (2.5 psi). It was then assumed that this shear strength arose from cohesive and frictional origins in the usual way, and that therefore the revised Coulomb equation would apply. Shear vane tests (by Mr G L Evans) of a weak slurry-like mud from a failure plane at the surface of the slide gave a cohesion value of 5.9 kPa (0.86 psi), which was accepted as a reasonable lower limit of residual cohesion. With the further assumption that the piezometric surface was at ground level, it was calculated that the lower limiting value for ϕ'_r , the effective residual friction angle, was 13.7°.

If there are numerous imponderables, any remedial treatment of landslides by drainage should aim at achieving a large factor of safety. In this case, if a safety factor of 3* could be accomplished by reducing moisture content from 30% to 15% and by drawing down the average piezometric surface to half its former height above the failure plane, the residual value of cohesion would be about 30kPa (4.4 psi). In the light of shear vane values of 21kPa (3.0 psi) obtained for cohesion at the ground surface at high (above plastic limit) moisture levels, this requirement seemed to be well within practicable attainment.

* This unusually high factor of safety was considered necessary because quantitative data about the landslide were scanty, sampling was probably not representative, and some gross simplifying assumptions were made in calculations. Had there been the opportunity to build up a more complete data base, a more conventional factor of safety in the range 1 to 2 would probably have been chosen.

FIGURE 4
LONGITUDINAL AND TRANSVERSE
CROSS-SECTIONS OF THE
LACLARE LANDSLIDE
(as at 20-10-77)



Thus, it was concluded that the twin goals of the drainage programme were to reduce average moisture content from 30% to 15%, and to lower the relative piezometric head by half. The demand that these goals placed jointly on the natural and artificial drainage of the landslide was the extraction before winter 1978 of about 6 or 7 million litres of surplus water stored in the soil, in addition to the net water input from normal surface and sub-surface infiltration. In a normal or dry summer the latter quantities would not be very great. Once a moisture safety margin was created, the artificial drainage system would need to prevent the seasonal build-up of soil moisture from reaching 30%. Both tasks were greatly aided by the rediscovery, during removal of the road-fill, of two of the springs known to exist in the basin, and the piping from the basin of their combined flow. One of the springs was estimated to have an initial rate of flow of 20 litres/minute, but this has since greatly declined.

The next step was to devise a method of removing 6 or 7 million litres of water from the loess before the onset of the 1978 winter. A single deep counterfort drain running from head to toe of the slide, and located just below the slide plane, was considered to be the most effective because it would create steep hydraulic gradients and hence high discharges; it would reduce pore-water pressure at the slide surface; and it would be practicable to install and less likely to be disrupted by any future movement of the slide.

Hydraulic conditions for such a drain were analysed, using the Goodman modification of the Dupuit horizontal flow formula, and assuming a value of 10^{-6} ms^{-1} for the permeability of loess. The analysis suggested that the drain would discharge on the average about 12 litres/minute and, at the

end of six months, would have removed some 3 million litres of water (leaving a soil moisture content of 23%), and have lowered the average piezometric surface by 42%. These measures would have raised the safety factor to more than 2, which was a little less than the original goal.

4 RECOMMENDATIONS

At the conclusion of investigations, the following recommendations for treatment of the La Clare landslide were made:

- a) Removal of all the road-fill, and, after stabilization measures, reconstruction of the embankment only to the extent dictated by stability analyses.
- b) Installation of an interception drain excavated to bedrock around the crown of the landslide to intercept water from above the slide, and a deep counterfort drain, as described above.
- c) Location of all natural springs beneath the road-fill and diversion of their water out of the area by piping.
- d) The careful control of miscellaneous sources of water entering the landslide.
- e) Regarding of certain areas of the landslide's surface to reduce infiltration (eg from hollows), and the possible use of tree planting on the upper part of the landslide to increase evapotranspiration and to intercept precipitation.
- f) The removal of all existing unlined ditches and drains on the surface of the landslide.

g) Continued monitoring of the landslide (so that the effectiveness of remedial measures may be assessed) by:

- i standpipe piezometers in auger holes to monitor pore pressures
- ii free ground water levels from auger holes
- iii the installation of permanent movement-monitoring stations
- iv determination of monthly soil-moisture levels
- v measurement of discharge rates from all drainage systems.

h) The measurement of *in situ* permeability of the loess by means of simple *bailing-out* tests in existing auger holes, to compare with the assumed value of 10^{-6} ms^{-1} used in the calculations.

A wide range of investigations could be carried out on the landslide, but the aim of those suggested is to obtain fundamental data needed to understand and monitor its behaviour using the limited resources available.

5 CONCLUSIONS

- I The La Clare landslide is the direct result of man's interference with a geological sensitive and unstable landscape. The main causes of the landslide are:
- i the surcharging (by construction of a large road embankment) of accumulated landslide debris consisting of re-worked loess, which is inherently weak and prone to failure when excessively wet;
 - ii the burial of ephemeral springs beneath the road embankment and the resulting saturation of the fill and landslide debris, which increased loading and decreased strength;
 - iii the reduction of natural drainage of the ancient landslide by blockage of subcutaneous tunnels, thereby increasing its water uptake.

II Drainage offers a technically practicable means of stabilizing the landslide in the long-term, but the most critical period will be the 1978 winter. Any drainage scheme will need adequate time to reduce the soil moisture content and piezometric surface by a safe margin before wet weather starts.

III A preliminary engineering geological appraisal, using cheap and easily applied techniques, would have enabled the limiting natural factors of the Akaroa landscape to be recognised before planning and construction of the road embankment commenced, and would almost certainly have enabled such a major landslide to be avoided. The occurrence of the landslide in no way implies the area is unsuitable for roading and subdivisional housing, but demonstrates that engineering works and their preparation have to be properly matched to the geological terrain, which is the role of the engineering geologist. It is to be hoped that in future work the special problems of this sensitive loessial ground will be duly recognised.

6 ACKNOWLEDGEMENTS

The consent of the Akaroa County Engineer, Mr K E Paulin, to the publication of the information contained in this paper is gratefully acknowledged. The assistance of Mr D Barrett and Mr G Borrie with field work, and of Mr G Scott with laboratory work, is noted with much thanks.

7 POSTSCRIPT

Lack of funds prevented the Akaroa County Council from installing the counterfort drain recommended. Various surface measures were instituted instead, including ditching and re-grading, plus a shallow subsurface drain in the lower part of the slide. During the winter of 1978, the landslide as a whole appears to have remained stationary, although local movement at the toe has continued to threaten the Jeffrey's house.

APPLICATION FOR MEMBERSHIP

of

New Zealand Geomechanics Society

A TECHNICAL GROUP OF THE INSTITUTION OF PROFESSIONAL ENGINEERS NEW ZEALAND

The Secretary
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PO Box 12-241
WELLINGTON

I believe myself to be a proper person to be a member of the N.Z. Geomechanics Society and do hereby promise that, in the event of my admission, I will be governed by the Rules of the Society for the time being in force or as they may hereafter be amended and that I will promote the objects of the Society as far as may be in my power.

I hereby apply for membership of the N.Z. Geomechanics Society and supply the following details:

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Signature of Applicant

Date 19

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