N.Z. GEOMECHANICS NEWS

No. 6

JUNE 1973

A NEWSLETTER OF THE N.Z. GEOMECHANICS SOCIETY

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CONTENTS

Persons interested in applying for membership of the Society are invited to complete the application form at the back of this newsletter. For 1973 the annual subscription varies depending on which International Society the member wishes to be affiliated to. The basic subscription rate is $2.40 and affiliation fees to the International societies are $0.60, $2.40 and $1.60 for Soil Mechanics, Rock Mechanics and Engineering Geology respectively. Members of the Society are required to affiliate to at least one International Society.

EDITOR'S NOTES

1. The future of N.Z. Geomechanics News

With this issue N.Z. Geomechanics News enters its fourth year and it seems an appropriate time to consider the future direction which the newsletter should take. As far as we can gather, the members of the N.Z. Geomechanics Society appreciate receiving N.Z. Geomechanics News twice yearly and it is helping to keep them informed about forthcoming events and the geomechanics scene in N.Z. However, there has not been a good response to appeals in each issue for contributions from the general membership - even when more controversial articles have appeared, and we have not received a single letter to the editor in the four year period. Perhaps it is a sign of the times that we are all just too busy to have time for this sort of thing.

However, despite this lack of response we are assuming that the newsletter in its present form is fulfilling a useful function and it will continue on a twice yearly basis, but the question arises as to whether it should be expanded to become a more technical publication, and in this regard we do present in this issue an article of a more technical nature. However, your management committee feels that the value of N.Z. Geomechanics News lies more in its readability as a newsletter and also that to publish photographs and diagrams as required in technical papers would considerably raise publication costs and strain the resources of the Society. Also the N.Z. Institution of Engineers is shortly to begin publication of "Transactions" and your committee feels that this is the more appropriate place for technical papers on geomechanics to be published. It could be that in the course of time a separate issue of these Transactions each year could be devoted to geomechanics papers, but to do this the number of geomechanics papers being prepared in N.Z. each year would have to be raised considerably above its present abysmally low level.

Therefore in the foreseeable future N.Z. Geomechanics News will continue in its present form being primarily a newsletter to keep the membership informed. We assume that this is what is wanted, but it would be nice to get some "feedback" occasionally.

2. Geomechanics at the N.Z.I.E. Annual Conference

It is now the policy of the N.Z. Institution of Engineers to encourage Technical Groups of the Institution to present one session or several sessions of papers in conjunction with the N.Z.I.E. Conference in February each year. In the past the N.Z. Geomechanics Society has promoted symposia at approximately four-yearly intervals but the management committee is looking closely at participation in this way in the N.Z.I.E. Conference, as being the oldest Technical group of N.Z.I.E. it is felt we should offer support in this new move which was begun by the Chemical Engineering Group at the 1972 Conference in Christchurch and expanded to include several groups at the 1973 Conference in Hamilton. It is not envisaged that all groups should participate in the Conference in any one year or it could become rather large and unwieldy.

An N.Z.I.E. Conference with a number of geomechanics papers would certainly be more attractive to many of our members than one where topics cover a very wide field and only a few papers are of particular interest. At the same time the opportunity would exist as at the present N.Z.I.E. Conferences to renew old acquaintances over the whole broad field of engineering and to make new ones. Also from the organisational viewpoint, the work required locally in arranging venues, accommodation, meals etc. as for our past symposia would be taken over by the Conference organising committee, although we would still require our own organisational work to edit papers and prepare a suitable programme of papers.

In this regard it is the Editor's personal view that papers for presentation at a conference should be solicited for consideration and possible selection on any topic within the field of geomechanics rather than being invited on particular topics as has been the case with our previous symposia. In this way there would be more incentive to our younger, relatively unknown members to come up with a technical paper with the "carrot" of presenting it at an N.Z.I.E. Conference, and also the additional incentive that if it is presented at Conference, it is almost certain to be published in the forthcoming N.Z.I.E. "Transactions" referred to above.

3. Insurance Against Damage Caused by Landslip

We present in this issue a summary of the Amendment to the Earthquake and War Damage Regulations which came into effect in July 1970 which provides insurance cover against damage caused by landslip to buildings and their contents for which a fire insurance policy is taken out. The intentions and limitations of the Amendment are explained together with some comments on the Amendment. We hope this explanation will be of benefit to our readers who after all could be expected to be among the best informed of citizens regarding this particular aspect of insurance.

Although we generally tend to think of geomechanics on the broader scale of large projects, geomechanics can also be of great importance to the individual property owner. A house is for most people their largest investment and it would be interesting to know how many of our readers have actually investigated the foundation soils beneath their house and the stability of the land, before purchasing the house.

In a later issue we hope to list some simple hints for methods of safeguarding stability both for individual house sections and development on a larger scale.

4. Contributions Still Wanted

Contributions to New Zealand Geomechanics News may be in the form of technical articles, notes of general interest, letters to the Editor, or book reviews and may cover any subject within the fields of Soil Mechanics, Rock Mechanics and Engineering Geology. Articles on site investigation, or construction techniques or design methods which have been successfully used in New Zealand and which would be of help to other members would be particularly welcome.

All contributions should be sent to:

The Editor
New Zealand Geomechanics News,
C/- New Zealand Geomechanics Society,
P.O. Box 12-241,
WELLINGTON.

J.P. Blakeley,
EDITOR

INSURANCE AGAINST DAMAGE CAUSED BY LANDSLIP

J.P. Blakeley

For many years people who take out fire insurance for their house or personal effects have been required to pay an extra premium to cover damage from earthquake or war. Therefore if a cliff collapses on to a house because of an earthquake (or less likely in a war) the owner, if insured against fire is able to claim some compensation from the Earthquake and War Damage Fund. Until recently, if the same cliff slipped down after heavy rain the owner had no rights to compensation from the fund, as landslip was excluded from the storm and flood cover provided under the Earthquake and War Damage Act.

However, in July 1970 an Amendment No. 3 was made to the Earthquake and War Damage Regulations 1956. This provided automatic insurance protection to property owners for damage caused by landslip which was defined as "subsidence of a substantial land mass other than by settlement, soil shrinkage or compaction; and includes the movement from any hill, mound, bank, slope, cliff or face of earth or rock, of a substantial mass of earth or rock which before movement formed an integral part of the hill mound, bank, slope, cliff or face".

The Amendment states that in determining whether any damage is landslip damage the Earthquake and War Damage Commission shall have regard to the following matters.

a) Whether the building complied with any applicable N.Z. standard model building by-law.

b) Whether basic principles of site investigation and foundation design have been observed, and the construction of foundations and earthworks have been properly supervised.

c) The standard of repair and maintenance of the building.

d) Any neglect or carelessness of the insured person.

e) Any other matter that the Commission considers relevant.

Therefore, from July 1970 any building, or property or personal effects within a building which is insured against earthquake damage or war damage by means of a fire insurance policy is automatically insured for the same amount against landslip damage. However, the insurance does NOT include:

a) Any part of the cost of re-siting a building or any part of the cost of stabilising the existing site or the new site of the building.

b) Any part of the cost of clearing landslip debris except to the extent that clearing debris is essential to enable landslip damage to an insured building to be repaired.

The Amendment also states that the Commission may have a survey made of any property to determine its susceptibility to damage from landslip, and may classify the property into the following classes:

Class A - Property not particularly susceptible to damage from landslip
Class B - Property fairly susceptible to damage from landslip
Class C - Property very susceptible to damage from landslip

but until the Commission has so classified any property under this Clause it shall be deemed to be in Class A. Any property contained in a building classified in Class B or C shall be classified in the same class as the building.

Where the property insured is classified in Class A, the franchise is computed at the rate of 1% of the amount of the insured loss or damage, but the franchise shall not be less than $200 (this means that the property owner is required to meet the first part of the costs - $200, or more if the compensation payable exceeds $20,000). Where the property is classified in Class B or Class C, the franchise shall be the amount the Commission from time to time determines, but not exceeding in any case 25% of the amount of the insurance.

The Commission may from time to time alter the classification of any property but if this has the effect of increasing the franchise it shall not take effect until 30 days notice in writing has been given by the Commission to each insured person.

Comments on the Amendment

Prior to July 1970 landslip insurance was not generally available, and although cover was available for some years on a voluntary basis, this was selective and the owner was required to do everything possible to reduce the possibility of landslip damage before he could obtain protection and a premium commensurate with the risk of landslip damage was charged. This meant that where it was within the control of a property owner to reduce landslip damage by the erection of retaining walls, planting of exposed slopes or improved stormwater drainage, this was made a condition of the issue of landslip insurance cover. If protection is automatically available, property owners may give little thought to stability and may have scant regard for the hazards they may cause to a neighbour's property. Landslips in developed areas can be avoided by proper site investigation and development. It is not the intention of the legislation to provide a means whereby the results of faulty earthworks, drainage or protection measures can be compensated. Local authorities thus have a responsibility to protect both private and public interests and should act through their by-laws and the administration of planning schemes to minimise the damage, inconvenience and hardship caused by landslips.

It should be noted that the cover applies only to property covered by fire insurance and that a minimum franchise of $200 applies. The landslip insurance provisions do not extend to cover a property owner for loss of land, damage to paths, fences or retaining walls, or for any part of the cost of stabilising a section.

The Commission has the power to classify a property or group of properties and as the recent incidence of landslip damage in some areas is already a cause for concern, this could mean that classification may have to be considered by the Commission, to safeguard the fund against claims where development has advanced without concern for liability for landslip damage. This classification would have far reaching effects, with a decline in property values in such areas. It has already been found that had there been better planning with greater provision for stormwater disposal in some areas, and stricter enforcement of by-laws and regulations governing stormwater disposal from individual sections, many thousands of dollars worth of damage which has already been done by landslip could have been avoided.

The Commission has also been concerned at the incidence of losses which have occurred where the damage has resulted from an act of neglect by a third party. Under the Act, the Commission has subrogated rights which it must exercise if payment is to be made under a landslip damage claim and it is established that the landslip resulted from the negligence of a third party. In other words, the person responsible for the damage may be called on to pay for it, rather than the Commission meet the cost. This could involve another property owner, a subdivider or even a local authority.

The Earthquake and War Damage Regulations do provide that an insured person must at all times take reasonable precautions for the safety of insured property. If as a result of past slipping or ground movement on the property or its immediate vicinity an insured person has prior knowledge that his house or other property may be endangered by landslip, some responsibility is thus placed upon him to seek competent advice as to what should be done to protect the insured dwelling from damage by further land movement. Failure to act in this respect could prejudice a future claim under the landslip insurance provisions of the Amendment to the Regulations.

REVIEW OF ENGINEERING GEOLOGY SYMPOSIUM, LOWER HUTT

B.W. Riddolls

An evening symposium was organized for members of the N.Z. Geomechanics Society in the Wellington area, and was intended to provide an insight into some of the detailed engineering geological work currently being undertaken for a major civil engineering project. The symposium was arranged by the Engineering Geology Sub-Committee of the N.Z. Geomechanics Society and was entitled "Engineering Geology in the Tongariro Power Development". It was held in Lower Hutt on 17 April 1973.

Mr J.H.H. Galloway, chairman of the Society, opened proceedings and mentioned that if sufficient interest was shown in meetings of this type, it might warrant the formation of a local branch of the Society.

Mr L.E. Oborn, Chief Engineering Geologist, N.Z. Geological Survey, then gave a brief introduction to the geology of the Tongariro area, and introduced the three speakers, all of whom are engineering geologists with the N.Z. Geological Survey at Turangi.

Mr G.T. Hancox described in detail the rock condition at the Moawhango dam site, pointing out how large scale defects such as faults had influenced the final location and design of the dam.

The various field, geophysical, and drilling investigations involved in the selection of the Moawhango Tunnel alignment were described by Mr B.D. Hegan. Particular emphasis was given to the detailed investigations that were required to determine the extent of ancient buried river valleys situated near the tunnel line.

Finally, Mr B.R. Paterson gave an account of the engineering geological problems associated with the construction of the Poutu intake, tunnel, and canal. Because of the limited cover over the tunnel, particularly detailed drilling and geophysical work were carried out to evaluate ground conditions as precisely as possible.

The symposium was attended by 42 persons.

ANOMALIES IN THE ASSESSMENT OF PILE LOADINGS

B.C. Hadfield

(Summary of an address given to the Geomechanics Group of the N.Z.I.E. Auckland Branch on 22 November 1972)

1. Introduction

The modern methods and tools such as the computer now available, together with a more precise knowledge of the behaviour of engineering materials, allows the structural engineer of today some confidence in his approach to the design of the superstructure of buildings, bridges, wharves etc.

However most engineers would (or should) admit that design of the foundations for the same structures could not be approached with the same degree of confidence or any assurance that a reasonable and economic factor of safety has been achieved. Naturally, since the designer is often faced with a complexity of sub surface conditions he will wish to increase the factor of safety to allow for the unknowns. Most of us have observed at first hand how the preconceived ideas of foundation conditions gained from a few test bores have had to be revised after a site has been opened up.

Some allowances therefore do have to be made for the unknowns in designs for foundations in general, but where pile foundations are being designed there does appear to be a rather inconsistent attitude on the part of the engineer in his assessment of allowable pile loadings. For piles which are required to support loads by end bearing only (which applies to most of the Auckland area) the allowable unit loading appears to depend entirely on whether the piles happen to have been installed by boring or driving.

2. Foundation Stratum in Auckland Area

Within the Auckland area probably 80% of the piles are founded on some type of rock - i.e. sandstone or mudstone of the Waitemata Series, basalt rock, or in some cases greywacke. Quite often a site will contain a mixture of founding rock.

It is in the assessment of the allowable stresses in these materials for pile loadings that inconsistencies are apparent.

3. Determination of Bearing Capacity

The methods available for assisting in the assessment of the ultimate bearing capacity of piles may be summarised as follows:

(a) Using the principles of soil mechanics - to determine soil properties from laboratory tests on samples.

This method is in common use for the determination of bored pile capacities where the unconfined strengths of the rock, as found from laboratory tests, is used in conjunction with Terzaghis empirical formula to give an ultimate bearing capacity.

$$Q_{dr} = \pi r^2 \; (1.3CN_c \; + \gamma D_f N_q \; + 0.6 \; \gamma R N_\gamma)$$

The last two terms of this equation can for all practical purposes be neglected.

$$\text{then } q_{dr} = 1.3CN_c = 7.4C \text{ when } \phi = 0^o$$

Normal Auckland City Council practice is to assume a ϕ value of 0^o so that for a sandstone having an average or mean cohesion of say 50 p.s.i. or 7200 p.s.f. the ultimate unit bearing capacity would be

$$q_{dr} = 7.4 \times \frac{7200}{2240} = 23.7 \text{ tons/sq.ft.}$$

Applying a factor of safety of 2.5 - safe unit bearing capacity = 9.5 tons/sq.ft.

(b) Static & Dynamic Penetration Tests such as the Dutch Cone Penetrometer and the Raymond Penetrometer - These tests were designed to overcome problems of sampling and testing cohesionless soils such as sands, and although used fairly extensively by the Ministry of Works in areas such as Hamilton, they have limited use in the Auckland area.

(c) Dynamic Pile Driving Formula

A large number and variety of formulae have been used in an attempt to relate the dynamic and static resistance of piles. These formulae are based on Newton's Law of impact and modified to allow for energy losses during impact. Those most commonly used are as follows:

Hiley $R = \frac{WH\eta}{S + C/2}$ (Used with F.S. of 2.5 to 3.0)

Engineering News Formula $R = \frac{WH}{S + 1}$ (F.S. of 6.0 but actually 0.5 to 20)

B.S.P. for Bottom Driven Piles $R = \frac{3.6 \; W \; (3.0 + h)}{S + 0.5}$ (F.S. of 2)

In my experience the most consistent and best results are obtained by use of the Hiley formula. However the use of any of the various dynamic formula, for end bearing piles founded on the Waitemata series of sandstone or mudstone, allows safe loadings which would not be acceptable by Ministry of Works or local authorities if checked by soil mechanics principles. There have been numerous instances of steel tube and precast piles being driven to practical refusal in mudstones of strengths comparable with those quoted above (i.e. 7200 p.s.f.) which according to the dynamic formula would safely support loads of 80 to 90 tons. The resultant stress at founding level from an 18" diam. pile is in excess of 45 tons/sq.ft.! The dynamic formulae do not take account of the shape or cross sectional area of the pile so that it is possible where steel "H" piles are driven to rock (say basalt), to have end bearing stresses as high as 5 ton/sq.in. (720 tons/sq.ft.).

These loadings are of course much higher than the normal 10 to 15 tons/sq.ft. normally accepted by the local authority for bored piles founded in Waitemata series sandstones. I would not, however, concede that because a pile is driven to the founding rock, the characteristics of this rock in terms of its supporting value are in any way better. On the contrary the upper surface of the founding rock is very often ruptured and fractured by over driving of the pile.

In spite of the foregoing remarks it is not my intention to make a case, for reducing the loadings generally acceptable for driven end bearing piles. To my knowledge there is no record of failure of these piles under load (where driven to Waitemata sandstone or basalt rock) in the Auckland area and as discussed below in most cases the factor of safety is adequate.

(d) Field Load Tests on Installed Piles

If more time and money was available for pile load tests, a large proportion of the element of doubt would be removed from the foundation engineer's assessment of safe loadings for piles under varied sub surface conditions. Since this is not the case, and probably unlikely to be in the foreseeable future, I do consider that more use should be made of the very few records which are available of full scale pile load tests.

It is of course important to realise the limitations of these tests. Apart from the restrictions of time and money particularly for the smaller jobs, even on a large job, a test loading programme cannot possibly cover the variations in soil properties that can occur over a site. For this latter reason care and discretion should be used in making settlement predictions on the basis of a load test on a single pile.

The various pile load tests with which my company have been associated, do, in my opinion illustrate one important fact: that in most cases piles driven or bored into the average Waitemata sandstone-mudstone formation in the Auckland area have a much higher load bearing capacity than generally allowed. This is particularly so of piles which have been bored some depth (8' to 10') into the formation.

NEWS FROM THE MANAGEMENT SECRETARY

1. Management Committee 1973

The following members comprise the Management Committee for 1973.

J.H.H. Galloway (Chairman)	: Wellington
J.P. Blakeley	: Auckland
R.O. Bullen	: Dunedin
G.L. Evans	: Christchurch
P.G.M. Imrie (Management Secretary)	: Wellington
G.D. Mansergh (Vice Chairman R.M. subcommittee)	: Christchurch
R.D. Northey	: Wellington
L.E. Oborn (Vice Chairman E.G. subcommittee)	: Wellington
D.K. Taylor (Vice Chairman S.M.F.E. subcommittee)	: Auckland
P.W. Taylor	: Auckland

2. New Members

New members elected to the Society since the last list was published in Issue No. 5 are as follows:

I.W. Anderson	: Auckland
J.B. Berrill	: Pasadena, California
S.J. Carryer	: Auckland
W.D.C. Clark	: Haast
C. Crampton (Miss)	: Auckland
R.O. Davis	: Christchurch
J.D. Dawn	: Auckland
J.N. Duder	: Turangi
A.J. England	: Hamilton
J.L. Gill	: Wellington
M.D. Gillon	: Upper Hutt
H.R. Green	: Auckland
W.H. Griffin	: Dunedin
R.C. Hall	: Havelock North
G.T. Hancox	: Turangi
B.D. Hegan	: Turangi
D.M. Hoskin	: Hamilton
L.S. Jones	: Wellington
I.C. McKellar	: Dunedin
A.G. Mahoney	: Lower Hutt
W. Nadler	: Auckland
N.D. Perrin	: Lower Hutt
S.A.L. Read	: Twizel
D.H. Robertson	: Wanganui
V.A. Ryan	: Kaikoura
R.M. Ursem	: Auckland
P.A. Van Grinsven	: Auckland
J.O. Wallis	: Wellington

3. Forthcoming Conferences and Symposia

We list below conferences and symposia in the 1973-5 period which we know about. Members may be interested in either attending or obtaining proceedings. Further details can be made available on request.

<u>1973</u>

26 - 28 February	National Symposium on Rock fragmentation. Adelaide, Australia - organised by the Australian Geomechanics Society.
May	International Symposium on Field Instrumentation in Geotechnical Engineering. London, England - organised by the British Geotechnical Society.
25 - 29 June	Fifth World Conference on Earthquake Engineering. Rome, Italy.
6 - 12 August	Eighth International Conference on Soil Mechanics and Foundation Engineering. Moscow, U.S.S.R.
20 - 22 August	Symposium on Mine Filling. Mount Isa, Australia.

10 - 13 September	Symposium of the I.A.E.G. on Engineering Geological Problems related to Soluble Rocks - Collapses and Subsidence. Hanover, West Germany.
October	International Symposium of the I.S.R.M. on Protection against Rock-fall. Katowice, Poland.
1974	
2 - 4 April	Conference on Settlement of Structures. Cambridge University, England - organised by the British Geotechnical Society.
May	International Symposium on Genetical Basis concerning the Geotechnical Study of Rocks. Moscow, U.S.S.R. - sponsored by the I.A.E.G.
18 - 24 August	Second International Congress on Engineering Geology. Sao Paulo, Brazil.
1 - 7 September	Third International Congress of the International Society of Rock Mechanics. Denver, U.S.A.
September	Walling and Anchors Conference. London, England - sponsored by the Piling Committee of the I.C.E.
1975	
July	Second Australia - New Zealand Geomechanics Conference. Brisbane, Australia.

4. I.S.S.M.F.E. List of Members

This I.S.S.M.F.E. publishes the above list every four years. The 1972 edition has been forwarded to all N.Z. Geomechanics Society members, affiliated to I.S.S.M.F.E. who were members at the commencement of 1972. Insufficient copies were received for all new members since that time but some spare copies are held by the Management Secretary and are available on request to members resident in New Zealand. This list can be useful when travelling overseas in order to contact people in a particular country or region who are interested in soil mechanics and foundation engineering.

5. Proceedings, Wanganui Symposium, September 1972

Copies of the Proceedings are available for sale from the Management Secretary at a cost of $8.00 for Society members, and $10.00 for non-members. Copies of the Proceedings have been dispatched to registrants at the Symposium.

6. Back Issues, N.Z. Geomechanics News

Copies of all back issues (1 to 5) of N.Z. Geomechanics News are available to members at a nominal cost of 50 cents per copy from the Management Secretary. Only a limited number of copies of issue 1 remain.

7. Membership Application Form

A membership application form is included at the back of this newsletter. If you show the newsletter to any non-member who expresses interest in joining the Society please cut out this form and give it to him.

For intending members the 1973 subscription is as follows:

Basic subscription N.Z. Geomechanics Society	$2.40
Affiliation fee to I.S.S.M.F.E. (Soil Mech. and Fdn.Eng.)	$0.60
Affiliation fee to I.S.R.M. (Rock Mechanics)	$2.40
Affiliation fee to I.A.E.G. (Eng. Geology)	$1.60

All members must affiliate to at least one of the International Societies, Members who joined the Society prior to 1972 have been affiliated to the I.S.S.M.F.E. unless they have requested otherwise. Members who wish to change the International Societies to which they are affiliated should advise the Management Secretary. The relevant portion of the membership application form at the back of this issue may be used for this purpose.

8. Change of Address Notitication

Some members in the past have not had their address updated or amended for N.Z. Geomechanics Society correspondence, although they have notified N.Z.I.E. of the change of their address for N.Z.I.E. correspondence. We are at present trying to rectify this situation. Please examine either the present list of members (sent out in January) or the address of this newsletter envelope. If the address is not correct please fill in and return the change of address form in the back of this issue.

P.G.M. IMRIE

Management Secretary
N.Z. Geomechanics Society,
P.O. Box 12-241,
Wellington.

I.A.E.G. SYMPOSIUM

10-13 September 1973, Hanover, Germany

SINK-HOLES AND SUBSIDENCE; ENGINEERING GEOLOGICAL PROBLEMS RELATED TO SOLUBLE ROCKS

World wide expansion of construction activity increases the risks of siting structures in areas underlain by soluble rocks.

The Symposium will provide an opportunity to bring together current knowledge and experience of hazards from soluble rocks (the sometimes sudden but usually slow changes to the earth surface), and ways of locating, containing and overcoming these.

The topic will be considered under 4 main headings:

1. Geological and geochemical conditions for the occurrence of sink-holes and subsidences as a consequence of the natural loosening of rocks.
2. Mechanism of sink-holes and natural subsidences.
3. Methods of containing such areas and the localisation of subterranean cavities.
4. Case histories and constructive measures when working in subsidence areas.

For more information write to L.E. Oborn, c/- Secretary of N.Z. Geomechanics Society.

or to Dr M. Langer,
Tagungssekretariat Internationales Symposium
Ingenieurgeologie - Bundesanstalt fur Bodenforschung,
3 Hanover 23, Alfred-Bentz-Haus,
Postfach 230153.

I.A.E.G. BULLETIN

Members of the N.Z. Geomechanics Society are invited to submit papers on engineering geology or related topics for publication in the Bulletin of the International Association of Engineering Geology.

The Bulletin is at present published twice yearly.

Enquiries may be made initially to L.E. Oborn, c/- Secretary, N.Z. Geomechanics Society.

INFORMATION ON
2ND INTERNATIONAL CONGRESS OF ENGINEERING GEOLOGY
São Paulo, BRAZIL, 18-24 AUGUST 1974

L.E. Oborn

The Themes of the Congress will be:

THEME I

Attempts of settling curricula for teaching in Engineering Geology, considering both theoretical and experimental knowledge. Training in Engineering Geology, mainly in countries in process of rapid development. Engineering Geology related to subjects like Soil Mechanics, Rock Mechanics, Geophysics, Hydrogeology, Geomorphology, Petrology, Structural Geology and Sedimentology.

THEME II

Seismic phenomena and Engineering Geology

Investigation criteria for seismic movements prediction, related to engineering structures in areas of large and small seismic activity. Record of seismic movements in areas of large dam construction. Prediction of seismic movements of potential catastrophic consequences.

THEME III

Engineering Geology related to urban and country planning

Methodology and use of geological mapping. Hydrogeological aspects in geological mapping related to urban and country planning. Geological occurrences, such as : river erosion, landslides, deep erosion, resulting from natural phenomena or human action, and consideration of remedial or preventive measures.

THEME IV

Engineering properties and classification of natural materials of construction

General and specific criteria for engineering classification of natural construction materials, related to engineering structures. Criteria for determination of degrees of rock weathering, durability and wearing, related to construction. Recent laboratory techniques for measurement of mineralogical, petrographical, physiochemical and mechanical properties of natural materials.

THEME V

Mass movements

Causes of mass movements, focusing types of movements, discontinuity effects and hydrogeological considerations. Methods of observation to detect signs of impending danger.

Performance observations of stabilization techniques

THEME VI

Engineering Geology relating to dam foundations

Direct and indirect exploration methods and techniques: recent developments. Recent methods of improving the properties of rock and earth masses. Instrumentation for dam foundation performance control.

Unsatisfactory performance of dams, resulting from lack of appropriate geological investigation.

THEME VII

Engineering Geology and underground construction

Recent geological, geotechnical and geophysical methods of investigation, related to underground works. Choice of excavation methods. Instrumentation for underground structures performance observation. Subsidence in areas of underground excavations.

There will be Technical visits and Post Congress excursions.

For more information write to:

Guidicini, G.,
Instituto de Pesquisas Tecnologicas,
Caixa Postal 7141,
01000 - São Paulo - SP,
BRAZIL

or L.E. Oborn, C/o Secretary, N.Z. Geomechanics Society who has a copy of the first circular.

THE GEODEX SYSTEM AND GEOTECHNICAL ABSTRACTS

P.W. Taylor

Ever since man learned how to write - and more rapidly since he learned how to print - more and more information has been accumulating, for those who wish to read, on every topic under the sun. The rate at which text-books, technical journals and conference proceedings are produced, increases every year. This phenomenon has been termed the "information explosion", and has led to the present-day problem of locating, in this vast mass of literature, that small fraction which may be of immediate use. This problem is labelled "information retrieval".

Fortunately, in the field of Geomechanics, a very useful tool is available - GEODEX - an index to the literature on Geomechanics topics. In this respect, Geomechanics appears to be much better served than most other branches of science and technology.

In Auckland and Wellington, Geodex systems are available. One is held by the School of Engineering library at the University of Auckland. In Wellington the Soil Bureau at Taita has subscribed to the scheme for some years, the M.O.W. library has recently purchased a set and another is to be found at the Wellington offices of Brickell, Moss, Rankine and Hill.

The system consists of two parts. The first is a set of abstracts which summarize, in a single paragraph, the important points in each technical publication. The second is a simple but ingenious index which quickly sorts out those references which are concerned with the particular topic of immediate interest.

Geotechnical Abstracts appear monthly and cover the fields of soil mechanics, foundation engineering, rock mechanics and engineering geology. They are prepared by the German National Society for Soil Mechanics and Foundation Engineering.

Originally, the abstracts were prepared by the Geodex Company (in U.S.A.) and covered a more restricted field; rock mechanics and engineering geology were not included. The abstracts are sequentially numbered.

The index system is based on a series of key words. For each key word, there is a card punched with holes whose positions correspond to abstract numbers which are concerned with that topic. Suppose, for example, information is required concerning the permability of compacted clays. The three cards bearing the key words permeability, compaction and clay are selected and placed on top of each other, in a special holder. Where holes in the three cards coincide, the location gives the abstract number of a technical publication dealing with the subject of interest. If only two of the cards (clay and permeability) are used, a larger number of publications, dealing with a wider topic (permeability of clays) will be referenced.

In practice, at least two sets of cards, one for the original Geodex abstracts and another for the Geotechnical abstracts, must be searched. The cards are updated every three months.

It will be found that much time can be saved by using the Geodex method of searching for information on a particular topic; it does provide a systematic approach to the information retrieval problem, which is otherwise a rather haphazard process.

THE CALCULATION OF COEFFICIENTS OF CONSOLIDATION AND PERMEABILITIES FROM ONE-DIMENSIONAL CONSOLIDATION TEST DATA

J.G. Hawley
Soil Bureau, D.S.I.R.

This paper has been written for those people who experience annoying doubts on the questions of whether original (t = 0) values, or average values, of sample thickness should be used when calculating coefficients of consolidation from conventional one-dimensional consolidation test data, and whether the factor $(1 + e_o)$ or $(1 + e_{average})$ should be used when calculating permeabilities from these coefficients. These questions are of practical interest in very compressible soils only, but there can be no merit in performing calculations in one way when more correct ways are no more complex.

Taylor (1942) has described methods for calculating coefficients of consolidation and permeabilities from the time settlement records of one-dimensional consolidation tests. These methods are based on the small strain theory for the one-dimensional consolidation of saturated clays developed by Terzaghi (1925). McNabb (1960) by making more precise definitions of length and velocity terms before writing the equation of continuity and applying Darcy's law avoided those approximations in the Terzaghi theory which limit that theory to small strains.

In consolidation tests on highly compressible soils, strains which may not be described as small may be encountered. The purpose of this paper is to answer the questions;

(i) should initial (t = 0) or average thicknesses of samples be used in the calculation of values of coefficients of consolidation (c_v) and

(ii) should values of $(1 + e_o)$ or $(1 + e_{average})$ be used in calculating values of permeability (k) from these values of c_v.

Common procedure in laboratory testing (see for example British Standard 1377:1967, test 16) is to double the applied load at 24 hour intervals on samples whose maximum drainage path length is of the order of one centimetre. Overall settlement is plotted against the square root of time or the logarithm of time and from these plots the coefficient of consolidation is calculated (Taylor 1942).

The coefficient of consolidation (c_v) is defined in the Terzaghi theory by

$$c_v = \frac{k\ (1 + e_o)}{\gamma_w} \quad \frac{d\sigma'}{de} \qquad ---- (1)$$

and appears as the 'constant'in the equation

$$\frac{\partial u}{\partial t} = c_v \frac{\partial^2 u}{\partial z^2} \qquad ---- (2)$$

It might be expected that the derivation of a constant which appears in an equation for excess pore pressure from a time-settlement curve involves the assumption that the degree of consolidation in terms of settlement is equal to the degree of consolidation in terms of pore pressure dissipation at all times. This assumption is justified only if $de/d\sigma'$ remains constant with time at any one depth and constant with depth at any one time as assumed in the derivation, by Terzaghi, of equation 2. However a closer examination of the theories of Terzaghi (1925), Davis and Raymond (1965) and Gibson, England and Hussey (1967) show that the calculation is better than might at first be supposed. This point will now be clarified.

It is not always appreciated that all three of the above theories yield an equation of the form

$$\frac{\partial e}{\partial t} = c \frac{\partial^2 e}{\partial z^2} \qquad ---- (3)$$

Considering each of the theories in turn;

(a) Terzaghi (1925)

Equation 3 may be derived using only the equation of continuity, Darcy's law and the effective stress equation,if self weight effects (i.e. effects due to the difference between the densities of the soil particles and the pore fluid) are neglected, and if the product $\frac{k}{\gamma_w} \frac{d\sigma'}{de}$ is assumed to be independent of z. No assumption concerning $de/d\sigma'$ alone, or restriction to step loading conditions need be made. Alternatively equation 3 may be recovered from equation 2, as follows:

Terzaghi assumed $de/d\sigma'$ to be constant

i.e. $$de = - a_v d\sigma' \qquad ---- (4)$$

so that $$\frac{\partial e}{\partial t} = -a_v \frac{\partial \sigma'}{\partial t} \qquad \text{- - - - (5)}$$

Terzaghi restricted his theory to step loading conditions $\partial\sigma/\partial t = 0$. The effective stress equation when differentiated with respect to time becomes

$$\frac{\partial \sigma}{\partial t} = \frac{\partial \sigma'}{\partial t} + \frac{\partial u}{\partial t} \qquad \text{- - - - (6)}$$

= 0 between increments of step loading.

Substituting in equation 5

$$\frac{\partial e}{\partial t} = a_v \frac{\partial u}{\partial t} \qquad \text{- - - - (7)}$$

The effective stress equation may also be differentiated with respect to z to give

$$\frac{\partial \sigma}{\partial z} = \frac{\partial \sigma'}{\partial z} + \frac{\partial u}{\partial z} \qquad \text{- - - - (8)}$$

and if self weight effects are neglected this may be simplied to

$$\frac{\partial \sigma'}{\partial z} = -\frac{\partial u}{\partial z} \qquad \text{- - - - (9)}$$

Differentiating a second time

$$\frac{\partial^2 \sigma'}{\partial z^2} = -\frac{\partial^2 u}{\partial z^2} \qquad \text{- - - - (10)}$$

Differentiating equation 4 twice with respect to z gives

$$\frac{\partial^2 e}{\partial z^2} = -a_v \frac{\partial^2 \sigma'}{\partial z^2}$$

$$= a_v \frac{\partial^2 u}{\partial z^2} \quad \text{(from 10)} \qquad \text{- - - - (11)}$$

Substituting $\frac{\partial^2 u}{\partial z^2}$ from equation 11 and $\frac{\partial u}{\partial t}$ from equation 7 into equation 2 yields.

$$\frac{\partial e}{\partial t} = c_v \frac{\partial^2 e}{\partial z^2} \qquad \text{- - - - (3a)}$$

The restriction to step loading conditions and the assumption that $de/d\sigma'$ (alone) is constant, cancel rather than confirm themselves. Terzaghi imposed these same conditions in his derivation of equation 2. Equation 3a is not subject to these conditions nor does it involve any assumption regarding k (alone); equation 2 is subject to all of these (Terzaghi) conditions.

(b) Davis and Raymond (1965)

Because equation 3 may be derived in the manner described above it is independent of the particular relationsip assumed between e and σ'.

Davis and Raymond make the assumption that

$$e = e_o - C_c \log_{10} \frac{\sigma'}{\sigma'_o} \qquad \text{---- (12)}$$

so that

$$\frac{de}{d\sigma'} = - \frac{0.434\ Cc}{\sigma'} \qquad \text{---- (13)}$$

This assumption leads them to the equation

$$\frac{\partial \omega}{\partial t} = c_v \frac{\partial^2 \omega}{\partial z^2} \qquad \text{---- (14)}$$

where

$$\omega = \log_{10} \frac{\text{(current local effective stress)}}{\text{total stress}}$$

$$= (e_f - e)/Cc \qquad \text{---- (15)}$$

and e_f is the voids ratio given by equation 12 for an effective stress equal to the total stress, σ_f.

Equation 14 may therefore be written

$$\frac{\partial e}{\partial t} = c_v \frac{\partial^2 e}{\partial z^2} \qquad \text{---- (3b)}$$

(which is identical to equation 3a).

This is a transformation which they do not make in their text. It is however a justification of the procedure which they adopt for calculating values of c_v. From their data it is apparent that they calculate values of c_v from their time-settlement curves, not from their time-pore pressure curves. Workers who calculate c_v from time-settlement curves in the belief that they are applying Terzaghi theory are performing a better calculation than they suppose. The values of c_v which they calculate should be better values of the constant in equation 3 than in equation 2.

There remains the question of the nature of the length term z, i.e. whether the factor in equation 1 should be $(1 + e_o)$ or simply $(1 + e)$. The length term z used by Terzaghi and by Davis and Raymond is not defined as either current or original length. Both of these theories are therefore 'small strain' theories.

(c) Gibson England and Hussey (1967)

Gibson et al, following NcNabb (1960) make careful definition of length and velocity terms and show that equation 3 may be written more precisely as

$$\frac{\partial e}{\partial t} = c_F \frac{\partial^2 e}{\partial a^2} \qquad \text{- - - - (3c)}$$

where

$$c_F = \frac{k}{\gamma_w} \frac{(1 + e_o)^2}{(1 + e)} \frac{d\sigma'}{de} \qquad \text{- - - - (16)}$$

$$= c_v \frac{(1 + e_o)}{(1 + e)}$$

and distances 'a' are measured at t = 0.

Gibson et al have emphasised that self weight effects have been neglected in equation 3c and that the validity of the equation does not rest on the <u>separate</u> Terzaghi assumptions of constant k and constant $de/d\sigma'$. In order that explicit solutions to equation 3c may be found it is necessary that c_F (as a whole) be assumed to remain constant with time t and distance 'a'.

Equations of the form of equations 3, 3a, b and c have solutions which may be expressed either as a Fourier series or an error function (Carslaw and Jaegar (1947). The form of these equations (and of equation 2) imply a t/z^2 or t/a^2 similarity rule. Dimensionless parameters known as time factors T may therefore be used to eliminate the effect of sample thickness.

$$T = \frac{ct}{H^2} \qquad \text{- - - - (17)}$$

If H is taken as the thickness of the soil layer per drainage face* (i.e a sample tested under conditions of double drainage has an overall thickness 2H), this time factor T has theoretical values of 0.197 and 0.848 when the process is respectively 50% and 90% complete. If the corresponding times t_{50} and t_{90} are estimated from the experimental time-settlement plot and H is measured, the value of c may be calculated simply as

$$c = \frac{0.197\ H^2}{t_{50}} \qquad ---- (18)$$

or

$$c = \frac{0.848\ H^2}{t_{90}} \qquad ---- (19)$$

If H is measured at t = 0 the resulting value of c will be c_F. Values of k may then be calculated using equation 16.

If an average value of H, (H_m) is used (as advocated in the British Standard 1377:1967, see also footnote below) the resulting value of c will be given by

$$c = c_F \cdot \left[\frac{H_m}{H_o}\right]^2 \qquad ---- (20)$$

$$= c_F \cdot \left[\frac{1 + e_m}{1 + e_o}\right]^2 \qquad ---- (21)$$

$$\simeq \frac{k}{\gamma_\omega} \left(1 + e_m\right) \frac{d\sigma'}{de} \qquad ---- (22)$$

and k should be calculated accordingly (rather than via equations 1 or 16).

The errors involved in adopting an inconsistent approach with regard to the H and the (1 + e) terms in the calculation of c_v and k will usually be small in comparison with other errors. There is however no merit in preserving avoidable errors, however small, when a more consistent calculation is no more complex.

*Notes: 1. The numbers '180' and '772' which appear in the formulae for the calculation of c_v values in BS 1377:1967 are appropriate if $\bar{H}$ is taken as the overall average thickness in double drainage i.e. $2H_m$. With $\bar{H}$ expressed in inches and t_{50} or t_{90} in minutes these numbers give values of c in ft^2/year as shown. These values will be values of c in equation 22 rather than values of c_v as defined in equation 1.

2. Similarly, the numbers '0.026' and '0.111' which appear in the 'draft for comment' for the revision of the BS are appropriate if $\bar{H}$ is taken as the overall average thickness ($2H_m$) in millimetres and t_{50} or t_{90} are expressed in minutes. The resulting c will be in m^2 per year and will be strictly appropriate for equation 22 rather than equation 1.

3. The numbers '0.197' and '0.848' being values of a dimensionless parameter are independent of the system of units being used. The other numbers arise from the incorporation, with these basic numbers, of the factors required to convert ins^2/min to ft^2/year in one case and mm^2/min to m^2/year in the other.

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FORTHCOMING STANDARDS ASSOCIATION OF NEW ZEALAND PUBLICATIONS

J.P. Blakeley

Provisional New Zealand Standard for Foundations

This Provisional Standard has been fully discussed in the two previous issues of "New Zealand Geomechanics News". The Society has received a letter from the Standards Association of New Zealand stating that the final draft is now in their publishing section, but because of the heavy work load on their printers it will probably be late in May 1973 before the Standard is available from their Sales Section.

The draft which was circulated for comment as D8463 is being published as two provisional standards NZS 4204 P "Code of Practice for Foundations not requiring specific design" and NZS 4205 P "Code of Practice for Foundations requiring specific design". The designation "NZS 1900 Chapter 12" will not be used.

This form is being adopted because the two standards will be cited as a means of compliance with NZS 1900 in line with the new format for the Model Building By-law.

Code of Practice on Earth Fills for Residential Development

This Code of Practice was also discussed in the previous issue "New Zealand Geomechanics News". A recent letter from the Standards Association of New Zealand states that it is anticipated that this code, to be designated NZS 4431 P "Code of Practice on Earth Fills for Residential Development", will be published by June 1973.

In addition a preliminary draft code of practice has been prepared for minor earth fills for residential development and the present aim is to work to having a 'draft for comment' prepared by December 1973. At this stage a minor earth fill is defined as filling not extending across more than one residential building lot or 25 perches in plan area.

Draft New Zealand Standard on Methods of Testing Soil for Civil Engineering Purposes

Three meetings of the technical committee which is considering this Standard have now been held with further meetings planned to discuss individual test procedures. No date has yet been set for circulation of a 'draft for comment'.

A RECENT ENGLISH COURT DECISION

J.P. Blakeley

A recent decision made by the Court of Appeal in England (1972) may have a considerable bearing on the work of all people who inspect foundation excavations prior to construction and other aspects of building work, and in particular the liability of a local authority for inspections made by members of its staff. This decision is of great importance in New Zealand as it is a binding decision on our courts.

In Bognor Regis there was a rubbish tip which had been filled in and the ground made up so that it looked like the land next to it. In 1958 a builder purchased the land for a housing estate and one of the lots was on the site of the old rubbish tip. Building plans for this site showing a house with normal foundations for the type of soil usually found in the area were submitted to the Bognor Regis Urban District Council and approved subject to all foundations and drains being inspected by Council staff prior to being covered up.

In 1959 the builder started work on this site and he dug trenches for foundations. When he got down about 2 ft he came upon the remains of the old rubbish tip - broken glass, tins and black slimy sludge. Therefore he made the outer trench 3 ft 6 in deep (which is much deeper than usual) and reinforced the concrete floor with steel mesh, but he did not bother much about the inner walls. He notified the Council that the trenches were ready for inspection which was carried out by a Building Inspector, who passed them. A subsequent inspection was made after the trenches had been filled in with concrete and the work was passed at that stage also and the house was finished towards the end of 1959.

Early in 1960 the builder sold the house to a man who owned it for only a few months before selling it to a Mrs Dutton in December 1960. At the time of purchase she noticed a crack in the wall of the stairs but the land agent assured her it was nothing to worry about. She did not have the house inspected herself but she borrowed money from a building society whose Surveyor passed it.

After Mrs Dutton had been in residence for a month or two the walls and ceiling cracked, the staircase slipped and the doors and windows would not close. She called in a Surveyor in September 1961 who diagnosed the trouble as being due to subsidence of an internal wall because the wall had inadequate foundations. The conditions got worse and her solicitors called in an expert Surveyor who had test holes dug and found that the house was founded on a rubbish tip which could easily have been seen at the time the house was built.

In February 1964 Mrs Dutton issued a writ against the builder and the Bognor Regis Urban District Council she claimed £2740 being £2240 for the cost of repair and £500 dimunition in value.

She claimed that the Council was negligent in passing the foundations. The Council did not call any evidence to deny this as their building inspector had left and gone to Australia.

The judge found that the Council's inspector was negligent. At the time the house was built one of the Council's by-laws dealt expressly with foundations and stated that the foundations must transmit the load to the ground in such a manner that the pressure on the ground shall not cause such settlement as may impair the stability of any part of the building.

The case was taken by the Council to the Court of Appeal who considered several aspects of it.

(a) The Position of the Council

The judge considered that the Council having a right of control over the building of the house also has a responsibility in respect of it. They must take reasonable care to see that their by-laws are complied with and must appoint building inspectors to examine the work in progress as occasion requires and carry out their inspection with reasonable care.

(b) The Position of the Builder

Based on past law in regard to negligence in connection with the manufacture of an article, the judge considered that if a manufacturer of an article is liable to a person injured by his negligence, so should the builder of a house be liable.

(c) The Position of the Professional Adviser

The Bognor Regis District Council submitted that their Inspector owed no duty to a purchaser as he was in the same position as any professional man who owed no duty to one who did not employ him but only took the benefit of his work.

To that argument the judge replied that it is clear that a professional man who gives his guidance to others owes a duty of care not only to the client who employs him, but also to another who he knows is relying on his skill to save him from harm.

The argument was then submitted that Mrs Dutton did not rely on the Inspector and he therefore owed her no duty. The judge said that at this point he must draw a distinction between several categories of professional men. A professional man who gives advice on financial or property matters (e.g. banker, lawyer or accountant) has a duty only to those who rely on him and suffer financial loss in the consequence; but in the case of a professional man who gives advice on safety of buildings or machines or materials, his duty is to all those who may suffer injury in case his advice is bad. The reason is not because those injured relied on him but because he knew or ought to have known that such persons might be injured if he did his work badly.

(d) Proximity

The Council submitted that in any case the duty ought to be limited to those immediately concerned and not extended to purchaser after purchaser down the line. To this argument the judge replied that the argument had merit but the reason is because a subsequent purchaser often had the house surveyed. This intermediate inspection or opportunity of inspection may break the proximity and would certainly do so when it ought to disclose the damage. <u>But the foundations of a house are in a class by themselves</u>. Once covered up they will not be seen again until the damage appears. The Inspector must know this or at any rate ought to know it and therefore should have subsequent purchasers in mind when he was inspecting the foundations.

(e) Limitation of Action

The Council also submitted that if the action were allowed it would expose the Council to endless claims as the period of limitation would only start to run when the damage was done (i.e. when the cracks began to appear in the house) and hence the Council might be liable for many years hence. The Council maintained that the damage was done when the foundations were badly constructed and the period of limitation (6 years) should run from then. The Council would thus be protected by a 6 year limitation but the builder might not be, as if he covered up his own bad work he would be guilty of concealed fraud and the period of limitation would not begin to run until the fraud was discovered.

To this argument the judge replied that the whole case was a novel one as never before had a claim been made against a Council or its Surveyor for negligence in passing a house. Hence it should be decided according to "the reason of the thing". He asked if allowing the action would lead to a flood of case which the Council would not be able to handle, nor the Courts, as such considerations had led in the past to the rejection of novel claims. However he saw no need to reject the claim on this ground. The injured person will always have his claim against the builder and will rarely allege - and still less be able to prove - a case against the Council.

The judge then stated that all these considerations led him to the conclusion that the policy of the law should be and is, that the Council should be liable for the negligence of their Surveyors in passing work as good when in truth, it is bad.

Although leave was granted to appeal to the House of Lords, it is understood that the appeal is not proceeding.

MEASUREMENT OF IN-SITU SOIL DENSITY

(No.5 in a Series)

J.H.H. Galloway

5. TEST HOLE DIGGING

This article discusses some of the problems of making satisfactory test holes.

In all test hole digging it is important to remember that the original ground surface forms one boundary of the volume to be measured. If the measuring system assumes this surface is level then it must be level, if plane, then it must be plane. All the measuring systems discussed in this series of articles also assume some datum or reference surface which must remain fixed in space during the course of the test. This datum surface is normally defined from a machined face in the digging plate so that the plate must remain fixed during the test. This plate is much more than the mere "metal tray" of B.S. 1377.

In all normal holes a digging plate should be used. This plate must be sufficiently large to provide an adequate bearing area on the soil, be rigid enough to support all loads without significant deflection and be able to be fixed firmly in position. Sheet metal digging plates are a waste of time. They neither maintain their planeness in use, nor are they rigid enough to support the measuring devices. Steel digging plates should be at least 3/16" thick for test holes of up to six inches diameter and ¼" thick for larger holes. Cast aluminium plates (which are serviceable) should be somewhat thicker. The plates should be flat (within 0.015") after fabrication (beware of welding distortions) with a mating face machined for the measuring device. Their width should be about twice the diameter of the hole so that the weight of the measuring device is transferred to the soil well away from the rim of the hole. Several ¼" holes should be provided round the edges of the plate so that it can be securely spiked in position before digging the test hole. Such plates are rather heavy but are robust enough to level off the test site by being rubbed to and fro over the soil and to stand up to normal use. For large holes (several cubic feet) a timber frame can make a satisfactory digging plate, but it must be carefully levelled and pegged in place.

The diameter of the test hole should always match that of the hole in the digging plate (and of the measuring device). Normally the depth of the hole should equal its diameter, which should be constant all the way down to a slightly concave bottom. This depth of hole is normally a good compromise between the poor accuracy of volume measurement in shallow holes and the difficulty of digging and clearing out a deep hole. The constant diameter ensures that equal weighting is given to all layers within the depth of test. For special purposes special shapes of hole may be advisable. Where calibration vessels are used as part of the measuring procedure (e.g. sand replacement) the shape of the calibration vessel should match that of the test hole desirable for the site conditions rather than the other way round.

In digging the test hole one must always beware of leaving sharp re-entrants (either inwards or outwards pointing). Large stones lying across the boundary of the hole are always a problem and both luck and good judgement are necessary to success in all holes. Usually it is necessary to remove these stones near the top of the hole otherwise the hole diameter decreases drastically with depth. One should save some of the fines from the diggings to round out the contours of the hole, as this reduces errors. Particular care must be taken at the top edge of the hole. Even with good digging plates, well spiked down there is a tendency for material in this area to collapse into the hole. All such spots should be patches with fines.

It is dangerous to assume that the moisture content of the material dug from the hole is the same as that of the material before the hole was dug (or, for that matter, when it was compacted!). I know one extreme case where about one third of the moisture disappeared during the hole digging even with the greatest care. On the other hand moisture gains seem highly improbable except in conditions when no self respecting Kiwi would work.

NEW ZEALAND GEOMECHANICS SOCIETY

NOTIFICATION OF CHANGE OF ADDRESS.

The Secretary,
N.Z. Institution of Engineers,
P.O.Box 12-241,
WELLINGTON.

Dear Sir,

CHANGE OF ADDRESS

Could you please record my address for all New Zealand Geomechanics Society correspondence as follows:

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____

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Name: ____

Address to which present correspondence is being sent:

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Signature __________________________

Date __________________________

APPLICATION FOR MEMBERSHIP

of

New Zealand Geomechanics Society

A TECHNICAL GROUP OF THE NEW ZEALAND INSTITUTION OF ENGINEERS

The Secretary,
N.Z. Institution of Engineers,
P.O.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 New Zealand Geomechanics Society and supply the following details:

NAME ____
(to be set out in full in block letters, surname last)

PERMANENT ADDRESS ____

____

QUALIFICATIONS AND EXPERIENCE ____

____

____

NAME OF PRESENT EMPLOYER ____

____

NATURE OF DUTIES ____

____

____

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

I wish to affiliate to:

International Society for Soil Mechanics and Foundation Engineering (ISSMFE) Yes/No

International Society for Rock Mechanics (ISRM) Yes/No

International Association of Engineering Geology (IAEG) Yes/No

Signature of Applicant ____________________

Date ____________________ 19__