N.Z. GEOMECHANICS NEWS

No. 1

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A NEWSLETTER OF THE N.Z. NATIONAL SOCIETY FOR SOIL MECHANICS
AND FOUNDATION ENGINEERING

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No. 1, November, 1970.

A Newsletter of the N.Z. National Society for Soil Mechanics and Foundation Engineering

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THIS IS A RESTRICTED PUBLICATION

"N.Z. Geomechanics News" is a newsletter issued to members of the N.Z. National Society for Soil Mechanics and Foundation Engineering. 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 annual subscription rate is at present one dollar.

AN INTRODUCTION BY THE CHAIRMAN

Dear Member,

In launching this expanded newsletter the National Committee hopes to achieve at least four things. These are:

(a) to keep you informed of what your Committee is doing and planning;

(b) to present information on forthcoming conferences, symposia and seminars of a geomechanical nature in New Zealand and overseas;

(c) to summarise articles of interest published in journals not readily available in New Zealand and to give local comment on papers and articles appearing in the international journals;

(c) to provide a forum in which members can discuss their ideas, experiences and problems informally.

The first three objectives involve essentially routine work on the part of the Editor and the National Committee but the last depends almost wholly on you as an individual member. If you make good use of the newsletter by writing to the Editor expressing your point of view, contributing articles on your experiences or problems, or discussing the experiences of others it can grow into a lively and useful thing. But if you ignore it, it will droop and die.

No fixed period between newsletters is proposed. They will come out from time to time as sufficient material comes to hand. This we hope will be several times a year, but if the rate drops to less than once a year it will be apparent that you are not interested in keeping it going and we will be forced to review its continuance.

If you feel that the objectives or format of the newsletter could be improved the Editor would like to know your ideas. If you have colleagues who might find it interesting let them see it and persuade them to join the Society and become regular readers and contributors. A membership application form appears elsewhere in this issue.

In conclusion I commend this newsletter to your attention. We have conceived it and given it birth. What it grows into depends largely on how well you use it and feed it.

J.H.H. Galloway

CHAIRMAN

N.Z. NATIONAL SOCIETY FOR SOIL MECHANICS AND FOUNDATION ENGINEERING.

EDITOR'S NOTE

This inaugural issue has been contributed almost entirely by members of the National Committee of the Society. As your Chairman has already stated, the success of the venture will completely depend on the support given to it by the membership of the Society.

Contributions may be in the form of technical articles, notes of general interest or letters to the Editor, and may cover any subject within the general fields of soil mechanics, site investigations, foundation engineering, rock mechanics or engineering geology. Book reviews would also be welcome.

All contributions should be sent to -

The Editor
N.Z. Geomechanics News
C/- N.Z. National Society for Soil
Mechanics and Foundation Engineering
P.O. Box 12-241
WELLINGTON.

Should you require any further information please contact a member of the National Committee of the Society. A list of names, addresses and telephone numbers of Committee members is printed elsewhere in this issue.

J.P. Blakeley

EDITOR.

SEVENTH INTERNATIONAL CONFERENCE ON SOIL MECHANICS AND FOUNDATION ENGINEERING, MEXICO CITY, AUGUST 1969.

Four of our members attended this conference and Dr Roy Northey had the honour of chairing one of the Speciality Sessions at the Conference on "Engineering Properties of Loess and other Collapsible Soils". Proceedings of the main Conference sessions are now available at some libraries in New Zealand.

Dr Northey has sent in his impressions of the Conference:

"Delegates to the Seventh International Conference seemed to regard it as a miracle of organisation or disorganisation depending on their personal interests, activities and experiences. I found both from superb attention to detail in some matters to utter chaos in others. Within a week from registration and the inaugural session on Monday morning, the organisers managed to cram in five main sessions and eighteen Speciality Sessions held in four series of five or six simultaneous sessions running at the same time as various technical visits, films and exhibitions together with an evening visit to Ballet Folkloria de Mexico and a final banquet on Friday evening. The Saturday visit to Teotihuacan (The Place of the Gods) with alfresco lunch was necessary light relief after an exhausting week, only slightly marred by the inevitable deluge in late afternoon.

Many details of the Conference programme were experimental with varying degrees of success. The Main Sessions each consisted of a presentation by the General Reporter of his state-of-the-art review followed by contributions from an invited panel and after a brief coffee break, a series of hurried presentations by authors from the floor interspersed with questions discussed by the panel. Much of this could be just as easily read in the Proceedings (if one had the time) especially since several sessions were lost in detail without bringing out broad principles.

The Speciality Sessions were originally conceived as offering an opportunity for more general participation in discussion of specific topics within a relatively small group. Unfortunately the number of such sessions offered simultaneously made it impossible to attend all those of interest, and the agonising decision for some so often meant not attending any. "Montezuma's Revenge" which managed to keep a substantial proportion of the 2000-odd delegates and their wives subdued for at least part of the time was also a significant cause of poor attendance. On the first day of registration, all had high hopes of attending many sessions, but as the week advanced more realistic actions prevailed. Experience with my own Speciality Session on loess may well have been typical. Before I left New Zealand 30 delegates had expressed some interest in participation, over 100 registered on the Monday, but by Thursday when the session was held only 25 turned up, mainly to listen rather than to participate.

For the Main Sessions the General Reporter had to prepare his review without seeing the conference papers so there was some truth in Moretto's humorous comment that there seemed to be three conferences being held at the same time:

(a) the conference of the General Reporters and their panels who had discussions among themselves;

(b) the conference of the Speciality Sessions which each went their own way; and

(c) the conference of the authors who had submitted papers and were then essentially ignored in the Sessions.

The main papers and at least summaries of discussions can always be read in the Proceedings so that I felt I gained most from the renewal of personal contacts and the many informal discussions which are quite impossible except at such an occasion.

Mexico City - a city of 7 million people living at 7000 ft. altitude is a city I shall always remember, not only for its foundation problems, but mainly for the vivid contrasts at every turn - the extreme wealth and devastating poverty; broad tree lined boulevards carrying up to 10 lanes of traffic at 40 m.p.h. (where one took one's life in one's hands to cross the street) and the quiet back streets and parks with fountains everywhere; modern and almost futuristic architecture both commercial and residential and old palaces and haciendas of classical line, not to mention the hovels and piles of rubble with TV masts everywhere.

All foundation engineers and those concerned with the measurement of soil consolidation should see Mexico City. Never again will settlements appear a problem after living where settlement is measured in metres, not in fractions of an inch and essentially all buildings look at least slightly askew yet reasonably sound. Since Mexico City is built on a lacustrine plain it was once essentially flat. Now following local variations in subsoil conditions, types of building construction and overall drainage, local hills and valleys of up to 30 ft contour prevail. Although everything has settled, buildings on deep piles grow out of the ground and those with inadequate shallow foundations settle further. Up to five kerb levels are traversed between footpath and road and the pavements would be no place for a baby carriage with local steps and slopes as each building is passed. Bjerrum's comment is appropriate - "We are all enchanted with the loveliness of their capital city even if we open wide one professional eye to observe the settlement of buildings as we pass by. Where else indeed are the movements so large that the engineer's wife can appreciate them also!"

Alan Pickens has sent us this report on his impressions as a younger engineer at the Conference:

"The timing of the Mexico Conference fitted in conveniently with my projected return to Auckland after working in Canada. En route to Mexico City I was able to combine pre-arranged technical visits with automobile touring, thus making the venture of threefold purpose adding in the Conference itself. The only conference I had attended previously was an Australia-New Zealand Soils Conference which I realised was small beer indeed in comparison with such an illustrious international assembly. However my initial fears about my presumptuousness were soon dispelled in

the anonymity of such an enormous gathering. The whole proceedings amounted to something of an anticlimax and presented an air of near impossibility when one realised how few hours were devoted to trying to cover so much ground. A few of the old hands muttered that the modern conferences are too big and not like they used to be, but I suspect that when venues like Mexico City continue to be chosen, attendances will keep increasing. I found the Conference a bit disappointing and would hesitate to recommend to another young engineer that he participate in such a Conference as an end in itself. However, through attending the Conference, I personally was able to make some most rewarding technical visits en route as well as being something of a tourist, and I feel that it is "fringe benefits" such as these which can make the whole venture very worthwhile for anyone."

Peter Taylor attended the Executive Committee meeting of the International Society as New Zealand representative and has filed this report:

"On the Friday and Saturday prior to the Conference, the Executive Committee held all-day meetings. Although minutes are published in v.3 of the Proceedings, this brief report by your New Zealand representative, deals with a few items which affect us here.

The meeting, chaired by Lauritz Bjerrum, was attended by representatives from 38 countries, together with two past-presidents and the six vice-presidents. The areas, and numbers of members represented by the vice-presidents are Europe (4,494), Asia (1,407), Africa (611), N. America (1,428), S. America (386) and Australasia (450). Apparently the Europeans do not feel under-represented, or perhaps they dare not undertake the task, with its possible political implications, of splitting Europe! Professor D.H. Trollope, the Australasian vice-president, capably reported on activities in the area during the preceding four years and showed that we have not been idle during that time. Professor Trollope was succeeded by Professor E.H. Davis, (Sydney) who will remain in office until the end of the next international conference. The President during this period is Professor Ralph B. Peck.

In an attempt to improve communications between National Societies and with the International Society for Soil Mechanics and Foundation Engineering, a new post, that of Secretary General, has been created. The appointee is Professor K.L. Nash (U.K.) who should perform this task very well, to judge from his activity as secretary to the Executive Committee.

The balance sheet (with £504 to carry forward in July 1969) shows that financially, the International Society just holds its head above water. With increased expenditure (e.g. $4,000 U.S. per annum, the honorarium for the Secretary General) it appears inevitable that subscriptions from the world's 8,800 members (paid by the National Societies) must increase substantially. This will probably occur next year.

The constitution of the Society has been revised, and is now much more clearly set out than formerly. One innovation is that there should now be an executive committee meeting approximately every two years, instead of every four, as at present. This should result in more continuous activity. The next meeting may be held during the conference in Sydney, about August of next year.

Both Sweden and the U.S.S.R. offered to provide the venue for the next (1973) international conference. The invitation of Professor Tsytovich, to hold it in Moscow was accepted."

PROCEEDINGS

The Proceedings of the main Conference Sessions (in four volumes) can be obtained from:

Sociedad Mexican De Mechanica Des Suelos,
A.C. 1 Apartado Postal 8200,
Mexico 1.

The price is $US40 which also includes the "State of the Art" volume which is also available separately for $US5.

Also available are reports from the following Speciality Sessions:

Session 1	Soil Sampling
Session 2	Soil Dynamics
Session 6	Engineering Properties of Lateritic Soils
Session 8	Negative Skin Friction and Settlements of Piled Foundations
Session 12	Advances in Consolidation Theories for Clays
Session 13	Mechanical Properties of Rockfill and Gravel Materials
Sessions 14 & 15	Cast-in-situ Diaphragm Walls and Anchorages, Especially in Soft Ground

Details of the price of each of these reports and the address from which it is obtainable is available from the Technical Secretary.

SEMINAR ON GEOTECHNICAL ASPECTS OF EARTHQUAKE ENGINEERING, AUCKLAND UNIVERSITY, MAY 1970.

This Seminar was held at the University of Auckland from 20-23 May, 1970. Over eighty civil engineers and scientists attended the Seminar and each session generated a good discussion. Speakers at about half the sessions were visiting lecturers. These included Mr G.A. Eiby, Mr G.J. Lensen and Mr L.E. Oborn of the D.S.I.R., Professor F. Evison of Victoria University, Professor P. Jennings of the California Institute of Technology, Mr R. Shepherd of Canterbury University, and three consulting engineers Messrs R.J.P. Garden, J.P. Hollings and R.M. Tonkin who discussed "The Viewpoint of the Practising Engineer".

Mr P.W. Taylor and Dr G.R. Martin of the Civil Engineering Department, Auckland University, spoke at the other half of the sessions and the topics covered by them were :-

1. Dynamic Properties of Soils
2. Liquefaction of Soils
3. Soil-Structure Interaction and Foundation Design
4. Design of Foundations for Earthquake Loading
5. Surface Layer Modification of Earthquake Waves
6. A New Version of the Caracas Story
7. Dynamic Response of Earth Structures to Earthquakes
8. Slope Stability in Earthquakes

A Summary of the main points covered in these eight addresses has been published in the "Bulletin of the N.Z. Society for Earthquake Engineering" Vol. 3, No. 3, September 1970, pp. 120-5.

In addition all participants were given in advance of the Seminar a bound copy of notes giving a summary of the main points covered by all the speakers.

A NOTE ON THE FOUNDATION INVESTIGATION CARD INDEX SYSTEM

This project has been initiated by the National Committee in an attempt to establish local borehole indexes which it is hoped will grow, and possibly eventually lead to a national borehole index.

During 1969 index cards were distributed to all N.Z.I.E. branches. On the card no attempt is made to log the soil conditions found on site. All that is asked for is a site plan showing the position of boreholes, and also details of the number of bores, range of depths, the types of bores and the diameter, the type of soil sampling done and the names of the soil tests carried out. In addition the name and address of the holder of the investigation record is listed.

Whether or not the information will be released to inquirers will remain the prerogative of the holder of the investigation record. The cards should now be available at the offices of all the larger local authorities, the intention being that a card should be filled in at the time of application for a building permit.

The responsibility for maintaining the card index system in a particular area lies with the local branch of the N.Z.I.E. Anybody who wishes to make use of the index system to obtain information on where boreholes may have been put down in a particular area should in the first instance get in touch with the local branch secretary of the N.Z.I.E.

GEODEX INTERNATIONAL

Early this year all members of the Society received details of the Geodex Retrieval System for finding references to information on a very large range of topics within the spheres of soil mechanics, foundation engineering, rock mechanics and engineering geology. No description will be given here of how the system works but it must be emphasised that all the system can do is provide a list of references which may not necessarily be easily obtained in New Zealand.

The Geodex System has been in existence for a number of years, but the publicity drive early this year coincided with the launching of a new publication "Geotechnical Abstracts" which is published monthly by the German National Society, and each issue will contain 144 abstracts of literature published throughout the world in more than 500 journals and other sources. The Geodex System will now be linked to "Geotechnical Abstracts", cards being punched with each keyword in the abstracts.

The cost of Geotechnical Abstracts on its own is $US32 per year and the matching Geodex Retrieval System costs a further $US60 per year. In addition the basic Geodex file costs $US190 and for another $US85 per year this basic file will be expanded with further important pre-1970 literature.

Application forms to join the Geodex System are available from the Technical Secretary. However, those members who may wish to use the System occasionally, but for whom the financial outlay would be too great to subscribe personally will be interested to know that the Geodex System is readily available at three places in New Zealand. These are :

Engineering Library, University of Auckland.

Brickell, Moss, Rankine and Hill, 19 Pretoria Street, Lower Hutt.

D.S.I.R. Soil Bureau, Eastern Hutt Road, Taita.

NEWS FROM THE TECHNICAL SECRETARY

1. ANNUAL GENERAL MEETING

The Annual General Meeting of the National Society will be held in Auckland during the Annual Conference of the N.Z. Institution of Engineers between 9-13 February 1971. Full details of the time and place of the meeting will be sent to members during January together with the annual report and statement of accounts. It is hoped that as many members as possible will plan to be present at the A.G.M.

2. THE FORMATION OF A GEOMECHANICS SOCIETY IN NEW ZEALAND

This proposal was fully outlined in the Newsletter sent out to members in October. No further details are available as yet but it is hoped to submit a definite proposal to members of the Society for postal ballot before the A.G.M. in February.

3. COPIES OF PROCEEDINGS OF SITE INVESTIGATIONS SYMPOSIUM, CHRISTCHURCH, AUGUST 1969

Some copies are still available at the cost of $7.00 to members of the Society. Application should be made to the Technical Secretary. In addition there are a limited number of copies of preprints of the papers presented which are available to members free of charge on request to the Technical Secretary.

4. COPIES OF PREPRINTS OF THE FIFTH AUSTRALIA-N.Z. CONFERENCE, AUCKLAND, FEBRUARY 1967

Although all stocks of the Proceedings of this Conference which were held in N.Z. have now been sold, Mr P.W. Taylor has a number of copies of the preprints of the papers presented and would make them available free of charge to members of the Society. Any interested members should write to Mr Taylor at Auckland University.

5. COPIES OF PAPERS BY R.M. TONKIN, L.D. WESLEY AND T. BELSHAW

Late in 1968 the National Society circulated to all members copies of three technical papers which had been received on various topics related to site investigations.

The authors and titles of these papers are R.M. Tonkin "Notes on the Use of the Standard Penetration Test (S.P.T.)", L.D. Wesley "The Dutch Static Soil Penetrometer", T. Belshaw "The Use of the Dutch Deep Sounding Penetrometer in N.Z.".

Xerox copies of these papers can be made available on request to the Technical Secretary. A charge would be made to cover costs.

6. FIRST AUSTRALIA-NEW ZEALAND GEOMECHANICS CONFERENCE

Details of this Conference were given in the October Newsletter. It will be held in Melbourne in August 1971. In the past five Australia-New Zealand Conferences on Soil Mechanics and Foundation Engineering have been held (the last of these was in Auckland in February 1967). This Conference will continue the series but its scope has been widened to include both soil and rock mechanics.

The keynote speaker will be Professor T.W. Lambe of the Massachusetts Institute of Technology. Along with papers of general interest in soil and rock engineering there will be a session devoted to the theme of "The Influence of the Structure of Soil and Rocks on their Engineering Properties".

It is hoped that a number of our members will plan to be present.

7. N.Z. NATIONAL ROADING SYMPOSIUM 1971

The National Roads Board is sponsoring a Roading Symposium to be held from 17-19 August 1971 in Wellington. One of the four main fields to be covered at the Symposium is "Pavements, Materials and Construction".

Papers are now being solicited, and authors who intend to submit papers should supply outline details to The Roading Symposium Secretary, National Roads Board, C/- Roading Division, Ministry of Works, P.O. Box 12-041, Wellington North, by 30 November 1970. Final drafts of papers will be required by 15 March 1971.

8. FOURTH ASIAN REGIONAL CONFERENCE, JULY 1971 BANGKOK, THAILAND

The Fourth Asian Regional Conference on Soil Mechanics and Foundation Engineering will be held in Bangkok in July 1971. It is sponsored jointly by the Southeast Asian Society of Soil Engineering and the Asian Institute of Technology. Further details are available from the Technical Secretary.

9. JOURNAL OF THE SOUTHEAST ASIAN SOCIETY OF SOIL ENGINEERING

This Society has recently published the first edition of its new journal.

The first edition contains the following papers:

1. Shear Strength Characteristics of Recent Marine Clays in Southeast Asia.
2. A Study of the Swelling Characteristics of Remoulded Clay.
3. Blast Tests at Tenughot Dam Site.

The annual subscription rate will be $US3, but sample copies of the first edition are available free on request to Dr E.W. Brond, A.I.T., P.O. Box 2754, Bangkok, Thailand.

10. OVERSEAS PUBLICATIONS RECEIVED

From time to time the National Committee receives copies of publications from overseas universities and other institutions.

Among those recently received are:

1. Harvard Soil Mechanics Series No. 81 "Liquefaction of Sand" from PhD thesis by Gonzolo Castro.
2. Harvard Soil Mechanics Series No. 82 "Cracking of Earth and Rockfill Dams" from PhD thesis by Sergio W. Covarrubias.
3. "On the Effectiveness of Sand Drains" by L. Casagrande and S. Paulos (Reprinted from the Canadian Geotechnical Journal).

These three publications have been placed in the Ministry of Works Library in the Vogel Building, Wellington.

11. MEMBERSHIP ENROLMENT FORM

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

12. NATIONAL COMMITTEE

Listed below are members of the National Committee of the Society. Please feel free to contact any member at any time if you have any suggestion to make regarding the running of the Society.

J.H.H. Galloway, (Chairman)
M.O.W. Central Laboratories,
P.O. Box 30325, LOWER HUTT.

Telephone 697086

K.H. Gillespie,
Brickell Moss Rankine & Hill,
19 Pretoria Street, LOWER HUTT.

Telephone 63741

M.J. Pender, (Technical Secretary)
M.O.W. Central Laboratories,
P.O. Box 30325, LOWER HUTT.

Telephone 697086

P.W. Taylor,
C/- Civil Engineering Dept.,
University of Auckland,
Private Bag, AUCKLAND.

Telephone 74740

J.P. Blakeley,
C/- Civil Engineering Dept.,
University of Canterbury,
Private Bag, CHRISTCHURCH.

Telephone 71649

Dr R.D. Northey,
D.S.I.R. Soil Bureau,
Eastern Hutt Road, TAITA.

Telephone 673119

C.M. Strachan,
C.M. Strachan & Associates,
106 Cuba Street, WELLINGTON.

Telephone 552502

R.M. Tonkin,
C/- Tonkin & Taylor,
P.O. Box 5271, AUCKLAND.

Telephone 361784

FORTHCOMING N.Z. SOIL MECHANICS PUBLICATIONS

1. N.Z. STANDARD MODEL BUILDING BY-LAW - CHAPTER 12 FOUNDATIONS

The original draft was issued early in 1966 and was circulated to all members of the Society at that time. A new revised draft D8463/2 was printed about two months ago but has not yet been widely circulated. Members wishing to see a copy of this revised draft should write to the N.Z. Standards Association, Private Bag, Wellington.

The new draft is divided into two sections. Section 1 sets out minimum provisions for investigation and for foundations of minor buildings. Section 2 sets out basic principles relating to investigation, foundation design and supervision of construction of foundations for all types of buildings and earthworks.

No date for the adoption of this by-law has yet been given by the Standards Association.

2. DRAFT N.Z. CODE OF PRACTICE ON EARTHWORKS FOR RESIDENTIAL DEVELOPMENTS

This code has been written by Mr O.T. Jones, a former National Chairman of the Society. The scope of the code as at present written is the description of earthworks practices which experience has shown to produce fills of satisfactory stability for residential construction involving one and two storey stud framed buildings, and the continued operation of residential services and streetworks. It does not cover methods of evaluation of the suitability of existing natural ground for founding houses and services.

The Code has been examined by members of the National Committee and it will now be forwarded together with comments made to the N.Z. Standards Association for their consideration.

3. DRAFT N.Z. STANDARD ON METHODS OF TESTING SOILS FOR CIVIL ENGINEERING PURPOSES

This is a revision being carried out by Dr R.D. Northey of B.S. 1377 : 1967 up to and including Test 14 (i.e. not including soil strength tests). It may also include a N.Z. Standard for the C.B.R. Test.

The revision is chiefly concerned with taking into consideration some of the peculiar problems associated with some of the volcanic soils found in New Zealand. It has been decided that it is preferable to rewrite the Standard rather than to issue a long list of amendments to B.S. 1377. It is hoped that a draft copy of the proposed standard will be available for submission to the N.Z. Standards Association in the near future.

SOIL MECHANICS RESEARCH AT THE UNIVERSITY OF AUCKLAND

P.W. Taylor and G.R. Martin

INTRODUCTION

From a modest beginning in the early 1950's research in Soil Mechanics has increased steadily over the years. In 1969 seven research students enrolled, including two for Ph.D., while in 1970 4 enrolled, including one for Ph.D., from graduating classes of about 60, in each year, in Civil Engineering.

In part, the increase in interest in this subject has been aroused by the greater emphasis placed on it in the undergraduate course. In 1953 only one hour a week in the final year of the B.E. (Civil) course was devoted to this topic. Currently, there is an introductory course in the 2nd professional year, (part of "Mechanics and Properties of Materials I"), the subject "Soil Mechanics" for all final year students and, as an elective (selected by about half of the civil engineering students) the subject "Advanced Soil Mechanics". In addition, seminars are held for research students.

Another factor which has resulted in an increase in research activity has been the readiness of the M.O.W. and N.R.B. to provide financial support for students.

About 1961, it was suggested by Professor Mowbray, head of the Civil Engineering department, that research within the various sections of the department should, where possible, be directed towards problems in Earthquake Engineering. Since that time laboratory equipment for the dynamic testing of soils has been developed, and applications to foundations and slope stability investigated. Also, the effects of sub-soil conditions on earthquake motion can now be estimated.

During the last three years, road pavements have received attention, the areas of study including pavement design methods and lime stabilization.

Major research areas have also been developed in the fields of slope stability and foundation design. Computer programs for slope stability (under static conditions) have been developed, both for earth dams and natural slopes, which enable calculations to be carried out in a few seconds, which take an hour or so using graphical methods.

Problems associated with foundation design, such as effects of preloading on bearing capacity, methods of settlement analysis, foundation interaction and stresses and deformations in earth masses have been considered. Several computer programs have been developed to facilitate research and practical design associated with these problems.

Current research projects and those completed within the last two or three years are outlined below. For the purpose of presentation, projects are grouped under headings representing major research areas.

EARTHQUAKE ENGINEERING

Soil mechanics research in the field of earthquake engineering has been subdivided into three main topic headings.

A. Dynamic Properties of Soils

In any soil dynamics problem - such as minimising machine vibration by suitable foundation design, or the stability of slopes under earthquake forces - the relationship between stress and strain under oscillatory loading is of fundamental interest. Dynamic triaxial compression test apparatus has been progressively developed since 1961. Masters theses by B.K. Menzies (1963) and J.M.O. Hughes (1965) described the characteristics of soils as determined in strain-controlled dynamic tests. More recent work is outlined below.

"Cyclic Deformation of a Clay" by D.R. Bacchus
(Ph.D. thesis, 1969 - supervised by P.W. Taylor)

This describes the further development of the strain-controlled dynamic test apparatus designed to study, in particular, variations in pore-water pressure during cyclic loading of saturated clay. The effects of consolidation pressure, strain amplitude and number of loading cycles on deformation characteristics, induced pore pressures and mean effective stress were studied in detail, for a kaolin clay. Some of the more significant results are recorded in a paper by Taylor and Bacchus (1969).

"Cyclic Deformation and Damping Characteristics of Some Auckland Clays" (Current M.E. study by R.W.M. Smith, supervised by P.W. Taylor)

The strain-controlled dynamic triaxial apparatus has been used to determine elastic moduli and damping properties of a wide variety of undisturbed soil samples from the Auckland area, including some from the site of a proposed major bridge. The parameters so determined were used to estimate the characteristics of earthquake motion at the bridge site, as described in a later paragraph. Attempts are being made to correlate static and dynamic properties, so that dynamic characteristics can be inferred from more-simply-obtained static test results. Also, the concept of "equivalent viscous damping" is being critically examined.

"Stress-Controlled Dynamic Tests on Soils"
(Current research project - P.W. Taylor)

While strain-controlled tests give useful information for situations where failure cannot occur, stress-controlled tests are necessary to investigate problems where there is a possibility of failure. The machine which has been developed applies a dynamic load (varying sinusoidally with time) superimposed on a constant (static) load. Thus conditions of stress e.g. beneath a foundation or within an earth dam, may be simulated before, during and after an earthquake. Such methods are being applied to the design of foundations for earthquake-resistant structures and to problems of slope stability in earthquakes. The phenomenon of liquefaction of sands can also be studied.

B. Effects of Site Characteristics on Earthquake Ground Motion

It is well known that the nature and depth of soils overlying bedrock have a significant effect on the surface ground motion in earthquakes. One method of assessing the effect is to perform a computer analysis in which the given bedrock motion is fed into a lumped-mass 'model' whose parameters are

found from dynamic tests. The resulting time-history of motion at the surface is computed, and can then be used for the dynamic analysis of a structure. Acceleration and velocity spectra of the surface motion may be very different from that of bedrock. Such an analysis was recently made for a proposed bridge site in Auckland. Another method of estimating the effect of site characteristics is to measure micro-tremors - a technique widely used in Japan.

"Microtremor Studies" by P.E. Salt.
(M.E. Thesis, 1969 - supervised by P.W. Taylor).

This describes the development of methods of recording microtremors, and analysis of the records. A slow-motion tape-recorder was made to record the output (greatly amplified) from a Willmore seismometer. For analysis, the tape was played back at about 300 times recording speed, to enable audio analysis methods to be applied. A computer program to model site characteristics was also developed.

"Soil Response in Earthquakes and the Application of Microtremor Measurements" (Current Ph.D. study by I.M. Parton, supervised by P.W. Taylor).

There are several aspects to this work. An alternative method of studying microtremors is being developed, using F.M. tape recording, and conversion of the data to digital form for analysis by computer.

The shear modulus and damping properties of soils at very small strain amplitudes are being studied using torsional free-vibration tests of samples in a triaxial cell. Frequencies in the earthquake range are obtained by adding rotational inertia at the free end of the sample.

A computer program to model the response of soil strata to earthquake motion applied at bedrock level has been fully developed. This was applied recently to estimate the surface motion during earthquake at the site of a major bridge to be constructed in Auckland. Dynamic soil properties, measured by Smith, were utilised as input parameters for the model. Results confirmed the importance of soil response on surface motion, high spectral accelerations being found near the natural period of the soils is at much longer periods than assumed in many design spectra found in building codes.

C. Slope Stability during Earthquakes

It is now generally accepted that the effects of earthquakes on slope stability should be assessed in terms of permanent deformations induced, rather than on the computation of a minimum factor of safety based on conventional limiting equilibrium methods of analysis, used in conjunction with pseudo static seismic coefficients (Seed and Martin, 1966). As deformation properties of soils under dynamic loading are a function of both the magnitude and number of stress cycles, such an approach necessitates the consideration of the entire time history of lateral forces acting on the slope or embankment. Research on the development and practical application of deformation methods of analysis are being investigated, the following projects having been initiated:

"Stability of Cohesive Earth Slopes in Earthquakes"
(Current research project - G.R. Martin and P.W. Taylor)

The development and practical application of deformation methods of aseismic design for cohesive earth slopes is currently under investigation. Research is at present based on a "proof test" concept, where soil samples are subjected to simulated earthquake stresses in a dynamic triaxial cell. Dynamic stresses are assessed by a method which takes into account the dynamic response characteristics of the slope. Slopes are considered "safe" provided dynamic tests on samples selected at points around a potential failure surface do not result in permanent sample deformations or induced pore pressures which exceed specified amounts.

> "Stability of Dry Cohesionless Earth Slopes in Earthquakes" (Current M.E. study by J.C. Wallace, supervised by G.R. Martin).

Observations of slides in dry cohesionless soils during earthquakes have indicated that the mechanism of failure is a shallow surface slide. With a well defined failure surface and the well defined yield point characteristics of cohesionless soils, such slopes are particularly amenable to the concept of evaluating seismic stability in terms of the magnitude of slope displacements that occur during an earthquake. This study is aimed at developing improved analytical procedures for such analyses.

ROAD RESEARCH

As New Zealand spends about $100 million annually on roading it seems highly desirable that a university civil engineering department should devote some of its research effort in this direction. Two masters theses have been presented recently and another is approaching completion.

> "Some Investigations into Pavement Design" by G.J. Tuohey (M.E. thesis 1968, supervised by P.W. Taylor).

In the experimental work, kneading compaction was used for the preparation of samples of subgrade soils for tests in the Hveem stabilometer. Results of these tests were used in the California method of pavement design and this was compared with the C.B.R. method as currently applied in New Zealand. Investigation of the seasonal variation of subgrade water content of a test section of road was also made. Suggestions for improvements in current practice were made.

> "Recoverable Deformation in a Flexible Pavement" by R.R. James (M.E. thesis 1970, supervised by B.H. Cato).

To investigate deformation of pavements during the passage of a wheel load three different parameters may be measured: vertical deflection, using the Benkelman beam; the change of slope, using an 'Electrolevel'; and the curvature produced, using some form of curvature meter. The methods were critically examined and applied on the M.O.W. test strip, Southern Motorway. Measurement of slope (seldom made currently) offers several advantages. A computer program was developed to predict deformation in a pavement structure comprising five layers of different elastic modulus. This program was applied to a three layer field situation, using moduli determined in dynamic triaxial tests.

"Lime Stabilization" by N.S. Luxford
(Current M.E. Project - supervised by B.H. Cato).

The use of lime for stabilization of a variety of soil types found in the Auckland area is being investigated. Strength effects are of prime importance, particularly as affected by time and temperature. Accelerated curing at elevated temperature, is under scrutiny. Records are being kept of daily and seasonal changes of temperature at various depths below an asphaltic pavement. Changes of index properties and swelling characteristics are also receiving attention.

"Transient Flow in Saturated or Near Saturated
Granular Media under Dynamic (traffic type) Loading"
(Current Ph.D. study by Do Van Toan, supervised by
G.R. Martin).

This study is aimed at assessing the nature and effects of the build-up and dissipation of excess pore water pressures in saturated or near-saturated granular basecourse materials beneath a sealed road surface, when subjected to traffic loading. The project, which at present is in its planning stages, will initially involve the development of large diameter triaxial testing apparatus suitable for both permeability and dynamic testing of typical granular basecourse materials. It is hoped that as a result of these studies, analytical models will be able to be developed which will permit the quantitative prediction of the effects of traffic loading on saturated or near-saturated basecourse layers.

SLOPE STABILITY

Failures of earth slopes provide major and costly problems for soils engineers. Over the past few years, studies on problems related to slope stability have developed into a major research area. Computer programs for static analysis of slopes have been developed to facilitate research in this field. These programs at the same time provide a valuable asset for soils engineers involved in the design and analysis of earth slopes or embankments. The following projects have been completed or initiated in this field.

"Computer Analysis of Earth Slope Stability"
by T.J. Kayes. (M.E. thesis 1968, supervised
by G.R. Martin).

This study presents a review of slope stability analysis, and describes the development and use of a versatile computer program for stability analyses based on circular arc failure. The program incorporates two of the most widely used methods of analysis, namely the "ϕ=0" method (based on total stress) and the Bishop "simplified" method (based on effective stress). The program can handle slopes of average complexity and has an optional search routine for the rapid location of the critical failure arc. The practical applicability of the program is described with reference to a proposed cutting on the City motorway route. A study of the effects of strength anisotropy and sample disturbance on the "ϕ=0" analysis is also presented.

"Computer Analysis of Earth Dam Stability" by
P.J. McGregory (M.E. Thesis 1970, supervised
by G.R. Martin).

This thesis extends the work of Kayes, with particular emphasis on slope stability problems associated with earth dams or embankments. General problems associated with earth dam stability analysis are initially reviewed. The computer program developed by Kayes was considerably modified and extended to handle complex zoned earth structures, and tailored to handle the critical stability phases of earth dams, namely immediately after construction, steady state seepage and rapid draw down. Analyses are in terms of effective stress, with pore pressures specified by $\bar{B}$ parameters or as specific values on a rectangular grid. The program can handle any embankment where the geometry may be defined by up to 30 straight lines. The practical applicability is described with reference to several examples. A study of the effects of compaction method and failure plane orientation on the strength characteristics of compacted cohesive soils is also presented.

"Progressive Failure in Slopes" (Current M.E. Study by C.P. Corne, supervised by P.W. Taylor).

The phenomenon of progressive failure, found in over-consolidated clays and clay shales has only recently been understood, and satisfactory methods of analysis have yet to be developed. A (6 cm square) shear box is being modified to determine residual shear strengths as well as peak values. It is intended to apply this test to soils in which the phenomenon may occur, and to study the mechanism of progressive failure in detail.

FOUNDATION DESIGN

Foundation design encompasses a broad range of soil mechanics problems. As many of these problems are encountered by soils engineers in routine everyday design, it is desirable that some research effort is devoted to this field. The following projects have been completed or initiated on problems related to foundation design:

"Preloaded Foundations" by T.A. Ooi (M.E. thesis, 1968 - supervised by P.W. Taylor).

Frequently the foundations of such as oil tanks are placed on soft silts and clays and rely for their stability on the increase in strength which occurs during consolidation. In this thesis, the immediate bearing capacity of normally-loaded soils, and the increase in bearing capacity resulting from consolidation are determined by computer analysis, and presented in chart form. Study of the partial failure case, where part only of the loaded area is unstable, provides an explanation for instances of this, which have occured in practice.

"Computer Analysis of Building Foundation Settlement" by C.J.A. Nicholas (M.E. Thesis, 1970 - Supervised by G.R. Martin).

In this thesis, a review of methods of settlement analysis for building foundations is presented initially, attention being confined to settlement resulting from one dimensional or three dimensional consolidation of compressible soils. Following the review, the development and application of a versatile computer program based on one dimensional theory is described. The program can cope with complex site conditions, which may involve irregular

surface profiles, and preconsolidated soil layers having sloping layer interfaces. New loads, existing loads, and negative loads from excavations are assumed applied on rectangular flexible foundations resting on a semi-infinite elastic medium. Such a program provides the soils engineer with a fast and accurate design tool, necessitating the minimum of design assumptions. Finally, a critical review and results of an experimental investigation of three dimensional analyses based on "stress path" methods is presented.

"Analysis of Beams on Elastic Foundations"
(Current M.E. study by G.J. Hadfield - supervised by G.R. Martin).

Most commonly used design methods for computing stresses in flexible foundation beams are based on the theory of subgrade reaction (or Winkler hypothesis), where the soil foundation is assumed to behave as a series of independent elastic springs. This thesis is aimed at critically studying such design methods, together with recently developed improved methods of analysis based on the assumption of a semi-infinite homogeneous elastic soil foundation. This latter approach results in more accurate solutions, and allows the effects of shear interaction to be included. A matrix formulation for the above elastic models has been developed, where the beam is considered as a series of "finite elements", and a computer program based on this approach written. This program is capable of analysing any arbitrarily loaded beam-foundation system based on either the subgrade reaction theory or the improved elastic medium theory. Several parametric studies have been carried out to assess the accuracy of the program, and to study the effects of varying stiffness parameters. The problem of assessing elastic parameters for clay soils suitable for use in the computer analysis is being studied. The results of plate load tests carried out in the field and triaxial compression tests on undisturbed clay samples are being examined for this purpose.

"Analysis of Stress and Deformation in Soil Media"
(Current Ph.D. study by G. Ramsay - supervised by G.R. Martin).

The aim of this study is to extend the scope and use of elastic theory as currently used in soil mechanics, by the development of further more versatile analytical solutions, and the use of numerical techniques to overcome the complex boundary conditions and the non-homogeneity of soils as are commonly found with many practical problems.

An analytical method for analysing loaded strip and rectangular footings on layered elastic media using a fourier series method, has been further developed and extended, and programmed for a computer. In its final form, it is hoped that the program will be able to handle rigid or flexible footings (either separately or as symmetrical arrays), resting on layered elastic media (either isotropic or anisotropic), and loaded with either direct, shear or moment loads. For such systems, the computer solution will provide information regarding stresses and displacements at any point.

A finite element computer program has been written for complex plane strain elasticity problems. The program includes automatic mesh generation and plotting options, and is capable of handling most practical problems

involving either stress or displacement boundary conditions, and non homogeneous soil media. The program is to be used to study the stress redistribution following excavations, and the stress distribution around buried foundations. To assist in this study, it is also planned to develop and make use of laboratory model tests.

PUBLICATIONS ON SOIL MECHANICS BY THE UNIVERSITY OF AUCKLAND

THESES

All theses presented for higher degrees are available for reference in the School of Engineering Library. For persons not in the Auckland area, theses may be borrowed through the library interloan service.

In recent years it has become the practice to publish theses in report form, i.e. a limited number of copies is available for distribution. While these are primarily intended for exchange with other university libraries in New Zealand and overseas, a few copies are available for distribution to persons particularly interested in the subject of the research.

SMS REPORTS

As part of the Soil Mechanics Seminar course, post-graduate research students are required to submit a report on some aspect of soil mechanics. Six such reports were written in 1969, and four this year. Each report, of 50-90 pages, is a comprehensive review of the 'state of the art' of some aspect of applied soil mechanics, and includes an extensive bibliography. In 1969, the emphasis was on construction processes, while this year instrumentation is the theme.

A charge of 25¢ (postage included) is made for copies of SMS reports, listed below. Reports may be obtained by writing to :

The Secretary,
Civil Engineering Department,
The University of Auckland,
Private Bag,
AUCKLAND.

SMS-6901 "Soil Stabilization" by I.M. Parton.

This presents representative data for most soil types, makes particular reference to the use of Portland cement and lime, and includes 36 references.

SMS-6902 "Determination of the Ultimate Bearing Capacity of Piles" by G.J. Hadfield.

Estimation of bearing capacity from laboratory soil tests, Dutch cone penetration records or standard penetration tests, as well as direct determination by loading tests are dealt with.

SMS-6903 "Cofferdams" by R.R. James

Choice of the most suitable type of cofferdam for a particular purpose is first considered, then methods of design and construction, and finally several case histories are included.

SMS-6904 "Underwater Caissons" by R.W.M. Smith.

These 'large substructures, wholly or partially constructed in the dry and sunk into water' are described, starting with their historical development. Types, materials, costs, design and construction methods are covered, together with several interesting case histories.

SMS-6905 "Chemical and Cement Grouting" by P.C. McGregor.

This covers the use of grouting, not only for its usual purpose of providing an underground cut-off, but also to increase strength, decrease permeability, decrease vibration, etc. and lists 21 references.

SMS-6906 "Buried Conduits" by G. Ramsay.

Loading under different installation conditions is described (with design charts) and the supporting strength of various pipes. Methods of horizontal boring and jacking of pipes are also presented.

SMS-7001 "Field Measurement of Earth Pressure" by N.S. Luxford.

Various types of earth pressure cells which have been developed to determine stress, either within a soil mass, or against a structure, are described each with its own advantages and disadvantages. 46 references are included and an appendix on resistance and vibrating wire strain gauges.

SMS-7002 "In Situ Instrumentation for Pavement Structures" by Do Van Toan.

This covers the measurement, beneath road pavements, of moisture content, and of static and dynamic strain. Typical results are presented.

SMS-7003 "Field Measurement of Pore Water Pressure" by J.C. Wallace.

A truly comprehensive review of the topic. Pore pressures can now be reliably measured in the field, results being used mainly for stability analysis, using effective stress methods. This report covers the types of device available, their relative merits and installation difficulties.

SMS-7004 "Field Measurements of Soil Deformation" by C.P. Corne.

This covers, very fully, measurements of surface movements, settlement, heave, horizontal movements and tilting, including data on slope indicators and concludes with selected case histories.

A NOTE ON RUSSIAN SOIL MECHANICS LITERATURE

J.P. Blakeley

Two Russian journals are now translated into English which makes it possible to keep in touch with recent work in soil mechanics carried out in the Soviet Union.

The first journal is entitled "Soil Mechanics and Foundation Engineering" and is published in English by the Consultants Bureau in New York and covers a wide range of topics within this field. The magazine is published six times yearly and each issue contains approximately 80 pages. It is available from the Engineering Library of the University of Canterbury.

The second journal is entitled "Hydrotechnical Construction" and deals more particularly with problems associated with the construction of hydro-electric power stations, but it does include a number of interesting papers within the fields of soil mechanics and rock mechanics. It is published in English by the American Society of Civil Engineers and comes out twelve times yearly, each issue containing approximately 100 pages. It is available from the Ministry of Works Library in Wellington.

As an example of the potential usefulness of much of the information contained in these two journals the following precis is given of part of a paper appearing in "Hydrotechnical Construction" in February 1969 written by G.K. Klein and reviewing a discussion which had taken place on the problem of the determination of the lateral pressure exerted by backfills on retaining structures.

"Results of full scale measurements carried out over many years have established that normal earth pressure diagrams have a form very different from a triangular distribution. The earth pressure was found to increase with depth down to a certain elevation, below which it decreases almost to zero at the base of the wall. In the locks of the Volga plants the resultant earth pressure was three times the calculated active earth pressure and at the Votinsk plant it was 1.9 times as large. The measured pressures turned out to be larger than those corresponding to an "at rest" co-efficient of earth pressure of 0.45. The resultant earth pressure was found to act at a height of 0.36-0.45 of the total height of the backfill.

In addition to a gradual increase of the pressure over many years, the observations established a seasonal decrease in pressure during the winter and short term variations during changes in water level in the lock chambers. It was also found that as the pressure increased the point of application of the resultant rose.

From laboratory tests carried out by Yakovlev and Lubenov the resultant of pressure on a fixed wall is 1.15 to 1.65 times larger than the value calculated according to Coulomb's theory, and as the wall displacement increases the resultant pressure decreases and the pressure diagram takes a parabolic form.

Experiments conducted by Tsagareli on a sand backfill 4 metres high also indicated a curved pressure diagram with lower ordinates close to zero and a resultant acting at 0.42 of the height of the backfill.

Experiments conducted by Fil'voze indicated that if the wall is free to move away from the backfill the lateral earth pressure can be determined with sufficient accuracy by applying Coulomb's theory, but for a wide retaining wall with small displacements a curved pressure diagram was established which had a maximum ordinate near the mid-height of the backfill."

FOR THE SOIL ENGINEER'S BOOKSHELF

SOIL MECHANICS by T.W. Lambe and R.V. Whitman

553 pages. Wiley New York 1969. N.Z. Price $17.30.

This book attempts to use a rather different approach to other introductory textbooks in soil mechanics. Instead of describing the observed properties of soils in considerable detail to begin with, this book almost right from the very beginning emphasises the fundamental concepts of soil behaviour. This cannot be done without introducing advanced concepts and the authors state that they have deliberately introduced far more material than should be included in an introductory textbook on the subject.

The book is divided into five parts. The first two parts are relatively brief and describe the relevance of soil mechanics in civil engineering and the nature of soil. The remaining three parts occupy the bulk of the book and describe soil behaviour and related practical problems. However the division of subject matter is most unusual. The authors rightly identify the presence of water in soil as the single most important factor which influences its behaviour and they divide the three parts accordingly. The first part deals with dry soil, the second with soil containing pore water which is stationary or under steady flow and the third with the situation where pore pressures are influenced by applied loads. The reader thus becomes fully conversant with the influence of water on soil, but from a practical point of view the book lacks continuity as related or very similar topics are dealt with in two or three different parts of the book.

This book sets out to stimulate the keen student of soil mechanics and it cannot be recommended to persons wanting only an elementary understanding of the properties of soils or a design manual. However it can be thoroughly recommended to all engineers or scientists who already have or who wish to acquire a deep interest in soil mechanics.

- J.P.B.

FOUNDATION ANALYSIS AND DESIGN by Joseph E. Bowles

659 pages. McGraw-Hill 1968. N.Z. Price $21.35.

This book is probably one of the most comprehensive ever written to cover the problems commonly met with by the practising soils and foundation engineer. Mr Bowles is an Associate Professor of Civil Engineering at Bradley University and in addition has had quite wide experience in consulting engineering work. It covers in detail both the soil mechanics design and the structural design of foundations and is particularly good on the computation of earth pressures and the design of retaining walls. The book also includes full chapters on soil exploration and sampling, sheet pile structures, pile foundations, pile groups and caissons, and the final chapter gives a brief introduction to soil dynamics. The book also includes a number of references at the end of each chapter and many worked examples. There is also a useful appendix at the back of the book giving

nine different FORTRAN computer programmes for the solution of various soil engineering problems.

This book is highly recommended to all practising soils and foundation engineers.

- J.P.B.

THE DESIGN OF PILED FOUNDATIONS by Thomas Whitaker

188 pages. Pergamon Press 1970. N.Z. Price $5.00

This very recent book attempts to give a concise, simple and yet thorough review of the 'State of the Art' of piled foundations and the author achieves his object well.

At the very low price of $5 it deserves a place on the bookshelf of every engineer who is in any way connected with the design or construction of piled foundations.

- J.P.B.

APPLICATION FOR MEMBERSHIP

of

New Zealand National Society for Soil Mechanics
and Foundation Engineering

A TECHNICAL GROUP OF THE NEW ZEALAND INSTITUTION OF ENGINEERS

THE SECRETARY,
N.Z. INSTITUTION OF ENGINEERS,
P.O. BOX 12241,
WELLINGTON.

I hereby apply for membership of the New Zealand National Society for Soil Mechanics and Foundation Engineering 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 _____

_____

_____

I have enclosed cash/a cheque for one dollar to cover my first annual subscription to the Society.

SIGNATURE OF APPLICANT _____

DATE _____ 19____