N.Z. GEOMECHANICS NEWS

No. 2

JUNE 1971

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

AND FOUNDATION ENGINEERING

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No. 2, June, 1971.

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

C O N T E N T S

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.

EDITOR'S NOTES

1. SEISMIC MICROZONING IN NEW ZEALAND

We are pleased to present in this issue a paper on this subject by one of our members Mr L.E. Oborn who is Chief Engineering Geologist for the D.S.I.R. N.Z. Geological Survey. As such, he has a direct active interest in all aspects of engineering geology in all parts of New Zealand. He is also Vice President for Australasia of The International Association of Engineering Geology and this paper is based on one he presented at the First International Congress of that body in Paris in September 1970.

Civil engineers in New Zealand have not as yet played a very active role in microzoning. In fact most civil engineers would profess to know very little about the subject, even those who are keenly interested in soil mechanics. This is a great pity because these people would have much to contribute, as microzoning must of necessity be very closely associated with the examination of the engineering properties of soil.

Perhaps part of the trouble is that it is difficult for people who might wish to become actively interested in microzoning in New Zealand to see how they can become personally involved, as to date most of the effort put into the microzoning problem has been by members of the D.S.I.R. and one or two other Government departments. University staff and other people outside the Public Service might welcome the setting up of some Committee through which they could make an active contribution to this problem.

One positive step which could be taken is the setting up of a central recording system for information from boreholes which could be of use in microzoning. This would apply particularly to deep boreholes in soft strata. The Foundation Investigation Card Index System set up by this Society is a step in this direction. However, the records are not held centrally, but by local branches of the N.Z.I.E. Also the information itself is not kept in these records but only details of the holder of the information. A much more complete system for recording information would be a great help in microzoning.

We would be very happy to hear from any of our members who have any thoughts on microzoning in general or on Mr Oborn's paper in particular. A letter to the Editor on this subject would be most welcome.

2. RECENT COURT DECISIONS

On the following pages we present a summary of two recent court decisions which directly affect many members of our Society. The first decision could not really be called controversial, except perhaps in the fact that the earthworks contractor concerned was held to be not in any way liable. The case did however highlight the responsibilities assumed by a Consulting Engineer in issuing a certificate that earthworks for a residential subdivision had satisfactorily been carried out, even though he was not paid an additional fee for full supervision of the work. Another feature of this case was that the legal costs were probably several times greater than the damage sustained to the house.

The second decision however has serious implications for all engineers concerned with the design of foundations for buildings and other structures. The case originally received only a small amount of coverage in a Wellington newspaper and it was only after Councillor W.G. Morrison took up the matter with the Wellington City Council that this court decision received the publicity that it warranted. The judge's decision may be correct in law but he noted that it was with some reluctance that he came to the conclusion which he reached. It is obviously at variance with sound engineering and soil mechanics principles and has some most serious implications. This particular law probably dates back to seventeenth century English common law, to days when excavations for the foundations of building very rarely if ever went more than a few feet below ground level.

All people interested in soil mechanics will surely applaud Councillor Morrison for the stand he has taken on this matter and will hope with him that the law can soon be changed so that it is more in keeping with the times in which we live.

3. <u>CONTRIBUTIONS STILL WANTED</u>

The response from members to the request in the first issue for contributions to this newsletter has so far been extremely limited. The success of the newsletter, and especially the variety of opinions expressed, will completely depend on the contributions received from 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.

A list of names, addresses and telephone numbers of National Committee members for 1971 is printed elsewhere in this issue. Please feel free at any time to contact any of these members to discuss a contribution you may wish to make to this newsletter or any other matter connected with soil mechanics in New Zealand.

J.P. Blakeley

TWO RECENT COURT DECISIONS

In recent months two court decisions have been announced which directly affect many members of our Society. A summary of each decision and the background to it is given below.

FIRST CASE

This case involved the progressive settlement of one end only of a single storey brick veneer house. The house had been built on land developed by mass earthworks filling. The Consulting Engineer who designed the subdivision requested the standard additional percentage fee for full supervision of construction work, but his request was declined by the land developer. Consequently, only limited supervision of construction work was carried out.

An investigation bore put down near the affected part of the house revealed that beneath the 6ft thick layer of gravel fill, there was a pocket of peat. It could not be established whether or not this peat had been exposed during the excavation work prior to the placing of the fill.

COURT DECISION

The judge found that settlement was due to consolidation of an underlying layer of unsuitable material which had not been removed. He apportioned 75% of all costs against the Consulting Engineer (who had issued a certificate stating that all unsuitable material had been removed from the site before placing of fill began). The other 25% of costs were apportioned against the land developer because he had not agreed to pay an additional fee to the Consulting Engineer for full supervision. The earthworks contractor was not held to be liable for any costs.

SECOND CASE

This case involved the collapse of a building wall. The building was erected in 1929 and had a brick wall along one boundary. A contractor excavated a trench immediately adjacent to the wall on the neighbouring property and the wall collapsed. The trench was being excavated as part of the construction of a new building. The plaintiff (owner of the collapsed wall) sued the contractor for the damage caused to his wall.

COURT DECISION

The judge found that the evidence established that the soil underlying the brick wall was of a poor type and he thought that it was clear that, but for the presence of the wall, there was no reason for the plaintiff's land to subside. This meant that it was not the excavation of the trench alongside which caused the plaintiff's land to collapse, but the presence of the wall on the soil. The judge therefore ruled that the collapse was due to the weight of the wall and the plaintiff lost his case.

(based on a report in the "Evening Post" of 15 March 1971.

SUBSEQUENT DEVELOPMENTS

In the Evening Post of 25 March 1971 publicity was given to a memo to all members of the Wellington City Council from Councillor W.G. Morrison, chairman of the Town Planning Committee (and also a civil engineer). Part of the memo (as quoted by the Evening Post) is as follows -

The judgment was a reserved judgment which means that the judge took time to study the case carefully and no doubt he looked up what legal precedents were available. The judge stated:

"It is with some reluctance that I come to the conclusion which I have reached. It seems to me on the evidence that it would have been a simple matter for the defendant to have carried out his work of excavation in accordance with normal practice instead of proceeding with a total disregard for the brick wall. Even elementary precautions should have preserved the stability of the wall.

I am compelled, however, to hold that as the defendant was acting as the agent of the adjoining owner, and as the evidence showed that it was the weight of the wall which caused the collapse, rather than the weight of the land itself, no duty was owed by the defendant to the plaintiff either of lateral support or in negligence."

Councillor Morrison went on to say that if this is the law then it should be clarified and a statute passed which will give the owner of a building adequate protection against what his neighbour may do. He said that the law should require the man next door not to remove lateral support to the adjacent land or any building which may be standing thereon. If he does remove it in the course of his own excavations he should be required to take adequate measures to secure the safety and stability of his neighbour's land and building.

The absurdity of the present law as it seems to be is that if there is no building and the lateral support is removed so that the land subsides, the aggrieved party is entitled to damages which might amount to $100. If he has on the land a substantial building he might suffer damages to the extent of $100,000 and have no redress provided it could be proved that the land would not have subsided had the building not been there. This could be the case in nine times out of ten, and even to prove it would be a complex exercise in soil mechanics in which experts might give differing opinions.

Councillor Morrison stated that it is quite normal practice for the building contract to include provision for the safeguarding of or underpinning adjacent buildings. This would enable the owner to shift the responsibility to the contractor if he was negligent or failed to observe the requirements of the building contract. However if the owner himself is under no legal obligation, he is not obliged to include such provisions in the building contract.

Councillor Morrison then asked how, with the law as it seems to be, can a building owner protect his building? He could safeguard his building by carrying the foundations deep, but how deep? 10ft, 20ft, 40ft or what? Suppose his neighbour sets out to build an underground parking building requiring an excavation of 50ft. He could set his building back from the boundary, but again how far?

Councillor Morrison concluded by pleading for a prompt amendment to the law leaving possible anomalies to be cleared up as they arise, rather than spending months or years trying to work out the perfect wording.

At the National Committee meeting of our Society held on 31 March the following motion was passed -

> "That an appropriately worded letter be sent to the N.Z.I.E. expressing extreme concern at the implications consequent on the decision in this second case and urging that this be pursued at the highest level".

More recently, an editorial has appeared in April in the Evening Post supporting the stand taken by Councillor Morrison and stating that his viewpoint had also found support from the N.Z.I.E. and the N.Z. Institute of Architects. Councillor Morrison had reported to the Wellington City Council that "These professional bodies agree that an urgent revision of the law is required to clarify the position and they would no doubt be pleased to give advice as to the framing of legislation to this effect".

The editorial also stated that the Wellington City Council now has before it a finance committee recommendation that the Council seeks from Government changes or clarification in the law to give property owners protection for their land and buildings against damage caused by excavations or building operations on an adjoining site.

NEWS FROM THE TECHNICAL SECRETARY

1. FIRST AUSTRALIA-NEW ZEALAND GEOMECHANICS CONFERENCE

The dates of this Conference are 9-13 August 1971 and the venue is the Camberwell Civic Centre, Melbourne. Bulletin One containing a provisional registration form, an accommodation request and a travel request is available from the Technical Secretary.

2. THE FORMATION OF A GEOMECHANICS SOCIETY IN NEW ZEALAND

Early replies were received from the postal ballot on changing the name and scope of the Society held at the end of last year. All 40 approved of the change in scope and 38 approved of the change in name. The matter was further discussed at the A.G.M. of the Society held in Auckland in February and a motion approving of these changes and authorising the National Committee to proceed with detailed negotiations was carried unanimously. A sub-committee of the National Committee is now working on this and it is hoped to have all arrangements and negotiations completed this year.

3. FOURTH ASIAN REGIONAL CONFERENCE ON S.M. AND F.E.

This will be held in Bangkok, Thailand, from 26 July - 1 August 1971. Further details are available from the Technical Secretary.

4. THIRD SOUTH-EAST ASIAN REGIONAL CONFERENCE ON S.M. AND F.E.

This will be held in Hong Kong in November 1972. Original papers are invited on the general topics of soil mechanics theory, testing and site investigations, foundations, earth dams and slope stability, roads and runways. Those interested should write to:

The Secretary,
Third South-East Asian Soil Conference
Organising Committee,
P.O. Box 13987,
Hong Kong.

5. PROCEEDINGS OF SITE INVESTIGATION SYMPOSIUM, AUGUST 1969

Some copies are still available at $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 reprints of the papers available to members free of charge on request to the Technical Secretary.

6. COPIES OF REPRINTS OF THE FIFTH AUSTRALIA-N.Z. CONFERENCE 1967

Although all stocks of the proceedings of this Conference held in N.Z. have now been sold, Mr P.W. Taylor has a number of copies of the reprints 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.

7. N.Z. NATIONAL ROADING SYMPOSIUM 1971

The National Roads Board is sponsoring this symposium to be held from 17-19 August in Wellington. Further details are given elsewhere in this issue.

8. MEMBERSHIP ENROLMENT FORM

A membership enrolment 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.

9. NEW MEMBERS

Recently the following new members have been admitted to the Society:

R.L. Bayly :5 Strassburg Street, Martinborough
L.A. Clemencs: 63 Drake Street, Howick, Auckland
D.J. Convery: P.O. Box 30325, Lower Hutt
G.J. Hadfield: Flat 1, 10 Panorama Place, Auckland
N.D. Hardie: P.O. Box 13045, Christchurch
Dr J.G. Hawley: D.S.I.R. Soil Bureau, Private Bag, Lower Hutt
W.D. Hopkins: 13 Gladson Avenue, Christchurch 4
D.H. Inch: Ministry of Works, Private Bag, Invercargill
S.T. Kingswell: 359 Riverton Drive, Shelley, Western Australia 6155
E.B. Lapish: 84 Stamford Park Road, Auckland
B.L. Laws: 2 New Street, Dunedin
S.A. Petrie: 46 Napier Street, Dunedin
G. Ramsay: 31 Coles Crescent, Papakura, Auckland
R.B. Smith: 22 Shanaway Rise, Birkenhead, Auckland
D.V. Toon: 17 Park Avenue, Grafton, Auckland
A.E. Tyndall: 6 Victoria Street, Christchurch
R.J. Watt: 2 Russell Avenue, Pukekohe
B.J. Wood: 158 Hereford Street, Christchurch

10. NATIONAL COMMITTEE

Listed below are the members of the 1971 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 Laboratores,
P.O. Box 30325, Lower Hutt,
Telephone: 697-086

J.P. Blakeley,
Beca, Carter, Hollings & Ferner,
P.O. Box 6345, Auckland.
Telephone: 362-007

R.O. Bullen,
Roading Division,
Ministry of Works,
P.O. Box 12041, Wellington.
Telephone: 46-080

G.L. Evans,
Civil Engineering Dept.,
University of Canterbury,
Private Bag, Christchurch.
Telephone: 71-649

K.H. Gillespie,
Brickell, Moss, Rankine & Hill,
19 Pretoria Street, Lower Hutt.
Telephone: 63-741

Dr R.D. Northey,
D.S.I.R. Soil Bureau
Eastern Hutt Road, Taita.
Telephone: 673-119

M.J. Pender, (Technical Secretary)
M.O.W. Central Laboratories,
P.O. Box 30325, Lower Hutt.
Telephone: 697-086

P.W. Taylor
Civil Engineering Dept.,
University of Auckland,
Private Bag, Auckland.
Telephone: 74-740

M.J. Pender
<u>TECHNICAL SECRETARY</u>.

<u>STOP PRESS</u>

1. The following meeting of the Royal Society will be of interest to Wellington members. Professor Martin Stout (Chairman Geology Dept. California State College) will speak on:

"How Firm is Terra Firma?"

This will be an illustrated discussion of slope stability and landslide problems in New Zealand with some analogies to the growing potential for failures in newer residential areas, particularly in the greater Wellington area.

The meeting is at 7.30 p.m. Thursday 8th July in the Royal Society Rooms, Dominion Museum, Buckle Street.

2. There have been some slight changes to the programme for the Roading Symposium. The sessions now run from 9.00 a.m. Tuesday 17th August to Thursday evening. There is no session on Friday morning as indicated on p. 11.

MEASUREMENT OF IN-SITU SOIL DENSITY

(No. 1 of a Series)

J.H.H. Galloway

This series of short articles gives one engineer's thoughts on field denisty tests. Only methods based on digging a test hole and measuring its volume are discussed in detail. Other methods exist but their detail treatment is beyond the scope of this series.

A general familiarity with the actual test procedures is assumed.

1. CLOVER SEED

The measurement of the in-situ density of a soil is often done by carefully digging a hole in the material, weighing the total amount of soil removed and measuring the volume of the hole. Moisture content determinations and simple arithmetic then give the dry unit weight of the material that filled the hole. The principle is simple but the execution is rather difficult and many ways of measuring the volume of the hole have been tried. One of the simplest and most enduring of these is to fill the hole with a standard sand of known unit weight and to weigh the sand used.

The standard sand, to be useable, must have a highly predictable unit weight when poured in a standard manner into a standard container (and the test hole). Preferably it should give the same unit weight when either the pouring method, or the container shape, or its surface texture or any of them is "non standard". This condition means that the individual grains must be of uniform size, spherical shape, small in relation to the size of the container, but not small enough to be much influenced by surface dampness of the test hole. Wind blown dune sands can be suitable but normally these are too fine and more suitable material has to be produced by selective sieving. This can be an expensive process as over two thirds of the natural sand may have to be rejected.

A New Zealand development has been the use of Suckling clover seed as a density sand. The individual seeds are of a uniform, suitable size, essentially spherical and with smooth, slightly oily seed coats. Experimental calibration of this seed has demonstrated a remarkably uniform unit wieght when poured into a standard container by a wide range of methods, insensitivity to high humidity over a period of a few days and a great ability to penetrate superficial cavities in a test hole. The last mentioned property can be a disadvantage where porous patches exist in a fill as substantial quantities of the seed will penetrate well beyond the bounds of the test hole. The unit weight of this seed is quite low (50 lbs per cu.ft.) and is permanently reduced about 6% on oven drying. This low unit weight is both an advantage and a disadvantage. It reduces the cost per unit volume of the seed (it is sold by weight) and it means that reclaimed seed can be cleaned of contamination readily by jigging and seed dressing techniques. On the other hand the low unit weight makes the effect of contamination by soil grains more marked. The individual seeds are very resistant to normal handling and few break up in use. On the whole the seed performs excellently as a density sand. Of course it is not a panacea. It's cost can vary from moderate to high (this depends on the vagaries of the season), but it is certainly of sufficient inherent merit to be seriously considered.

A point of interest is that some years ago I discovered that a similar line of reasoning that led to the choice of wheat as a density sand by the Prairie Farms Rehabilitation Administration of Saskatchewan. They were very satisfied with its performance and with its convenience. It was so readily obtainable that they rarely bothered to carry supplies with them into the field, they merely had to purchase a bushel or two from the nearest farm! Thus it appears that, in principle, seeds can be an acceptable density sand and that in emergency lentils, blue peas, haricot beans or any similar hard smooth seed obtainable from grocer or seed merchant could be used.

N.Z. ROADING SUMPOSIUM 1971

R.O. Bullen

A Roading Symposium will be held in Wellington from mid-morning Tuesday 17 August till late morning Friday 20 August 1971, at the University Union Building, University of Wellington. Of similar style to the successful 1967 symposium, the principal differences are slightly greater content (due to the large number of quality papers offered) and the inclusion of an evening "feature session" at which an Australian State Roading Commissioner will discuss "Putting Research into Practice".

The declared them of the symposium is "Application of Theory to Practice". Prime emphasis is being placed on discussions and papers will be grouped into 18 subject areas, each to be dealt with in a 1½ hour session. To ensure maximum benefit, time allowed for author introductions will be strictly limited, and at least two-thirds of each session allocated to discussion.

The subject areas are as follows:

1. What Should be Researched
2. Pavement Design
3. Earthworks and Testing
4. Aggregates Behaviour and Practice
5. Construction and Uniformity
6. Surfacings
7. Urban Planning and Transport
8. Transportation Planning Techniques
9. Parking
10. Traffic Signals
11. Traffic Accidents and Prevention
12. Computer Techniques
13. County Bridging
14. Bridge Research
15. Controversy Session
16. Economic Appraisal of Highway Projects
17. Heavy Load Movement
18. Maintenance

Papers offered in the areas which will be of direct interest to members are as follows:

Earthworks and Testing

(a) Slopes in rock and soft rocks by R.O. Bullen.
(b) Control of compaction by nuclear methods by D.J. Ferguson
(c) Testing and earthworks by G.A. Pickens et al.
(d) Testing of materials by K. Gillespie.

Aggregates Behaviour and Practice

(a) Basecourse saturation and stability by G.R. Martin et al.
(b) Moisture Movement due to temperature by Raudkivi et al.
(c) Granular base layers and what do we know by Bullen & Major.
(d) Stability of unbound basecourse by F. Bartley.
(e) Cement stabilised pavements by J. Ralston.
(f) Economics of aggregate processing by J. Carline.
(g) Economics of quarry operation by B. Bartley.

Construction and Uniformity

(a) Supervision and quality of aggregates and asphaltic concrete construction by I.W. Balch.
(b) Cost of attaining uniformity by J. Briggs.
(c) Achieving uniformity in county pavement construction by P. Shapcott.

Bridge Research

(a) Dynamic properties, laterally loaded piles by R. Shepherd.

SEISMIC MICROZONING IN NEW ZEALAND

L.E. Oborn

ABSTRACT

Seismic microzoning indicates areas where ground accelerations and felt intensities produced by earthquakes differ as a result of local topography and geology, and where variation of ground damage might be expected. A microzoning study in Wellington appraises reports of damage from previous earthquakes, geological surface and subsurface mapping, test drilling, geophysical exploration, and instrumentation. Strong motion accelerographs should provide data, but earthquakes of MM5, which are required to trigger these instruments, are infrequent. Interpretation is largely intuitive, based on a knowledge of surface and subsurface geology, ground-water, and expected behaviour of dynamically loaded soils.

INTRODUCTION

New Zealand is seismically active, lying within one of the belts of late Tertiary and Quaternary deformation. In a typical 10 yearly period there are about 1000 earthquakes with magnitudes between 4 and 4.9, 100-200 between 5 and 5.9, about 20 between 6 and 6.9 and 1 of 7 or more (pers. comm. G.A. Eiby).

The periodic damage that results from these events compel engineers and designers to adopt a realistic approach to the design of earthquake resistant structures. In an attempt to rationalise seismic design parameters and enable appropriate seismic coefficients to be applied in various parts of New Zealand, the country was seismically zoned.

Zoning which aimed at differentiating the relative frequency of destruction or damage, was based on damage from historic earthquakes, the distribution of epicentres, a probability study relating earthquake frequency and magnitude in a given locality (Dick. 1966), and Quaternary tectonics (Clark et al. 1965). The validity of using Quarternary tectonics is based on the assumption that destructive earthquakes would have been more frequent where tectonic activity was most frequent. The three zones finally adopted (after recourse to scientific reports but without the agreement of any scientist) have seismic coefficients appropriate to intensities MM9, 8½, and 8 (MP 12: 1965, NZSS 1900 Chapt.8: 1965).

It was known that the effect of an earthquake on the underlying soil and rock could realistically require that small areas within each zone be reclassified to either a higher or a lower risk zone. The intensity values assigned were considered to apply to a broad range of "intermediate soils".

In 1968 the Department of Scientific and Industrial Research began a systematic study for seismic microzoning in New Zealand. The aim is to assess the effects that local topography, surface and subsurface geology and hydrogeology have in modifying ground accelerations and felt intensities. It is expected that the results of this work will be of especial value to regional, town, and country planning, but should also be of value to engineers and designers planning a detailed site investigation.

APPROACHES TO MICROZONING

The response of the ground surface to earthquakes is very complex, depending upon the earthquake itself (magnitude, position, depth, spectral composition) and the geological features (rock and soil types and physical properties, groundwater, subsurface topography). The position of the focus of an earthquake relative to the area to be mapped is significant as this has a bearing on the spectral composition of the earthquake waves that arrive at the surface. Spectral composition in turn, largely determines the way that rocks and soils behave when excited by earthquake waves.

The body of published literature on microzoning is small as most countries are still in the research and development stage. Japan, Russia, France, United States of America and Canada have worked on microzoning, and most of these have produced microzoning maps. Judged by the literature, the Russian approach is to select an "average soil condition" and either instrumentally, empirically or intuitively derive the effect that different geological parameters (soil, engineering geology, hydrogeology) would have on intensities of ground disturbance. The steps that lead up to this are largely empirical, based, to some extent no doubt, on experiences gained from previous earthquakes. The Japanese, while using an intuitive geological approach, have at the same time tended to stress research on microseisms.

Seismic microzoning, which as the name implies is zoning of small areas within regions, even if these are small urban regions, should not be confused with the determining of design parameters, as for example, the dynamic properties of soil, shear wave velocities and shear moduli, and the interaction of buildings with their foundations during earthquakes. Microzoning will assist with town and country planning, but is no substitute for detailed site investigations.

There are three principal ways of approaching microzoning in New Zealand and in other countries where the record of earthquakes and their effects on the landscape is short. The intuitive one, where someone, possibly a geologist, looks at the rocks and soils, considers what is known about groundwater, reflects on his knowledge of subsurface topography and the geological history of the region, and makes a subjective assessment about orders of risk. He assigns a relative order of risk, probably a "1,2,3" type of classification. The second approach is to install a wide variety, and ideally a large number of instruments, especially strong motion accelerographs, and wait for an earthquake. The third approach is to study microseisms and small earthquakes.

The intuitive approach is certainly quicker and cheaper, but it must leave many doubts until it is in each case proven correct - or incorrect! An instrumental approach, possibly backed by limited field testing, must be the ultimate aim if numbers are to be proposed with any degree of confidence. With additional work, confidence in microseism methods might be enhanced. At the present time it is difficult to apply the results of microseism surveys to microzoning directly.

Whatever the approach adopted, microzoning cannot be accurate for all earthquakes, as these will have different foci and magnitude. The instrumental approach is the one most likely to produce biassed results until a representative number of earthquakes have been recorded.

MICROZONING PRACTICES

Regions to be included in the initial studies were selected on three criteria, their capital value, seismic risk, and research content. Wellington city was an obvious first choice. Other cities have been selected for future studies.

The topics relevant to microzoning that are being studied by various Divisions of the Department of Scientific and Industrial Research include:-

1. Topography.
2. Geological and geophysical exploration.
3. Earthquake damage.
4. Microseisms.
5. Seismology, including strong motion studies.
6. Soils.

1. Topography

Earthquake-engendered ground damage can occur on flat, rolling or steeply dissected landscape, but is more usual on steeper terrain. Topography is of especial importance in those areas where steep relief and weak rocks and soils present conditions of inherent instability. Stability of hill slopes is endangered during an earthquake by an effective steepening of slopes resulting from applied horizontal and vertical accelerations, as well as by adverse soil behaviour during dynamic loading (e.g. liquefaction) and by joint surfaces. Spurs and ridges suitably oriented in relation to the incidence of earthquake waves concentrate energy and precipitate failure.

Landscape relief is studied semi-quantitatively from contoured topographic maps.

2. Geological and Geophysical Exploration

Conventional surface and subsurface geological mapping is supplemented in geologically complex regions by other site investigation techniques (including test drilling, geophysical exploration).

The bulk of the surface data for the Wellington City investigation came from outcrops and excavations for building foundations. Exploratory test drill holes for foundations provided valuable subsurface information. The data yielded from these sources were inadequate to give a good indication of subsurface geology in this geologically complex region. Seven exploratory holes were drilled to provide additional stratigraphic data. A gravity survey was made to assist with subsurface interpretation.

With a knowledge of the geological structure, subsurface topography, groundwater, and an intuitive assessment of the physical and dynamic properties of the rocks and soils, microzoners have been able to prepare a tentative, simple, intuitively-based zoning map.

3. Earthquake Damage

Damage from past earthquakes reflects the behaviour of rocks, soils, and buried topography. Data from the damage surveys must, however, be interpreted with caution as damage reflects not only the geology of a site, but also the age, condition, design and construction of buildings built on it, and the magnitude of the earthquake and the position of its focus. Searching poorly-documented, doubtfully-reliable records is time consuming and largely unrewarding. Difficulties arise when attempting to compare damage in areas where the buildings are of a different standard. Where documentation allows it, it is preferable to compare damage to one type of fitting or structural feature.

Reports were studied of damage caused in Wellington by earthquakes in 1942 (Wairarapa earthquake, magnitude 7, 60-70 miles away), 1966 (Seddon earthquake, magnitude 6, 40-50 miles away), 1968 (Wellington earthquake, magnitude 5, 20 miles away). Data for the earlier events were from records compiled for insurance purposes, and were too sketchy to be of real value. Results for the latest earthquake gave a confused pattern, in part perhaps because of complex subsurface geology. It proved difficult to decide whether the extra damage in some of the older buildings was due to their age, design and construction, or whether it was due to real microzoning effects.

Accurate reporting and careful documentation in the future will enable microzoners to benefit from the potential worth of this technique.

4. Microseisms

Microseisms, low energy earth tremors that are generated by meteoric storms, surf pounding on coasts, and traffic and other industrial vibrations can be detected and recorded instrumentally. Microseisms have been recorded in the Wellington City area when traffic flow was at a minimum, and their amplitudes compared. Values obtained, which range from 0 to greater than 100 on an arbitrary scale, when plotted, resembled those from the gravity survey. It is tempting but too early to draw sweeping conclusions from this comparison.

The worth of microseisms to microzoning has yet to be convincingly demonstrated. It is thought that they indicate the response of the soils and rocks through which they pass, to wave excitation. The non-linearity of the stress-strain properties of soils raises doubts about the validity of scaling the effects of microseisms and comparing these with earthquakes. Future work on the spectral analyses of microseisms and earthquakes might prove a useful, positive correlation between them.

5. Seismology, including Strong Motion Studies

Accelerations produced at the surface by an earthquake can be measured directly by a strong motion accelerograph. The instrument (M02) used widely in New Zealand is set to trigger at about MM5 (an acceleration of ca 0.1g). Triggering can occur at lower intensities if the earthquake wave has a high component of frequencies at about 6 cycles per second.

Nine strong motion accelerographs have been installed in Wellington. Every effort has been made to ensure that these are sited near test drill holes or where rock and soil types and sub-surface topography is known. One is installed on bedrock. No earthquake of sufficient severity has occurred to trigger these instruments since they were installed.

Earthquakes sufficiently severe to trigger these instruments are infrequent in most parts of New Zealand. In Wellington, for example, events producing this intensity occur only once in about 8 years. In Auckland the frequency would be very much less than this.

As essential instrument in a microzoning programme is the seismograph which provides seismological data and evaluates the seismicity of regions. Seismographs installed in the Seismological Observatory in Wellington are considered an integral part of the microzoning instrumentation.

6. Soils

The physical properties and thickness of soils have a major effect on the propagation of earthquake waves through them (causing attenuation, amplification, resonance, and interference). The dynamic loading of the soils resulting from this propagation, has in turn, a major effect on their physical properties (causing liquefaction, plastic yielding, and compaction).

Many of the factors that determine the behaviour of soils under earthquake loading, for example shear velocity and shear modulus, can be evaluated in the laboratory, although even here problems can arise over sample rigidity and altered stress distribution patterns. They can be evaluated with more difficulty in the field on a research or detailed site investigation scale, but they cannot feasibly, as yet, be evaluated on the scale required for regional microzoning surveys.

Although no detailed studies on the dynamic properties of soils have as yet been undertaken in Wellington, an intuitive assessment of the likely order of some of these parameters is proving valuable in the assigning of orders of seismic risk.

No one of the above six topics can by itself provide the basis for a microzoning map. Each topic must be considered an essential part of the microzoning programme.

FUTURE OF MICROZONING IN NEW ZEALAND

Methods of approach and techniques have yet to be developed and improved, and thus there remains a large research content in microzoning.

Microzoning in New Zealand must continue to remain entirely separate from detailed engineering site investigation until microzoning parameters can be evaluated. Microzoners will aim to refine the basic data upon which the intuitively-based microzoning is now founded. Present day investigation techniques will be refined and advanced. Three fields in which notable advances may be made, are the recording and interpretation of low-intensity earthquakes, the better understanding of the value of microseisms in relation to earthquakes, and the spectral composition of earthquakes and microseisms.

In time, technology and instruments will improve, and accumulated data from detailed site investigations will grow. Highly sophisticated microzoning maps may follow the completion of detailed site investigations in those regions where the parameters determined include design parameters.

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M.O.W. CENTRAL LABORATORY REPORTS

Soil testing and subsequent reporting by Central Laboratories, Ministry of Works, began in 1957. The majority of the Reports are concerned with the routine testing and site investigation for power projects and motorway projects. However, in addition other Reports on soils and soil structures, somewhat beyond the range of routine investigation, have been compiled and a list of these is presented below.

Report No.	Date Issued	Title
40	Oct. 1958	"Specific Gravity of a Volcanic Soil"
52	May 1969	"Notes on the Design and Operation of a 'Washington Densometer' type Volume Measuring Device for Soils"
68	Mar. 1960	"Interim Report on Triaxial Testing Apparatus and Methods" (Details on testing 4" diam. and 9" diam. cylindrical specimens)
74	May 1960	"Some Notes on the Use of the Atterberg Limits to Control the Quality of Roading Materials"
77	June 1960	"Field Permeability Testing with Particular reference to the 'Standpipe' or 'Drum' Apparatus"
85	Nov. 1960	"Liquid and Plastic Limit Investigations"
96	Jan. 1961	"Tests on Hydrostatic Settlement Apparatus"
113	Aug. 1961	"A Study of the Performance of the 6" Densometer for Determining Density of Compacted Material"
147	May 1962	"The Effect of Drying on Atterberg Limits Especially as Applied to Roading Materials"
159	Jan. 1962	"Taihape Pressure Cell Investigation"
225	Jan. 1966	"Te Henui Deviation : Investigation of Embankment Stability"
260	Jan. 1967	"Waipara Drain Slope Stability Investigation" (Results of laboratory tests and stability analysis)

Report No.	Date Issued	Title
281	July 1967	"Rubber Membrane Model of the Matahina Earth Dam" (This test was carried out to ascertain likely strain patterns and tension areas in the dam).
322	Aug. 1969	"Calibration of Troxler Nuclear Gauge" (Used for the measurement of moisture content and density in-situ).
376	Dec. 1970	"Ground Vibration during Pile Driving at Hamilton Police Station."

All of the above Reports are available from the Ministry of Works Library, Head Office, on Interloan. The Interloan Service is available at any Public or University Library in New Zealand.

SOME ASPECTS OF MY OVERSEAS LEAVE

T.A.H. Dodd

I spent the 1970 calendar year at the University of Manchester in the Department of Engineering in the Faculty of Science. I had a part-time teaching post there, and though my teaching duties were relatively light, I found them very stimulating. The Engineering Department has a lively soil mechanics section, headed by Professor P.W. Rowe, and I was able to benefit considerably from both giving and receiving lectures in soil mechanics, and from the many discussion sessions I had with members of staff. Manchester students have the reputation of being rather proletarian, and it was quite a relief to me to find them to be as studious and industrious as those here; I had a good hearing from those to whom I lectured.

The University of Manchester is a big one, with a large number of faculties. This is reflected in the fact that in Graduation Week in July 1970 there were ten graduation ceremonies, extending over four days. In the Faculty of Science, a total of 158 students graduated with a first degree in Engineering; this is just below the annual output from each of our Schools of Engineering in New Zealand. However, the Faculty of Technology also graduated an approximately equal number of engineers at a similar ceremony later in the week.

It is something of an anomaly that one can obtain a University of Manchester BSc (Eng) degree in most branches of Engineering in either the Faculty of Science or the Faculty of Technology. These two faculties are housed in separate complexes of buildings only a mile apart, but the students of one have no academic contact with the students or staff of the other up to graduate level.

Basically the course-work in England and New Zealand is similar; one of the major points of difference is that in England the course takes three years (in Scotland, four), the equivalent of our three professional years in this country. Students must have certain minimum attainments in the A-levels examination (the equivalent of our University Scholarship examination) to qualify for entry, and a high standard of mathematical ability is demanded of all entrants. My impression is that the students are taught less than is customary here, but have to rely more on their own reading to broaden their knowledge of a particular topic.

Early in the year there was unrest among the students of the University of Manchester, over the allegation that the University held files on the political activities of certain students and staff. The situation was fanned into flame by the action of the then Vice-Chancellor in obtaining a Court injunction to prevent the president, secretary, and treasurer of the Socialist Club from speaking at a meeting of the Students' Association. The students resolved to stage a sit-in in the administration buildings, and this occupation continued for two weeks, with several hundred students bedding down nightly in corridors and in the Great Hall. The University authorities very kindly left the heating on overnight and through the weekends, and the students for their part were well-disciplined and tidy. An attempt was made also to boycott lectures at this time, but this failed to get the required 2/3 majority vote. It was interesting to see that most of the agitation arose amongst the liberal arts students - the engineering students seemed to have little to do with it.

I was interested so see that the SI metric system is in full use throughout all years of the engineering course. In the laboratories, all equipment is now sized in millimetres, dead-weights have been replaced by kilogramme weights, and pressure gauges have been re-calibrated in SI units. However, inch-reading dial gauges are still in use, and are likely to remain so until they wear out, because the cost of their conversion to metric units is close to the cost of new gauges.

An important addition to the laboratory equipment at the University of Manchester is a centrifuge, which was due to be completed in March of this year. It has an effective arm radius of 3 metres, with a capacity for spinning a model, of up to 2.5m by 1m by 0.6m and with a mass (including container) of up to 3.5 tonnes at up to 250 r.p.m., giving a maximum acceleration of 200 g. The centrifuge can be used for studies of stability of natural or artificial slopes, and where time factors are involved, as in consolidation, these are speeded up in the model. If the model is built to a natural scale of 1/N, then at an acceleration of N gravities, it will behave exactly as the prototype, except that in the model the time scale will be $1/N^2$ of the prototype time.

I attended two meetings of the British Geotechnical Society at the I.C.E. rooms in London - the Rankine Lecture by the late Professor K.H. Roscoe in February, and a lecture by Professor A. Casagrande in November. These were both very well attended, and there was an overflow audience in the adjacent hall for the Rankine lecture. I also attended a meeting of the I.C.E. in London in November, at which J.P. Hollings spoke on the Inangahua Earthquake. It was pleasing at all three of these meetings to meet fellow New Zealanders in the audience, many of them former students of mine.

After the summer vacation I began a series of visits to other Universities and research institutions. I spent a most interesting week at the Norwegian Geotechnical Institute in Oslo, studying the problems of sampling and testing their quick clays; I visited Imperial College, and the Universities of Glasgow, Strath Clyde, Nottingham, and Cambridge, and the Road Research Unit and the Building Research Station. The commercial soil testing laboratories of Cementation Ltd were also of considerable interest. All these institutions gave generously of their time and knowledge, and I had many interested inquiries about conditions in New Zealand from their members.

I returned home via the United States, stopping off at Boston, where I was able to visit Harvard University (the soil mechanics section there is now disbanded since the retirement of Professor A. Casagrande) and M.I.T., and also a private soil testing laboratory run by a partnership of four

Harvard PhD's. While there, I attended a dinner of the Boston Society of Civil Engineers, which was followed by an evening of papers on aspects of refuse disposal by controlled tipping. I stopped off again at San Francisco, and spent a day at Berkeley seeing the soil mechanics research there. As at Harvard and M.I.T., I was freely shown everything of interest to me, and their interest in New Zealand was as great as had been evident in the United Kingdom.

A FURTHER NOTE ON THE FOUNDATION INVESTIGATION CARD INDEX SYSTEM

This note is to provide further information to that given on page 8 of N.Z. Geomechanics News No. 1. The N.Z. Institution of Engineers (P.O. Box 12241, Wellington) now has a supply of 2,000 cards. These are available to any organisation or individual who requires them at 4½ cents each. Most branches of the N.Z.I.E. now have the Foundation investigation card index in operation. The location of the completed cards in various centres is as follows:

AUCKLAND:	The Auckland branch of the N.Z.I.E. has been running a card index of investigations for some years and now have several hundred cards completed. It is located at - Geology Department, University of Auckland.
DUNEDIN:	Dunedin City Council (Mr G.G. Dunn)
GISBORNE:	City Engineer's Office
GREYMOUTH:	Ministry of Works, Greymouth
INVERCARGILL:	Invercargill City Corporation
PALMERSTON NORTH:	Palmerston North City Council (Building Inspectors Section)
WANGANUI:	City Engineer's Office
WHANGAREI:	Whangarei City Corporation (Building Inspector's Office)

FOR THE SOIL ENGINEER'S BOOKSHELF

THE DESIGN OF FOUNDATIONS FOR BUILDINGS

by Sidney M. Johnson and Thomas C. Kavanagh

393 pages. McGraw-Hill 1968. N.Z. Price $20.15.

This book restricts its subject matter entirely to building foundations. It does not discuss lateral earth pressures and retaining walls or any other matter related to foundation engineering work but confines itself almost entirely to allowable loads on shallow foundations and on piles.

After a brief introduction the first 50 pages are devoted to a chapter discussing site investigation techniques. This is followed by two shorter chapters, one discussing the minimum depth of foundation and the other discussing the various types of loading the foundations may be subjected to. It is noticeable that earthquake forces are discussed only very briefly but in New York where the authors' work this is probably understandable.

The next chapter is almost 100 pages long and discusses the allowable soil pressure on shallow foundations and on drilled piers. This is followed by three chapters totalling 150 pages on pile foundations. The first is a general discussion on allowable pile loads and this is followed by a chapter on the measurement of pile capacity by penetration resistance. The third chapter discusses various design considerations for pile foundations.

The book is completed by two short chapters, one describing procedures for various types of load test for both shallow and deep foundations and the other describing various miscellaneous matters including strengthening existing foundations.

The book is well set out and easy to read. Although soil mechanics theory is used where necessary the book is principally based on the large amount of practical experience in designing building foundations which had obviously been gained by the authors as consulting engineers in New York.

\- J.P.B.

THEORY AND PRACTICE OF FOUNDATION ENGINEERING

by Louis J. Goodman and R.H. Karol

433 pages. MacMillan, New York, 1968. N.Z. Price $16.35.

This book contains a comprehensive treatment of most aspects of foundation engineering. It covers similar ground to another recent book by

Bowles (reviewed in the previous issue). It does not have the same wealth of detailed information for the design engineer as Bowles and it does not cover earth pressures and retaining walls. However, it is considerably less expensive.

Perhaps the best guide to the contents of this book is a list of the chapter headings as follows:

1. Introduction (containing basic soil mechanics theory)
2. Subsurface Investigations
3. Excavation, Dewatering and Bracing
4. Footings
5. Mat Foundations
6. Piles and Pile Foundations
7. Caissons and Cofferdams
8. Special Foundations
9. Procedures for Foundation Selection
10. Case Histories (very good. 30 pages long)

The book contains much useful information and deserves a place on the bookshelf of any engineer who is considerably involved in foundation engineering.

- J.P.B.

ADVERTISING IN "N.Z. GEOMECHANICS NEWS"

At the A.G.M. of the Society at Auckland in February a proposal to include advertising in "N.Z. Geomechanics News" by the front and back covers (so as not to separate any of the text) met with the general approval of the members present.

Accordingly advertising material will be accepted for the next (third) and subsequent issues. It is hoped that the third issue will be produced in August or September and therefore, an indication of interest in advertising space is required as soon as possible by completing and posting the form at the bottom of this page. Further details will be sent to those interested. The charge for advertising space is $30 per page (quarto) or $15 per half page. In addition, printing costs will be charged if the advertisement is not typewritten, but this cost will be reasonably small if the advertiser can provide his own plates for printing.

Members who belong to organisations which would consider advertising are urged to use their influence to promote this advertising. In this way, production costs of "N.Z. Geomechanics News" to members of the Society can be kept down and thus extra issues can be produced. Although the circulation is at present only 200 copies per issue, it is one of the best means of reaching all people in New Zealand who are interested in soil mechanics and soil engineering. Examples of concerns to whom this should particularly appeal are drilling contractors, testing laboratories, agents for laboratory equipment and contracting firms specialising in soil improvement, ground anchors etc.

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The Technical Secretary,
N.Z. National Society for Soil Mechanics and Foundation Engineering,
P.O. Box 12-241,
Wellington.

Dear Sir,

Please send me further details regarding advertising in "N.Z. Geomechanics News".

Name: -

Address: -

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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,
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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 ______________________________

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QUALIFICATIONS AND EXPERIENCE ______________________________

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NAME OF PRESENT EMPLOYER ______________________________

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NATURE OF DUTIES ______________________________

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

SIGNATURE OF APPLICANT ______________________________

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