

N.Z. GEOMECHANICS NEWS

No. 15

NOVEMBER 1977

A NEWSLETTER OF THE N.Z. GEOMECHANICS SOCIETY

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THIS IS A RESTRICTED PUBLICATION

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

Persons interested in applying for membership of the Society are invited to complete the application form at the back of this newsletter. Members are required to affiliate to at least one of the following international societies; Soil Mechanics, Rock Mechanics or Engineering Geology.

EDITOR'S NOTES1. Election of Management Committee for 1978

In the past, election of members of the Management Committee has taken place at the Annual General Meeting. Only a small proportion of members of the Society are usually able to attend the AGM and, last year, in order to obtain a wider voting participation the Management Committee decided to hold a postal ballot for the 1977 Committee prior to the AGM. This procedure is to be repeated for the election of the 1978 Committee.

Members of the Society have been circularised with a newsletter to inform them of the manner in which the postal ballot will be run and to bring relevant rules of the Society to their notice.

Members of the Society should be aware that not only are they required to a return on efficient working Committee, but that representation on the Committee should be maintained as broad as possible with respect to the field of interest, occupational, and regional classification.

2. N.Z.I.E. Annual Conference, Hamilton, 1978

Following past practice the Geomechanics Society has reserved time at the 1978 Annual Conference for Technical Group sessions to coincide with the Annual General Meeting of the Society. The Conference format is slightly different this year in that Technical Groups are able to nominate submitted papers for presentation at group sessions or as mainstream papers.

The programme which has been fixed this year is as follows:

Monday 13 February

Afternoon; Technical Group Sessions

North P.J. and Patterson-Kane K.J. "Large Diameter Bored Piles in Cohesionless Materials".

Northey R.D. "A Discussion of NZS 4402P".

Mitchel M.T. "Slope Stabilization Through Non-planar Cut Surfaces".

Evening; N.Z. Geomechanics Society Annual General Meeting.

Tuesday 14 February

Morning; Mainstream Conference Sessions with papers of Geomechanics interest.

North P.J. "Design and Construction of Boundary Road Bridge".

Blakeley J.P., Green H.R. and Toan D.V. "A Design Method for Heavy Duty Flexible Pavements"

3. Proceedings Second Australia - New Zealand Conference on Geomechanics, Brisbane, 1975

The Society has a limited number of copies of these proceedings which are available from The Management Secretary at a cost of \$25.00 per copy.

4. Visit of Professor Meyerhof

During a brief visit to New Zealand by Professor Meyerhof in May of this year, the Society was able to arrange addresses in Auckland, Wellington and Christchurch. A report on the two addresses given in Auckland appears in this issue.

Professor Meyerhof gave the second of the two addresses reported in this issue to a very receptive audience at the School of Architecture in Wellington, and repeated the pattern of an afternoon university lecture and a Society evening lecture in Christchurch.

5. "Missing Members"

Members' attention is drawn to a note contained in the "News from the Management Secretary" concerning members who are unable to be traced. Any assistance from members in re-establishing contact would be appreciated.

CONTRIBUTIONS TO NEW ZEALAND GEOMECHANICS NEWS

Contributions to New Zealand Geomechanics News may be in the form of technical articles, notes of general interest, letters to the Editor, or book reviews, and may cover any subject within the field of soil mechanics, rock mechanics, and engineering geology. Articles on site investigations, construction techniques or design methods which have been successfully used in New Zealand, and which would be of help to other members, would be particularly welcome.

All contributions should be sent to:

The Editor, New Zealand Geomechanics News,
C/- New Zealand Geomechanics Society,
P.O. Box 12241, WELLINGTON.

I.M. Parton
EDITOR

VISIT OF PROFESSOR MEYERHOF TO AUCKLAND

J.P. Blakeley

On Wednesday 25 May, Auckland Members of the Society were privileged to hear two addresses by Professor G.G. Meyerhof, Professor and Head of the Civil Engineering Department at the Nova Scotia Technical College in Halifax, Canada. A brief review of these two addresses is given below.

Afternoon Address"The Bearing Capacity of Foundations on Layered Soils"

This address was given as a research seminar at the School of Engineering, University of Auckland, and was attended by about 50 people.

The problem addressed in this lecture by Prof. Meyerhof was the situation where strong soil overlies weak soil and there is a possibility of foundations "punching through". The lecture was based on three papers prepared by Prof. Meyerhof:

- for footings: "Bearing Capacity of Footings in Layered Soils" which has been published in the Canadian Geotechnical Journal in 1974
- for single piles: "Piles in Layered Soil" published in the proceedings of the Ninth International Conference for Soil Mechanics and Foundation Engineering held in Tokyo in July 1977
- for pile groups: "Punching Effects and Group Effects of Piles" to be published in the Canadian Geotechnical Journal in 1978.

Prof Meyerhof said that in order to assess the risk of a pile foundation "punching through" it is necessary to separate out the point bearing resistance from the shaft friction. Either instrumentation on piles should be used to determine the shaft friction or else push and pull tests should be carried out. Otherwise an estimate of shaft friction can be made using Tomlinson's coefficient. He stated that when using the ratio of shaft friction/point resistance it is justifiable to use the same ratio in a layered soil as for a uniform thick layer of soil as it is generally found that when the point resistance of a pile diminishes, the shaft friction in that layer goes down in about the same ratio. For clay soils this ratio is generally 5-10% (which is the ratio of $0.5-1.0 C_u$ skin friction and $10 C_u$ point resistance).

With regard to the point resistance of a pile, Prof Meyerhof said that normal bearing capacity theory can only be applied above the critical depth of the pile, as below this critical depth the effects of local shear failure govern the point resistance of the pile. He said that the critical depth varies from $10B$ in loose sand to $20B$ in dense sand for full sized piles (where B is the diameter of the pile). On the other hand, for model piles ($\frac{1}{2}$ inch diameter) the critical depth has been found to range from $40B$ to $50B$. Also the critical depth to some extent depends on whether the sand is dry or wet.

Prof Meyerhof concluded by saying that a lot of confusion arises when people work back from the results of full scale loading tests on piles to obtain bearing capacity factors. If they do this using conventional Terzaghi bearing capacity theory, they get much lower bearing capacity factors than are actually the case because if the pile is founded below the critical depth the Terzaghi theory does not in fact hold any more.

Evening Lecture"Bearing Capacity and Settlement of Pile Foundations"

This lecture was presented to an evening meeting of the Auckland Group of the N.Z. Geomechanics Society held in conjunction with the N.Z.I.E. Auckland Branch. About 80 people were present.

Prof Meyerhof presented the material which was given in the Eleventh Terzaghi Lecture as published in the Journal of the Geotechnical Engineering Division of A.S.C.E. Volume 102 No. GT3 (March 1976).

He began by comparing the performance of driven piles compared with bored piles and emphasised that a zone of compaction around the pile base will improve the bearing capacity of the ground when a driven pile is used, but when a bored pile is used the bearing capacity of the ground will in fact be reduced. Prof Meyerhof again emphasised that bearing capacity theory can only be applied down to the critical depth of the pile.

If the angle of internal friction of the pile bearing layer is known, it is possible to relate the bearing capacity of a long pile with cone resistance as obtained using a Dutch cone penetrometer. He had found that a good agreement in practice was obtained for piles in dense sand. However, in loose sand the bearing capacity of a pile was greater than predicted because of densification due to pile driving. Also, the critical depth must be greater than 10B in order to obtain correct bearing capacity values. Experiments had shown that in the field, the bearing capacity of bored piles is less than that of jacked piles which in turn is less than that of driven piles up to the critical depth. It is also possible using the Dutch cone penetrometer to obtain values of skin friction which are to be applied below the critical depth of the pile providing the angle of internal friction of the soil layers can be reliably estimated. He said that if the pile does not go down to the critical depth then a reduced cone penetration resistance must be used in determining the bearing capacity of the pile.

In addition to using Dutch cone penetration resistance, another method of assessing the ultimate pile bearing capacity is to use the standard penetration test. A study of the results of a large number of field load tests has established a relationship

$$\text{Ultimate pile bearing capacity} \approx 4N \text{ tons/ft}^2$$

providing the pile embedment is greater than the critical depth. For lesser embedments, a lower pile bearing capacity must be used.

The above relationship applies for driven piles and bored piles have been found to have only half to one-third of the point resistance of driven piles. Hence as an approximation the formula

$$\text{Ultimate bearing capacity} \approx 1.2N \text{ tons/ft}^2$$

can be used.

Prof Meyerhof emphasised that in order to use the above relationships, N values must be used which have been obtained for the same ground water conditions and excavation conditions as will apply for the building foundations. Otherwise the N values must be adjusted to allow for these factors.

In addition to the above relationship for point bearing resistance of piles, Prof Meyerhof suggested the following relationships for skin friction:

For driven piles, skin friction = $\frac{N}{50}$ tons/ft²

For bored piles, skin friction = $\frac{N}{100}$ tons/ft²

Prof Meyerhof then went on to describe the problem of analysing bearing capacity when driving piles through a soft clay into a hard bearing stratum. He said that providing the pile penetrates at least 10B into the bearing stratum beneath the soft clay stratum then it is permissible to use the value of 4N for ultimate point resistance of a driven pile as given above. Also the same considerations would apply for the skin friction on the pile within the bearing stratum.

Prof Meyerhof then went on to discuss the more complicated problem of punching failure of piles through a bearing layer into a softer layer beneath. He established that in order to develop the full bearing capacity of the founding layer, this layer must extend for a thickness of 20B beneath the base of the pile.

In the case of pile groups it is possible to either get individual pile failures or a failure of the pile group as a whole. He stated that as a general approximation, with a group of bored piles the bearing capacity of the pile group would be about two-thirds of the sum of the bearing capacities of the individual piles due to the interface of the zones of pressure beneath the individual piles.

Prof Meyerhof then went on to discuss bearing capacity of piles in clay. He said that in general the bearing capacity of a pile in clay is estimated as 9 x the undrained cohesion of the clay. However, it is only possible to achieve the full bearing capacity of the pile after driving has been finished and allowing shear strength to gradually build up again over a period of about 30 days. A new approach for estimating the bearing capacity of piles in clay is to use effective shear strength, allowing for the dissipation of pore pressure. Prof Meyerhof suggested using a skin friction factor of 0.2 - 0.3 x the shear strength around the pile for ϕ value of 15 - 30°. He also said that whereas for short piles it is generally possible to get mobilisation of shear strength over the full depth of the pile, in the case of long piles it is only usually possible to get partial mobilisation of the full shear strength. Therefore it is necessary to use reduced values of skin friction factor for both positive and negative skin friction for very long piles.

Prof Meyerhof said that finite element techniques had been used to analyse the ultimate bearing capacity and the settlement of single piles but in practice it is generally necessary to know the bearing capacity and settlement of the pile group.

For a point bearing pile the shear zone to be considered is essentially over a depth of 4B above the pile base and 1B below the pile base. However if the shear zone decreases in strength with depth it would be more appropriate to take a shear zone of 1B above the pile base and 4B below.

When uplift loads have to be considered, tension piles are often a viable alternative proposition to soil anchors. In assessing the uplift resistance of a tension pile, results from Dutch cone penetrometer tests can be applied for loads in the upward direction. Hence reliable predictions of uplift loads can be used using the Dutch cone penetrometer for both single piles and pile groups. However, another factor is the tolerable amount of upward movement which can be permitted. An example is the use of tension piles beneath pole structures on highways.

Although the standard penetration test is a very widely used test and has the

advantage that at the same time a soil sample is obtained as a by-product, it is not as good a test as the static Dutch cone penetrometer test because in fact the bearing capacity of a pile in point resistance is a static test. However, Prof Meyerhof emphasised that wherever Dutch cone penetrometer tests are used to assess pile bearing capacity, bores should also be put down to get a good description of the soil strata and to obtain information on the ground water conditions. The Dutch cone penetrometer test has the disadvantage that suitable anchorage for the penetrometer must be obtained, and also that it can only be used up to a penetration resistance equal to the capacity of the rig. In some situations a combination of the cone penetration test and a driving test on the cone when the ground becomes too hard is used. There is a lot of doubt about the interpretation of the results of standard penetration tests in clay soils but the standard penetration test is usually almost as reliable as the Dutch cone penetrometer in sandy soils.

In the investigations for the large offshore structures which are being erected in the North Sea gasfield, the Dutch cone penetrometer test has been widely used as it gives readings from which it is possible to back-calculate values of ϕ . Such testing has been carried out in depths of between 100-200 ft of water.

Another factor to be considered is that in stiff clays the shear strength of the soil can be reduced due to over-consolidation. The K_0 value indicates the over-consolidation ratio of the soil (i.e. the ratio of the vertical to the horizontal stress in the soil at a given depth). In the case of bored piles a reduced skin friction factor is obtained because K_0 is reduced as the pile is being bored. It is possible to obtain values of K_0 in a clay by use of a pressuremeter. However, these techniques are likely to over-estimate the bearing capacity of a bored pile and to under-estimate the bearing capacity of a driven pile. For pile groups in stiff clays, a reduction factor to about 0.33 of the sum of the individual pile capacities should be used. The settlement beneath piles in clays should never be calculated on the basis of the settlement beneath an individual pile but always beneath the pile group. Peck Hanson and Thornburn have described a method where the group of piles is taken to be a deep pier. As a guide, the settlement of a pile group can be 10-15 times that of a single pile under the same individual pile load. However, pile settlements cannot be predicted with confidence in this manner and in practice for piles in clay, where there is any doubt, the bearing capacity and settlement of the piles should always be confirmed by means of a full scale pile load test. However, the settlement of an individual pile should never be assumed to be similar to that of a pile group.

Prof Meyerhof said that driving formulae should only be used as a relative indication of variability of founding conditions over a site, i.e. as a yardstick once bearing capacities have been established by means of load tests or Dutch cone penetrometer tests or by some other method. He said that pile formulae have been found to be useless in cohesive soils.

Discussion

In the discussion which followed the presentation of the paper it was pointed out that the N value approach to determining bearing capacity of piles was developed from the original approach conceived by Terzaghi and Peck which is known to be very conservative. This was because it was basically adopted from footing theory where the Terzaghi and Peck approach has been shown to be satisfactory but it becomes too conservative for piles. Prof Meyerhof said that the $4N$ relationship for bearing capacity of piles was when the N values had been adjusted to allow for the effects of confining pressure. When no such allowance had been made, then the bearing capacity would vary between $5N$ and $3N$ with increasing depth of the pile. The correct adjustments to be made to N values with depth had been developed by Peck

and Bazarra and these are given in the 1975 edition of the text book "Foundation Engineering" by Peck Hanson and Thornburn. The correction is based on a standard confining pressure for an N value of 1 ton/sq.ft. For a very long pile the correction can reduce the N value to half its measured value. Also if this method is used for piles which are to be constructed in a deep excavation, then the N values must be adjusted for the overburden which will be removed from the excavation. Prof. Meyerhof pointed out that it is not possible to measure ϕ directly in cohesionless soils beneath ground water table level. Hence it is necessary to obtain ϕ using a correlation with N value, or better still use a formula to determine bearing capacity which uses N directly.

With regard to the use of bored piles which are belled at the base, Prof Meyerhof said that the bearing capacity on the base of the bell will be one-third to one-half of that of a driven pile of the same base area, but in the base of a belled pile no skin friction is to be allowed for.

The question as to the bearing capacity of caissons was raised and Prof Meyerhof said that this is definitely a non-standard foundation condition. Large diameter caissons are often used now beneath offshore structures and bearing capacity should be analysed for the bored pile condition. However, if the depth of the founding layer is not greater than ten times the width of the caisson and there is a possibility of a softer soil layer beneath, then the normal bearing capacity theory cannot be applied.

Another possibility is that the bearing capacity of the foundation soil can be improved by the application of pressure by jacking or grouting. In this way it has been found that in sand soils the bearing capacity can be increased by up to three times (i.e. similar to the difference in bearing capacity between a bored and a driven pile). In effect pressure jacking is setting up a new K_0 condition beneath the base of a bored pile and in this way the settlement is much reduced. In the case of bored piles in clay soils it has been found possible to obtain twice the bearing capacity by means of such pressure jacking. In this way it has been possible on some jobs to pay for the cost of flat jacks by the reduction in the number of piles and at the same time to obtain much greater security against subsequent settlement. Also, Kerisel has described a method of pressure grouting to increase skin friction on piles.

The meeting concluded with a vote of thanks being expressed to Prof Meyerhof by Mr B. Bartley, Chairman of the N.Z.I.E. Auckland Branch.

REPORT FROM ROCK MECHANICS VICE-CHAIRMAN

(I.M. Parton)

Two items of correspondence have been received from the International Society for Rock Mechanics (ISRM). The first concerns a report from the Chairman of the Commission on Publication and Translation. At the founding of the ISRM it was decided that the Society would have three official languages - English, French and German - with contributing papers to a congress or symposium written in one language but summarized in all three official languages.

An analysis of all papers presented at ISRM congresses and symposia has shown that over half of the papers are in English with the remainder equally distributed between French and German. With congresses and symposia now being held out of Europe it is expected that about 75% of the total number of submitted papers could be in English. As a consequence, it has been suggested that authors should be encouraged to use English rather than the other two languages, simplifying translation needs at international meetings and reducing publication costs.

The second item of correspondence concerns reports and documents which were to be discussed at the ISRM council meeting in Sweden in September of this year. The items for discussion included:

- Supporting Membership
- Commissions of the Society
- Secretariat Services
- Report on the Financial Situation of the ISRM
- Audit of Accounts
- Budget for 1978

Members affiliated to the ISRM who wish to peruse any of these documents should contact the Rock Mechanics Vice-Chairman.

LOCAL ACTIVITIES

AUCKLAND GROUP

The second edition of the booklet "*House Foundations - Advice to Prospective House and Section Owners*" which was originally produced by the Auckland Group about ten years ago is now almost sold out, due mainly to the efforts of committee member Mike Wesseldine in selling numbers of copies to Local Authority engineers for distribution to the public. It is proposed to revise the document next year to include a section on cutting and minor filling within individual house sections, which is an area in which many house owners trigger off damage to their properties and instability problems.

Following a recent decision of the Management Committee of the N.Z. Geomechanics Society that local conveners will be appointed each year by the Management Committee from local members of the Society, the Auckland Group committee has been restructured and now comprises J.P. Blakeley (Convener); T.J. Kayes (Secretary); A.P. Codling; G.R.W. East; B.C. Hadfield; I.M. Parton; M.J. Pender; W.M. Prebble and M.A. Wesseldine. (The Auckland Group was at one time a sub-committee of the N.Z.I.E. Auckland Branch).

Two recent meetings of the Group have been held:

1. "Soil Testing for Septic Tank Disposal Fields"

This meeting was held on 12 July 1977 with an attendance of 64. The speakers were:

- * Mr Simon Carryer, Consulting Geologist: *"Mechanisms Related to Infiltration and Permeability of Soils"*
- * Mr Ian Gunn, Auckland University Civil Engineering Department: *"Use of Soil Test Data in the Design of Disposal Fields"*
- * Mr Athol Robertson, City Inspector, Waitemata City Council: *"Practical Aspects of Testing and Performance of Field Systems"*

A lively discussion followed the presentation of these three papers. It is hoped to publish a detailed article on this subject in the next issue of "N.Z. Geomechanics News".

2. "Huntly Power Project - Foundation Investigation"

This meeting was held on 11 October 1977 and the attendance was 35. The speakers at the meeting were D.K. Taylor, T.J. Kayes and L.D. Wesley of Tonkin and Taylor, Consulting Engineers.

Mr Taylor gave a general outline of the project and of the geology of the site and the foundation soil conditions. Mr Kayes then described in more detail the foundation conditions. As time did not permit a detailed description of the site investigation procedures and laboratory testing carried out, he concentrated on describing some of the full scale in-situ tests which could be carried out because of the large size of the project. These included an instrumented test embankment to enable rates of settlement and pore pressure dissipation to be measured, pile load tests, tests on the use of sandwicks to accelerate settlement and also on the use of a power flotation for deep compaction of sandy layers. The large number of piles driven on the project were all taken down to an identified stratum where bearing capacity had been established by means of pile loading tests rather than using measurements of pile set to establish bearing capacity. A very small variation in the actual pile lengths was achieved in relation

to the assumed lengths. A tolerance between 2 m above and 1 m below the required level of the top of the pile was obtained.

Dr Wesley described the analyses carried out to determine the best method of constructing a large concrete box section intake structure to be constructed beneath existing ground level on the site through pumiceous sands beneath water-table level. Methods of dewatering prior to excavation were considered so that the structure would be constructed in position in the dry, but the risk of piping failure in the light pumiceous sands was a major problem. The solution adopted was to construct the intake structure above the ground surface and then to sink the whole structure down to the right level by excavation. Representatives of the project staff of the Ministry of Works and Development were also present at the meeting and they showed a number of recent slides of the structure being sunk into its final position.

The meeting was followed by an interesting discussion and the convener then expressed his thanks to the three speakers for sharing with the audience the experience they had gained on this large project.

JPB

SILTATION ARISING FROM EARTHWORKS

(Proceedings of a Joint Meeting of
N.Z.I.E. Auckland Branch/Auckland Geomechanics Group
held on 20 April 1977)

The Chairman of the N.Z.I.E. Auckland Branch, Mr B.A. Bartley, opened the meeting and then Mr J.P. Blakeley, Chairman of the N.Z. Geomechanics Society, outlined the aims and objectives of the Society and of its Auckland Group. Mr T.J. Kayes then introduced the speakers and chaired the meeting. He issued an invitation to everyone at the meeting to submit comments on the document "Urban Earthworks - Suggested Practices" which had been prepared by the National Water and Soil Conservation Organisation.

Mr G. Barnard (A.R.W.B.) outlined the establishment of the Auckland Regional Water Board and its objectives in siltation control. He described the problems experienced with siltation from urban subdivisional earthworks in the upper areas of the Browns Bay catchment which first became a problem in 1973 and 1974. It was quite clear that controls had to be introduced to significantly reduce the volume of silt being washed down from the bared slopes through downstream waterways for deposition in the lower reaches of the catchment and often on to the beach at Browns Bay. The life on the bottom of a stream or the harbour bed will be effectively suffocated by a silt layer being deposited. He said that if on-site silt control is not practiced then large scale drainage channel clearing or river and harbour dredging may be required to give the degree of flood protection necessary for any particular area or to preserve navigation channels. In this regard it is necessary to draw a distinction between normal geological erosive processes and accelerated sedimentation. Sediment levels in established urban areas frequently fall into the range 100-10,000 mg/l. However, peak sediment loads of 59,000 mg/l have been measured in the Browns Bay catchment.

Mr Barnard then described existing legislative control and said that the Town and Country Planning Act 1953 and 1960 Regulations, the Municipal Corporations Act 1954 and the Counties Amendment Act 1962 give the powers necessary to the relevant local authorities responsible for the controlled development of the areas under their control. The Water and Soil Conservation Act 1967 together with the Soil Conservation and Rivers Controls Act 1941 and 1959 Amendment Act give the powers necessary to catchment authorities and regional water boards for the effective control and management of water and soil resources. The Water and Soil Conservation Act makes it an offence to place any waste "in a position where it is liable to fall or descend or be washed or to percolate into any natural water". To legalise such an action a water right is required under Section 21 of the Act. It must be realised that silt is a waste as defined in the Act.

Mr B. Wither, A.R.W.B., said that because earlier approaches to the problem of silt control had not worked, there was about to be a change of policy of the A.R.W.B. to require water rights specifically for the carrying out of urban development earthworks. The A.R.W.B. will therefore require water right applications from the developer for a short term silt control temporary right whereas the permanent right for discharge from the storm-water reticulation system would be applied for by the developer on behalf of the local authority with local authority prior approval of the features. It is believed that within a relatively short time the diligent exercise of silt control practices will become as much the normal engineering requirement "for subdivisional works as are now placed on roading and services."

Mr Wither then gave a brief review of measures to provide control of siltation including silt detention structures, ponds and contour drain design. He said that often a chain of ponds will get in the way of subdivisional development more than a single large pond. He said that the plans for the subdivision should show silt detention proposals and he emphasised the importance of good construction management.

Mr Wither said that the A.R.W.B. has adopted a policy of comprehensive catchment planning whereby long term silt control measures are incorporated into the development of the whole catchment plan. The local authority is then left to control individual subdividers and grant them discharge authorisations in line with the whole catchment policy. Silt control is however only one aspect of comprehensive catchment planning. Finally, Mr Wither commented on the lack of uniformity of engineering standards for residential subdivisions and he appealed for the engineering profession to strive for a code of uniformity which will achieve high standards of engineering construction, including silt control measures. He also appealed for more innovative design in subdivisions to lift them out of the bread-and-butter approach and to give them a personal touch. He would like to see more original design thought including a few open channels and other natural landscape features being retained, but not to the extent that public safety and protection is lost.

Mr J.D. Dawn (Tonkin and Taylor) reviewed the design methods given in the document "Urban Earthworks". He said that the objectives of the work should be sufficient control of sedimentation and run-off from erosion. There were two basic methods of doing this: preventing the erosion from occurring; and catching the sedimentation which has eroded from the subdivision by means of a silt detention structure or pond. He said that he was speaking as a user of the document who had studied it and applied the principles contained in it to practical jobs. He suggested that the name of the document might be changed as it does not consider other aspects of urban earthworks and the recommendations given could apply to control of sediment run-off from any earthworks construction.

In the first category of erosion control and principal recommendation is that large areas should not be left without topsoil and vegetation any longer than absolutely necessary. It recommends that this be achieved, firstly by controlling the sequence of the earthworks so that the minimum area required for working is stripped at any one time, and also that the working season should be limited to suit the local climate. Where earthworks are not completed within a single season a nominal thickness of topsoil should be spread and seeded, to be removed again at the recommencement of the work. The permanent topsoil cover should be placed, seeded and fertilised as soon as possible after completion and it recommends that the whole area be topsoiled and then cut back for roads, footpaths etc., when required at a later date. (This is probably not practical unless roading will be delayed for some time).

With regard to the placing of topsoil, it recommends that on flat or gently sloping areas topsoil should be placed in two layers, the first being compacted with a medium weight roller and the second only lightly. On slopes steeper than 1 in 5 the minimum thickness of topsoil should be spread which is necessary for seeding and no topsoil should be placed on slopes steeper than 1 in 2 where hydroseeding should be considered.

As erosion is greatest where slopes are steep or where run-off is concentrated, emphasis should be placed on the treatment of cut and fill batters. Run-off should be prevented from coming down a cut face by a drain at the top and for high slope batters, benches with drains should be used to break up the flow. For gentler slopes, contour furrows should be used to break up the

flow. During construction of a fill batter, a temporary open drain should be maintained around the top of the fill at the end of each day, or alternatively the top of the fill should be sloped away from the batter.

Discharge down the slope should always be via a drop chute of sheet metal, concrete pipe or asphalt with erosion protection at the bottom. Drainage channels (both natural and temporary for construction) should be carefully maintained throughout the work. Riprap should be placed at potential scour points.

A number of recommendations for control of erosion during earthworks are made. These are good general practices which a well organised contractor would carry out in any case. These include: keeping the site tidy with a minimum of loose soil; sealing fill surfaces at the end of each day and before rain; temporary drains at regular intervals to collect run-off and direct to controlled discharge. It also makes the somewhat less practical suggestions that scrapers should load along contours rather than down the slope, and that if the fill is rolled with the sheepsfoot roller at the end of the day, run-off will be much reduced (although it is noted that thought should be given to the effect of extra water infiltrating the fill).

The second category of erosion control is to remove the sediment from the run-off, and in this regard the closer to the source of the run-off the more effective such measures will be. The "Urban Earthworks" publication recommends two main types of control:

- (i) the use of brush retention structures such as a post and wire, or netting fence with brush (e.g. manuka) interwoven, or the use of a filter cloth barrier as described in the October 1976 issue of A.S.C.E. Civil Engineering magazine
- (ii) the use of sediment settling ponds.

Mr Dawn said that standards for sediment control are given in the document but not explained. These are that the discharge from a two year run-off should not transport sediment particle sizes of greater than 20 microns (coarse silt size).

Recommendations are given for the design of sediment retention ponds with a worked example. It is suggested that if a pond is the only silt control measure, it should retain the whole of a two year/one hour run-off. It is noted that the size of the pond is determined by the run-off and not by the sediment volume (which is difficult to calculate in any case). In summary the procedure recommended is:

- (i) Calculate the run-off using a rational formula.
- (ii) Make provision for over-topping in case of greater run-off (i.e. a less frequent event).
- (iii) Protect the outlet and overflow from the scour.
- (iv) Provide a slow outlet to empty the pond after the sediment has settled.
- (v) Provision must be made for disposal of excavated sediment.

Mr D.M. Coombe (Broadlands Estates Ltd) said that generally siltation protection measures are either written into contract documents by the principal or they are left to the contractor to decide on and to implement.

However, if a water right is issued prior to letting the contract the measures may be listed and policed by the Regional Water Board.

Mr Coombe then briefly summarised some of the siltation prevention measures previously described by Mr Dawn, including toe and top drains (to prevent scouring of cut and fill batters), temporary channels with semi-pervious barriers (constructed with wire netting and manuka), retention of existing vegetation, diversion of stormwater from a catchment area above the subdivision into a piped system, sealing off construction areas prior to rain with rubber tyred plant, construction of silt retention ponds, hydraulic seeding of areas to re-establish vegetation quickly and measures enforced through contract documents including staging of earthworks, limiting of the earthworks construction season and ensuring all areas stripped are re-topsoiled and grassed prior to the end of the earthworks season.

Mr Coombe said that in his experience the above measures, with the exception of revegetation before the winter rains, are not particularly effective in eliminating silt run-off. In particular he had found that contour drains either silt up and become ineffective or the velocities become too great and the drains scour deeper; temporary channels with semi-impervious barriers either block or fail to settle solids in suspension and silt ponds do not effectively control settlement of soil particles unless they occupy such a large area that they may be impractical to construct, and even if such silt ponds are constructed it is usually impossible to maintain the ponds free of silt throughout a winter period. However, in spite of the lack of effectiveness of the above measures, Mr Coombe still believed that the only practical solution is to adopt these measures over the earthworks season with silt traps as the main line of defence and accept the risk that a major storm will breach these defences. He considered that this is an acceptable risk providing topsoil and vegetation is quickly established on reformed areas prior to the winter period and that earthworks are staged to enable completion of any particular area within one earthworks season.

Mr E.H. Thompson (Housing Corporation of N.Z.) said that in his experience with the Housing Division of the MWD and now (since 1974) with the Housing Corporation, he did not know there was any problem about siltation - until the Regional Water Board arrived! However, up until recently his organisation had been developing mainly flat land. He briefly outlined his experiences in using some of the measures available to prevent siltation which had been outlined by previous speakers. He then concentrated his remarks on the respreading of topsoil and the use of temporary topsoil. He said that the most effective measure was to expedite the permanent respreading of topsoil to full depth and permanent regrassing. Permanent regrassing with seed and fertiliser costs about \$400 - \$500 per hectare. Another alternative is to respread the first one third or one half depth of permanent topsoil and apply temporary regrassing. This would be used where earthworks are complete but sewers are not yet laid. Temporary regrassing costs about \$150 - \$200 per hectare. Another alternative is the temporary respreading of a thin layer of topsoil (50 mm depth) with temporary regrassing over an area where earthworks are to be continued the following season but this whole operation will cost about \$700 - \$1000 per hectare. Another alternative is temporary regrassing of bare clay which will cost about \$150 - \$200 per hectare but which is of doubtful effectiveness. Finally, the cost of hydroseeding is about \$2400 per hectare.

Mr Thompson then discussed the responsibility for providing effective measures for the prevention of siltation as between the developer and his contractor. He said that although the responsibility is primarily that of the developer, as he had let a contract for the work to be carried out there is a division of responsibility between the developer and the contractor. He asked to what extent the whole problem can be made the contractor's

responsibility without specific payment. He said he doubted whether this can be done, at least with the present state of knowledge of what is specifically required in the Auckland district.

In regard to the division of responsibilities for siltation prevention measures, Mr Thompson quoted two large recent Housing Corporation subdivisions and described the rather different approaches to tackling this problem which had been taken. The specifications had been drawn up so as to put a good part of the financial responsibility for siltation prevention measures on to the developer and not the contractor and to have the developer's engineer direct what should be done. This had included the design of silt traps and provisions included in the schedule of quantities for silt retention measures. However, any contract requires good housekeeping to prevent erosion occurring and the implementation of good practice has been left to the contractor. The contractor if directed is to be responsible for temporarily topsoiling areas and grassing them. In one of these two contracts it was specified that the contractor must regrade and grass the area by 30 April each year. Hence important decisions must be made as to exactly when to finish earthworks for the season.

Mr Thompson noted that there appears to be some conflict of interest between past good earthworks practice (which from soil mechanics considerations required water to be shed readily from earthworks areas) and what is now advocated as good earthworks practice from the soil conservation point of view where it is desirable for water to be absorbed to prevent it running away. This conflict may be resolved with further experience.

Mr Thompson concluded by saying that he believed it is too early for the "Urban Earthworks" document to be put into any final form until more is known as to what measures are really necessary and what are effective in the Auckland Region and also about the relative economics of different siltation control measures.

Mr D.A. Finlay (Harrison and Grierson and Partners) described a water right case history which began in April 1974 with an initial enquiry to the local authority on their requirements for discharge of stormwater into a natural watercourse from a subdivisional development. Resulting from this an application was made by the consultants to the A.R.W.B. to discharge water from an area of 19 hectares in May 1974.

Due to various objections and other matters raised, the local authority required a revamping of the stormwater proposals with consideration of a wider area before further submission could be made to the A.R.W.B. This request was made in December 1974.

By this time two adjoining properties were being considered for development and a joint scheme for an area of 135 hectares was mooted in May 1975 and following numerous meetings between owners, consultants and local body officers a formal submission for the discharge of stormwater was lodged by the consultant with the local authority in October 1975.

This application was now approved by the local authority and first reached the A.R.W.B. during March 1976, almost two years after the initial submission. As a consequence of advertising the application, certain objections were received by the A.R.W.B. and in an effort to overcome them the Board requested the encompassing of a further area within the water right. With the addition of this new area the total under consideration became 278 hectares and the consultant submitted a revised proposal to the A.R.W.B. in July 1976. The revised proposal failed to satisfy all objections and the matter of granting the right was taken before a regional water board tribunal in August 1976.

The outcome of the tribunal was the issue of an interim right for a period of two years for an area of 32 hectares only, allowing limited development of the three properties considered for subdivision in December 1974. However the issue of this interim right was subject to the local authority bringing down a comprehensive scheme over the entire catchment within a period of six months. The entire catchment comprises 594 hectares, some thirty times that of the original application.

To date the comprehensive scheme for 594 hectares has been presented to the A.R.W.B. but its formal acceptance depends upon the outcome of further negotiations with objectors over discharge rights and there is no guarantee that this scheme will meet all objections to the proposed development.

Mr Finlay said that over three years have now passed since the initial application and only sixteen months of the two years interim right remain. He said that the real cost which a developer is involved in during the delays caused by these procedures must be taken account of, and a developer can only recoup this cost by increasing the price of the developed land. He said that in the particular case history he had described, the developer did not object to the cost of providing the necessary siltation control measures but he did object very strongly to the delays to which he was being subjected and the consequent costs involved in the delays. The cost of providing siltation control measures is surely small when considered against the costs incurred in delay such as has been experienced in this case history.

Mr Finlay emphasised that in the case of some subdivisions the necessary procedures can be gone through quickly without delays but in other subdivisions problems such as the ones he had described would be bound to occur. He believed that the professional institutions involved in the development of land must make submissions to have the required procedures streamlined to prevent the wastage of money in land development through bureaucratic delays.

DISCUSSION

Mr Thompson was asked what grass seed he used for temporary grassing and he replied that he used Bushburn grass seed spread at 30 Kg per hectare which is relatively inexpensive.

A comment was made that at one time provision used to be made for a cutoff drain at the top of a cut batter to prevent water running down the cut face. However, almost invariably a crack would develop in the bottom of this drain through which water infiltrated and caused a slip near the top of the batter. Consequently this practice has gone out of favour in recent years.

A question was asked about the legal consequences of failing to comply with preventive measures to prevent siltation and Mr Barnard replied that fairly severe penalties were provided with a maximum fine of \$2000 plus \$100 per day for continuing offence. What actually happens in practice is that when a problem develops, in general up to the present time the ARWB has been able to resolve the problem without resorting to prosecution procedures. However, on one occasion it had been necessary to cancel a water right but the situation was generally resolved in consultation with the developers and their consultants. It was pointed out that the cost of providing siltation measures may be of the order of \$60 - \$100 per section on a subdivision. With this order to relative cost of providing protection against siltation, a developer could decide that the penalties are not high and that he will not obey the law. Also, the question was asked as to why, from the developer's standpoint, siltation protection measures should be provided initially. Mr Barnard replied that often contractors and developers haven't seen fit to comply with the procedures and that is why water rights have been insisted upon. However, in policing this policy the ARWB have to weigh

up the administrative costs bearing in mind that siltation protection measures are only one part of total water resources management. In policing this the ARWB has to look at its priorities. It is illegal to discharge waste material into a waterway and silt is regarded as waste material. If such discharge occurs the ARWB will ask:

1. Has the developer got a water right?
2. If he has a water right, has he complied with the special conditions imposed?

If the developer hasn't got a water right the ARWB will insist that he gets one but will tend to deal with him a little more leniently than if a developer already has a water right but does not comply with the terms of the water right.

It was pointed out that local experience needs to be gained in the Auckland area into how big a problem siltation is. In particular, it is necessary to gather statistics on the volume of silt which may be expected to accumulate in silt ponds over a given area of subdivision.

An example was quoted of a subdivision in North Auckland constructed in greywacke-derived clay. A total of 600,000 m³ of earth was placed. The whole area was cleared progressively and contour drains were installed as each area was stripped. All these drains led into a main silt pond. Boards were used to adjust the level of a weir as the silt rose in the ponds. The whole area of the cut face was hydroseeded and windrows of hay were used to further prevent scouring. This avoided sedimentation of the silts and no complaints were received from any local bodies. The area of the silt pond was approximately ¼ acre and during the job this was filled to a depth of about 1 m. The surface area of exposed clay would be about 5-6 acres.

A question was asked regarding how to predict the quantity of silt which may erode off a subdivision and reference was made to a recent large subdivision where everybody was astounded at the amount of silt which was washed off the subdivision and overflowed ponds in less than half a winter, and deposited the remainder of the silt in a park. Hence quantities of sediment eroded must be related to local conditions which must take account of such factors as the soil type, the rainfall and the topography and the maximum particle size to be retained in the silt ponds have to be related to these factors. Hence the next step is developing a method of design of silt traps which will apply to the Auckland area. However, the procedure must be essentially a practically-oriented one. If procedures get too complicated the cost of determining the required size of silt traps for a given particle size to be retained could approach the cost of actually providing the silt traps themselves.

It was pointed out that when a subdivision is stripped of all topsoil this tends to cause a severe erosion problem and that surely it is best to reduce the stripping of topsoil to an absolute minimum to reduce the erosion problem. As one of the main purposes of levelling the ground in a subdivision is to improve the value of the land, this must be equated with the cost of providing necessary anti-erosion measures. It was felt that pressure should be applied to developers to reduce the denuding of vegetation to an absolute minimum and also to retain as many trees as possible in order to reduce erosion. It was pointed out that local authorities do have ordinances which they have used to try to control the extent of stripping of topsoil and vegetation. They have been difficult to enforce but the intent has been quite reasonable. The emphasis of development should be on disturbing the existing country as little as possible. In reply to this argument it was pointed out that in development of a subdivision, by far the largest portion of the earthworks volume involved was needed to create the roads. Generally all the topsoil

stripped from a subdivision in the first place was reinstated after the filling had been completed. Many subdivisions being currently developed were on steeply sloping ground and if a local authority demanded a maximum gradient of the subdivision roads of 1:8 then if much of the subdivision was on slopes of the order of 1:2 a considerable volume of earthworks would be required to create such roads.

Devonport was quoted as an example where some people do not have vehicular access to their houses and this in fact adds to the charm of the area, but it was pointed out that Planning Ordinances would not allow this to happen in new subdivisions.

A further comment was made that up to the present, most housing development works have been in developing reasonably flat land and now developers were moving into land for development which was not really suitable for housing. In planning a subdivision and in particular the roading layout, the developer should always be conscious of the basic lie of the land.

Another speaker pointed out that the main objectives of carrying out earthworks in subdivision development were:

- (i) To provide suitable subdivisional roading
- (ii) To provide piping in watercourses and then to fill in the gullies
- (iii) To provide a suitable building site for each house in the subdivision.

In the average slope over the area is 1:2 then it will generally be found that earthworks will be necessary over at least three quarters of the total area of the land. The local authority rules on the grading of subdivisional roads are largely responsible for this large area over which the earthworks will extend. Also the piping of watercourses may mean an extensive volume of filling and local authorities often insist that all watercourses be piped. Also any instability problems within a subdivision can increase the volume of earthworks. In order to improve the stability of sites it may often be necessary to fill in a gully. The result of the above factors is that a large volume of earthworks will be necessary if sloping ground is going to be developed for housing, particularly if the current local authority requirements that each house has to have vehicular access and a suitable slope to the front of the section are to be enforced.

Another speaker stated that we must become more socially aware in deciding what land is to be developed for housing. In order to avoid the loss of productive and fertile flat land for farming, there will be an increasing tendency to develop steep country for housing. People will have to continue to live with the problems created by developing this country, particularly during the construction period. There are a number of constraints on any contractor developing land for housing in built up areas. These include noise, pollution, soil type, run-off and the length of the summer earthworks season. All these factors are going to continue to push up the price of developing hilly land for housing to the point where it could become uneconomic. Provision of suitable measures to prevent run-off of silt due to erosion is just one of the factors which must be considered in the development of such land.

INTERNATIONAL TUNNELLING ASSOCIATIONINTERNATIONAL TUNNEL SYMPOSIUM 1978

The Ministry of Works and Development, as the New Zealand Representative on the International Tunnelling Association, has received information on a tunnelling symposium entitled "International Tunnel Symposium 1978" to be held in Tokyo from 29 May to 9 June 1978..

The main theme of the symposium "Tunnelling under Difficult Conditions" will be divided into four sub-themes:

Design and Planning

Construction

Environmental Problems

Contracts

Further information and copies of the official circular are available from the Management Secretary of the Geomechanics Society.

NEWS FROM THE MANAGEMENT SECRETARY1. NEW MEMBERS

New members elected to the Society since the last list was published are as follows:-

M.P. Chandler, J.J. Chapman, T.N. Costello, W.J. Henderson, J.A. Horsley, C.W. Howell, D.N. Jennings, D.F. Macfarlane, R.J. McKelvey, R.J. Manley, D.E. Peterson, M.B. Spicer, L.I. Taylor, R.J. Thorburn.

2. FORTHCOMING CONFERENCES AND SYMPOSIA

Listed below are Conferences and Symposia in the 1977-1979 period which we know about. Members may be interested in attending or obtaining Proceedings. Further details can be made available on request.

1977

November 30 - December 4 N.Z. Geological Society Conference, Queenstown (includes Geological Aspects of Energy Resource Development in N.Z. as a theme)

1978

January 15 - 20 International Conference on Evaluation and Prediction of Subsidence, Pensacola Beach, U.S.A.

March 8 - 10 International Symposium on Ground Freezing, Bochum, Germany

May 22 - 26 7th International Harbour Congress, Antwerp, Belgium

May 24 - 25 12th Canadian Rock Mechanics Symposium, Sudbury, Canada

June Southern California ASCE Geotechnical Engineering Specialty Conference

September 4 - 8 Third International Congress on Engineering Geology, Madrid, Spain

November Conference on Clay Fills, London

December 20 - 22 Conference on Geotechnical Engineering, Indian Geotechnical Society, New Delhi, India

1979

April 2 - 5 Third International Conference on Numerical Methods in Geomechanics, Aachen, Germany

October 25 - November 2 13th ICOLD Congress, New Delhi, India

3. MEMBERS "GONE NO ADDRESS"

The Secretary of N.Z.I.E. informs us that recent correspondence to the following members of the Society has been returned to him:

Mr T. Belshaw	Mr W. Nadler
Miss C. Crampton	Mr S.A.L. Read
Mr B.J. Gallagher	Mr D. Van Barnveld

I would be grateful if other members of the Society who know these people could tell them that they have been taken off the mailing list at the Society until such time as we receive their present address.

4. ELECTIONS FOR 1978 MANAGEMENT COMMITTEE

A voting form is enclosed as a looseleaf supplement to this issue of "N.Z. Geomechanics News". All members are urged to record their vote and thereby demonstrate their continuing interest in the Society. Biographical details of each candidate are attached to the voting form. To be recorded all votes must be in the hands of the Management Secretary by 9 December 1977.

5. CHANGE OF ADDRESS FORM

A form for notification of change of address is included at the back of this issue. N.Z.I.E. members should note that they should either use this particular form in addition to notifying the N.Z.I.E. of their address change for other correspondence, or else make it clear when they notify the N.Z.I.E. Secretariat that the address change applies to the Geomechanics Society as well. Otherwise we will not be notified of your address change.

6. PROCEEDINGS, NELSON SYMPOSIUM ON THE STABILITY OF SLOPES IN NATURAL GROUND, NOVEMBER 1974

Copies of the Proceedings are available from the Secretary, N.Z.I.E. at a cost of \$15.00 for Society members and \$18.00 for non-members.

7. BACK ISSUES, NEW ZEALAND GEOMECHANICS NEWS

Copies of most back issues are available to members at a nominal cost of 50¢ per copy from the Management Secretary.

8. Copies of "Slope Stability in Urban Development" are available to members at the reduced price of \$1.50, from Dr B.W. Riddolls, P.O. Box 30368, Lower Hutt.

J.M.O. HUGHES
Management Secretary

LANDSLIP INSURANCE AND STATEMENTSBY REGISTERED ENGINEERS

In an article under the same heading in issue No. 14 Geomechanics News in June 1977 I referred to forms of "Statement" relating to land stability which had been adapted for use by some Local Bodies but which were under review. That review has now been completed by a joint Subcommittee working on behalf of the Territorial Local Government Council and revised forms have been circulated to Territorial Local Authorities. The same committee is also investigating legislative amendments which would allow restrictions on landuse, on account of stability, to be recorded on property titles.

The revised forms are reproduced here together with summary notes from an accompanying background paper.

The section at the end of Summary Note 5, in parenthesis makes an important point. If a whole string of conditions have to be appended to a judgement of land stability then it is very likely that, that piece of land should not be used at all, but that nobody is quite prepared to face the music and say "No!"

D.K. Taylor

SUMMARY:

The committee recommends that local authorities with any involvement in residential development:-

- (1) Read DSIR Information Series No.122 - Slope Stability in Urban Development.
- (2) Take care with planning in relation to land stability and indicate on the relevant town planning data map the areas where instability is known, potential, or suspected. (Note - be careful not to give a spurious air of accuracy or certainty to the information).
- (3) Whenever development is proposed in such areas insist on a proper opinion in format 1 from a suitably qualified person before granting provisional approval and laying down the necessary conditions.
- (4) When approving such proposals reserve the right to amend the conditions of, or withdraw, such approval should information brought to light during construction make such action desirable.
- (5) Before accepting the subdivision as complete require a further proper opinion in format 2, if appropriate, and make such further conditions as may be necessary relating to individual sections. (Every effort should be made at the format 1 stage to avoid such further conditions. When it does happen, become a little more determined to do better next time).
- (6) Take all practicable steps to ensure that purchasers are made aware of any and all conditions relating to the use of each individual section.
- (7) Where appropriate require a proper opinion in format 3 before the issuing of a building permit.
- (8) Take every practicable step to prevent actions which are beyond the control of Council but may well place persons or property at risk.
- (9) At every step involving any technical issue make full use of the qualified professional advice of the Council's own staff or consultants to evaluate all opinions, proposals and recommendations made.
- (10) Do not call for the use of the Formats unless there is a genuine reason for them. This can lead to them being treated in a perfunctory manner on both sides. Remember the boy that cried "Wolf!"
- (11) Get a copy of "Slope Stability Considerations in Residential Sub-division Planning", a paper presented by David E. Hollands at the 1977 Conference of the New Zealand Institute of Surveyors.

Format 1 (6/77)

FORMAT FOR ENGINEER'S OPINION ON LAND STABILITY FOR RESIDENTIAL SUBDIVISION

Explanatory Note:

The professional opinion provided for in the following format deals with an aspect of the suitability of land for subdivision for building purposes and may be submitted to Council with the Scheme Plan pursuant to specific provisions of the District Scheme required by Regulation 16(3) of the Town and Country Planning Act 1953. Alternatively, the opinion may be required as a condition at the time of Scheme Plan approval pursuant to the Municipal Corporations Act 1954 or the Counties Amendment Act 1961. Because of the cost of obtaining such opinion, it should normally only be required in an area previously defined as having problems of known, potential or suspected land slope or foundation instability and where there is no reason to expect that the subdivision will not be approved on other grounds. Modifications to this format should only be made to the extent that they are appropriate to the specific opinion and are drawn to the attention of the local authority engineer accordingly.

To "The Borough/City/County Engineer,

.....

SUBDIVISION/LAND DESCRIPTION (insert)

I (insert name) of

..... (insert firm name and address)

hereby confirm that:

1. I am a Registered Engineer experienced in the field of soils engineering and more particularly land slope and foundation stability as applicable.
2. Site investigations have been carried out under my direction and are described in our report(s) dated
The professional opinion given in para 4 is based on the assumption that the data obtained from these investigations are representative over the whole subdivision.
3. I am aware of the details of the proposed subdivision and proposed engineering works as shown on the following drawings and specifications:
.....
.....
(insert references to all drawings and specifications, including dates of latest amendments).
4. In my professional opinion, not to be construed as a guarantee, (the proposed works give due regard to landslope stability considerations and that) there is (will be when the work is completed in accordance with the drawings and specifications) (delete as appropriate) on each residential section a site suitable for a residential building not requiring specific design in terms of NZS1900 and related documents, providing that:

Format 1 (6/77)

- (a).....
 - (b).....
 - (c).....
- (insert here details of any special conditions and/or special design criteria for building location and/or site grading and/or foundations and/or drainage, of which Council and future section owners should be made aware).*

This professional opinion is furnished to the Council for its purposes alone, on the express condition that it will not be relied upon by any other person.

Signed Date

NOTE: Where engineering works are to be undertaken before sites will be considered suitable for house construction, a condition of the Scheme Plan approval would normally require an "Engineer's Opinion after Works for Residential Subdivision" to be provided at the final plan stage. Such further opinion should afford the opportunity to vary the special conditions and/or special design criteria given in Section 4, based on site conditions as exposed during construction and any changes in the proposed works. Variations, if significant, might in turn cause Council to reconsider its approval and/or conditions.

Format 2 (6/77)

FORMAT FOR ENGINEER'S OPINION AFTER WORKS FOR RESIDENTIAL SUBDIVISION

Explanatory Note: The professional opinion provided for in the following format may be required as a condition at the time of Scheme Plan approval, pursuant to the Municipal Corporations Act 1954 or the Counties Amendment Act 1961, where engineering works are to be undertaken. Modifications to this format should only be made to the extent that they are appropriate to the specific opinion, and are drawn to the attention of the local authority accordingly.

To: "The Borough/City/County Engineer",
.....

SUBDIVISION/LAND DESCRIPTION (insert)

I (insert name) of
..... (insert firm name and address)

hereby confirm that:

1. Drawings and specifications relating to the above residential subdivision have been prepared by and are referenced as follows:

2. The works have been carried out by Contractors, and I enclose their certificate that they have carried out the work in full accordance with these drawings and specifications.

3. I inspected the works during construction to the extent I considered necessary to ascertain the design was correctly interpreted and that the works were being carried out generally in accordance with the contract requirements; it should be noted that such inspection does not provide an assurance that the works were carried out exactly as detailed. I enclose my report on Earthfills in terms of the N.Z. Provisional Standard 4431-P, 'Code of Practice for Earthfills for Residential Development'.

4. On the basis of the above certificate, inspection and report, I am of the opinion that the works have been carried out generally in accordance with the drawings and specifications.

5. As a result of this work, it is my professional opinion, not to be construed as a guarantee, that the completed works give due regard to land slope stability considerations, and that there is on each residential section a site suitable for a residential building not requiring specific design in terms of NZS.1900 and related documents providing that:

- (a)
- (b)
- (c)

(insert here details of any special conditions and/or special design criteria for building location and/or site grading and/or downcations and/or drainage, of which Council and future section owners should be made aware).

6. This professional opinion is furnished to the Council for its purposes alone, on the express condition that it will not be relied upon by any other person.

Signed Date"
(Registered Engineer)

Format 3 (6/77)

FORMAT FOR ENGINEER'S OPINION ON LAND STABILITY FOR RESIDENTIAL BUILDING

Explanatory Notes: The professional opinion provided for in the following format may be obtained in support of a building permit application. Because of the cost of obtaining such opinion, it should normally only be required for a site which is in an area previously defined as having problems of known, potential or suspected landslope or foundation instability, or for a section in a subdivision where final plans were approved subject to specific investigation and engineering design for that section. Modifications to this format should only be made to the extent that they are appropriate to the specific opinion and are drawn to the attention of the local authority engineer accordingly.

To: "The Borough/City/County Engineer"
.....

BUILDING/SITE DESCRIPTION (insert)

I (insert name) of
..... (insert firm name and address)
hereby confirm that:

- 1. I am a Registered Engineer experienced in the field of soils engineering and more particularly land slope and foundation stability as applicable.
- 2. Based on my inspection of the site and knowledge of local conditions I am able to provide the following professional opinions: *(Note: where this opinion is also based on reliance on previous plans and reports by others, reference should be included here).*

OR

- 2. Site investigations have been carried out under my direction and are described in our report(s) dated The following professional opinion is based on the assumption that the data obtained from these investigations are representative over the whole subdivision.
- 3. I am aware of the details of the proposed residential building and engineering works as shown on the following drawings and specifications
(insert references to all drawings, and specifications, including dates of latest amendments)
- 4. In my professional opinion, not to be construed as a guarantee, the drawings and specifications give due regard to land slope and foundation stability considerations, providing that:
 - (a)
 - (b)

(Note here if the proposed engineering works and/or foundations involve requirements which should be subject to inspection during construction by a Registered Engineer or person acting under his direction. Also note any special conditions of which Council and future section owners should be made aware.)

Format 3 (6/77)

This professional opinion is furnished to the
Council for its purposes alone, on the express condition that it will not be
relied upon by any other person.

Signed..... Date.....

APPLICATION FOR MEMBERSHIP

of

New Zealand Geomechanics Society

A TECHNICAL GROUP OF THE NEW ZEALAND INSTITUTION OF ENGINEERS

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

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

I hereby apply for membership of the New Zealand Geomechanics Society and supply the following details:

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

PERMANENT ADDRESS _____

QUALIFICATIONS AND EXPERIENCE _____

NAME OF PRESENT EMPLOYER _____

NATURE OF DUTIES _____

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

I wish to affiliate to:

International Society for Soil Mechanics and Foundation Engineering
(ISSMFE) Yes/No (\$2.25)

International Society for Rock Mechanics (ISRM) Yes/No (\$6.20)

International Association of Engineering Geology (IAEG) Yes/No (\$2;\$6 with Bulletin)

Signature of Applicant _____

Date _____ 19 ____

N.B. Affiliation fees are in addition to the Geomechanics Society membership fee of \$5.50.

Nomination:

I _____ being a financial member
of the N.Z. Geomechanics Society hereby nominate _____
_____ for membership of the above Society.

Signed _____

Date _____ 19 ____

NEW ZEALAND GEOMECHANICS SOCIETY
NOTIFICATION OF CHANGE OF ADDRESS.

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

Dear Sir,

CHANGE OF ADDRESS

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

Name: _____

Address to which present correspondence is being sent:

Signature _____

Date _____