N.Z. GEOMECHANICS NEWS

No. 11

NOVEMBER 1975

A NEWSLETTER OF THE N.Z. GEOMECHANICS SOCIETY

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CONTENTS

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

EDITOR'S NOTES

1. The Collection of Rock Defect Data for Engineering Purposes

This is the second article in a series concerning the analysis of rock defects and the use of stereographic projections. In Geomechanics News No. 10 it was stated that the articles would form a two part series. However the author, Mr I.R. Brown, has included an additional article on the collection of rock defect data, and the practical application of the method will be covered in a further article.

2. Cut Batters in Typical Weathered Wellington Greywacke

Included in this issue is an article written by Mr A.G. Mahoney on slope stability in urban development. Mr A.G. Mahoney is a geologist employed by Brickell, Moss, Rankine and Hill, Lower Hutt.

Although the material presented refers specifically to hillside development in the Wellington region, much of the information may be applied to slope stability problems in any urban development. It is reassuring to note that at last there is widespread awareness of the problems created by indiscriminate hillside development.

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

Professor P.W. Taylor attended this conference in his official capacity as Australasian Regional Vice-President of the ISSMFE. Professor Taylor gave the closing address to the conference. The text of his closing address is included in this issue.

Proceedings of this conference are now available through the Management Secretary of the Geomechanics Society. The price of the Proceedings, which will include a bound volume of papers and a discussion volume, is $25. As a guide to intending purchasers, a list of the papers contained in the Proceedings is included with the Management Secretary's News.

4. N.Z.I.E. Conference 1974 - Proceedings of the Workshop Session on Lateral Earth Pressures

The above workshop formed part of the Society's technical activities at the 1974 N.Z.I.E. Conference, and was based on the presentation and discussion of six papers covering the various aspects of lateral earth pressure analysis and retaining wall design. The Proceedings have now been published by the N.Z.I.E. as Vol. 1 No. 1(G) of the new publication format for N.Z.I.E. Technical Group Proceedings. Copies are available from the Secretary, N.Z.I.E., at a cost of $1.30.

5. N.Z. Geomechanics Society Symposium - "Stability of Slopes in Natural Ground" - Nelson, 1974

Proceedings of the above symposium have now been published and are available through the Secretary, N.Z.I.E.

The Nelson symposium was an extremely successful meeting at which a range of topics relating to slope stability were discussed. Papers presented covered legalities of slope stability, classification of land slides, geological assessment of slope stability, case histories, engineering assessment of slope stability and stability of rock slopes.

Copies of the Proceedings are available at $15 to members of the Society and $18 to non-members.

6. IX International Conference on Soil Mechanics and Foundation Engineering, Tokyo, 1977

Members' attention is drawn to a short article in this issue covering a call for papers for the above Conference. Copies of Special Bulletin No. 1 are available from the Management Secretary, which covers submission of papers and details of presentation.

7. N.Z.I.E. Conference 1976 - Geomechanics Society Participation at Technical Sessions

Following the precedent set at previous N.Z.I.E. Conferences, two technical sessions have been reserved for Society participation. The theme for the technical sessions will be "Slope Stability and Urban Development".

The first session will be presentation of a paper by Mr G.L. Evans entitled "Problems of Erosion and Stability in the Loess Slopes on the Port Hills, Christchurch." The paper is a presentation of case studies and a description of the erosion and stability problems as they affect hillside and urban development in loess slopes.

The second session will be a panel discussion related to the above topic and entitled "Problems associated with the formulation of a N.Z. Code of Practice". The N.Z. Geomechanics Society have formed a sub-committee to study this problem and are looking for positive comments from the profession.

8. International Tunnelling Association News

In accordance with our agreement with the Ministry of Works and Development (a member of the I.T.A.) a copy of the press release concerning the first Annual General Meeting of the International Tunnelling Association has been received and is included with the Management Secretary's News.

9. 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 fields 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:

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

I.M. Parton
EDITOR.

THE COLLECTION OF ROCK DEFECT DATA FOR ENGINEERING PURPOSES

I.R. Brown

1. Introduction

The description of a rock mass for engineering purposes requires that as much data as possible relating to the nature of rock defects is obtained from the available exposures. This information can then be used to classify the rock mass (Bieniawski 1973, Coates 1964, Deere 1968), or to produce rock quality values related to tunnel support designs (Barton *et al*. 1974, Terzaghi 1946, Wickham *et al*. 1972).

To ensure that all relevant data are collected in the field, the N.Z. Geological Survey Engineering Geology Section has adopted a logging sheet as shown on Figure 1. The use of such a logging format ensures standardisation of observations with different technical personnel, and also acts as a checklist where all columns must be filled in. These data can then be easily coded for storage on computer files, enabling the systematic combination and correlation of geological and rock mechanics data.

2. Explanation of Defect Survey Sheet

The defect survey sheet (Fig. 1) can be used at any rock exposure (natural outcrop, trench, tunnel). The location of the section to be examined is recorded as well as a general description of rock type, weathering (using the scale in Table 1) and rock structure.

At each defect position the following information is recorded:

Station

The position of the defect relative to a surveyed point, generally a distance from the beginning of a tape traverse.

Defect Type

Joint, fault, shear zone.

Dip Direction and Amount

Asimuth and angle measured with a clinometer, or protractor device in a magnetic environment.

Wall Rock Hardness

The hardness of the rock along the walls of the defect, using the scale in Table 2.

Continuity

The distance that the defect can be traced in the exposure.

Amplitude of Waviness

The amount of undulation of the defect surface.

Roughness

Two types of roughness are recognised, 'first-order' and 'second-order' (Fig. 2, after Patton 1966). Because of the variation in roughness along a fracture it is necessary to make an estimate of mean values of both orders of irregularity, and to describe the roughness in general terms as shown in Table 3.

Fracture Separation

The distance between fracture walls, which may be influenced to some extent by local stress relief.

Gouge

Thickness and continuity of defect infilling material.

Set Number

On field evidence, defects are recognised as belonging to a set of defects, each having similar orientations.

Spacing to Next Parallel Fracture

The distance between one defect and the next belonging to the same set.

Water Condition

The amount of water flowing out of the defect.

3. References

BARTON, N.; Lien, R.; Lunde, J. 1974 : Engineering classification of rock masses for the design of tunnel support. Rock Mechanics 6 : 189-236

BIENIAWSKI, Z.T. 1973 : Engineering classification of jointed rock masses. Transactions of the South African Institution of Civil Engineers 15 : 335-342

COATES, D.F. 1964 : Classification of rocks for rock mechanics. Rock Mechanics and Mining Sciences 1 : 421-9

DEERE, D.U. 1968 : Geological considerations. In Rock Mechanics in Engineering Practice (Stagg, K.G. and Zienkiewicz, O.C. eds) John Wiley and Sons : 1-20

PATTON, F.D. 1966 : Multiple modes of shear failure in rock. Proceedings of First Congress, International Society of Rock Mechanics, Lisbon 1 : 509-513

TERZAGHI, K. 1946 : Rock defects and loads on tunnel supports. In Rock Tunnelling with Steel Supports (Proctor, R.V. and White, T.L. eds) The Commercial Shearing and Stamping Co., Youngstown, Ohio : 15-99

WICKHAM, G.E.; TIEDEMANN, H.R.; SKINNER, E.H. 1972 : Support determinations based on geological predictions. Proceedings of the Rapid Excavation and Tunnelling Conference, New York : 43-64

to do their own compaction. It is essential to have a proper roller on the job.

Footnote: At a subsequent meeting of the S.A.N.Z. Earthworks Committee, the comments made at the above discussion were considered and it was resolved that NZS 4431P be left as a Provisional N.Z. Standard until more experience has been gained on its use on residential earthworks and more comment has been received back by the S.A.N.Z. Committee on its use in practice. Invitations to comment further on NZS 4431P are to be advertised as widely as possible.

NOVEMBER 1975

"Discussion on Temporary Support of Bulk Excavations" led by B.C. Hadfield of Gilberd-Hadfield Pile Co Ltd and F. Kratky of Auckland City Council.

A separate article is to be prepared for N.Z. Geomechanics News summarising this discussion.

(Attendance 27)

J.P.B.

WELLINGTON

So far three of the four meetings planned for the year have taken place.

The first meeting, a combined activity with the Wellington Branch of the NZIE was devoted to legal problems associated with civil engineering works, and was reported in the previous issue of Geomechanics News.

The second meeting, attended by about 20 people, was devoted to earthquake prediction. We were most fortunate to have Mr George Eiby, of the Geophysics Division of the DSIR, to give a most interesting address about recent developments in the understanding of changes that take place in the earth's crust prior to the occurrence of an earthquake. There has been a good deal of discussion of these developments in the geophysics and engineering literature and even in the popular press. Mr Eiby summarised the main concepts and was able to clarify the issues involved and reply to questions and objections. One aspect of interest to soil mechanists is the suggestion that the phenomenon of dilatancy plays an essential role in the process. It is postulated that prior to the earthquake there is an increase in shear stress in the rock surrounding the incipient fault. This increase leads to a volume increase in a large volume of rock surrounding the earthquake region. The dilatancy gives rise to changes in many physical properties of the rock, for example p- and s- wave velocities, so that there is an anomolous change in the ratio of these two before the earthquake. Other properties are also affected, as are other observations, such as level of water in wells.

One interesting sideline to the meeting was the great precision to which the geophysics people can determine these changes in properties. Mr Eiby emphasised that although the changes observed were small, they were only arrived at after the application of a number of corrections to the raw data. Perhaps there is a lesson to be learned from all this by civil engineers when embarking on monitoring of construction activities. If we were to make more use of the techniques and procedures employed by the geophysicist, we might be able to make more accurate observations of the effect of our construction activities on the surrounding material and so better understand the nature of the processes.

The third event for the year was the Second Geomechanics lecture which is reported elsewhere in this issue.

The final event took place on November 18 and was the lecture series presented by Dr E. Hoek.

CUT BATTERS IN TYPICAL WEATHERED WELLINGTON GREYWACKE

A.G. Mahoney

Over the last few years there has been considerable publicity given to failures of hillslopes and cut batter faces in urban development work. The number of cut batter failures in the Wellington area reached an apparent all time high during the exceptionally wet winter of 1974.

A Wellington firm has for many years been involved in design and supervision of residential development in the Wellington area. More latterly acting on behalf of the Earthquake and War Damage Commission, engineers from this firm have inspected numerous land slip claims in the district. Consequently the writer has been fortunate in seeing, and hopefully learning, from some of the harvest of cut batter failures which time has inevitably brought.

For many years the accepted standard cut slope in the Wellington area (that has not required specific design, i.e. probably about 99.9%) has been of the order of ½ : 1 (horizontal to vertical) up to 7 or 8 metres high. Where intermediate benches are constructed, these have generally been of the order of 2 metres wide. Many, indeed most of these batter faces have stood well excepting small localised fallouts, but certainly some have failed badly. Though localised edge failures involving only several cubic metres of debris may be of no consequence to engineers, they are ranked as some of the world's greatest disasters to the owners concerned.

It is suggested that there in fact could be a reasonable case for slightly varying standards on slope design according to the access restriction for clearing slips and the potential damage a failure will entail, i.e. cut batters at the rear of houses with only pedestrian access should be of a different standard from cut batter faces with good access, i.e. on roadsides.

Due to the numerous features in weathered rock which controls its stability as an open standing face, i.e. degree of weathering, orientation and type of structures within the mass, water influence etc, not all these features can reasonably be ascertained prior to cutting without extensive and expensive subsoil investigation. However, by using reasonably inexpensive precutting inspection of the site, most stability problems can be reasonably forecasted. Where poor ground conditions are encountered during excavation, which were not considered during design, it is suggested that the stability of slopes be reappraised before cutting to final slope and grade.

Outlined below are some ideas which may help improve the stability of batters, particularly when designing for large scale subdivisions into steep country:

1. Slope Design

Design the batter in the first place to be reasonably "slip-free", i.e. reasonable overall stability without extensive pre-cutting subsurface investigation. This will probably entail a surface reconnaissance of the proposed cut in order to pre-judge the likely order of weathering in rock exposures either immediately on the location or closely adjacent. Based on experience, suggested slopes are:

a. Batters less than 6 metres high.

¼ : 1 in fresh rock, i.e. grades I and II (according to weathering classification proposed by Pender (1971)).

The internal structure of the rock will determine its failure mode.

½ : 1 in slightly to moderately weathered rock, i.e. Grade II to III.

3/4 : 1 in moderately weathered rock, i.e. Grade III.

1 : 1 in highly weathered to completely weathered rock, i.e. Grade IV to V.

b. Batters up to 10 metres high in typical moderately to high weathered grades - 1 : 1.

c. Batters over 10 metres in similar conditions - 1½ : 1.

It may be useful to remember at this stage, that if a batter slope is of the order of 1½ : 1 or less steep, people can then begin to "use" their land, i.e. for terracing, planting, etc. Surely, the very fact that a cut slope may be useful to the owner (if on a private section), should be sufficient reason for more sensible slope design. The minimal added cost during the initial earthworks stage of cutting a 1½ : 1 slope instead of typical ½ : 1 will readily be recouped by selling a more attractive section.

2. Benching of Slopes

There appear to be various arguments for and against having slopes benched and there is probably no single right answer, i.e. each case should be treated on its own merits.

Some argument for benches -

i) easier to physically cut

ii) benches below catch localised fallouts

iii) individual benches may be useful to landowner

iv) psychologically the batter appears less awe-inspiring when looking up or down slope, i.e. benches tend to break the line

Some against -

i) present drainage problem in time. One small slip negates a carefully constructed fall and leads to saturation on the bench

ii) individual batters between benches steeper than overall slope - hence obviously have less stability

iii) vegetation will grow on benches but sparsely on faces steeper than 3/4 : 1. Other than grass, larger growth causes local rock falls on steeper faces

iv) hillside looks unnatural with steep stepped slopes whereas on one continuous slope aesthetically more pleasant

v) less steep slopes i.e. 1½ : 1 or less, whole batter face can be more useful to property owner than steeper benched equivalent.

3. Construction Layout

The construction layout should be designed to suit existing batter faces or proposed batter faces if these faces appear to be over-steep and cannot economically be regraded or designed less steep.

a. Preferably plan roads, right-of-ways, etc. to lie at base of batter, i.e. separating private property and dwellings from danger of slipping. This may mean areas of rear sections served by right of ways off the road. Slipping onto road will not damage property and is readily accessible for machinery to remove debris;

b. Leaving a safety zone between building and batter toe. Minimum machine width will be about 3 metres (i.e. width of Drott Loader). A safe distance between building and batter toe will obviously depend on the height, slope and weathering of batter, i.e. ½ : 1 slope 6 metres high - 3 metres clearance strip will allow for a substantial slip from upper half of batter face with the debris fan sloping back from the house foundations at approximately 30^{o}.

Such an angle would be a reasonable Ø angle for angular sandy gravel of which the debris is likely to be comprised. Generally the minimum distance of a structure from the toe could be calculated by 33^{o} projection from the centre point of full batter slope.

c. Rear (batter) facing walls of dwellings could be substantially strengthened to withstand impact loading, i.e. use of reinforced concrete or block as distinct from lightweight cladding like asbestos. On very steep slopes, i.e. natural cliff faces - full rear retaining walls and parapet to restrain slips and allowing some freeboard above local surface to stop rolling debris. On bare rock slopes, where rolling coarse debris is common, safety screens of heavy mesh netting;

d. Strict construction control on steep sites. Particular attention must be paid to stormwater drainage, both temporary and permanent. The average homeowner appears to be completely ignorant of the importance and effect of uncontrolled stormwater. In fact, often it appears that many consider roof guttering being necessary only to stop water dripping on their heads. Suggested measures to control stormwater are:

i) cut off drains above heads of batters where significant amount of surface drainage can be expected from up slope and piping of intercepted runoff;

ii) roof drainage and all hard surfaces (i.e. driveways, paths, patios, etc) should have proper stormwater provision such as sumps, falls, drains, etc. Very few people are aware of the volume of runoff that can originate from these surfaces during heavy rain and also from lawns if the rain is intense and the soil is saturated;

iii) subsoils and channel drains along rear of buildings near base of cut batters;

iv) temporary stormwater ditches during construction phase led into existing drain or water courses, not indiscriminately fed onto neighbouring property.

4. General Location of Cuts and Fills

a. Ridges in insitu rock are in general better locations to cut batters, i.e. at right angles to line of ridge than across or oblique to flanks. This can be related to natural drainage off the flanks and the structural orientations of the underlying rock comprising the ridges.

b. Cutting across the valley -

i) could result in major change in soil type hence change in stable angle of proposed batter;

ii) intersection of drainage system must be allowed for according to size of catchment and depth of valley infill (both natural and man-made). Depth of valley fill will possibly control depth of groundwater movement which will in turn probably control behaviour of soil.

c. Earth fills should not be left "hanging" in upper portion of steep valleys, particularly if cutting below is anticipated.

5. Influence of Geological Structure on Batter Behaviour

All planar features (i.e. bedding, joints, shearing) should be studied or mapped, if not prior to construction, during construction of batters. Structure will probably have the greatest influence on batter stability in weathered greywacke of classes I - IV.

Noted below are some typical examples of structural control in batter stability as may be evidenced in the Wellington area. Generally the standstone member controls failure when jointing is predominant. Joints are usually well developed in folded sandstone. Argillite (siltstone) is often sheared approximately parallel to the bedding and without well defined jointing, although thicker argillite beds are more likely to have better developed jointing than thin beds.

Example 1 (Figure 1)

Bedding dipping into the batter face at low to moderate angles and striking parallel or near parallel to the face. Failure will be along joints developed approximately at right angles to the bedding. This kind of failure is probably the most common type of failure in Wellington, both in permanent and temporary excavations.

Batters cut in thin interbedded argillite and sandstone are often weak due to open jointing of the more brittle sandstone and the low shear strength of the typically sheared argillite component.

Example 2 (Figure 2)

Bedding dipping steeply into the cut batter face and striking parallel or near parallel to the same. Failure will take place through joints (as above) or in a toppling mode in the upper portion of the beds. Toppling is seen more in grade IV-V weathering, generally on a relatively small scale, particularly on steep temporary construction cuts.

Example 3 (Figure 3)

Bedding dipping out of the cut batter face and striking parallel or near parallel to the same. Failure is by sliding along bedding planes and can lead to large scale failures with particularly serious consequences.

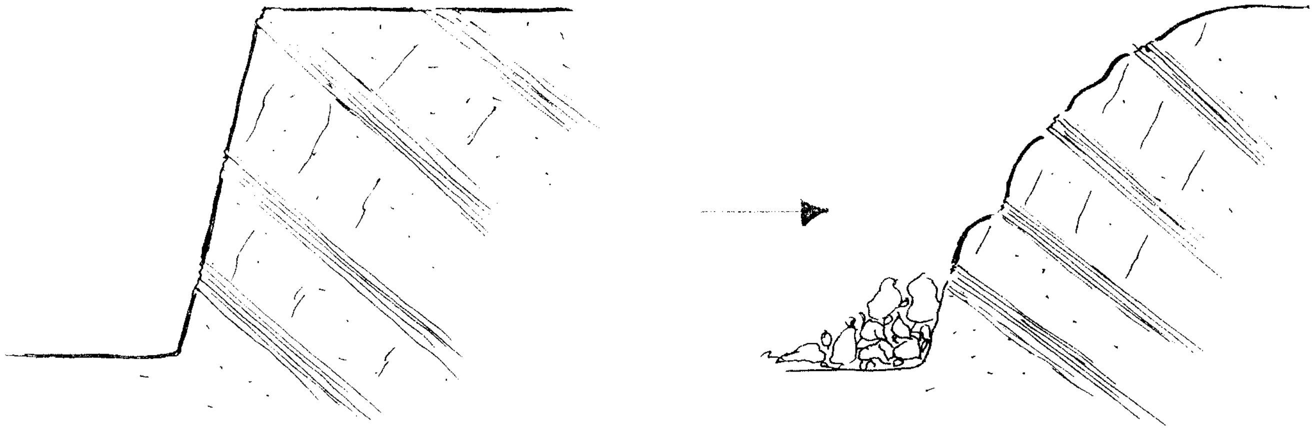
Example 4 (Figure 4)

Wedge type failures are commonly seen in cut batters in the Wellington area. Generally they are a result of the intersection of bedding planes with either jointing or shear planes defining a wedge which dips out of the face. Commonly they are of limited volume but damage caused by such "dropouts" is often determined by proximity of structures at the head or toe of the failure.

Wedge type failures cannot realistically be avoided by design of batter alignment and slope because of the multitude of planar structures generally developed in local Wellington greywacke. They are best counteracted by a safety margin left along the toe of the batter as is also the case for avoiding block falls.

REFERENCE

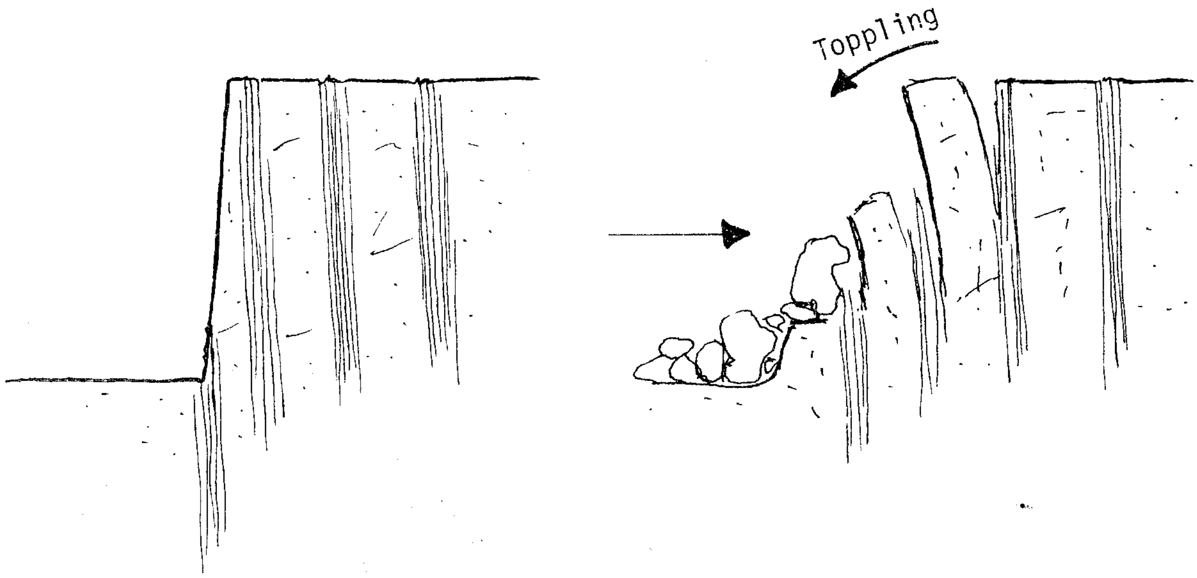
Pender M.J. "Some Properties of Weathered Graywacke" Proc 1st Aust.-N.Z. Conference on Geomechanics, Melbourne, 1971.



Jointed, interbedded argillite and sandstone

Failure along established joints

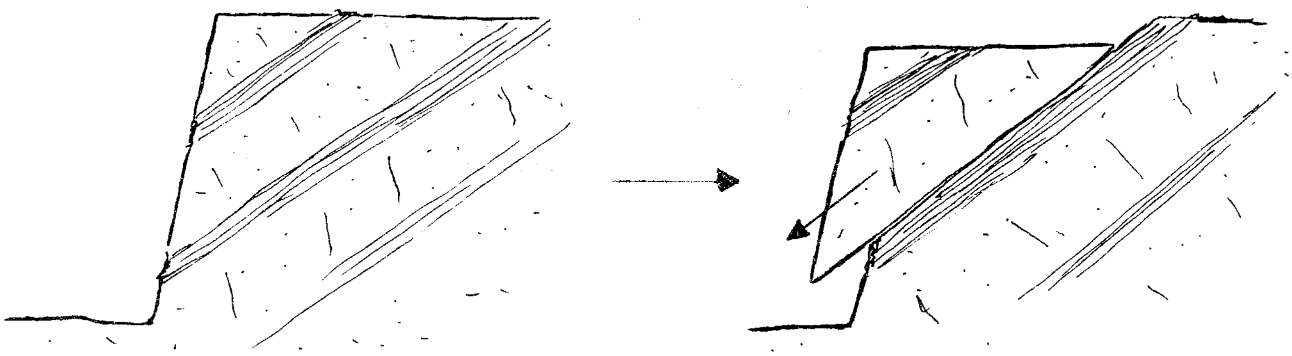
Figure 1



Jointed, interbedded argillite and sandstone

Gaps open along bedding, blocks topple into excavation

Figure 2



Jointed, interbedded argillite and sandstone

Movement down dip

Figure 3

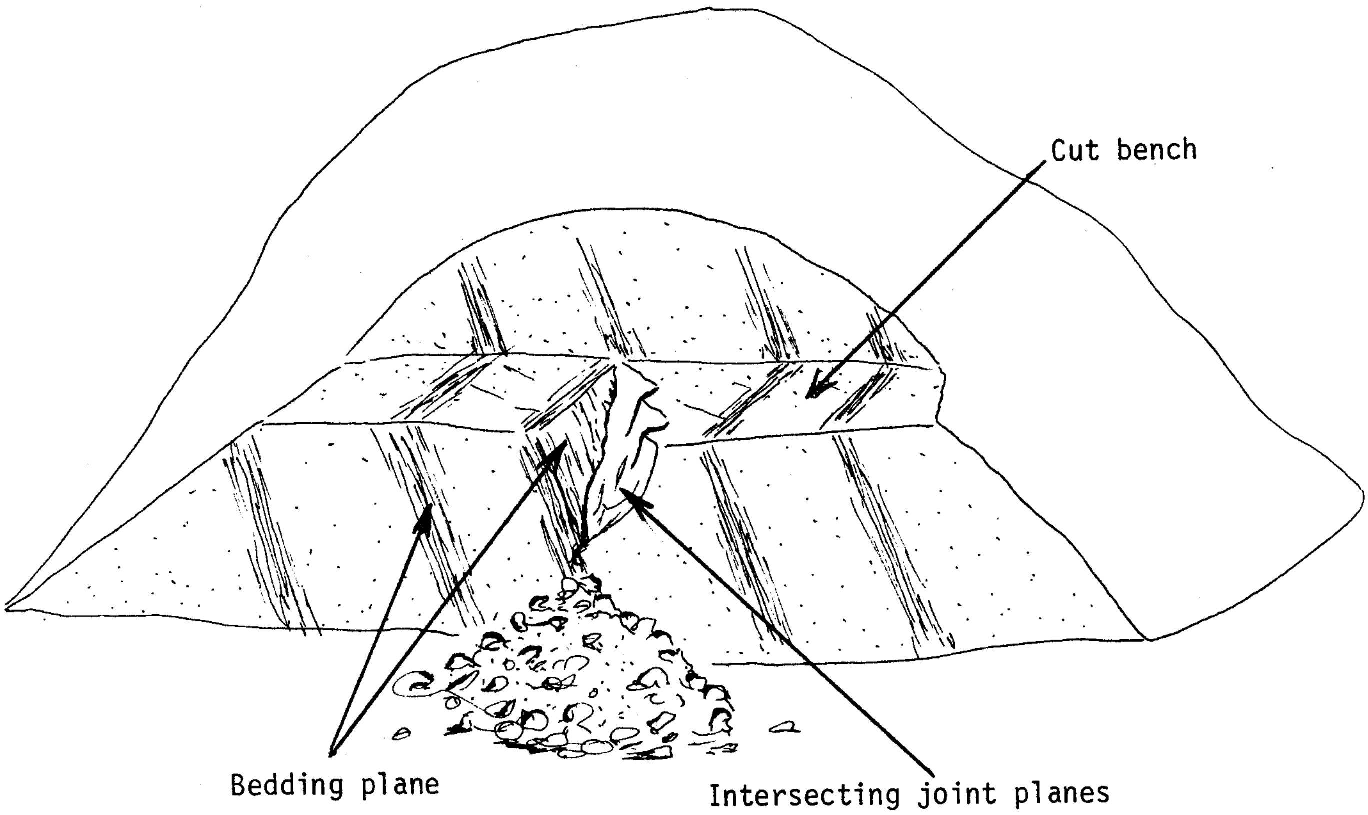


Figure 4

THE SECOND N.Z. GEOMECHANICS LECTURE

J.G. Hawley

Dr C.P. (Peter) Wroth gave 'The Second N.Z. Geomechanics Lecture' in Auckland, Christchurch and Wellington early in August. Dr Wroth, who is Reader in Soil Mechanics at Cambridge University, had been asked to choose a topic of reasonably broad civil engineering interest. This he succeeded in doing by basing his lecture on a review paper which he had written (jointly with Dr J.B. Burland) for the conference on the 'Settlement of Structures' organised by the British Geotechnical Society and held at Cambridge University in 1974.

The Lecture was entitled "A Fresh Look at the Damage caused to Buildings by Settlement." In the first half of the Lecture Dr Wroth reviewed many papers - particularly the classical ones by Skempton and MacDonald, and Polshin and Tokar. Noting that buildings usually became unserviceable well before they were in danger of structural collapse he developed the concept of a critical tensile strain associated with the onset of visible cracking. This concept allowed correlations to be drawn between (a) the criteria laid down in the papers mentioned above, (b) the results of laboratory tests on model walls and (c) case histories. Many of the case histories had been presented very recently - most of them at the 1974 conference on the 'Settlement of Structures'.

The extreme sensitivity of many types of building to hogging deformations was emphasised and illustrated.

In the second half of the Lecture, Dr Wroth looked at the interaction between structures and the underlying ground. He emphasised that as damage due to settlement is usually confined to the cladding and finishes, it was the deflections and rotations occurring subsequent to the application of the finishes which was of importance. Some effects which soil properties (such as non-homogeneity and anisotropy) could have on settlement predictions were then considered.

A condensed version of the Lecture will be published in N.Z. Engineering.

In addition to the Lecture, Dr Wroth gave colloquia at each of the three centres, earlier on the same day in each case. These were aimed at audiences with an interest in theoretical soil mechanics. Dr Wroth gave a brief outline of the possibilities of establishing a correspondence between the elastic/plastic behaviour of metals and the behaviour of soils. He then touched on some of the major features of 'Critical State Soil Mechanics' and finally gave a description of the application of these in an embankment performance prediction competition organised (in Boston) by Professor Lambe. These colloquia were co-sponsored by MWD, DSIR and the Universities of Auckland and Canterbury. They were well attended and well received.

All three Lectures were scheduled to fit in with N.Z.I.E. Branch activities. Local arrangements were handled by -

Dr J.M.O. Hughes and Professor P.W. Taylor in Auckland

Messrs T.A.H. Dodd and D.H. Bell in Christchurch.

and Dr M.J. Pender in Wellington.

- all in consultation with Local Branch Chairmen.

The Secretary of the Institution in Wellington gave invaluable assistance by handling finance and airline bookings.

The writer wishes to record his thanks to these people, who made his job of organising the visit as a whole, a very light and pleasant one.

FIELD INSTRUMENTATION

PART 3 - MEASUREMENT OF LOAD AND EARTH PRESSURE

P.R. Barker

The final part of this series on field instrumentation deals very briefly with some of the instruments used to measure loads on a foundation and to measure total earth pressure. Parts 1 and 2 appeared in Geomechanics News No. 9 and No. 10 respectively.

LOAD MEASURING INSTRUMENTS.

Mechanical Load Cell.

In most load cells the principle of operation amounts to the measurement of the deformation of an elastic body by the load to be measured. The elastic body is usually "linear elastic", i.e. it exhibits a linear or constant relationship between load and deformation within its design range.

The proving ring (fig. 1) is a precision elastic load measuring device and can be used for the measurement of tensile or compressive loads in field tests, such as plate bearing tests and pile loading tests. The change in diameter along the axis of the load is measured by a micrometer screw, dial gauge, or a linear displacement transducer.

Photoelastic Indicators.

When a cylinder of optical glass is strained by the application of a load, photoelastic interference fringe patterns are visible in the glass cylinder when illuminated by polarised light. The fringe pattern observed may be calibrated to give a direct measure of the load applied to the cell. Tensile and compressive loads can be measured using this method.

Some of the advantages of this load indicator are that it is relatively cheap to manufacture, easy to install and use; the main limitation is that access to the load cell is required to take readings.

Strain Gauge Load Cell.

These cells work on the principle that the electrical resistance of a metal varies directly with deformation caused by applied load. A number of resistance strain gauges are bonded on the surface of a machined metal strut, fig. 2. When an axial load is applied the resistances of R_1 and R_2 decrease, due to shortening, and the resistances of R_3 and R_4 increase. By connecting the strain gauges to form a Wheatstone Bridge circuit, as shown, the output measured between points 1 and 3 will vary in proportion to the applied load. Such a device is easy to calibrate.

These load cells have a rapid response to applied load and are suitable for recording rapidly varying loads. The sensitivity of a cell may be selected by the number of elements and arrangement of the strain gauge circuits.

Vibrating Wire Load Cells.

A gauge wire is stretched between two posts on a structuralmember or load cell transducer element fig. 3. When the gauge wire is plucked it will vibrate at its natural or resonant frequency. If strains are induced in the element, the distance betwen the wire supports changes, and this results in a change in the natural frequency of vibration. This change of frequency can be directly related to the strain and hence the load on the transducer element.

Advantages of this type of load cell are; it is accurate, sensitive and stable; installation is simple and the measurements may be made remotely.

EARTH PRESSURE MEASUREMENTS.

Most cells consist of a diaphragm, the deflection of which is measured. By calibration the average pressure can be related to this deflection.

Strain Gauge and Vibrating Wire Earth Pressure Cells.

Two electrical methods can be used to measure the deflection of a diaphragm; resistance strain gauges and vibrating wire gauges. The principles of these methods have been discussed above. The vibrating wire principle has been used in a number of types of earth pressure cells. One such type, developed by the Building Research Station, U.K. is shown in fig. 4. It consists of 2 metal discs both of which are recessed to form a flexible diaphragm. When bolted together they form a load capsule, and the deflection of the diaphragms is measured by a vibrating wire strain gauge. The cell can be used either as a boundary cell or for earth fill pressure measurements. Advantages of the cell are; it has a linear calibration with no hysteresis; it can detect bedding errors by differences in readings on each face.

Hydraulic Cell.

The Gloetzl pressure cell, fig 5, consists of two fluid systems separated by a diaphragm. A thin sensing pad filled with oil is connected by a tube to one side of the diaphragm. To take a reading the oil pressure on the other side of the diaphragm is increased until it equals the pressure on the sensor pad side. Any further increase causes the diaphragm to move and diverts the oil into the bypass. The pressure in the supply line cannot exceed the pressure on the sensor pad side of the diaphragm. The maximum applied oil pressure, i.e., that which causes the diaphragm to operate the bypass, is therefore equal to that on the sensor pad.

Epilogue.

This series has hopefully given a brief insight into some of the sorts of instruments that are available to the engineer to enable him to better understand and also to monitor what is taking place in a section of country or a structure. The use of field instruments for engineering purposes in New Zealand is limited, mainly to Government organisations, probably because of finance. However, perhaps it is a suitable time for other Members who have had experience with field instruments to relate to the membership some of their experiences.

Selected References.

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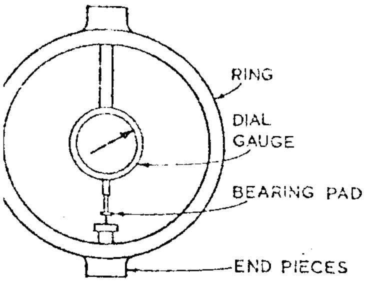
Triandafilidis, G.E. 1974. Soil - Stress Gauge Design and Evaluation. Journal of Testing and Evaluation. Vol. 2 No. 3. pp. 146 - 158.



ig. 1 : The Proving Ring Principle.

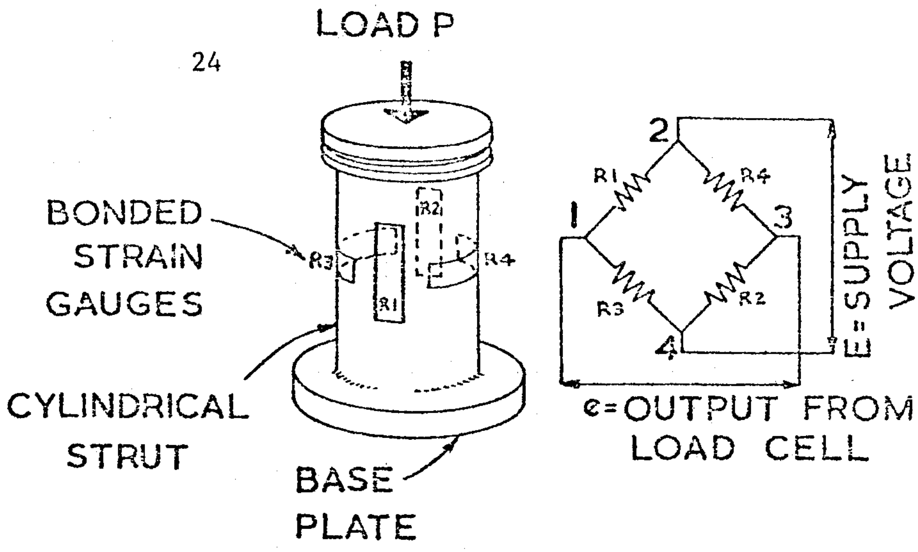


Fig: 2 :
(a) View of strain gauge layout on load cell element;
(b) Circuit diagram of strain gauges.

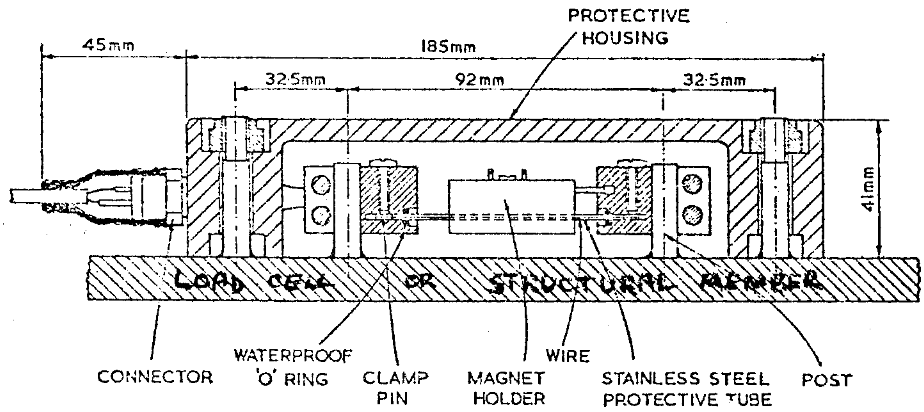


Fig. 3 : NGI Vibrating wire strain gauge

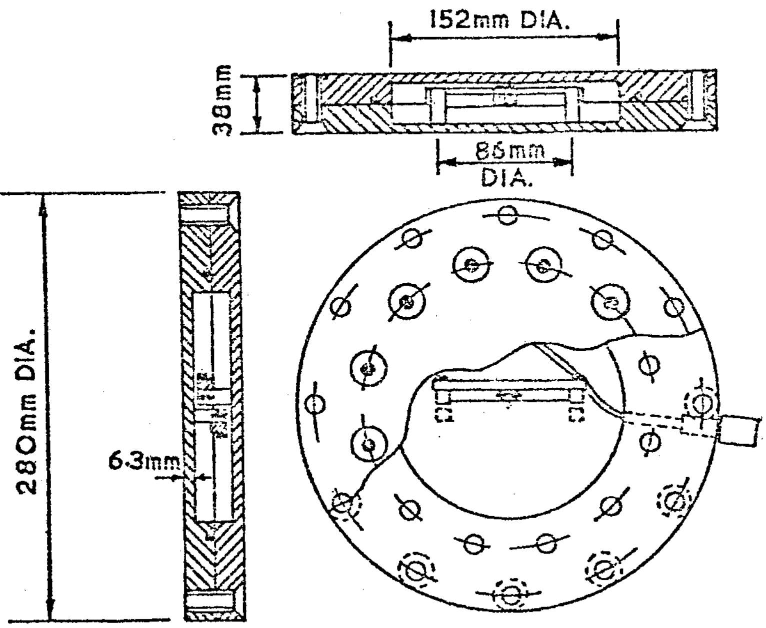


Fig. 4 : Vibrating wire earth pressure cell

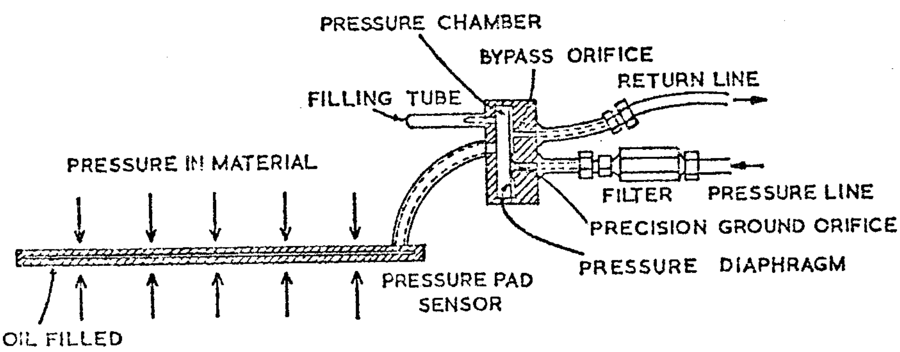


Fig. 5 : Principle of the Glötzl earth pressure cell.

NEWS FROM THE MANAGEMENT SECRETARY

1. New Members

New members elected since the last list was published in issue No. 19 are as follows:

L.M. Cumming	H.M. Patel
P.L. Fairburn	J.R. Pettinga
P.M. Hancock	G. Ramsay
D.E. Hollands	J.R. Rice
N. Kananghinis	R.P. Suggate
H.J.F. Kennedy	R.G. Taylor
J.D. McLean	

2. 2nd Australia-New Zealand Geomechanics Conference - Brisbane, July 1975

The conference attracted 250 registrants including 10 from New Zealand. The technical programme of 60 papers (including 9 by N.Z. authors) was very varied, and included topics covering mining, foundations, rock mechanics, engineering geology and theoretical and experimental soil mechanics. The Australian organizing committee have suggested the Society order a bulk supply of the bound papers to meet the N.Z. demand. In order to get some indication of likely demand, it is suggested that prospective buyers indicate their interest by writing to the Management Secretary. The cost is likely to be of the order of $25 - it is hoped that this will include a discussion volume.

3. 3rd Australia-New Zealand Geomechanics Conference

At a joint meeting of representatives from the Australian and New Zealand management committees held during the Brisbane Conference, an invitation from the New Zealand committee to hold the 3rd conference in Wellington in approximately four years time, was accepted.

4. Forthcoming Conferences and Symposia

1975

19th - 22nd December	5th Asian Regional Conference on Soil Mechanics and Foundation Engineering, Bangalore, India

1976

1st - 7th March	International Symposium - "Tunnelling 76" London
22nd - 24th March	6th European Regional Conference on Soil Mechanics and Foundation Engineering, Vienna, Austria (Bulletin No. 3 available from the Management Secretary)
20th - 25th June	2nd International Conference on Numerical Methods in Geomechanics, Virginia, U.S.A.

27th June - 2nd July	ASTM Symposium on Dispersive Clays, Chicago, U.S.A.
10th - 14th August	ISRM Regional Conference - Investigation of Stress in Rock, Sydney
16th - 26th August	25th Session of the International Geological Congress, Sydney
1977	
11th - 15th July	9th International Conference on Soil Mechanics and Foundation Engineering (Bulletin No. 1 available from the Management Secretary)

5. Publications

The following are available from the Management Secretary:

(a) Proceedings, Wanganui Symposium on Foundation Engineering
- \$ 8.00 Society members
\$10.00 Non members

(b) Back Issues, N.Z. Geomechanics News
- 50 cents per copy

The following publication is available from the Secretary, N.Z.I.E.:

Proceedings of the Workshop Session on Lateral Earth Pressures (held at the 1974 N.Z.I.E. Conference)
- \$ 1.30

G.R. MARTIN
Management Secretary

INTERNATIONAL TUNNELLING ASSOCIATION

PRESS RELEASE

The first Annual Meeting of the International Tunnelling Association was held in Munich, on 28-30th April 1975. It has got together 95 participants (delegates and observers) representing 15 out of 20 member nations of the Association, 4 out of 12 nations likely to soon join the Association and 6 International Associations.

Member Nations represented

South Africa, Federal Germany, United States of America, Spain, Finland, France, Iceland, Italy, Japan, Norway, Netherlands, United Kingdom, Sweden, Switzerland.

Member Nations not represented

Algeria, Australia, Canada, Greece, New Zealand.

Other represented Nations

Austria, Belgium, Czechoslovakia, Turkey

International Associations

The Permanent International Association of Road Congresses (PIARC) was represented by M. Jacques Rerolle, President of the Road Tunnel Committee, the International Road Federation (IRF) by its General Director, Count Ferdinand Arco, the International Society of Rock Mechanics (ISRM) by its President, M. Pierre Habib, the International Railway Union (IRU) by M. Etienne Chambron, President of the sub-commission of tunnel, the Association of Mining Congresses (AMC) by M. Roger Schweitzer, the International Society of Soil Mechanics by its Committee of Federal Germany.

The International Tunnelling Association has the primary object of promoting appropriate international cooperation and exchange of information between all those who, throughout the world, are interested in matters concerning the planning, design, construction and operation of all types of tunnels and underground excavations, for all purposes, including : communication, transport, services, hydro power, storage, water supply, sewerage flow and sewerage treatment, etc...

The most effective role of the Association lies in the setting up of international Working Groups, from its members and from other interested organisations.

The following working groups were decided:

Standardisation	:	led by M. Plichon (France)
Research needs	:	Dr Girnau (German Federal Republic)
Safety	:	M. Wilson (South Africa)
Underground Planning	:	M. Jansson (Sweden)
Contractual sharing of risks	:	M. Mathews (United States of America)

In addition, the Secretariat of the Association takes in charge the work concerning the following fields:

Exchange of technical information

Demand forecasting

Interchange of technical information on a number of topics, including lists of works in progress and cost/benefit analysis.

Election of Executive Council has given the following results:

President	:	M. A.M. Muir Wood (United Kingdom)
Vice President	:	Prof. H.C. Fischer (Sweden)
Vice President	:	M. W.N. Lucke (United States of America)
Additional Members	:	M. Shinohara (Japan) and a representative of Federal Germany
Secretary General	:	M. P. Duffaut (France)

The Secretariat, under the direction of M. Claude Berenguier, is situated in France, 109 Avenue S. Allende, 69672 Bron, tel. : 26.04.55, to which address all inquiries about the Association should be directed.

The Meeting in Munich was made possible by the courtesy and generosity of the German Association for Underground Works (D.A.U.B), by the Land of Bavaria, by the City of Munich and by the Munich Metro.

The next annual meeting is to be held in London, towards the end of February 1976 immediately preceding a conference to be held there, "Tunnelling 1976" at the beginning of March.

SECOND AUSTRALIA-NEW ZEALAND GEOMECHANICS CONFERENCE, BRISBANE, 1975

LIST OF PAPERS

FROM THE ENGINEER'S BOOKSHELF

"SOIL PROPERTIES AND BEHAVIOUR"

Raymond N. Yong and Benno P. Warkentin, Elsevier Scientific Publishing Co., Amsterdam, Oxford, New York, 1975

This is a most disappointing book, the more so because at first glance it promises well. The 'contents' listing raises the hope that the book might present soil engineering concepts and practice as an aspect of soil science rather than as a specialised field of civil engineering. Such a book would be invaluable in these times of environmental concern. Increasingly, soil engineers need to communicate with soil scientists (such as pedologists) and few soil scientists engaged in real problems can avoid dialogue with engineers for long. This book fails to meet the challenge.

If it were true that the only thing wrong with the book was the many misprints (particularly in formulae and diagrams), adverse criticism could properly be directed at the proof-readers alone. However, the problem is deeper than this. In some chapters (e.g. Chaps 5 and 7) muddled concepts are to be found on almost every page, while concepts which are just plain wrong are to be found on many. These are poor rewards for readers who have fought through the atrocious grammar and the muddled terminology.

Almost incredibly, derivations of some well known formulae are misquoted. One example of this is the derivation of the Kozeny-Carman equation. Here the reader is invited to distinguish "the wetted surface area per unit volume Sw from the total surface area S per unit volume..... SW = S(1-n)." The symbol n represents porosity. After trying unsuccessfully to visualise a difference between the wetted surface and the total surface (within a saturated soil) this critic was relieved to read in another text that this stage of the derivation concerns the surface area of soil particles per unit total volume, and per unit volume of solids. With these two quantities thus defined, and represented by the symbols Sw and S respectively, it is clear that Sw is indeed equal to S(1-n). The explanation given by Yong and Markentin is not only a misquotation, it is nonense. This particular muddle also occurs on page 356 of the earlier book "Introduction to Soil Behaviour" by the same authors. Another amalgam of bad grammar and erroneous concepts occurs in the analysis of sedimentation on page 12 of this book and page 18 of the earlier book.

Some parts of the book which did not appear in the earlier book are particularly rich in errors. An outrageous one is to be found on pages 147-8 where the effects of introducing a horizontal layer of less permeable material into a column of soil experiencing one-dimensional vertical seepage is examined. After noting (correctly) that the effect of such a layer is to concentrate the head loss within the layer, they conclude that the flow through this layer would be increased!

Only four lines after the above 'howler' the reader is faced with an equation (5.8) which is dimensionally non-homogeneous and a page further on an equation in which a missing plus sign turns a sum into a product. This is indicative of how thick and fast the errors come.

Quite apart from the misprints, this book's deficiencies are so serious that it should be kept away from students: it can only confuse and depress: it could not enlighten or stimulate.

J.G.H.

NINTH INTERNATIONAL CONFERENCE ON SOIL MECHANICS AND FOUNDATION ENGINEERING

TOKYO, 1977

The ninth ICSMFE is to be held in Tokyo, July 1977. The following programme has been arranged for the technical sessions:

MAIN SESSION

1. Stress-deformation and strength characteristics.
2. Behaviour of foundations and structures.
3. Slopes and excavations
4. Soil dynamics and its application to foundation engineering.

SPECIALTY SESSION

1. Tunnelling in soft ground.
2. Soil sampling.
3. Relationship between design and construction in soil engineering.
4. Ground anchors
5. Determination of soil parameters from in-situ tests.
6. The probabilistic approach to soil mechanics design.
7. Geotechnical problems in ocean engineering.
8. Deformation of earth/rockfill dams.
9. Constitutive equations of soils.
10. The effects of horizontal loads on piles, due to surcharge of seismic effects.
11. Geotechnical engineering and environmental control.
12. Computer analyses in soil mechanics.

In addition there are to be Special Lectures by Mr M. Fujii (Japan), Prof. A.W. Skempton (U.K.), Prof. T. Mogami (Japan) and Dr R.B. Peck (U.S.A.).

A call is made to members of the Gemechanics Society for submission of papers for presentation at the Tokyo Conference.

Synopses of approximately 300 words are required to be submitted to the Management Secretary of the N.Z. Geomechanics Society not later than March 30, 1976, and finished drafts not later than June 30, 1976.

Requirements for preparation of papers are contained in the Special Bulletin No. 1, copies of which may be obtained from the Management Secretary on request.

LETTERS TO THE EDITOR

The following correspondence has been received by the Editor:

Sir,

re Letters to the Editor.

The May 1975 issue of "N.Z. Geomechanics News" contains an interesting letter by J.H.H. Galloway on the scope, and choice of name, for the subject of geomechanics.

Although his letter states that he realises the value of brevity, your correspondent then coins the word "geomechanicist", which looks and sounds a tongue-twister. What is wrong with the short word "mechanic" to describe a person working in the field of soil mechanics, fluid mechanics, or geomechanics? If our subject is geomechanics, surely each of us is a geomechanic.

- Roderick Agnew

RECENT GEOMECHANICS PUBLICATIONS

The Society has been asked to publicise the following Geotechnical Texts which may be of interest to members:

"Handbook of Soil Mechanics, Vol. 1, Soil Physics", by Arpad Kezdi, 1973. 256 pages, $US29.60.

"Grit and Clay" by M.D. Picard, 1975. 258 pages, $US25.00.

"Limit Analysis and Soil Plasticity", by Wai-Fah Chen. Vol. 7 of Developments in Geotechnical Engineering, 1975. 630 pages, $US99.95.

"Soil Properties and Behaviour" by Raymond N. Yong and Benno P. Warkentin. Vol. 5 of Developments in Geotechnical Engineering, 1974. 300 pages, $US36.50.

All the above may be obtained direct from:

Elsevier Scientific Publishing Co.
P.O. Box 211,
Amsterdam,
The Netherlands.

SECOND AUSTRALIA - NEW ZEALAND CONFERENCE ON GEOMECHANICS

- Brisbane, 1975 -

CLOSING ADDRESS

P.W. Taylor

Vice President, International Society for Soil Mechanics and Foundation Engineering, Associate Professor of Civil Engineering, University of Auckland.

It is an honour and a privilege to be asked to address you at this closing session of what has proved to be a most successful conference. We are deeply indebted to those who have organised it so well as will be acknowledged by Dr Martin, later in this closing session.

If we consider publication of Terzaghi's Erdbaumechanik to mark the birth of Soil Mechanics, then the topic has been regarded as a separate discipline for fifty years. The rate of development over that period has not been steady. Terzaghi's own powerful influence gave a tremendous initial impetus which continued for many years. As well as periods when exciting progress was being made, there have been periods of quieter consolidation (if I may use that term).

As was suggested by Dr Wroth in his lecture at the opening ceremony, we are, at present, in a period of exciting new developments, which I hope to return to later.

It is of interest to recall that Karl Terzaghi came to the study of soil mechanics through Geology. Having found geological methods of description inadequate for some problems, he concluded that new, more exact, numerical methods of description were necessary. This does not mean that he discarded geology - far from it. He regarded geological knowledge as essential for the full understanding of any geomechanics problem.

This is only the second Australia-New Zealand conference covering the broader field of Geomechanics and it has demonstrated the advantages of engineering geologists and rock mechanics men getting together with specialists in soil mechanics and foundation engineering. We are coming to understand each other better. During this conference, the multi-disciplinary approach to engineering problems has been more evident than previously, and it is to be hoped that this trend continues. The co-ordination of activities in Rock Mechanics, Soil Mechanics and Engineering Geology, which we have in Australia and New Zealand is envied in some other parts of the world. On an international level a combined secretariat has been established in Brussels to achieve co-operation.

At the 1967 conference, Professor Trollope of James Cook University expressed the opinion - with which I agree - that, in the training of a civil engineer, the study of geomechanics is at least as important as the study of the mechanics of structures or of fluid mechanics. He felt then that this was not fully recognised within the universities, either in their course structure, or in staffing. This situation, I believe, is continually improving, and, if complete equality with the other major sectors of civil engineering has not been achieved, it is certainly being approached.

To turn now to the university training of civil engineers in its broader context, there are conflicting pressures for change. On the one hand there is a demand for more in-depth training in narrowly specialist fields, while at the same time there is a demand for broader training which considers the environmental and sociological effects of civil engineering works. The universities must face this challenge.

I believe it is essential to include within the undergraduate curriculum these broader planning aspects and to emphasize the point, sometimes forgotten, that engineering is for people. One way in which this can be approached is by including Systems Engineering as part of the Civil Engineering course as is now being done, for example, at James Cook University which I had the pleasure of visiting before coming to Brisbane.

There will, undoubtedly, be an increasing proportion of graduates proceeding to higher degrees. There are clear advantages in young engineers obtaining practical experience for a year or so before postgraduate study. In New Zealand, this trend is being encouraged by our Ministry of Works which now maintains selected engineers on full salary while doing postgraduate work. Continuing education programmes providing short intensive courses on new methods and techniques will form an important part of the university's work in the future.

Research is, of course, an important part of the work of the university. Preferably, it should be directed towards engineering problems of local or national importance. There is a real danger, however, that research interests may take precedence over teaching. At least in this part of the world the primary function of university engineering departments, is I believe, to train the engineers of the future - and this cannot be satisfactorily done if undergraduate teaching is neglected in favour of more glamorous research commitments. I am not saying that this happens at the moment, but it is a pitfall to be avoided.

There is, I believe, a good relationship between the profession and the universities, in that university staff tend to become involved in practical problems. This is something to be encouraged - lectures that can be related to real engineering experiences gain relevance in the eyes of students, while at the same time, worthwhile topics for research frequently emerge from such involvement.

Several papers at the conference have included ideas of probability, and these notions will come into more general use in the future. When we state a factor of safety absolutely ("this slope has a factor of safety of 1.2") we give the impresssion of omniscience. Attitudes towards the engineering profession are changing. A failure that once may have been considered an "act of God" is now regarded as the result of negligence of the engineer. Is this an indication of a retreat from orthodox religion, or a growing belief in the omniscience of the engineer? Perhaps it would be more honest to describe the stability of the slope in terms of probability of failure, provided this can be done in a rational manner. The probability approach can be abused, however. If it is used in conjunction with poor quality testing, then it is being abused. There is no substitute for high quality sampling and test work. Perhaps more than in any other area of technology, we are very dependent on the skill of those people carrying out sampling and testing. Test results which are obtained using poor techniques are not merely meaningless - they are misleading. Good sampling and testing can only be done by well trained, highly skilled people under close supervision of qualified, experienced engineers. Unfortunately this aspect is too often neglected. To some extent it is the result of inadequate technician training programmes in this part of the world.

Reverting, in conclusion, to future developments. These were clearly outlined in a stimulating way by Dr Wroth at our opening session. New laboratory techniques, better computer facilities and greater attention to field measurements were mentioned. I know that in my own special field of interest, which is geomechanics aspects of earthquake engineering, we have devised improved methods of laboratory testing; we are making new sorts of field tests, and the results of these are being utilized in new methods of analysis only possible with the computer. These are examples of only three of the many current avenues of development. Throughout the broad spectrum of geomechanics the prospects for advancement seem very bright indeed.

APPLICATION FCR 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 & EXPERIENCE ____________________________

____

____

NAME OF PRESENT EMPLOYER ______________________________

____

NATURE OF DUTIES ____________________________________

____

____

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

I wish to affiliate to:

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

International Society for Rock Mechanics (ISRM) Yes/No

International Association of Engineering Geology (IAEG) Yes/No

Signature of Applicant ______________________

Date: ______________ 19 __

I .... being a member of the New Zealand Geomechanics Society, hereby support the above application by .... for membership.

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: ______________________________