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SESSION 10 — GENERAL REPORT

FIELD EXPLORATION AND SAMPLING (GEOTECHNICAL)

Reporter
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1 INTRODUCTION

This brief review paper has two objects namely:

(i) to give my personal assessment of the scope and value of the material covered by the papers falling in this session,

and

(ii) to give a brief overview of the current state of practice in the Australian scene.

No apologies are made for being fairly outspoken in my views. Too often we are too "diplomatic" to criticise inadequate or poor quality material and too blind to recognize the pearls. The papers under review here contain, in my opinion, both ends of the spectrum.

As must be expected in an all-embracing Geomechanics Conference, it is not possible to define a coherent theme that runs through the papers under review for this session. They range from tests on soft clay, through coral, to rock. Thus the papers will be dealt with individually and general comments are reserved to the end of this review.

2 PAPERS COVERED BY THIS REVIEW

The papers covered are as follows:

2.1 Rock Mechanics or Rock Testing

Paper 1: A new stress relief concept for in situ stress measurements in rock and its implementation in two recoverable stress-meters.
Bock, Foruria & Lequerica

Paper 2: Determination of the deformation modulus of rock from tunnel and borehole loading tests.
Carter & Booker

Paper 3: Determination of rock mass modulus.
Chappell

Paper 4: Measuring properties of rock with a high pressure pressuremeter.
Jewell & Fahey

2.2 Soil Mechanics

Paper 5: Shear strength of estuarine mud of the Swan River.
Geidans & Kelvington

Paper 6: Modulus and shear strength values measured in the pressuremeter test compared with results of other in situ tests.
Fahey & Jewell

Paper 7: Recent developments in screw plate testing in Adelaide.
Kay, Nicholls, Mitchell and Avalle

2.3 Other Topics

Paper 8: Experimentation with the German dynamic probing technique on the Great Barrier Reef.
Bock

Paper 9: Statistical site characterisation
Haldar

For simplicity of presentation in the following discussion, the papers will be referred to by the above numbering system.

3 PAPER 1

The material presented in this paper was published by the same authors in the Proceedings of the ISRM Congress in Melbourne in 1983. At that Congress the authors were not given the opportunity to present their work and had to be content with a poster presentation in the lobby. The present paper gives more details than when presented at Melbourne and goes on to describe the application of the slot-cutting technique at Mt. Isa.

Two ideas are presented. The first involves the use of a very high capacity borehole jack to induce radial cracking along a length of borehole, in conjunction with reuseable, friction type, strain gauges. This idea was, in essence, unsuccessful although the friction gauges appear to work well.

The second idea is the one that has promise, although I must be honest and say that it appears a bit odd at first sight. The method involves cutting a slot down the side of a borehole by means of a very cunningly constructed diamond saw. A specially designed displacement gauge measures the slot closure which is a function of the applied stress field.

The advantages of this type of approach are listed by the authors but this reviewer would raise the following points for their consideration and reply:

(i) It would appear that this technique would have a significant borehole length limitation. What is the maximum length from the tunnel sidewall? Can the device work in a vertical hole?

(ii) The analytical basis for interpretation seems to invoke St. Vernant's Principal somewhat loosely. How valid is the method of analysis?

(iii) Would it be necessary to measure the rock modulus on core samples taken from the bore-hole?

(iv) What would be the effect of cross anisotropy as in a closely bedded sedimentary rock or a schistose material?

There have been many attempts at developing rock stress measurement devices and a fair amount of criticism has been directed to this proliferation of gadgets. However, Bock et al have taken a practical and very honest approach to their work which this reviewer considers worthwhile because most of the current stress measurement techniques usually don't work very well.

4 PAPER 2

This theoretical paper is one of the pearls in this Conference because it provides correct solutions to tests commonly undertaken and usually analysed incorrectly.

The tests covered by the theoretical solutions given in this paper are:

(i) Any form of plate bearing test inside a small adit or tunnel.

(ii) Pressure chamber test or pressuremeter test.

(iii) Goodman-Jack test.

The authors show how the conventional (half-space) analysis of a plate bearing test inside a tunnel may overestimate the mass modulus by 40% or more. The potential errors in the conventional analysis of the Goodman-Jack test are ± 20%.

The conclusions reached by the authors regarding the length to diameter requirements of pressure-meters are not new and were obtained by Hughes (see Ervin, 1984).

5 PAPER 3

I consider this to be a poor paper that contains significant technical errors and presents almost nothing new. A detailed review has been forwarded directly to the author for his reply and it would not be appropriate to include all the comments here. However, the following points should be noted.

(i) Some 80% of the paper constitutes an intro-duction and the actual subject it claims to cover is discussed only in two paragraphs in the last two sections of the paper.

(ii) Sect 2 (Rock Mass Structure) - 1st Para.

The material covered in this paragraph is in essence the same as that first published by Chappell in 1980 and in Chappell 1983a and 1983d. The following symbols or terms used in Figure 1 are not defined

E_u

E_L

Relative Volume Vj

(iii) Sect 2 (Rock Mass Structure) 3rd Para.

The discussion in this paragraph is simply a rehash of well established principles in rock mechanics and engineering geology which can be traced back to publications at least a decade ago.

(iv) Sect 3 (Plate Bearing Flat Jack Tests)- 2nd Para.

This paragraph is very difficult to follow and contains a technical error in that the stress concentration around the adit is not required if the flat jack test is used for modulus determination.

(v) Sect 3 (Plate Bearing Flat Jack Tests)- 4th Para.

Bieniawski's proposal for rock mass classifi-cation dates from 1973 not 1978.

The statement in the 4th sentence (top of page 3) is wrong. There is no way that the factors of in-situ stresses, orientation and boundary constraints can all be incorporated in one parameter measured by the "plate bearing jacking test".

The last sentence of this paragraph is also rather a contradiction and is not what Muller implied in 1974. Stability or instability is a function of non-linear behaviour whereas this paper is dealing with the determination of rock mass modulus which is essentially an elastic concept.

(vi) Sect 5 ((actually typed as Sect 4) Plate Bearing Jacking Test) - 1st Para.

4th Sentence:
If it is possible, from the laboratory test data to determine both the lower and upper bound moduli (which this reviewer does not believe), then what is the point of doing the field test?

6th Sentence:
What form of anisotropy is implied? This reviewer would suggest that nobody has succeeded in measuring the variables for generalised anisotropy on a rock mass in the field and that it cannot be done from five plate bearing tests on an in-homogenous medium such as a jointed rock mass.

(vii) Sect 5 (Plate Bearing Jacking Test) - 2nd Para.

Figure 4 gives a numerical model of a tunnel not a test site. It is unclear to the reviewer how the numerical model of the whole test site can be used to correlate between the laboratory test and the field plate test which is conducted on a small volume of the rock on the perimeter of such a tunnel. It is quite unclear whether the iterative procedure the author is discussing involves altering the laboratory data, or the data from the field tests, or the numerical model itself.

(viii) Sect 5 (Plate Bearing Jacking Test) - 3rd Para.

5th & 6th Sentences:
The reviewer would expect that the use of

explosives to form the anchor cavity would affect the rock mass, opening joints etc. This effect would be significant since it appears from figure 6 that there is a datum rod down the centre of the hollow bolt and anchored in the anchor area.

(ix) Section 6((typed 5) Rock Mass Performational Response) - 2nd Para.

The reviewer now comes to the horrifying statement that the information he is actually awaiting and for which he has had to wade through 3 pages of introduction is in another paper (1983d). What follows reads like an advertisement for other papers the author has published and no data whatsoever are given in this paper.

(x) The paper finally concludes with the one useful piece of information - namely that given in the table. However, since there is no basis whatsoever in the paper for the generalization given in this table, this reviewer is left with some doubt as to the validity of the values in the table. In particular, the method of determination of the Poissons ratio values is not stated.

6 PAPER 4

This paper, which describes the development of a "new" pressuremeter instrument capable of applying a radial pressure of 20 MPa, is very unsatisfactory in that it makes no mention of equivalent instruments that have been commercially available (Oyo, Coffey PMX20) and in regular use in Australia for at least 5 years (see Ervin, Burman and Hughes, 1980).

The only "differences" with this new instrument seem to be that

(i) It uses gas pressures up to 20 MPa - something which the commercial instruments can do but which is very dangerous and to be discouraged.

(ii) It has 4 displacement transducers as opposed to 2 individually read gauges in the PMX20 and 2 averaged gauges in the Oyo instrument.

(iii) With a length to diameter ratio of 6, it is unnecessarily long (see comments on Paper 2 above).

7 PAPER 5

Six case studies, involving slip failures through the estuarine muds of the Swan River, are summarised. The calculated undrained shear strengths are compared with the measure vane strengths and the equivalent Bjerrum correction factors are computed. These correction factors are generally higher than those given by Bjerrum and there is no correlation factor between the correction factors and the Plasticity Index.

The approach adopted by the authors assumes that true undrained conditions pertained during the construction and subsequent failure of these embankments. While this may well be true, the paper does not give any data in terms of Coefficients of Consolidation and construction rates to justify the method of analysis.

The paper gives comparisons between vane and self-boring pressuremeter strengths at one site. The pressuremeter strengths are 1.4 to 1.7 times the vane values which are in turn higher than the back calculated strengths. This is rather disturbing and may be due to anisotropy in the strength characteristics of the materials. Alternatively it may be a loading rate effect. Either way it is a matter which deserves detailed discussion at the conference.

One significant factor that the authors should consider is the possible inaccuracies in the slip circle analyses for a material whose strength increases linearly with depth. Published work by Booker and Davis at Sydney University has indicated that quite significant errors may arise from the slip circle approach and this may well affect the interpretation of the correction factors to be applied to vane or pressuremeter test results.

8 PAPER 6

An interesting and useful paper that compares the modulus and strength results from pressuremeter testing with the data produced from conventional site investigations (SPT, Dutch Cone, etc.).

Two of the most significant points made in the paper are:

(i) The appropriate modulus to use from pressuremeter tests is the reloading modulus, even for self-boring pressuremeter work. This is a very significant statement because, as the authors point out, the reloading modulus may be up to 10 times higher than the initial loading modulus. It would be valuable if the authors could provide detailed justification for this statement.

(ii) The simple interpretation of the SPT test proposed by Parry for the prediction of settlement is satisfactory. Since this interpretation involves no correction for overburden pressure, it would be worthwhile for the authors to expand on the reasons why such corrections are not necessary.

9 PAPER 7

The screw plate test has received a fair amount of attention at both the Universities of Adelaide and Sydney in recent years. This paper presents data from the Adelaide area and, in particular, considers two case studies involving stiff clay profiles. The paper provides some interesting data but is very misleading in implying that "conventional" site investigation techniques are limited to SPT and Dutch Cone tests.

The second case study refers to a Grain Silo investigation and implies that the "conventional" site investigation, based on SPT tests in clay, leads to the recommendation for a piled foundation, whereas a saving of $200,000 was achieved by using the screw plate data. This reviewer would suggest that the estimation of settlements in clay based on SPT data does not represent the present state of "good practice" in Australia.

Two other questions are raised for the authors' comments:

(i) Does Figure 2 refer to Gault Clay or is the data from Adelaide,using the test apparatus given in Figure 1.

(ii) The authors assume that the modulus determined by the screw plate test is the "true" value. Is there no disturbance with this test method? Do the authors have any comparative data between screw plate and pressuremeter modulus values?

10 PAPER 8

This paper is an extension of the work at James Cook University which was described by Bock and Brown in 1980. The paper describes the main features of the heavy dynamic cone apparatus and presents test data from Keeper Reef (same data as presented in 1980), Heath Reef, Hope Island and Ribbon No. 5 Reef. A generalised profile through the Barrier Reef type formation is given and the paper concludes with the finding that the blow count values for the HDP apparatus are equivalent to normal SPT values. Therefore, it is assumed that conventional methods of foundation design and analysis based on SPT values would be appropriate. This reviewer would suggest some reservation in this regard because the experience with carbonate type materials is that they don't behave in the usual engineering manner - particularly with respect to side shear and end bearing behaviour of piles. The authors' comments in this regard would be appreciated.

11 PAPER 9

A copy of this paper was not received in time for inclusion in this review and it will thus be dealt with verbally at the Conference.

12 GENERAL COMMENTS

The papers incorporated within this session contain much useful information but unfortunately, with one exception, there are no data comparing the performance of actual structures with predictions based on site investigation data. It is not easy to obtain data on actual structural performance but this is the way research should be directed if significant advances are to be made in site investigation techniques.

Four general trends seem to be emerging from the proliferation of papers on site investigation techniques. These are:

(i) The results of SPT tests can be interpreted without overburden correction, as per Parry.

(ii) The vane shear test gives a satisfactory measure of undrained shear strength.

(iii) Uncertainty still exists with regard to the accuracy of the modulus and strength values produced by self-boring and conventional pressuremeters. There appears to be a ground swell of opinion that reloading modulus values should be used.

(iv) The electric cone penetrometer (Dutch Cone) is proving to be one of the most useful tools in site investigation practice.