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THE ENGINEER AND THE ENGINEERING GEOLOGIST

Last night, the 24th November, I attended a debate arranged by the Association of Engineering Geologists. The motion proposed was : 'This house believes that site investigation is too important to be left in the hands of Engineering Geologists'.

The proposer was Andy Robertson, while Dr. van der Merwe opposed the motion.

I could go on for pages by reciting the arguments put forward in support of the motion; the fact that Engineering Geologists have no formal training in Soil Mechanics or Structural Engineering, the fact that the Engineering Geologist's duty is merely to define the soil strata, the fact that the continuity required in a civil engineering project demands the presence of the engineer from the start, and so on.

I could go on somewhat fewer pages by recording the points against the motion; that the general run of the mill site investigation can be quite easily dealt with by the Engineering Geologist, the fact that it is he alone who has a sufficient knowledge of stratigraphy to adequately and safely carry out a site investigation, and so on.

I could go on for many pages discussing the questions such as who is best suited to perform site investigations but such questions and the arguments for and against the motion have been heard before and in themselves do not advance anybody's cause.

Indeed as long as there is money to be made by performing site investigations so long will geotechnical engineers and engineering geologists scrap about who is best suited to earn the fees; at least this strife will go on until and unless all subscribe to a code of ethics such as that governing professional engineers.

This question of the registration of engineering geologists was one of the between-the-lines topics that arose during the debate. I propose therefore in this report to concentrate on these seemingly side issues from the debate which however appear to me to be the issues of the future and to be of the utmost importance and interest to geotechnical engineers.

It appears that the Professional Engineers Joint Council is considering the registration of members of the so-called para or quasi engineering disciplines. The issue that was discussed at the debate and that on which the A.E.G. has been asked to make recommendations is the academic and practical qualifications that are likely to entitle a person to be registered as a para or quasi engineer. Andy Robertson spoke of a three year geology degree plus seven years appropriate training or a four year geology degree with five years training. This should be compared to the engineer's four year degree and three years training. In addition Andy Robertson pleaded that training, preferably academic, in soil mechanics, hydraulics, materials and structures to name a few, be made a prerequisite for registration. It was conceded that a person so trained would be entitled to act as an engineering geologist carrying out site investigations alone.

The point was quickly taken that few people, let alone civil engineers, wereso well trained. Undoubtedly true but surely the time has come when the geotechnical division and the universities should pick up and promote the idea first publically mooted at the Durban conference that training facilities for an entirely new type of civil engineering professional should be established. He would be a person who for four years will have studied basically the same subjects as present engineering students except that the amount of structural engineering or electrical engineering or higher mathematics or concrete and steel design he would be taught would be curtailed to enable him to study four years of geology and site investigation and engineering geology.

This is the person the PEJC should aim to register. Except for those existing engineering geologists who have proved their mettle and who are undoubtedly worthy of professional status the PEJC should avoid opening the doors to geologists who because of the magnetic pull of economic forces are drawn to the lucrative fields of quasi-engineering operations.

It is not simply a matter of organising, controlling and rationalising the existing state of affairs; it is also very much a matter of planning and preparing for the future and of promoting the status of the engineer by ensuring that registration is meaningful in terms of engineering competence and integrity and those qualities which found the professional code of ethics. If registration is to become no more than belonging to another group of technical men then indeed it is meaningless and money-hungry geologists who have survived seven years of practical work can be registered without further ado.

I do not intend by what I have said above to imply that geologists or for that matter any other scientific person is not entitled or should not be considered to be a professional person. In fact the very contrary is what I believe. However if such disciplines aspire to professional status then let it be by routes other than the Professional Engineers Act. The future holds sufficient by way of the difficulty of persuading the layman of the professional intent of engineers; it seems unwise to shoulder the additional burden of explaining how scientists and geologists must be thought of as professional engineers.

On an entirely different subject the matter of so-called team work by geologists, engineering geologists and engineers was mentioned. I would have thought that the balloon diagrams by Tony Williams a few issues of Ground Profile ago would have disposed of the topic.

Of course there must be team work on almost any civil engineering or building project; men have grouped as teams since first they hunted savannah flesh. But Hamlet was not written by a committee nor yet Peanuts by a group and even a cursory glance at the names of consulting and contracting civil firms in this country will reveal the predominance of firms that bear the name of a prominent man or outstanding leader. It is the quality of a leader that makes the worth of a team more than the sum of the individual components. It is the leader who attracts the public eye and enhances a profession or group. It is the leader who makes innovations and breaks new ground, it is his decisiveness that carries a crisis, it is his discipline that curbs a possible fault, it is he who makes a team at all possible as a functioning entity and not a mere chaos of self wills.

The question really is who should lead the team? Should it be the engineering geologist or the engineer ? And how should he be trained ?

I submit that it makes no difference who leads or how he is trained. For leaders are born not made and as long as the leader has a smattering of knowledge about the work of those he leads that is enough.

The matter is not quite so simple as this, unfortunately. Traditionally and regardless of personal qualities the members of certain professions lead certain teams. The most obvious example is the architect who tends to be the leader of building teams even where the structure is a work of engineering complexity.

In the same way the innocent title of the debate really hid a far more brutal aspect and that was the problem as to who should, by tradition and custom and trade usage, lead the geotechnical team: the civil engineer or the engineering geologist. The matter is one of discipline precedence or right to the top post. Faint pleas for teamwork will not solve the problem, perhaps registration will.

On a lesser plain it was suggested during the debate that the problem was not one of education of the engineering geologist but was one of education by the engineering geologist. He should educate the engineer in the meaning of the true worth of geology in the site investigation process. He should bring to the attention of the civil engineer the ability he possesses to perform tasks undreamed of or unimagined or uncredited by the engineer. An interesting problem, the solution to which lies in the engineering geologist's hands and personality.

Certain speakers (engineering geologists), during the debate berated the engineer for his frequent inability to perform what is essentially his task and that is the provision of information and description of the proposed structures on a site. To the extent that this is true, it is worthy of note by engineers.

The evening closed without a vote to the motion which is a pity for I have always thought a debater should be judged by his ability to present a case, whether he believed in it or not, and that the audience should judge not by their personal prejudices, but by the strength of the arguments for or against the motion; professionalism should consist not of shielding incompetence but of rewarding competence.

JACK CALDWELL

SOUTH AFRICAN ATTENDANCE AT THE TOKYO SOILS CONFERENCE

Pursuant to the report in the previous issue, No. 6, of Ground Profile :

The Divisional Committee regrets any comments that may be construed as being directed against Professor Nash.

Special Bulletin No. 1 on the Ninth International Conference is available to interested parties from the Divisional Committee Secretary.

Those who intend submitting papers to the Conference are reminded firstly that their submissions should conform to the standards set out in Bulletin No. 1, and secondly that *all prospective submissions should be forwarded to the Divisional Committee for vetting not later than the end of April 1976.*

Just to remind prospective authors the titles of the Main Sessions are : Stress-Deformation and Strength Characteristics; Behaviour of Foundations and Structures; Slopes and Excavations; and Soil Dynamics and its Application to Foundation Engineering.

Speciality Sessions have been organized on the following topics : Tunnelling in Soft Ground; Soil Sampling; Relation between Design and Construction in Soil Engineering; Ground Anchors; Determination of Soil Parameters from *In-Situ* tests; The Probabilistic Approach to Soil Mechanics Design; Geotechnical Problems in Ocean Engineering; Deformation of Earth/Rockfill Dams; Constitutive Equations in Soils; The Effects of Horizontal Loads in Piles ; Geotechnical Engineering and Environmental Control; and Computer Analyses in Soil Mechanics.

While the possibility of South Africans attending the conference remains as remote as lunar green cheese, it is interesting to note from Bulletin No. 1 that South Africans B.A. Kantey and G.E. Blight are respectively the Chairman of Main Sessions 2 and Co-Reporter of Main Session 3. Professor Blight informs me that other commitments would preclude him from attending regardless but a session chairman is hard to dispense with.

REINFORCED RUMINATIONS AND PEREGRINATIONS

A member of the Geotechnical Division, Andrew Smith, recently spent some time in Paris at the headquarters of La Terre Armee. During this time he studied the methods and techniques of the design and construction of reinforced earth. Now that he has returned, he is with Reinforced Earth (Pty) Ltd., a company which has been formed with the specific purpose of introducing and applying the technique of reinforced earth into South Africa.

He has been asked to and thus reports on his experiences as follows:-

Imagine standing on a heap of clean, cohesionless sand. The sand would possibly support your weight if it were confined, but being unconfined it fails in shear and "flows out" from beneath your feet. Now imagine the same sand heap reinforced in horizontal layers with mats of pine needles. If one were now to stand on the sand - pine needle structure, as the sand tried to flow out from beneath your feet, it would be prevented to some degree from doing so by the frictional forces which would develop between the sand and the reinforcing pine needles. If slipping is prevented by a sufficient contact area of pine needles the mass is in effect given a cohesive or tensile strength. This analogy explains the behaviour of the material called reinforced earth.

The concept of reinforced earth has been utilised in practice and in the past eight years some one thousand reinforced earth structures have been constructed. The pine needles have been replaced by reinforcing strips usually of galvanised steel. The earth used is usually a granular material; the reason for this being that the angle of friction both internally and in contact with the reinforcing strips can be determined with reasonable accuracy and is not materially effected by water entering the mass. The reinforced earth is unstable at a face and for this and for practical reasons is clad with cruciform precast concrete elements or steel elements with an elliptical cross-section.

Reinforced Earth has some interesting and most desirable features. One of the prime applications of reinforced earth is for retaining earth on steep side slopes. A good example of this use is illustrated by the two structures at Vigna on the French-Italian Highway. The problem was to support a highway on a steep side slope at a general angle of 35^{o} to the horizontal on a foundation of recently deposited boulders and debris. A simple earth embankment with a 1½ : 1 slope would require such a large right of way that the only possible solution was to retain the embankment in some way or to provide a bridge structure which would necessitate a good foundation beneath the piles. Reinforced earth was proposed and chosen because it afforded the possibility to build structures with large resting surfaces, giving guarantees against a general slip and it also showed a cost advantage over any other method. Two reinforced earth structures were designed; the lower one 17 metres wide and 10 metres high supporting earth on a 1½ : 1 slope 7 metres high. On top of this slope a second wall was built 11 metres wide by 7 metres high directly supporting the highway platform. The total length of the structure is about 250 metres. Due to the very poor stability of the natural slope it was necessary for the cut to be left open for the shortest possible time and consequently the work was done in stages. One section of the cut being opened and a section of the wall erected, the next section of cut opened and so on. Fig. 1 shows a typical section of the work.

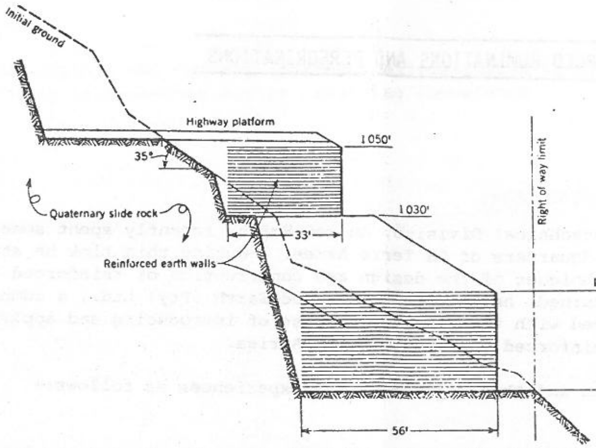

Fig. 1. Typical section, Vigna works, French-Italian Highway. Elevations are from sea level. Together, the two reinforced earth structures are 50 ft high. Cut slope beside the highway platform can be left quite steep.

Many retaining walls have been built in reinforced earth. The width of the wall is usually 0.8 times the height. This geometry results in very high factors of safety against overturning and also results in bearing pressures very little more than those under an earth embankment of equivalent height. The precast concrete cladding elements are able to accommodate themselves to differential settlements of the order of 1½% without any damage. Another advantage is the speed of construction. An average construction rate is about 70 m^2 of face area per day.

Reinforced earth structures are economical when the height required exceeds a certain limit. Their cost does not increase with increasing height as rapidly as that of reinforced concrete walls and they have no limitation in height as does sheet piling.

Extensive use of reinforced earth has been made for bridge abutments. An example of this form of construction is near Lovelock, Nevada in the United States. Two reinforced earth abutments each about 50 metres long and 8 metres high permit the Interstate Highway 80 to pass over the Big Meadow Ranch Road northeast of Reno. The State Highway Commission of Nevada selected the reinforced earth process for the abutments primarily because it met the technical specification and offered substantial cost savings in comparison with ordinary pile supported abutments made of reinforced concrete. Reinforced Earth provided important technical advantages including:

a) uniform distribution of pressure on the foundation soil;
b) the integration of the roadway and abutment so that, in the event of settlement of the deep foundation soils, the entire system will react as a unit, thus eliminating the "bump at the end of the bridge" often observed when the backfill and the abutment structures are founded in a different way.

At the Nevada site deep, poor foundation materials exist, thus accentuating the problem of settlement of the foundation soil and/or backfill. Ordinary pile foundations here would have been subjected to large negative friction loads as the approach embankments cause the natural ground to settle.

For abutments the Reinforced Earth design is further dimensioned in order to withstand not only the earth pressure, but the horizontal and vertical loads transmitted by the bridge deck as well. The load of the bridge deck is transmitted through the bearings onto a distribution beam which assures the uniform distribution of loads at the top of the Reinforced Earth structure.

I was shown a very striking pair of bridge abutments on the section of the French-Italian Motorway now under construction in the mountainous region north of Nice. These abutments were 18 metres high and allowed a small residential road to pass beneath the motorway. The bridge only spans some 8 metres and on first sight one wonders why a simple box culvert was not chosen for this function. The reason, of course, is the extremely poor clay foundation on which the structure is founded. During construction of the reinforced earth abutments the one end of the abutments settled 800 mm while the other end settled 400 mm. The length of the abutments is about 28 metres and thus the differential settlement of the reinforced earth with its precast concrete cladding elements was about 1½%. No cracking of the panels occured. Once about 90% of the final settlement was considered to have taken place and this was at the end of the construction period (9 months) the deck was placed. Here reinforced earth solved a difficult foundation problem and eliminated the need for piling which a box culvert or a reinforced concrete solution to the problem of the underpass would have required. See Figure 2.

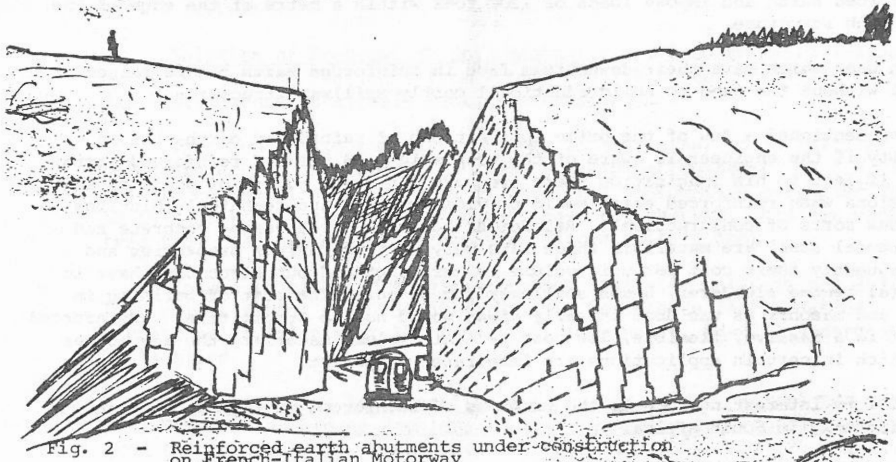

Fig. 2 - Reinforced earth abutments under construction on French-Italian Motorway

Another prime application is that of protective dikes and barricades. Reinforced earth, being flexible, can absorb a lot of energy without structural damage and is used extensively in Japan and other earthquake zones. Secondary containment at Liquid Natural Gas terminals presents difficult problems. What is needed is a system which will not require large amounts of land and will perform under extreme conditions of heat and cold. Reinforced earth dikes encircle the LNG storage tanks at Cove Point, Maryland in the States. The double faced walls require a minimum of space and permit easy access to tanks and piping. Temperature variation of between 160° C and 1100° C could result if fire occured in the event of failure of one or more of the LNG tanks. Reinforced earth performance under such conditions has been proven in tests conducted by Gas de France. At Maryland the reinforced earth system was 30 - 50 % cheaper than any alternative system.

What specific application might there be for reinforced earth in South Africa? Of course for highway construction in mountainous regions it could be used to economic advantage in saving fill and often will provide the solution to difficult foundation problems; for embankments in urban areas fill and expropriation costs could be saved. See Fig. 3.

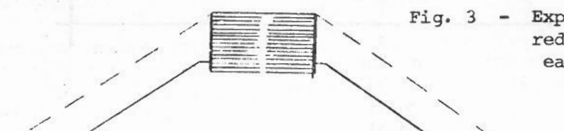

Fig. 3 - Expropriation and fill costs reduced by use of reinforced earth.

Reinforced earth can be used for retaining structures at crusher plants and in general wherever a grade separation is required. Could not the problem of founding tanks on our heaving clays where differential settlements and movements are a problem be solved by reinforced earth? A seal of some sort would be required to line the inside of the reinforced earth tanks, but large differential settlements could be accommodated.

It could be possible to terrace our mine dumps and possibly make them into living environments with reinforced earth construction. A mine dump tiered in the fashion with prefabricated housing units would possibly be cheaper than a high rise building and provide a better living environment than the building would do. There are two "towns of reinforced earth" near Paris. One at Marsinval and one at Les Gatignes where extensive use has been made of reinforced earth to optimize the use of the land on fairly steep hill slopes.

Industrial applications are illustrated by two structures at Dunkirk where coal is separated from iron ore by reinforced earth walls. Travelling cranes run on the reinforced earth and impose loads of 1200 tons within a metre of the edge of the 14 m high structure.

Earth dams which have their downstream face in reinforced earth can be raised in level without the need to build additional costly spillway structures.

I have mentioned a few of the prime applications of reinforced earth, but in reality if the engineer is aware of the properties and uses of reinforced earth, then if left to his imagination there are surely a great number of projects and occasions when reinforced earth would provide economic and technical solutions to various sorts of construction. Reinforced concrete, prestressed concrete and structural steel are materials which have very good mechanical properties and consequently their cost per unit volume is very high and our structures have in general become slenderer, beams shallower and so on. The cost of building in rock and masonry as was done in early times would now be prohibitive. Reinforced earth is a massive, flexible, low cost per unit volume material, the advantages of which in certain applications are immediately apparent.

It will be interesting to note the progress of reinforced earth worldwide and specifically in South Africa.

Editing of the discussions to the various Sessions of the 6th Regional Conference held in Durban in September is in progress. Many who contributed verbally to the discussions have failed to submit their written contributions. Deadline for editing is the end of 1975, so will all who desire to have their contributions appear in Volume II of the Proceedings please submit the same as soon as possible. Failure to submit timeously will probably result in their non-appearance.

NEW PUBLICATIONS

Limit Analysis and Soil Plasticity by Wai-Fah Chen, an Associate Professor at Lehigh University Bethlem, Pennsylvania. Available at $99,95 from Elsevier Scientific Publishing Company, P.O. Box 211, Amsterdam, The Netherlands. So far I have only read the introductory parts of this heavy volume but it promises to be an exciting adventure into the world of advanced soil mechanics. I can remember as a postgraduate student listening to a lecture by Dr. Brian Watt on limit analysis and after the lecture Professor Jennings pointed out that Dr. Watt was telling us no more than we had always done intuitively; but to recall Dr Watt's reaction and to peruse this book is to realize that indeed there is a tremendous amount more to limit analysis and the plasticity of soils than defining the limiting values of a plastic soil's response.

Solution of Problems in Soil Mechanics - a Problem Based Textbook by B.H.C. Sutton, Available from Pitman Publishing Co., Craighall Mews, Jan Smuts Avenue, Craighall Park, Johannesburg.

This book is so similar in format to that other soils textbook 'Elements of Soil Mechanics for Civil and Mining Engineers' by G.N. Smith that to review it all I need do is refer the prospective purchaser to Smith's book. Hopefully, although I have not checked, this new book is free from the innumerable errors that plague Smith's book.

Volume II of M and A Reimberts book Retaining Walls is now available. This volume treats of a 'Study of Passive Resistance in Foundation Structures' available at $30 from Trans Tech House, CH-4711 Aedermansdorf, Switzerland.

A short Course in Foundation Engineering by N.E. Simons and B.K. Menzies and Degree Problems in Soil Mechanics and Foundation Engineering from the same authors, names reversed, are available from IPC House, 32 High Street, Guildford, Surrey, England GUI 3EW at $15 and $5 respectively.

Other new volumes, details of which are available from the Newsletter Editor are :

Proceedings of a Symposium on the Analysis of Soil Behaviour and its Application to Geotechnical Structures - July 1975, New South Wales.

Proceedings of a conference on Diaphragm Walls and Anchorages. London, September 1974.

Proceedings of a Symposium on Ground Treatment by Deep Compaction. London, May 1975.

Proceedings of a Symposium on Field Instrumentation in Geotechnical Engineering. London, May 1973. South Africans MacKellar and Nunn of Ninham Shand sport a paper in this volume on 'Instrumentation of Some Embankment Dams in Southern Africa'.

W(H)ITHER SOILS ?

In editing the discussions for the second volume of the Proceedings of a recent Durban conference I have come across the following extracts from the Second Main Session; these extracts surely contain some message or warning for the profession and accordingly they are singled out for publication prior to the official appearance in the next volume of conference proceedings.

From a discussion by Professor Jennings on a paper by Ian Brackley :

'Mr. Brackley had really repeated some experiments conducted in the early 1950's. Exactly the same logic had been followed ... Unfortunately, the tests did not work out very well and the heave calculated in this way was about half of that actually observed in the field. Mr. Brackley had not attempted in any way to correlate his findings with those observed in practise. He is advised to do this at an early date before making claims that his method of predicting heave is any more satisfactory than any other.'

From a discussion by L.C. Wilson :

'Jennings and Knight, in their paper, mention the seriousness of this problem in earth dam construction. Dam engineers have in fact long been well aware of the problem. More than twenty years ago Walker and Holtz (1951) described the procedure used by the U.S. Bureau of Reclamation in determining the lower limit of placement moisture so that settlement would not occur on inundation.'

From a discussion by V.F.B. de Mello :

'Finally,it is rather unfortunate and incomprehensible that such a preliminary suggestion (with regard to categories of Relative Densities) as made by Meyerhof twenty years ago, should not have been gratefully received as a first hint, and duly revised subsequently.

SYMPOSIA

News has recently been received of a Symposium on Soil Structure Interaction to be held in Roorkee, India, 3-7 January 1977. Further information is available from the Divisional Secretary.

The International Association of Hydrological Sciences is seeking information on land subsidence occurrence, research and remedial work throughout the world. Any members prepared or able to provide such information can obtain from the Divisional Secretary a standard questionnaire to facilitate the provision of such information. This same Association is organizing the Second International Symposium on Land Subsidence in Anaheim Claifornia (near Los Angeles, next to Disneyland), during the period 10-17 December 1976.

A CALL FOR REPORTS

The Divisional Committee is responsible for producing the feature 'A Day's Work' as it regularly appears in 'The Civil Engineer in South Africa' in the early part of 1976.

Accordingly members are requested to forward to myself (J.A. Caldwell, Department of Civil Engineering, University of the Witwatersrand) brief reports of any projects of any nature at present in progress or recently completed. A glance at past issues of 'The Civil Engineer in South Africa' will illustrate the general nature of material required, but as a guide each report should not exceed an A4 typed sheet and should contain pertinent information about the project; photographs are welcomed. Such reports should reach me before mid January 1976.

THE 1976 DIVISIONAL COMMITTEE

The results of the election of the 1976 Divisional Committee are as follows :

Andy MacG. Robertson who is a partner with the firm of geotechnical engineers, Steffen, Robertson and Kirsten, and who rumour has it is doomed to be next year's Chairman.

A.A.B. Williams who is a C.S.I.R. Soils *cognoscente* if one is to judge his outpourings of fine papers and his punctilious regard to honour.

Professor J.E.B. Jennings who is too well known for me to report anything except that he has recently been ill but is now recovering from a recent eye operation. I am sure we all wish him well. It is possible, I surmise, that the Prof. has joined the Committee in order to facilitate the organization of a great International Soils Conference in South Africa.

G. Donaldson whose name, eyebrows and work at C.S.I.R. are too well known to warrant further comment.

Joe de Beer who is Ove Arup's engineering geology expert and who more than any can be said to be putting the soils of Johannesburg on the map.

Harold Weber who has built up Soiltech's reputation to the point where it stands today.

Gary Jones who is head of the Soils Road Research Division at C.S.I.R.

J. Gregg, a Cape Townian and partner with Hill, Kaplan and Scott.

L. Wilson, likewise from Cape Town where he is Ninham Shand's soils man.