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GROUND PROFILE
GROND PROFIEL

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CONTENTS

NEWSLETTER OF THE DIVISION OF GEOTECHNICAL ENGINEERING
SOUTH AFRICAN INSTITUTION OF CIVIL ENGINEERS

KORRESPONDENSIE: VOORGESTELDE VERTALING VAN „BURLAND"-KLEURKAART

Aangesien daar sover ek bewus is, nog nie 'n vertaalde weergawe van die „Burland"-kleurkaart bestaan nie, stel ek voor dat die verskillende kleure as volg in Afrikaan oorvertaal word:

1.	Dark grey	Donkergrys
2.	Light grey	Liggrys
3.	Pale red	Bleekrooi
4.	Dusky red	Halfdonkerrooi
5.	Light reddish brown	Lig-rooibruin
6.	Dark reddish brown	Donkerrooibruin
7.	Light brown	Ligbruin
8.	Dark brown	Donkerbruin
9.	Light olive	Lig-olyfgroen
10.	Dark olive	Donker-olyfgroen
11.	Pale green	Bleekgroen
12.	Dusky green	Halfdonkergroen
13.	Pale blue	Bleekblou
14.	Dusky blue	Halfdonkerblou
15.	Light yellow	Liggeel
16.	Dark yellow	Donkergeel
17.	Light yellowish orange	Liggeeloranje
18.	Dark yellowish orange	Donkergeeloranje
19.	Light reddish orange	Ligrooi-oranje
20.	Dark reddish orange	Donkerrooi-oranje
21.	Light red	Ligrooi
22.	Dark red	Donkerrooi

Voorstelle vir 'n beter vertaling en gewysigde spelling sal waardeer word.

E.H. TERBLANCHE
nms. BRUINETTE, KRUGER, STOFFBERG & HUGO

THE PREDICTION OF SETTLEMENT ON SANDS

A healthy spirit of negativism prevailed at a recent meeting of the geotechnical division at which Dr. Noel Simons spoke of the prediction of settlements on sands. Dr. Simons, whose varied career includes spells at the CSIR, the Norwegian Geotechnical Institute, a Ph.D from Natal University and now a professorship at Surrey, was on a visit to check the welfare of some fourteen of his students currently working in South Africa for a year as part of their undergraduate training.

Incidentally, Dr. Simons appealed for offers of work for students who in future may wish to come to work here for a year before returning to their final year of study.

As with many aspects of geotechnical engineering, the prediction of settlements on sands is notoriously difficult, as Dr. Simons pointed out. In the January issue of "Ground Engineering" are listed some dozen different formulae for calculating settlement alone, all based upon the use of the Standard Penetration Test, not to talk of Dutch Cones or plate loading tests. When using various available formulae to predict the settlement of a tank which ultimately settled 60mm Dr. Simons calculated settlements ranging from 6mm to 120mm.

He confessed that the chances of predicting the correct settlement of sands from the results of Standard Penetration Tests are equally good whether you use the results of SPT tests or random numbers for the N value. He feels a good value for the settlement of sands is 30mm.

It is little wonder that his frank advice about predicting settlements from SPT results is a crisp: "Don't".

Of course the situation is not as gloomy as so far made out. Judgement and experience, and especially the observation of settlements on comparable surrounding structures give good guides to the likely settlements. The very act of probing into the soil can expand one's knowledge and feel for the problem, even if the probing takes the form of attaching sound sensors to the probe and listening with earphones to the yells of agony of the soil as the probe advances (Prof. James spoke on this method during the discussion period).

Critics, such as Hendrik Kirsten, were not slow to point out the anomaly that in using the SPT to predict settlements one is comparing horses and apples. For the SPT involves shear failure of the soil, whereas settlement involves compression and there is no logical necessity for the different sets of properties involved in the two phenomena to be connected in spite of a plethora of empirical relationships.

The CSIR under Gary Jones, it is encouraging to note, are attempting to overcome this criticism by conducting research into the prediction of soil settlement properties by using a truly static cone. The cone fitted with pressure sensors is allowed to settle under the applied loads at the rate nature dictates rather than being abruptly plunged forward. A true in situ consolidometer test is being performed.

Dr. Simons conceeded that the only method that comes close to measuring the compressibility of a sand is a plate loading test. He spoke of a long neglected screw jack forgotten in the confines of the CSIR. Is it too pious to hope that it will be dusted off and research on its use and interpretation recommenced.

The influence of lateral pressures on settlements of sands was discussed. The lateral pressures or even anisotropic elastic moduli influence the magnitude of settlement. Thus Dr. Simons held out little hope that a standard oedometer test would assist in predicting the settlement of sands.

An interesting concept discussed during the evening was that of the over-consolidation of sands. Almost impossible to detect, it has a great influence on both the soil properties measured by probing apparati and on the settlement of the sand. Schmertman multiplies his calculated settlements on a over-consolidated sand by one half and this, he claims, yields acceptable results.

Dr. Simons is nevertheless optimistic. There is light at the end of the tunnel for along the way great advances in understanding the role of the over-consolidation, overburden pressure, grain shape and grading curve are being made and this understanding combined with the collection and interpretation of settlement data from existing buildings can only serve to refine the prediction of settlements on sands.

JACK CALDWELL

Factory Establishment

Criticism has previously been levelled at this newsletter for publishing commercial interest stories, but as the following is considered to be of general interest and of at least some patriotic pride value (Dr. Mulder please note) the wrath of attack is again chanced:

From the Natal Mercury -

"The Kaymac Group, which is based in Pinetown, Natal, is to spend R2 million on the construction of a factory at Atlantis in the Western Cape, to manufacture non-woven polyester filter fabrics for the civil engineering industry.

Mr. K.M. Mackenzie, chairman of the group, said that Kaymac Industries had signed a technical assistance agreement with the Rhone-Poulenc Group of France and had placed orders for all the equipment which would be installed at the new factory.

Local production was expected to start about the end of this year. It would result in a considerable saving in foreign exchange as the fabric was, at present, imported from France.

"As we expect production at Atlantis to be in excess of South Africa's requirements, the balance will be committed to certain export markets by agreement with Rhone-Poulenc.".

Another company, Noel P. Hunt (Pty) Ltd., which was at present importing the French fabric, would continue to handle technical sales and distribution."

MEETINGS ABOUT PARTIALLY SATURATED SOILS

The Annual General Meeting of the Geotechnical Division was held in Pretoria on 14 September, 1976. The lack of any printed records will mean that some of the important issues discussed will be lost, although contributions to the topics discussed were lively at the time. Several contentious points were raised, such as the adequacy of 'van der Merwe's method' for predicting heave on residual soils, the viability of some traditionally recommended building solutions for heaving clays, and the validity of controls placed on township development after soil surveys. The meeting did not yield any clear consensus of opinion either as to the most satisfactory methods for predicting heave, or collapse, or for defining the problems.

As the Divisional Sub-Committee charged with organizing a Conference on Partially Saturated Soils, is in some doubt about whether another special conference on expansive clay is warranted, it was felt that readers reaction should be sought. The following topics require consideration:

- The prediction of heave, or settlement on residual clay soil profiles: The activity as determined from laboratory tests on remoulded soil samples may be deceptive. Clarity is required about the control of the initial moisture condition for any type of oedometer test.

- Other economic methods for building houses on expansive clays, if the use of under-reamed piles is considered too expensive: site preparation and methods of monitoring the adequacy of this, or other structural methods such as slab-on-ground may find some place in the list of possible selected methods.

- The estimation of lateral pressures in expansive soils: the design values to be adopted for retaining walls, or techniques used to safeguard basements, as well as the assessment of problems with sewer pipe failure should be considered.

- The state-of-the-art of road building on expansive subgrades: it seems to be acknowledged that a severe problem can exist and that there is no complete structural solution as for buildings. The known palliatives which together lead to a final solution do not seem acceptable.

- The prediction of the strength of expansive clays which are highly fissured: this affects bearing capacity, the stability of excavations and also the earth pressures.

- The prediction of settlement and 'collapse' on both transported and residual soils: the soil-structure interaction may lead to new features of design for structural solutions.

Many of the above subjects are of interest, but what is required is an adequate record of predictions made and the results of follow-up measurements. Unless this is done, a proper contribution to the art and science of Soil Mechanics will not have been made.

Any comment would be welcomed by the Chairman of the Organizing Committee for a Conference on Partially Saturated Soils, Mr. G.W. Donaldson, c/o NBRI, P.O. Box 395, Pretoria, 0001.

Ph.D. Profile : Dr. A.A.B. Williams

Dr. A.A.B. William, as his new designation implies, has recently been awarded the Degree of Doctor of Philosophy for a thesis entitled "The Behaviour of Clays Containing Pre-Existing Discontinuities".

The profession no doubt joins in congratulating him on his achievement and well deserved recognition.

The Abstract of his thesis is published in this issue for it nicely summarizes the contents of four large tomes.

ABSTRACT OF THESIS -

"The Behaviour of Clays Containing Pre-Existing Discontinuities"

There are large areas of South Africa where clay soils are encountered. While these are generally stiff, because of the dry cycles of climate, they are weakened by cracks or fissures. These inherent defects have been the main cause underlying the occurrence of some landslides affecting housing schemes, roads, high embankments and have been the cause of sudden failures in deep excavations.

Similar problems are encountered in other parts of the world, but it was not known whether the standard theories, methods of testing, or design rules could safely be applied in this country. The patterns of cracking in certain residual soils, such as weathered shales, could be explained by the inherited jointing along bedding planes or by shrinkage cracking, but in our transported soils there was little information on definite modes of origin or the occurrence of the abundant inclined slickensides.

Much time was spent in the field studying the jointing which was revealed in a number of different soil profiles exposed in trenches, or large excavations. While most of the sites were located near Pretoria, Johannesburg or Vereeniging, important observations were recorded from exposures in the Orange Free State and as far afield as Cape Town and Luanda. The technique for collecting information by means of a 'line survey', as used in the study of jointed rocks, was successfully applied in fissured soils. Measurements of the dip angles of joints, dip direction, joint lengths, spacing, waviness, surface texture and any other special features were taken. A statistical analysis of the large amount of data was undertaken using both existing and new computer programs developed for the purpose.

A major aspect of the research was a full-scale field experiment where actual failure was induced through an excavation with vertical banks at two adjacent sites in a stiff fissured clay profile at Vereeniging. The movements at the surface and at a number of points within the clay mass were monitored during the experiment using an optical plummet and precise survey techniques. In trying to explain the mechanism of failure and analyse the stability of the banks, model analyses were carried out using data from small-scale laboratory and field tests. A physical modelling technique, employing a base friction apparatus, adequately defined the mechanical behaviour of the soil mass. A mathematical model, which was based on the finite element method and which allowed for jointing, gave a close simulation of the deformations and distress developing in the material on excavation in a number of steps. The existing fracture pattern governed the mode of failure, which differed from the classical slip circle assumed for intact clays. The importance of the tensile strength of soil in steep slopes was also brought out.

Some useful findings resulted from this work, the most significant perhaps being that, although the dip direction of fissures, or slickensides, in the transported clays were quite random, the distributions of dip angles, joint lengths and joint spacing had characteristic patterns.

Simple equations were derived for these frequency distributions and this enabled proabability predictions to be made for any particular clay horizon. Further, it was found that for design purposes, the analysis of 'first time' slides in fissured clays under South African conditions should be based on residual strength values. This is in contrast to practice overseas where the peak value is commonly used. In our soils the clay particles on a pre-existing slick joint plane are strongly oriented parallel to the joint surface, which is consistent with past shearing action due to passive failure in the soil mass caused by high lateral swelling pressures. Because of the intensity of fissuring the overall strength is thus at the minimum, or residual value.

The work has also led to the development of new techniques for both laboratory and field testing. A number of computer programs were used for data sorting, laboratory test calculations, or analysis of plane strain behaviour of a clay mass. All these are available to any other user and the input requirements are fully described."

A TUNNEL UNDER THE BEREA : DURBAN

A 1000m long stormwater tunnel is being planned by the Durban Corporation to drain the low lying areas behind the Durban Berea. It is understood that the tunnel is to be constructed using conventional tunnelling techniques but that some interesting monitoring will be carried out in the partially saturated Berea Reds overlying the tunnel route. At the deepest point the tunnel will be 65m below ground level.

The monitoring which is planned is to be carried out not only for the sake of safety, but for the purpose of research, and will therefore encompass more than precise ground level measurements. An attempt is to be made to determine the earth pressure distributions before, during, and after construction of the tunnel and for this purpose the subsoil investigation boreholes, six in all, have been utilized for determining the ambient soil conditions.

The boreholes have been sited in pairs, one on the tunnel centre line and one 10m off the centre line, and these pairs will be used to monitor horizontal pressure, horizontal movement and vertical movement respectively. Instrumentation for these measurements is to be installed from the surface at 5m intervals and will extend to 15m below the tunnel invert in all cases.

The monitors have been designed and built by the department of Civil Engineering of the University of Natal and include transducer pressure cells approximately 40mm in diamter and sensitive to approximately 1kPa for measuring horizontal pressure, borehole inclinometers for measuring horizontal movement and magnet censors for measuring vertical movements.

Temperature variations within the earth mass will be recorded as will be precise surface levels 10, 20 and 60m off the tunnel centre line.

The boreholes 10m off the tunnel centre line will remain in continual use while measurements on the centre line below the tunnel will be interrupted temporarily during construction but will be reconnected and monitored on a long term basis after completion.

The results of this project promise to be interesting since the scope for analysis is wide from the point of view of general stress-strain behaviour of the earth mass as well as the hitherto unpredictable behaviour of the Berea Red sands.

JOHN WATES

REPORT ON 7TH MEETING OF SSSSA

The 7th Conference of the Soil Science Society of South Africa was held at the University of Pretoria on 13 and 14 January, following the Agricultural Conference 1977. The sessions covered the description of soil profiles, soil classification, land use, and urban development. A number of papers were presented by geotechnical engineers and geologists as well as pedologists, and it was obvious that there was a considerable degree of overlap in interest, and useful professional contacts were made between the various disciplines of soil science. It was learnt that a new book is to be published shortly by the Soils and Irrigation Research Unit of the Department of Agricultural Technical Services which gives a new national soil classification system. About 500 Soil Series covering the country will be illustrated and described in some detail and this information should be of use to engineers who will soon learn to interpret the 'jargon' of pedologists.

It is hoped however that the proposed soil classification system will make provision for the inclusion of information that will be of engineering significance.

In particular, the following items would be of great practical value in any publication about soil profiles.

(i) The Atterberg Limits of each soil horizon (together with the grading analysis)

(ii) The depth of bedrock (i.e. total thickness of soil cover)

(iii) The geological description of the bedrock

(iv) A specific comment on the level of a perched, or a permanent, water table.

DR. A.A.B. WILLIAMS

OF THIS AND THAT

The Legal Reponsibilities of the Geologist and Geotechnical Engineer

From Civil Engineering ASCE July 1976 -

"Speaking for the geologist, geotechnical consultant Eugene B. Waggoner cited the growing trend to litigation, with money seekers encouraged by contingent lawyers. He observed that some lawyers now sell shares in prospective suits, and at least one bar association conducts courses in how to sue soils engineers. Failure to prepare the client for adverse surprises, and failure to exercise personal responsibility ("tell it as it is, and in writing"), are frequent sources of disputes. A surprising number of suits (perhaps 35%) result simply from attempts by clients to avoid paying fees.

As remedies, Waggoner counseled that insurance is costly and cancellable, and therefore unreliable; the answer to this is that the geologist's contract with his client should state directly what he will and will not do, and that it avoids giving warranties. He should eschew assuming responsibilities outside the scope of his contract."

The South African law governing the possible selling of shares in a suit to sue geotechnical engineers or in running courses on how to sue them was stated clearly in the Transvaal Supreme Court in 1907 by one of our great Judges, Innes, C.J. In the case of Patz v Salzburg he said:

"Of course it is against public policy to traffic or gamble in lawsuits, or to maintain them for speculation or wrongful purposes. This is both the English and Roman-Dutch Law. But it is not unlawful bona fide and properly to assist a litigant to defend or establish his rights, even though the person so assisting may derive some benefit from the subject matter of the action."

"Agreements of this kind ought to be carefully watched and when found to be extortionate and unconscionable, so as to be inequitable against the party; or to be made not with the bona fide object of assisting a claim believed to be just, and of obtaining a reasonable recompense therefor but for improper objects, as for the purpose of gambling in litigation or of injuring or oppressing others by abetting and encouraging unrighteous suits, - effect ought not to be given to them".

In short, you may emulate the Americans if you feel the claim is just, you are bona fide or of course if you do not attempt to sue on your speculative shares contract.

Claims and Contractors

From Civil Engineering ASCE Dec. 1976 -

"Quite frequently, to economize, the owner fails to have his consulting engineer spend the necessary time, money and brain power to do a thorough geotechnical investigation and design job.
RESULT: Contractors bidding the job don't have adequate information, thus must make their own investigations of water conditions, ground stability, bedded support - all within 30 to 60 days. With such short-sighted skimping on the part of the owner, everybody loses in the long run. The owner, as well as the contractor, will have to incorporate substantial sums to provide for unforeseen problems, costly delays, litigation, and subsequent claim settlements. The time and money that is not spent before the project starts will surely be spent during the project and afterwards, in the courts.

If the high cost of underground construction is to be dramatically slashed, the engineering designer must be allowed to do a much more thorough job; and he must have the guts to put his geotechnical interpretations down on paper. And the owner must assume the risk for the unforeseen problems.

Among contracting practices recommended: putting changed condition clauses in the contract; compensating the contractor for extra work needed because of unexpected conditions; full disclosure of all geotechnical data and consulting engineering interpretations prior to the contractor working up his bid; elimination of disclaimers."

Unfortunately, as would appear from recent experiences and reported cases, South Africa is not immune to these ills.

The nature of geotechnical investigation is such that it will always involve a greater component of the unforeseeable than say the construction of a steel bridge. Perhaps a liaison between the Geotechnical Division and the other appropriate groups within the profession should set as a worthy and useful aim the investigation and formulation of recommendations for appropriate contracting practices aimed at setting right the ills and shortcomings of the present system.

Fishing an Old Borehole

From "Boart Drilling News" March 1977 -

"A borehole which was drilled between 1945 and 1947 was recently re-opened in the Orange Free State. The results were interesting and some of the articles that were pulled out of the 30 year old hole would have done a scrap metal merchant proud.

The following bits and pieces were found as the 1440m hole was cleaned.

A wire cable end at a depth of 15m; a brass valve at 20m; a spindle section of a mono pump at 60m; a wedge show at 30m; the foot valve of a mono pump and parts of another pump at 61m; a steel flat bar at 30m; and at various depths, a gauze wire was found, a collection of pump parts, a core tray with all parts showing NXC core when the hole was deflected, a core tray housing and a general collection of parts.

The top part of the hole was filled with sand.

EDITORIAL

At the time of writing this no news is available from the Department of Civil Engineering at the University of the Witwatersrand about the appointment of a new professor to assume the chair previously held by Prof. Jennings.

Thus the present is about the best time to write what is here recorded, for no personal slight to any known individual can be read into these idle thoughts.

The advertisement for the post called for candidates for a chair of soil mechanics, or transport engineering, or construction management. If this implies that Wits will not have a fully fledged chair of soil mechanics in the event of the future appointee being either transport or construction oriented, then a great change in the normal order of things is upon us.

Rumour has it that there are thirteen candidates for the chair. As it is hard to imagine that there are thirteen potential geotechnical professors in South Africa we must assume that the other two disciplines are well represented.

Now is perhaps too late to ask, but not too late to discuss, the question: "Should geotechnical engineering be taught at University undergraduate level in preference to transportation engineering or construction management?"

Considerations of space preclude that all but a few brief points be made in this regard. The total membership of the Geotechnical Division is some 500 out of a total of 5600 members of the Institution - less than 10 per cent. I do not know what the membership of the divisions of construction, or those that are transport-oriented, is, but it is fair to say that probably more civil engineers earn their living in fields more closely allied to transportation or construction than to geotechnical engineering. Do the Universities then not have an obligation to train for these former aspects of engineering rather than the latter if they aim to turn out useful practical men of the world?

Traditionally soil mechanics along with structures and hydraulics, have been viewed as the tools with which, or the routes by which civil engineers could be trained, but there is no real reason in logic why soils as a teaching tool, as a mode of inculcating the engineering method into students' heads, should be any better or worse than construction management.

If soil mechanics is nevertheless viewed as such a fundamental cornerstone of civil engineering, that no trained engineer can be truly competent unless versed in its more esoteric aspects, it can with equal force be argued that except for the effective stress principle, soil mechanics is but a branch of the study of materials or static mechanics and thus should be taught as such.

If no professor of geotechnical engineering is appointed this piece may be viewed as a bunch of sour grapes. If a professor is appointed it will be hailed as pure adverse comment, but it is offered rather in a spirit of self doubt that may motivate others to question the precise role geotechnical engineering should play in the education of civil engineers.

JACK CALDWELL