Ingenieurs Geologische Kring
Netherlands Section of Engineering Geology
Secretaris: Dr. J.J.A. Hartevelt
Postbus 63, 2260 AB Leidschendam (the Netherlands)
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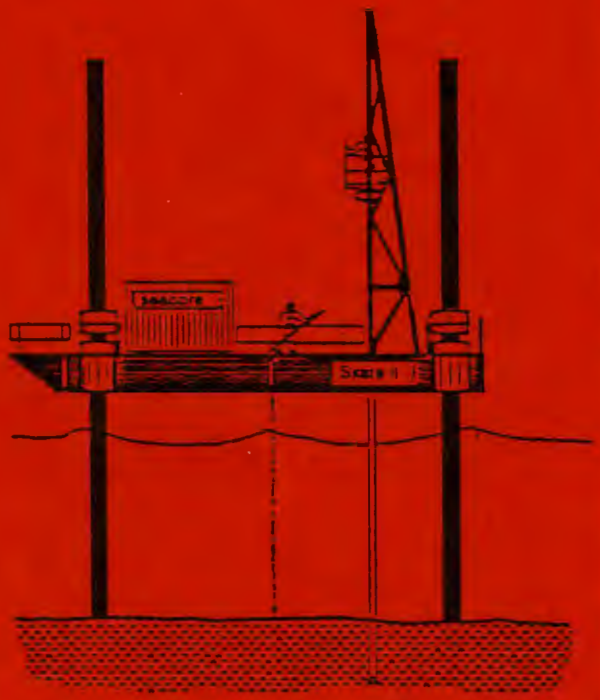

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Nieuwsbrief Ingeokring

juli 1989

INHOUD pag.

Nieuwsbrief van de Ingenieursgeologische Kring
Redaktie:
Drs. P.N.W. Verhoef
F. Bisschop
W.O. Molendijk
A.R.G. van de Wall

Van de redactie

Voor U ligt het tweede nummer van de nieuwsbrief. In dit nummer is onder andere te vinden: Het vervolg van het verslag van de in Shanghai gehouden conferentie over "Underground Spaces and Earth Sheltered Buildings", een stukje over het afstudeerscriptie van Ir. I.K. Deibel en een beschouwing over paalfunderingen op gesteente in Nederland.

Intussen is de redactie gedeeltelijk van samenstelling veranderd: E. Zwerver en J.W. Nijdam zijn vervangen door W.O. Molendijk en A.R.G. van de Wall. Drs. P.N.W. Verhoef en F. Bisschop zijn beide aangebleven.
Zoals U zult opmerken wordt vanaf heden gewerkt met een nieuw systeem en een verbeterde tekstopmaak.

Het volgende nummer zal in oktober verschijnen. Kopij voor deze nieuwsbrief moet uiterlijk 20 september worden ingeleverd.

Correspondentie adres:
Redactie Nieuwsbrief Ingeokring
Faculteit der mijnbouwkunde en Petrolumwinning,
sectie Ingenieursgeologie
Mijnbouwstraat 120
2628 RX Delft,
Nederland.
telefoon: 015-782543

Summary of results of doctoral-thesis on

GEOPHYSICAL DETECTION OF SOLUTION PHENOMENA

by Drs I.K.Deibel, August '88
Section of Engineering Geology
Delft University of Technology

INTRODUCTION

A major part of the province of South-Limburg, the Netherlands is underlain by limestones of Upper Cretaceous age.

Where the limestone is situated beneath a thin cover of Tertiary sediments or superficial deposits, the surface of the limestone is often highly irregular. Localized solution weathering of the limestone surface can produce vertical cylindrical pipes or funnel shaped sink-holes. Usually the pipes and sink-holes are filled with gravel, sand or clay derived from the overlying deposits, but the fill may be loose and contain weakly bridged cavities.

For these reasons, pipes and sink-holes are potentially a hazard to surface structures and where suspected they should be detected and fully investigated by appropriate site investigation techniques.

SUBSIDENCE MECHANISM

Solution pipe genesis can result in two common forms of metastable structures created in the ground.

* If the cover deposit is a low cohesive permeable granular deposit, solution subsidence can sometimes produce loose zone ground conditions. Consider a sand and gravel layer undergoing solution subsidence to produce loose zone ground conditions; the loss of basal support to the layer, below a circular area, caused by solution subsidence, encourage a local downward movement of the sand grains and gravel clasts. Assuming the layer was compact to start with, the localized solution subsidence effectively cause a portion of the layer to take up a larger volume of space in the ground than it occupied previously. This volume expansion results in a disturbance of the original

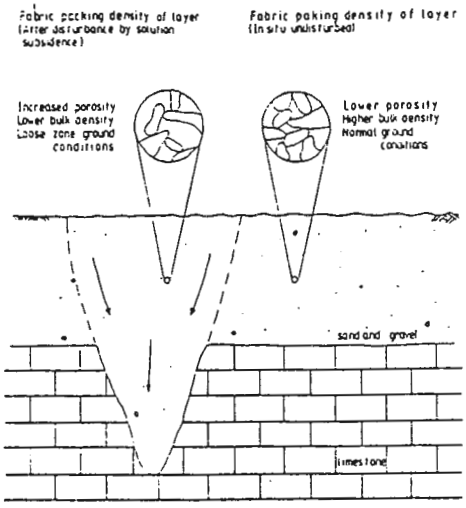

Figure 1 Formation of loose zone ground conditions by solution subsidence.

compactness of the undisturbed in situ fabric. The volume increase of the layer, occurs by an increase of void space i.e. porosity and hence a lowering of the bulk density. The extent to which the deposit fabric can expand to accommodate the downward movement depends on angularity and grading of the deposit; figure 1.

If the downward movement is more than can be accommodated by expansion of the layer, the overlying layers will be effected too.

* If a more cohesive or resistant layer is present in the superficial sequence then instead of loose zone ground conditions continuing to migrate up through the sequence, the movements halt at the base of the resistant layer. As the solution pipe continues to deepen, the deposits below the resistant layer continue to undergo gravitational settlement creating a metastable cavity roofed over by the resistant layer. Cavities produced have curved walls with arched roofs and their volumetric size tend to be a function of the overburden pressure (confining stress), their size often decreasing with increasing overburden pressure; figure 2.

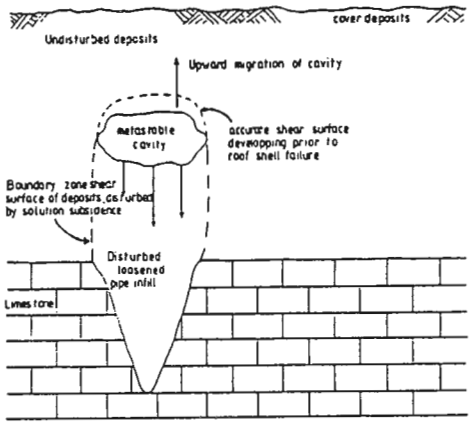

Figure 2 Formation of metastable cavity by solution subsidence

The problem of solution pipes is aggravated by their localized character and the frequent absence of surface evidence.

solution subsidence can take place slowly (low cohesive overburden) or suddenly (forming of cavities), either way it can be disastrous for surface structures and where suspected they should be detected and fully investigated by appropriate site investigation techniques.

The investigation techniques can be divided into three categories namely, I : remote sensing
II : direct methods
III: geophysical methods

A geophysical investigation was carried out on a test site in South-Limburg, the Netherlands.

GEOPHYSICAL DETECTION OF SOLUTION PIPES

Introduction

The success of geophysical methods for locating filled solution pipes is controlled by four main factors: penetration (how deep can you measure), resolution (what is the anomaly), signal-to-noise ratio (can you distinguish the anomaly from the noise) and contrast in physical properties (this determines among other things the signal-to-noise ratio and the resolution).

The following methods are used on a test site in South-Limburg:
- magnetic methods (the OMNI 4 protonmagnetometer)
- electromagnetic methods (EM 31 and EM 34)

Location and geology of the site

A test site with a known solution pipe was chosen. This was done to see if a cavity with subsided overburden would also give an anomaly in the measurements. Figure 3 shows the location of the site, it is situated in the south-east of Limburg in the wooden areas (Vijlenerbossen) near Vaals.

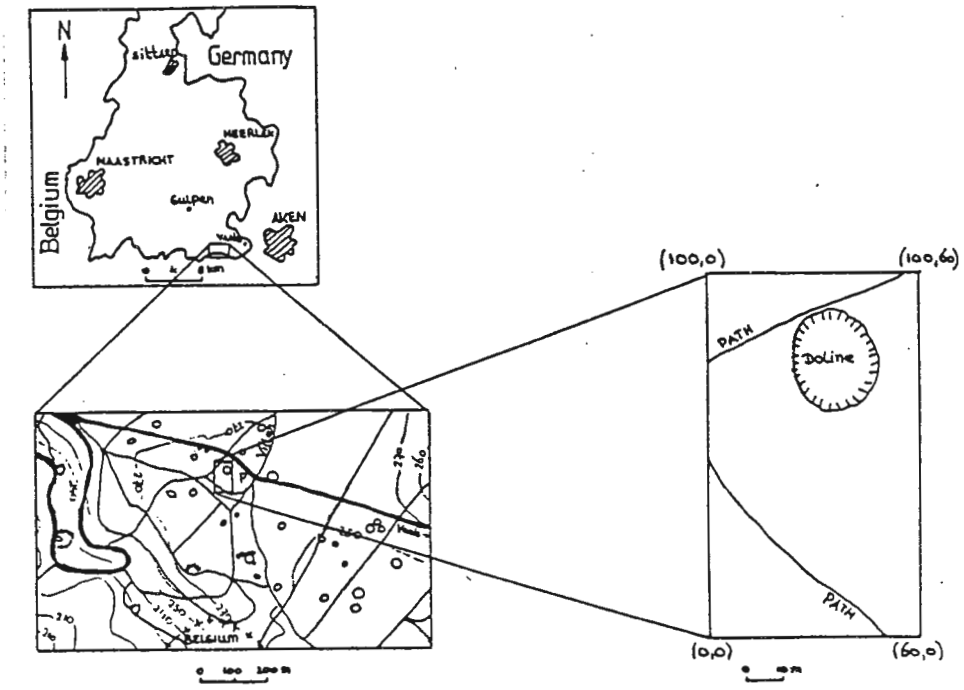

Figure 3 Location of the test site

A possible profile of the investigated area is given in figure 4.

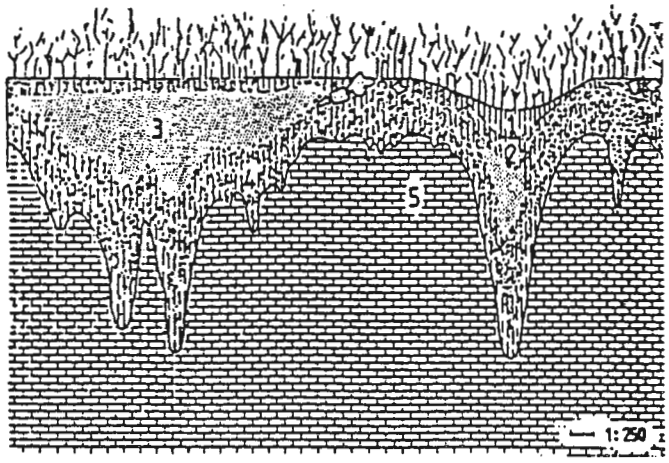

Figure 4 Possible profile of the investigated area

1 = Loess, thickness: 0 - 2.5 m. The loess will become thicker in a doline, as deposition probably took place during formation of the doline.
2 = Periglacial displacement material, thickness: 0 - 3.5 m Periglacial displacement material is a mixture of weathered and decalcified residual loam of limestone.
3 = Tertiary sand, this will only be found as a lens in the solution pipes.
4 = Flint-eluvium, thickness: 3.5 to 15 m. The flint-eluvium is present everywhere, it is formed by the weathering of the limestone and consists of decalcified residual loam and flint.
5 = Limestone (Formation of Gulpen).

Magnetic methods

In magnetic methods the earth magnetic field is measured, indicating a difference in magnetic materials (e.g. magnetic minerals).
The measurements were taken on N-S lines with a station spacing of 2 meters and a line spacing of 5 meters.

However, the differences in the measured values were too small (at the most 20 nT) to indicate anomalies suggesting a possible solution pipe.

It is not sure whether this is only noise (resulting from concentrations of magnetic minerals which obscure the target anomaly) or an indication of possible structures in the ground.

Electromagnetic methods

In electromagnetic methods a magnetic field is induced by electrical currents. The magnetic field is proportional to the terrain conductivity. The conductivity of the ground can be an indication of soil properties such as water content, porosity and mineralogy.

The EM 34 consists of separate portable transmitter and receiver coils. These are connected by a flexible cable.

On the test site measurements were taken with vertical (exploration depth = 7.5 m) as well as with horizontal coils (exploration depth = 15 m) and with an intercoil spacing of 10 meters. The lines along which the measurements were taken are oriented N-S with a station spacing of 5 meters and a line separation of 5 meters.

The apparent conductivity of the ground to a depth of 7.5 and 15 meters is measured at the surface. With the help of a computer program a model of the ground can be made.

Three layers are assumed:

1) The loess, periglacial displacement material and tertiary sands together, with a conductivity of about 0.6 to 0.8 mS/m.
2) The flint-eluvium with a conductivity which lies between the values of 22 and 26 mS/m, and
3) The limestone with a conductivity of 5 to 6 mS/m.

These values are put in the computer program and the thickness of each layer is determined. The apparent conductivity at the surface is calculated for these values and compared with the measured values. In this way a model can be made of the underground of the test site. Especially the depth to the limestone surface is of interest for the detection of solution pipes. Figure 5 gives a contour map of the depth to the limestone surface. The doline is the result of solution subsidence, thus is situated above a solution pipe and borings carried out by the RGD (Dutch Geological Survey) revealed a thickening of the loess layer in the surrounding of the other possible solution pipe in the figure.

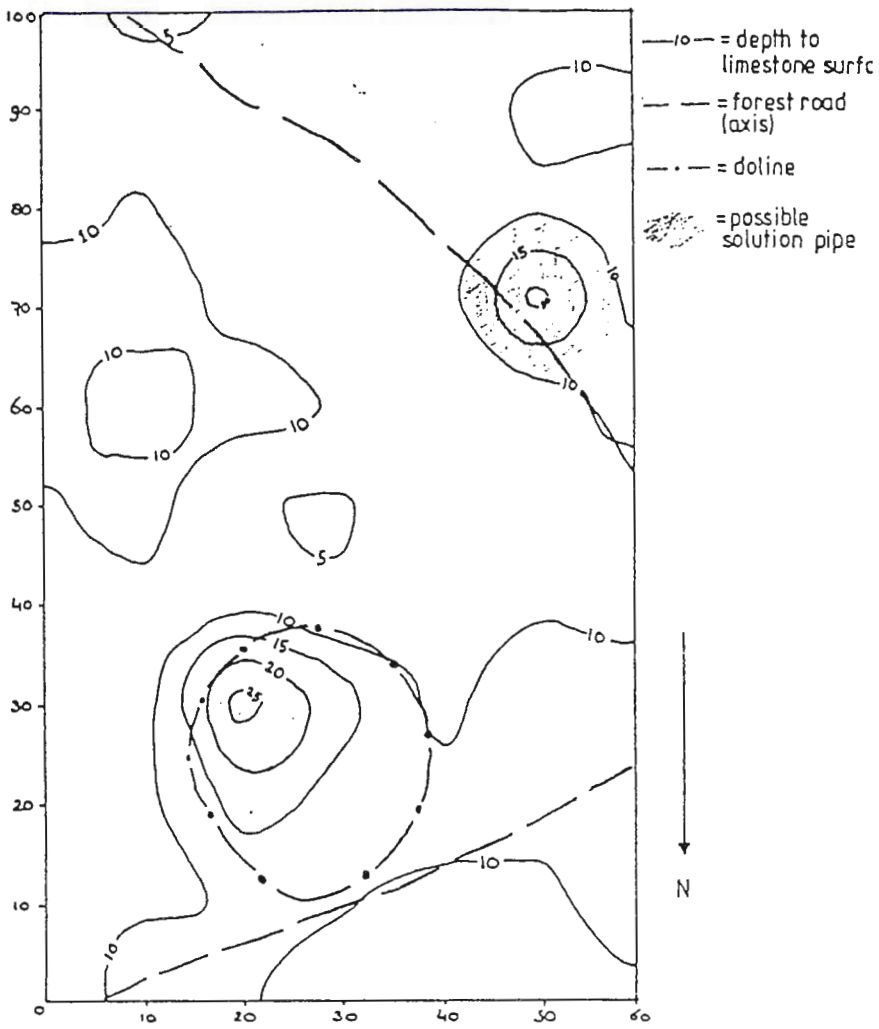

Figure 5 Contourmap of the depth to the limestone

The EM 31 has an exploration depth of only 6 meters and will work in case of near surface phenomena, but is not suitable for solution pipes located deeper than 6 meters. It seems that the lower density and thus the higher porosity (i.e. higher water content) above a solution pipe is not sufficient enough to indicate the solution pipe.

CONCLUSIONS

Solution phenomena can seriously damage structures. It is therefore wise to detect them before subsidence takes place.

Geophysical methods which offer fast continuous profiling (e.g. magnetic- and electromagnetic methods, ground radar) have a distinct advantage over methods where one has to set up equipment for each reading separately (e.g. gravity, resistivity, seismic). For the two methods tried, only the EM 34 seems to be successful. However, in order to do a reasonable reliable prediction more measurements with different coil-separations (different exploration depths) has to be taken, also borings to verify the possible location of a solution pipe should not be forgotten.

A 3D Hydrological Geographical Information System

Report of the lecture of Prof. Dr. Keith Turner,

March 15th
Faculty of Mining and Petroleum Engineering
Delft.

Dr. A. Keith Turner is Professor of Geological Engineering at the Department of Geology and Geological Engineering of the Colorado School of Mines (Golden, Colorado, USA).
This presentation was the first meeting of the Earth Sciences computer users club (being established). The club is being sponsored by the computer users group of the Royal Netherlands Engineering Institution and the Engineering Geological Netherlands Branch of the IAEG. The computer users group has also received support from the Royal Netherlands Geological and Mining Society.

A 3D-Hydrological Geographical Information System

The process of hydrological analysis can be considered in terms of four fundamental modules:

1. Subsurface characterization
2. Three-dimensional GIS
3. Statistical evaluation and sensitivity analysis
4. Groundwater flow and contaminant transport modelling

1. Subsurface characterization

The are some difficulties in describing the geotechnical & geological environment:

- Incomplete, conflicting information;
- Subsurface has complex spatial relationships;
- Economics prevent sufficiently dense sampling to resolve all uncertainties;
- Scale effects: The relationships between property values and volumes of rock represented.

It is impossible to make an exact model of the geotechnical & geological environment, only a simplified version from exploration data can be made.

There are two methods the reveal the geotechnical subsurface information:

- Brute force by the drilling of many holes.
- Geological process simulation modelling: convert a few observations into most likely conditions. Intelligent Systems can be useful for the interpretation of geological data.

Three-dimensional GIS[1]

There are no true 3-D commercial systems for geological and geotechnical use. In contrast, over the past few years, increasingly accurate hydrological flow models have been developed. With help of a 3-dimensional GIS, 3-D subsurface information can be fully utilized for interpretation and prediction of groundwater flow. One of the problems of this moment is the lack of 3-D hydrological data. This is called *'the Parameter Crisis'*.
Further difficulties are:

- The hydraulic conductivity (k) is a critical, but difficult to obtain parameter.
- The coefficient of dispersion is a 'non-constant' constant.
- 3-D Heterogeneity in hydraulic conductivity affects flow velocities more than hydraulic heads.

Statistical evaluation and sensitivity analysis

The most favorite method of statistical evaluation is stochastic modelling. Only it is very important to consider that the geology is the end product of many processes and the method is statistical, not deterministic.
In the near future, a system which uses 'The Marcov Process' can be a helpful instrument to do an 'intelligent' computer interpretation of geology. The Marcov Process uses processes of today to determine the processes of tomorrow.
This system needs a data management system. There are no good data managements systems available yet, which can handle the enormous amount of data that is required for a good geological interpretation.

Groundwater flow and contaminant transport modelling

A 3-D GIS is a very good help in the prediction of the dispersion of pollutant chemicals in the groundwater. One of the problems here is again the 'Parameter Crises'.
The american law 'prevents' research workers of doing extensive site investigations. This is because of the strict rules for the treatment of the chemical waste once a dump is sampled. One has to guarantee that no (further) contamination of groundwater aquifers occur during and after the drilling of a well. Polluted samples have to be stored in a proper way after testing, which is very expensive. The insurance companies now ask enormous amounts of money for the drilling of one simple hole. So in practice there are not many holes drilled.

F. Bisschop, W.O. Molendijk

[1] Geo Information System

Pile Foundations on Rock in the Netherlands

INTRODUCTION

In 1980 about 65 % of all foundations in the Netherlands were piled foundations (Tromp, J.P.M; 1980). Much has been written on this subject. Many topics dealing with pile foundations in the Netherlands were investigated and described e.g.: (negative) skin friction, pile bearing capacity, horizontal and vertical stresses in piles, piles on sand and (over) consolidated clays, etc. But nothing was written about pile foundations in situations where soft alluvium overlies rock in the Netherlands. A literature search was done on this subject but no articles or books were found.
The following magazines and conference papers didn't show any articles on the subject of pile foundations on rock in the Netherlands: Land en Water, de Ingenieurskrant, Geotechnique, Congress reports of the International Conference of Soil Mechanics and Foundation Engineering, Geotechnical Abstracts of The German Society of Soil Mechanics and Foundation Engineering, Delft Geotechnics abstracts.
So some companies were visited and telephone calls were made to companies which had investigated a particular project on this subject.
In the southern part of The Netherlands calcarenites (Cretaceous) are near to the surface. Here a lot of buildings are built on the calcarenite.
IGF, settled in Maastricht, investigated projects which were dealing with this subject. Ir. H.P. Ritt was here very helpful by providing information. Ir. L. Snijders (Geoconsult, Hoensbroek) and Ir. Kraayepoel (Fugro-McClelland, Nuenen) told something about their experiences with pile foundations on calcarenite in South Limburg.
Also information was gathered with the help of Ir. L. Posthumus (Delft Geotechnics, Delft). He provided a report of a German company which was dealing with an investigation concerning a foundation of a brewery (de Leeuw). In the eastern part of the Netherlands the Muschelkalk formation is only a few meters below the surface. Here only one project was known about the foundation on rock.
The "Steenfabriek Winterswijk" is built on the Muschelkalk, no piles were used, but this project is a good example of how the subject "rock" is handled in the Netherlands. In the next chapter the experiences with the subject are listed. Some case studies are presented and the last part contains some conclusions.

PILE FOUNDATIONS ON THE CALCARENITES IN SOUTH-LIMBURG

In this chapter the following topics of pile foundations on the calcarenite in South-Limburg are described:

- design considerations;
- methods of site investigation;
- kind of piles used/prescibed;
- calculation of bearing capacity;
- settlement and skin friction of piles.

Design considerations

The stratigraphy of the soil/rock in South-Limburg consists mostly of several meters of loess overlying sands, gravels and calcarenite.
There are mainly two foundation possibilities in this part of the country:

- raft foundation (on the loess, gravel or calcarenite);
- foundation on short or long piles (on the gravel or calcarenite);

Raft foundation depends mainly on how many ground has to be dug away, groundwater problems and possible extra settlements of neighbouring buildings. Piles are placed on the gravel or calcarenite. This depends on the thickness and depth of the gravellayers. Because the pile bearing capacity calculations require a minimum thickness of 4 times the diameter of a pile (diameter between 0.25-0.5 meter and bored piles 0.5-1.0 meter) the gravellayers need a minimal thickness of one meter.
When the gravellayers are not thick enough to resist the expected forces the piles are placed on the calcarenite.

Methods of site investigation

The used methods of site-investigation are:

- *Cone Penetration Test* (CPT): a cone is pushed in the soil/rock with a certain average speed and the resistance to progress is measured;
- *Static Penetration Test* (SPT): a cone is hammered in the soil/rock one meter below the borehole and the amount of blows required for penetration from 15 to 45 cm is counted;
- "*Rammsondierung*" (heavy penetration test): the amount of blows to hammer a cone of certain dimensions 20 cm in the soil/rock is counted;
- *borings*;

Typical results of these methods are presented in figure 1. From the CPT-curve the different layers can easily be distinguished. The gravel can be distinguished by a high cone resistance and a high friction ratio. The weathered calcarenite has a lower cone resistance but the friction ratio remains the same. In the weathered calcarenite the penetration resistance increases with depth until penetration becomes impossible.
The most used method is the cone penetration test because there is in the Netherlands much information and experience available about that the test is mostly used for the investigation of soil. The CPT-test is a relative cheap investigation method and gives no problems with the flintstone in the calcarenite. When the penetration became impossible the calcarenite is assumed to be strong enough to act as a bearing layer.
The SPT-test and heavy penetration test are mostly used by German companies and can penetrate deeper in the calcarenite, but the different layers are more difficult to distinguish.

Kind of piles prescribed/used

The following types of piles are used:

- bored piles: a hole is bored down to the bearing layer. A steel (fig. 2) casing is placed to support the sides of the borehole. The cage of reinforcing steel is lowered and the hole is filled with concrete. During the filling the injection pipe and casing are raised;
- augered piles: an auger with in the middle an injection pipe is (fig. 3) used to make a hole. When the bearing layer is reached pressure is applied to the concrete, the auger is lifted and the concrete will fill the hole;
- hammered piles;
- vibrated piles;

The most commonly used piles are bored piles because it is difficult to pass the gravellayers with hammered piles. A vibrated pile passes only with difficulty the big pebbles in the gravellayers. Hammered piles are used / prescribed by some companies, but they can cause a lot of problems. The design consideration used here is: where a CPT-test is possible a hammered pile can be placed.
During the construction of a bridge over the river Maas these piles were used, but this became a financial disaster.
Augered piles require a strong augering machine because otherwise it will stick up in the gravel or calcarenite layers. These piles have a limited diameter (one meter).
Bored piles have the advantage over augered piles that they can have larger diameters. Two conditions for the construction of the pile are very important:

- the surface of the concrete has to raise gradually;
- raising the casing with a shock will cause a good density of the concrete.

Calculation of bearing capacity

The sole method to calculate the bearing capacity of a pile on the calcarenite is the Koppejan Method with the help of the results of the CPT-test. The SPT and other tests are only used to get a first impression of the stratigraphy and bearing capacity.
The maximum limits for the bearing capacity of a pile on rock are:

- bored and augered piles: 3.5 N/mm2 (safety factor: 3);
- hammered piles: 5.0 N/mm2 (safety factor: 2).

The safety factor for bored and augered piles is higher than for hammered piles because during the construction of these piles the soil around the borehole relaxes. This will cause a lower side friction.
When using the Koppejan Method cone penetration values above 20 N/mm2 are disregarded. These values are unreliable due to the fact that the cone builds up a certain stress and then suddenly relaxes. This process distorts the real value of the penetration resistance.

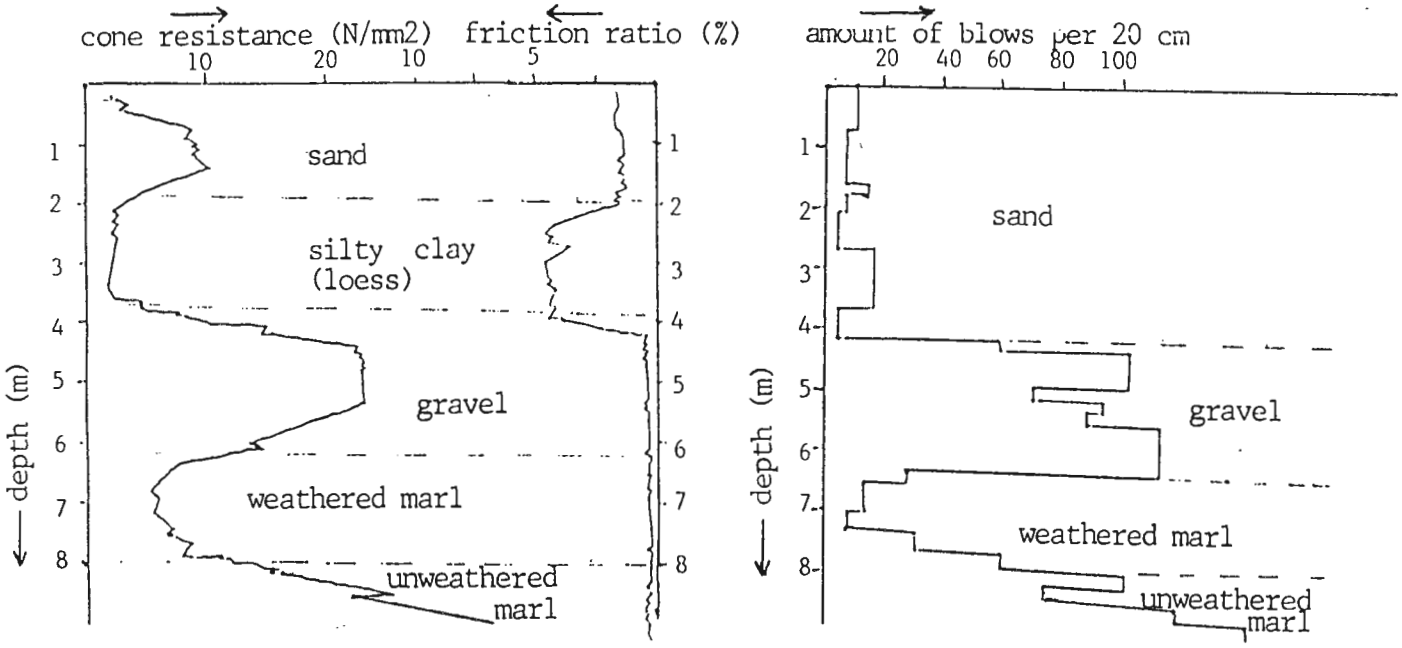

Figure 1: Typical results of cone penetration test and heavy penetration test (schwere rammsondierung).

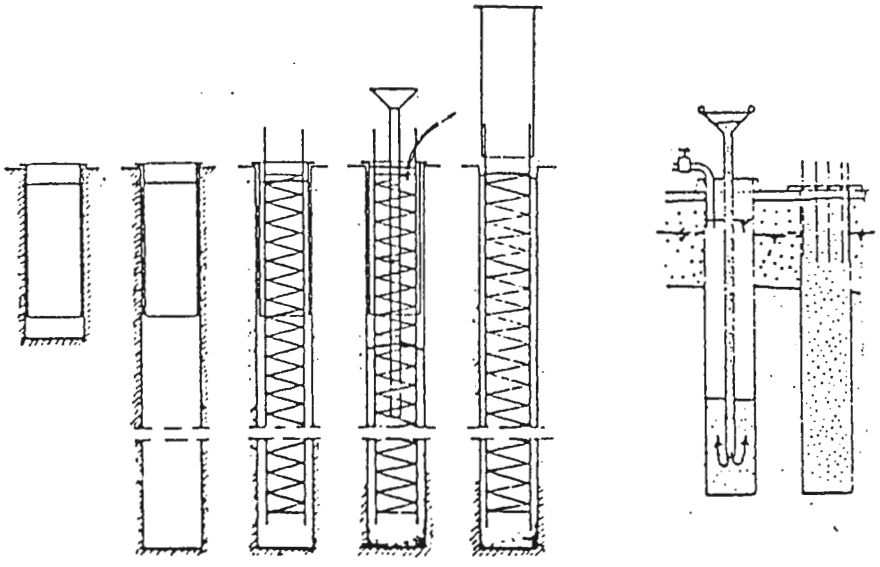

Figure 2: Construction of a bored pile.

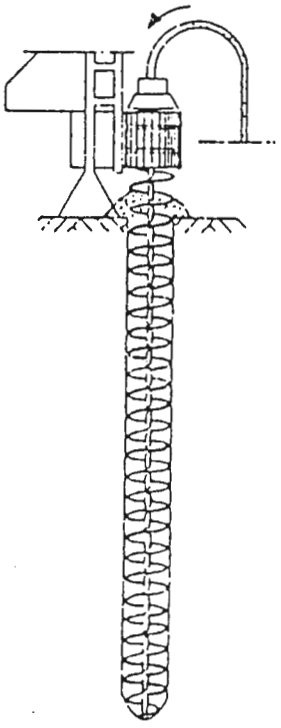

Figure 3: Construction of an augered pile.

Settlement and skin friction of piles

The settlement of a pile on calcarenite is mainly expressed as a percentage (10 %) of the pile diameter plus the elastic shortening of the pile (mostly between 2.5 and 5 millimeter).
In the Netherlands this is done for all pile foundations on sand and gravel. The effect of skin friction is usually not taken into account for the following two reasons:

- bored piles cause relaxation of the soil around the borehole, so no or almost none side friction will be developed along the pile-shaft;
- the piles are placed a very short distance in the bearing layer, so the side friction of the bearing layer is also very small.

Another calculation method only the elastic shortening into account for the settlement, because the calcarenite is seen here as a strong rock which allows no, or almost none, settlement. Here the skin friction is neglected because, due to the very small settlements, no side friction will be developed.
To prove which theory will give the best approximation of the real situation, stress and settlement measurements should be taken of constructed piles.

CASE STUDIES

Investigation concerning the building of a police office in Maastricht (IGF, Maastricht)

The investigation was carried out in 1975. The site investigation consisted of:

- heavy penetration tests;
- borings;
- cone penetration tests.

Raft foundation was rejected because this would require a very large excavation and the groundwater level would have to be lowered. This would have caused damage to the surrounding structures. The tests revealed that the gravellayers were too thin to support the building. The upper part of the calcarenite was weathered with a low bearing capacity. Below the weathered calcarenite existed a strong unweathered calcarenite with a high penetration resistance. So it was decided to put the piles in the calcarenite. The foot of the piles had to be placed in the first one to two meters of the unweathered calcarenite on top of the weathered calcarenite. It was decided to prescribe bored piles, because hammered piles would not survive the hammering through the gravellayers and vibrated piles would have problems with the very big pebbles in the gravel.
Two problems were faced with the construction of the bored piles:

- more concrete was used than the theoretical volume of the borehole due to the porosity of the gravel. One pile was excavated and the part of the pile in the gravel showed to be bigger. This causes a higher bearing capacity and lower the settlement of the pile. No negative effects were expected from this problem.
- during the raising of the casing the cage of reinforcing steel was lifted up with the casing due to some parts of calcarenite sticking to the casing. This problem was solved using a casing of a smaller diameter (80 cm).

Foundation of an underground garage in Maastricht (IGF, Maastricht)

Site investigation was carried out in the beginning of 1974. Here the site investigation consisted also of: cone penetration tests, boring and heavy penetration tests. No laboratory tests were performed.
The results of the site investigation revealed alternating layers of clay, sand and gravel overlying weathered and unweathered calcarenite.
Raft foundation was rejected because of the three following reasons:

- risk of floating of the structure due to the changing of the waterlevel of the river Maas;
- very unequal bearing capacity of the unconsolidated sediments;
- deep excavation would need a lowering of the groundwater level and this could cause an extra settlement of the surrounding structures.

Another method of foundation was put forward: foundation on very short piles ("*poeren*") which were placed on top of the calcarenite. They are constructed by making a hole in the ground and fill this with concrete. The bearing capacity of the piles is 0.8 N/mm2.
But again lowering of the groundwater level was necessary. The best method proposed was a foundation on bored piles which should be placed somewhat deeper in the calcarenite. Higher bearing capacities could be allowed (1.5 N/mm2) and only draining in an open pumpingwell was required. The bored piles were chosen according to the same reasoning as in the preceeding project.

Foundation of a brewery in Valkenburg (Ordinarius fur Verkehrswasserbau, Grundbau und Bodemmechanik; Technische Hochschule Aachen)

The investigation was started in december 1963 and finished in january 1964.
The site investigation for this project consisted of:

- borings, stopped at surface of calcarenite;
- SPT-tests;
- heavy penetration tests (schwere rammsondierung);

Again no samples for laboratory testing were taken from the calcarenite. The results of the tests showed waste of old building material, silty sand and gravel (total thickness 4 to 6 meter) overlying unweathered calcarenite.
Because the very low bearing capacity and the irregular character of the waste material and silty sand a raft foundation was rejected.
Because the gravel layer was too thin it was decided to place the piles on top of the calcarenite. Due to the strong character of the calcarenite no settlements were expected.

Foundation of steenfabriek Winterswijk

This factory is not constructed on piles but this project is yet interesting because it shows clearly how the engineers handle rock in Holland. The foundation method is a raft foundation.
The surface of the rock was flattened with concrete.
There was no geotechnical investigation carried out on the Muschelkalk, only geological fieldwork was done.
Mr. Jansen said that the foundation was designed on, I quote his own words: "op zijn janboerefluitjes". It was accepted that the Muschelkalk would have enough strength to support the structure. The factory is still standing, so the rock was strong enough to provide enough bearing capacity for the structure.

CONCLUSIONS

The Civil Engineers in the Netherlands treat rock in Holland like soil. The only specialized test for rock used here is the heavy pentration test. But for the calculation of the bearing capacity of the piles a method is used which is made for calculations in soil.
The bearing capacity and settlement of the hammered, bored and augered piles should be tested, because then the assumptions, which are made during the calculations, can be checked.
Maybe it is possible that the bearing capacity of the calcarenite is higher than is assumed now, so less piles or smaller piles may be used.
There is also much confusion about which kind of piles are the most suit-able to use for this purpose. The bored and augered piles seems the best piles to me.

F. Bisschop,
Student Ingenieurs Geologie, TU Delft

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Practisch werk in Italie

Vorige zomer heb ik de mogelijkheid gehad om in Italie wat inzicht te krijgen in wat ingeneursgeologie nu eigenlijk inhoudt. Met hulp van de heer Maurenbrecher ben ik in kontakt gekomen met het adviesbureau Studio Geotechnico Italiano (SGI). Het is een bedrijf dat adviseert en assisteert bij geologische en vooral civiele projecten voor zowel particuliere bedrijven als overheidsinstellingen.

Het bureau heeft zijn hoofdkantoor in Milaan en verder in Rome en in Cesena FO. Het is opgericht in 1964 en sindsdien uitgegroeit tot een op internationaal niveau werkend bedrijf. Sinds 1980 staat het onder leiding van Ing. L. Albert M.Sc. (civiele techniek en grondmechanica) SGI heeft een grote invloed gehad op de ontwikkelingen in de geotechniek in Italie. Vooral haar onderzoekingen hebben geleid tot een innovatie in de onderzoeksmethodologie. SGI adviseert en assisteert zowel overheidsinstellingen als particuliere bedrijven. Tot haar werkterrein behoren o.a. de grondmechanica, fundamenten, de toegepaste geologie en de seismiek en dynamiek.
Afgezien van tijdelijk verbonden medewerkers werken in het bedrijf ongeveer 75 personen.
Enkele voorbeelden van projecten waar SGI betrokken is geweest zijn:

- De brug over de Yangtze rivier,
- De metro van Hong Kong,
- Het behoud van de toren van Pisa,
- Onderzoek naar de seismische activiteiten voor de stad El Salvador.

Ten tijde van mijn verblijf was dit laatste net afgerond, wat mij de gelegenheid bood hier wat meer over te weten te komen. Een ander project dat op dat moment aan de orde was, was de aanleg van een snelweg voor vrachtverkeer naar Bologna. Het probleem hier was de instabiliteit van de hellingen aan de voet van de Appenijnen. Mijn bezoek gold het traject tussen Sasso Marconi en Barberino di Mugello. Het grootste stuk van de weg moet hier onder de grond komen te liggen., hetgeen een intensief onderzoek vereist. Dat het een niet al te gemakkelijk gebied is mag blijken uit de problemen die naar voren kwamen bij de eerdere aanleg van een snelweg hoger op de valleiwand. Het grootste deel van de pilaren onder de weg schoven al tijdens de bouw weg en anders gebeurde dat later wel. De weg is nog steeds in gebruik maar moet zeer regelmatig onderhouden worden. De gevolgen van de grondbewegingen op de weg zijn duidelijk zichtbaar, en ook op de kleinere wegen zijn de klassieke verschijnselen op te merken.

Het bedrijf heeft de klassieke volgorde van onderzoek aangehouden en was destijds bezig met sonderingen op verschillende locaties. De sonderingen worden niet door het bedrijf zelf uitgevoerd maar door een ingehuurd bedrijf. Een medewerker is altijd aanwezig om het werk te controleren. Dit is, in ieder geval in dit geval, beslist noodzakelijk omdat de uitvoerende krachten niet altijd lijken te beseffen dat zonder nauwkeurige navolging van de instructies en/of standaards de resultaten geen enkele waarde hebben. Een voorbeeld hiervan is de volgende situatie:
Bij de bepaling van de permeabiliteit met behulp van de pumping in test (Lungeon methode) moest de hoeveelheid ingepompt water worden gemeten terwijl de druk in het afgesloten gedeelte constant bleef. Op een gegeven moment werd opgemerkt dat de waarden van de ingepompte hoeveelheid water (in relatie met de tijd),niet overeen wilden stemmen met de verwachtingen. Na enige observatie van de werkers bleek dat het bespreken van de krantekoppen belangrijker was

dan de controle van de druk in het afgesloten gedeelte. Deze liep constant terug, zodat de resultaten waardeloos waren. Door ingrijpen van de Medewerker van SGI konden de juiste waarden alsnog bepaald worden.

Wat vooral opvalt in Italie is dat de wijze waarop diagrammen en grafieken worden getekend nogaleens afwijken van die zoals ze op de faculteit geleerd worden. Dit vindt zijn oorsprong in het bestaan van verschillende standaards in de verschillende landen. Een resultaat hiervan is dat een rapport soms in drie of zelfs meer versies geschreven moet worden. Het is een noodzaak om te proberen hier een eenduidige norm te ontwikkelen en hopelijk zal hier zo spoedig mogelijk verandering in komen.

Tot slot kan gezegd worden dat ik positieve indruk heb gekregen van de Ingenieursgeologie in Italie. Bovendien lijken daar goede toekomst mogelijkheden te vinden zijn, daar in Italie nog geen aparte studie bestaat zoals in Nederland.

A.R.G. van de Wall

Impression of an ITC-Student

Introduction

The following article has been written by an ITC student from Bolivia. In order to get more knowledge in the field of engineering geology he has been sent to the Netherlands to follow courses on this subject. Together with Dutch students they attend courses at ITC and at the Delft University, department of Engineering Geology.
ITC stands or International Institute for Aerospace Survey and Earth Sciences and gives the possibility to foreign countries, mostly third world, to catch up with the present state of knowledge. ITC gives courses on geology geophysics, etc.

(red.)

Antonio Diaz Villamil
Bolivia

One of the most profitable aspects of a fellowship in a foreign country is the social relationships with people of different cultural environments.
This experience is really unique. Some deep and unknown instincts of a person an be reclaimed in the middle of the most unexpected human situations.
Although it is a real challenge for a third world professional to come to Europe and to study and to live there successfully the greatest challenge is for the country which receives the foreign students.
The International Institute for Aerospace Survey and Earth Sciences (ITC) is wellknown in Latin-America, mostly because of its remote sensing training programs.
The postgraduate course in engineering geology offered by this institute figures in technical bulletins like the IAEG Bulletin and AGID News. This is the most common source for information given by the people who participated in ITC courses; in Bolivia most of them are geologist.
The geologist in Bolivia, after studying for five years in one of the four universities which offer this career mainly work in the following application fields: mining, geological mapping, civil works, petroleum geophysical investigations and groundwater surveys.
After presenting a thesis in the Universidad Mayor de San Andreas in La Paz city I had working experiences with all of these fields with exception of petroleum geology.
My current job is with an urban river basin managing project within an agreement between GTZ of the Federal Republic of Germany and the Municipality of La Paz. The german partner on this project made possible my participation in this postgraduate course in The Netherlands.
I like the course. I personally find it very useful and I am having an intense and wonderful period in my life.

Book review

"Stresses in rock" by G. Herget, 1988, Balkema, Rotterdam, pp. 179, price: Hfl. 85,--

This concise book gives an introduction into the analytical techniques available to tackle rock engineering problems in mining and civil engineering. After a short introduction into the types of stresses that are present in rock masses and how these are measured, the first half of the book deals with stress analysis in elastic , isotropic, homogeneous media. In this part the usual topics are treated, like stresses in two and three dimensions; stress around underground openings; strains and stress-strain relationships. Compared with other books on this subject, in this book considerable attention is paid to the algebraic manipulations necessary to derive the formulae. Also repeatedly examples are given. These consist mainly of filling-in the derived expressions with numbers. At first sight this constantly repeated procedure troughout the book (even the most simple formulae are followed by an example calculation) seems rather odd. On the other hand, the text was written as an introduction to rock mechanics for students and this way a newcomer can get a feeling for dimensions and magnitudes. The second part of the book deals with failure of rock (Coulomb, Mohr, Hoek-Brown criterea, Griffith theory), rock masses and rock mass classification systems and the application to room and pillar mining. The last chapters, where the mining application is treated, deal with the analytical methods one can use in loading of multiple openings (tributary area theory, pressure arch) and the stiffness concept is explained. Stresses in pillars, roof and floor are discussed and the effect of supporting methods. In these chapters the earlier developed theories are effectively applied.

This book covers to a large extend the rock mechanics subjects given to mining engineering students in an introductory course. It is written very consisely. I admire the author in addressing, in most cases, the very essentials of the topic. It is necessary to read the book from cover to cover for a good understanding. For example, a beginning student will not grasp the essentials of stress measurement in rock after reading the first chapter where some in-situ measurement techniques are treated. Only one short sentence refers to the necessity of knowing the E-modulus; the full implications will become clear later, when in chapter 4 some examples of in-situ stress calculations are given. A student working through the book (or professional engineer or geologist who wants to get some analytical calculation skills in rock mechanics) the book will develop the skills to make simple calculations on stress distributions and supporting methods using elasticity theory and the Mohr-Coulomb failure criterion.

As a first introduction into rock mechanics this book is recommended, because it treats those subjects which are really necessary to grasp. It could be an ideal compagnion to an introductory course. The book has some draw backs, however. It is a pity that it has not been very critically re-examined before publication. The figures are of a very small size and often not too clear. There are also mistakes and omitments, especially in some figures (e.g. Fig. 5.3 is not an illustration of the brittle/ductile transition, (although the definition of this is given correctly in the text). On page 86 the Hoek-Brown "m" value for argillaceous rocks is missing. Fig. 5.13 does not illustrate "controlled and uncontrolled" deformation clearly: the uncontrolled part could be a "type II" material. The definitions on page 93 of major and minor discontinuities are confusing.)

Drs P.N.W. Verhoef

CONFERENCE REPORT

Instalment 2

Conference on Underground Spaces and Earth Sheltered Buildings
Shanghai, September 1988

Chronicle of a trip to China

by P.M. Maurenbrecher

This is the second instalment on the visit of P.M. Maurenbrecher and Prof. Ir. H.S. van Lohuizen to China. Despite mishaps they both managed to arrive in China. Prof. van Lohuizen is still without his suitcase which probably has become part of the confusion at Hong Kong airport. The second instalment finds us on the third day of the conference. The conference now consists of three parallel sessions. These were held in the administration building committee/ reception rooms. One either stood or if seated one sat in a very comfortable sofa.

The sessions were divided as follows:

A:	B:	C:
1. Vernacular approaches	Design and construction	Environment & Health
2. Urban underground space	Soil & Rock Mechanics	Protection

"Vernacular": Belonging to or developed in a particular place, region or country; native; indigenous

Saturday, 3rd September, 1988

The following notes are from session B 1 (programme 7B):

Zigong combined arcade traffic tunnel

K.S. Zhu et al (paper p246) gave a presentation on a multipurpose tunnel in mountainous city to allow for both pedestrian and wheeled traffic. The tunnel has two levels, the top level for pedestrians and a "street market" and the bottom level for traffic. Such a configuration only required a 5% increase in crossectional area over a one level traffic/pedestrian tunnel. Construction was by the-new Austrian tunnelling method. Other design aspects were
-tunnel is larger then present needs to allow for future needs.
-Aesthetics formed important consideration : the facades are to become a "treasured symbol" of Zigong City and the southern portal will have a "mural painting of a giant dinosaur dallying with a pearl" and the north entrance a "magnificent scene of a dinosaur and a crane over the famous brine well". (Zigong City is famous for its brine wells and dinosaur museum).

Shield tunnelling in Budapest

Mr. Janitsary (page 262) talked about shield tunnelling in Budapest and details of sealing tunnel lining segments, involving concepts such as "hinged" joints, bituminous sealant and running an epoxy cement mortar between lining segments. Such techniques are also used in the Calcutta metro. The soil conditions at Calcutta are alluvial sediments consisting of

clayey silts, loam with sand and silty sands, silts. Below 15 m clayey silts and "loams" occur. Lastly Mr. Janitsary presented stress bending moment diagrams as a result of loading by very soft soils. (Not given in his paper)

Ground movements caused by underground openings

F.M. Kuwajima (a Japanese engineer from Brazil working in Canada) presented a joint paper (page 332) on ground movements around openings in gravitational stress field. The paper presents the analysis for deformations around an arched opening with a flat floor for different height to span ratios. Results from a numerical analysis (the actual method not given; only a general function equation giving the pertinent variables) are given in tables. Four dimensionless displacement values, at the floor, springline (horizontal displacement half height point up the wall), crown and corner (horizontal displacement junction floor/wall). Twenty seven profiles were considered representing up to 118 caverns studied. The results are then re- analyzed to develop general equations using regression/best fit methods with the aid of a "simplex algorithm". A simple equation for the springline became

$$U = -(0.1603 + 0.1470\ L/H)/K + (0.5696 + 0.4211\ H/L).$$

Comparisons with existing case histories doesn't appear to be favourable (elastic displacement twice the estimate, plastic from 4 to 50 times. In terms of "order of magnitude" the method may yield useful results.

Hochtief's Japanese slurry shield

Next a representative from Hochtief gave a presentation (not in proceedings and speakers name not in programme). A separate paper is available. The method described an air/slurry shield known as the Japanese slurry shield. In Europe bentonite is used whereas in Japan natural clays. The German system is an adaptation and has a compressed air reservoir. The advantage of the system is that cuttings are dry though compressed air can escape along the cutting edge.

Grain storage using NATM lining

Yang Linde (conference secretary) presented the next paper on the design of underground openings for grain storage. New Austrian tunnelling method type lining is proposed for the cavity.

Underpining structures above a subway

M. Nakashima (page 255), who is organising the next conference in 1990, gave a presentation on design and construction of a subway line under large permanent structures by underpinning in Nagoya, Japan. Subsurface consists of sands and clays (it appears erroneously described as "diluvial" an obsolete term for flood deposits, hardly consistent for clays.) The method of underpinning was to strengthen the ground by grouting. An elaborate monitoring system was installed to measure settlements.

Cyclic fatigue in rock

Tao Zhenyu presented a paper on cycling loading of rock (page 310). Experiments were made to study the effects of fatigue in marble and sandstone on cosine and triangular loading waveforms. To quote the authors:

"on basis of irreversible thermodynamics, an endochronic constitutive equation of rock has been derived under equal temperature and small deformations conditions." The terminology is impressive, but all this means, presumably, is that the laws of thermodynamics are analogous to cyclic loading behaviour. The paper does not suggest which conditions in nature the cyclic loading is supposed to simulate except with a rather general *"the foundation of dam (!) and underground engineerings such as tunnel and underground chamber often subject to cyclic loading"*. Trains?, generators? celestial (tidal)?, jackhammer? marching soldiers? surge chambers in hydro-electric power stations? Wanted: a reviewer.

Tea break and second session: The Vernacular Approach

The first session of which the latter half was based straight from the proceedings was followed by a tea break, much needed.

Not being able to face the wilder rock mechanics theories and the dexterity of some people's analytical prowess I found consolation in more relevant *Session A: The Vernacular Approach*. My notes show cartoons of underground dwellings of the great Loess Plateau, however the first presentation came from Mr. Saari who will host an Underground Conference in an underground space centre north of the Arctic Circle (he promised) in 1994.

Finish vernacular: impressions

The first presentation was given by K. Saari from Finland on "Public subsurface buildings in Finland (page 11). Impressive examples of underground churches, auditoriums (suggest Mijnbouw with its poor lecture space make an underground auditorium underneath the quadrangle) of which a good example was made to extend the museum facilities without having to add an appendage to the historical National Museum building. The economics are justified according to Saari on basis that rock excavation is cheap compared to cost of conventional construction (20 to 50% of total project).

The Loess plateau dwellings

Guo-Bao Zhou gave an excellent slide show of numerous examples of underground dwellings from the Loess plateau (page 27). Caves show arched construction up to 2.5 m high and about 2 m between cave entrances. His paper lists the compressive strengths, more in line with a very weak rock (about 1 MPa). Overburden varies from 3 to 10 m. The entrance portal construction dominates the strength of a cave dwelling. Such portals often use stone or brick. Caves withstand severe earthquakes if properly constructed and maintained. The loess appears to have properties of a "shock absorber". The only hazard is the brick or stone facing. Wood appears to survive earthquakes better than brick. As wood is rather scarce commodity concrete rib sections are used instead to form a complete arch inside the structure.

Room and pillar Tuff mines of Japan

T. Konishi presented a fascinating paper on vast underground spaces in the Tuff-building stone mines of Ohya, Japan. The plans are not dissimilar to the limestone room and pillar mines of South Limburg. The difference is the size. Ceilings average 20 to 25 m and in some cases up to 50 m. Inside the

caves the impression is that of standing in a forest. Pillars are 8 to 10 m in dimension. The width of chambers are not given but pictures indicate at least 20 m, sufficient for art galleries and concert halls. The space is to be used for holography and storage of bulk food. (Very constant humidity and temperature.) The very uniform stone was excavated by sawing and has a consistent compressive strength 5MPa.

Inducing a blocky structure by simple shear

A presentation by R. Mo...(?) from the USSR given of simple shear on rock which then induces a blocky structure. A paper on this subject has been published recently (?) by the Soviet Mining Science and translated into English in New York.

Aesthetic earth multi-storey ring buildings

Lu Bing-jie gave a presentation on strange earth structured circular buildings of Tu-Lou in Tian-Liao Keng (South China). These structures are built around an inner circular courtyard. The dimensions of the building are such that they conform to the "golden section law" giving them aesthetic appeal. Up to two hundred inhabitants to one building. The author does not present any illustrations (he did show slides) but aptly describes the buildings as follows: *"In the high mountain ridges, particularly looking down from the Shi-qi-dong mountain ridge, a group of the round roofs, that one roof linked to another, just like a group of UFOs coming down from the sky, and float on the green mountain ridges. This scene which seems mysterious is so harmonic and so strange."*

Working lunch

It's raining heavily. Van Lohuizen and I attended lunch as Netherlands representatives for the 1990 conference. The luncheon is hosted by Prof. Hou Xueyuan. Also present Ray Sterling and , Yange Linde, K. Saari & J. Autio Finland, Prof. B. Maidl, Germany, Yoshio Higashikata and Prof. Emeritus Yoshiaki Yoshime, Japan. The result of meeting is that Japan will try and hold the next conference in 1990, the Netherlands in 1992 together with a tunnelling conference and Finland either the following year or 1994. The Finns may have a underground conference centre north of the arctic circle by that time.

Afternoon excursion Shanghai Underground works

In the rain to visit the construction of a road tunnel projected beneath the main river, very wet. Safety, as on any European construction site means donning a safety helmet. Many of the safety helmets made from straw. The hosts kindly allowed us to keep these and so now I am the proud possessor of a straw safety helmet. The second visit was to an underground civil defence centre situated underneath a watch factory; essentially a reinforced concrete basement area with large blast-proof doors. In the rain back in wet condition to guest house. Stomach trouble from lunch, lomotil to rescue. Flooding widespread in Shanghai. Not many notes made as my "free" evening ended up for a whiskey with other guesthouse inmates (Eisenhofers (NZ), Granits (Sweden) and the Tiede's (Germany). Never got round to buying a bottle of something so got chocolates instead.

Rain persisted to next morning but lessened. Wet clothes hardly dry. Use

heat from lampshade to dry clothes.

Sunday, 4th September, 1988

Van Lohuizen is still without his suitcase. He has managed to loan some clothes from last night's whiskey drinkers.

For the first session I have decided to stick to *the vernacular.*

Young daughter and excavations for grain storage

Prof. Mrs. Dunkel (page 1)(who had a very pretty eligible young daughter in tow and something of a linguist) gave talk on storage of grain in underground pits. Aspects such as temperature and moisture effect growth of fungi. Despite decline of oxygen mites and other insects can survive.

Beijing subway station

Xiu-Yue Cai (page 110) gave a talk on a subway station in Beijing, its method of construction and the uses to double up as underpass, bicycle parking and shopping precinct. The construction consists of inserting piles, spanning a bridge deck span across the piles then excavate beneath.

Reliability analyses tunnel support

From there changed to *session B, Soil and Rock Mechanics* to listen to presentation from X.Y. Liu on reliability analysis of support with shotcrete & rockbolt system for circular tunnel. (Separate paper not in proceedings, copy handed out). The failure analysis models for shotcrete rock bolt systems consist of a limit state function. At present the work still part of continuing research as there are still too many parameters involved.

Seismic stresses and tunnel displacements

The final paper of the session was on seismic stresses and displacements of underground circular tunnel by S.H. Yan (page 377). The summary of the paper is as follows: *The dynamic stresses and displacements of circular tunnel which consists of steel plate liner and concrete filler in rock medium acted upon by P and SV waves are determined with elastic dynamic methods, and the formulas of P and SV waves..... are derived respectively. The tunnel at #2 intake at Bai Shan hydro-electric scheme is analyzed by computer for the case of firm and of loose surrounding rock with or without steel liner. Results show that the tunnel can resist an earthquake of magnitude 7.* For those who like matrix analyses the paper is worth reading.

Tea break and final session

The rain was coming to its end. Walking round puddles I left the administration building for a neighbouring more spartan edifice where *Session C: environment and health protection* was being held. The meeting room had its usual sofas. Projection screen was part wall and part white sheet. This did not, however, deter the speakers. The papers concerned had to do with radon pollution and its treatment.

Radon pollution in China

The presented was given by Z.Y. Tsai (the paper is not given in the proceedings, but a copy was handed out. Mr. Tsai also provided a second non proceedings papers entitled *Systems analysis on the surrounding rock collapse*. He mentions the different quantities of radon that exists in different lithologies. He shows how radon moves in through the subsurface by solving a Laplace type equation similar to that use for ground fluid flow. Treatment methods are relocation, lowering of water table and ventilation

A second paper was given by Tian Zhigian on "*Radon and air ions in Underground engineering*" (This paper is not in the proceedings, a draft copy was handed out). Curves showing variations of concentration are given. By generating negative air ions the pollution from both dust and radon can be improved.

Cost benefit and safety

The last two papers presented in session c had little to do with the session theme. The first was a cost benefit analysis one by Qian Q.H. and W.G. Lee (Not in the proceedings) in which he examined by computer the return on investments for underground storage, for transport and as a work place. Such analysis should take into consideration safety aspects.

Diaphragm walls in China

The last paper was about diaphragm walls by Zhong BaiYi et al (page 221) was on the application of diaphragm walls in China. This paper describes the design of a diaphragm wall used together with a basement slab part way up the wall so that the composite structure resembles a skirt foundation. The basement has a civil defence shelter and parking area. Built in Shanghai in loose clayey sands which extended to at least 30 m depth.

Boat trip on the Huangpu River

That afternoon in overcast skies, (the rains had subsided), the conference delegates were treated to a an afternoon tour. The conference bulletin had said "*an evening tour along the beautiful Huangpu River for three hours to enjoy the night scene of Shanghai City*". Instead we enjoyed the afternoon scene all the way to the junction with the Yangtze from the luxurious front lounge of the double hulled touring *Spido*-type boat called the "The Pu-jiang". The brochure describes it as *the greatest touring ship in Shanghai*. The front lounge was in *special class*. Toilets were marked "*Mans*" and "*Womans*". One could admire the baronial stone clad building along the Zhongshan Road, of which one of the hotels, I was informed by another delegate, sports a genuine jazz band from pre-revolution reinstated musicians all of whom are well into their eighties.

It appears I have not kept any more notes on the trip. One could enjoy the scenery, consisting of typical harbour views of many cargo vessels, barges for up river traffic, quays and warehouses, river boats, and offshore oil installation vessels, in this instance a large crane barge with what looks like a lifting capacity of 1000 to 2000 tonnes. Alternative entertainment was available in the lower class section situated below decks where

passengers were treated to a conjuror.

Monday, 5th September, 1988

Excursion to Su Zhou, the Venice of the East

The following day by buses to Su Zhou "the east Venice" as the Bulletin No 2 describes them; *"The gardens of Su Zhou are world famous for the way bring together the beauties of nature, architecture and painting."*. My notes say: leave by ZhongZei Road 6:15. Lots of people about purchasing from early morning market. (The female head of the family does the shopping). There are also people exercising. Queues at bus stops. Just past the railway line very picturesque almost medieval housing run-down but kept (clean and neat), earmarked for replacement by regimented monolithic apartment blocks. The bus turns right after about 3 to 5 km after railway crossing near a large new hotel development complex. In the morning visit two gardens with pavilions walls trees and lots of ponds set in imported karstic stone. Second garden the designer opposite of Capability Brown; he went all out for a rather nightmarish collage of the karstic stone. The town is tiled roofed and shady streets with lots of bicycles and ring bells, trucks and a few cars. Lunched at a pavilion restaurant set in a park with lakes and fun fair. Had to bear blowing air-conditioners compensated by a sumptuous lunch with plenty of the very low alcohol content Chinese beer. Stroll in park revealed a canal at back with monolithic flats beyond, heavily loaded barges being painstakingly inched along by barge-poling and a geese farm making a din.

Tiger hill is the next venue. It is of interest: an inlier (?) of granite with basaltic/dolerite inclusions differentially eroded leaving cleft gorges where from a spring emits. At the top a leaning brick pagoda from 951 AD. Hill got its name from Tang dynasty when the emperor buried his wife on the hill. She was called White Tiger. (Paper published on this hill in recent conference 1988 on engineering geology of ancient structures). Leaning possibly caused by part of pagoda founded on in-filled material contained by massive stone masonry retaining walls. The last visit, the west gardens is part of very orange coloured Bhudist temple complex. The bus is whistled into its parking bay.

Farewell Reception

That evening the farewell reception. Sit next to John Butlers, an architect from Zambia. Did not see him at rest of conference, probably been touring. Prof. van Lohuizen sits at principal table near to the chancellor who is guest of honour. He is lucky as the chancellor has a very attractive looking female interpreter. They then roam from table toasting the occupants who get up and return the toast by clinking their beer glasses. Very noisy so that the speeches go unheard. The reception is held in the rather spartan refectory, bare walls and polished concrete floor. The evening ends early, at about nine p.m.

Next issue: Closing session of Conference and a trip to the west of China by train, bus and train.

BESTEL FORMULIER

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FACULTEIT DER MIJNBOUWKUNDE EN PETROLEUMWINNING
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2600 GA DELFT 2628 RX DELFT
TELEFOON: 015 78 3192/4751
GIRO NUMMER DIG: 5780457

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Naam en adres:

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Postcode_____Plaats_____

Omschrijving:

Proceedings: Symposium "Milieu en Aardwetenschappen" 19 mei 1988, Dfl 15,00

Handbook: Symposium "The use of personal computers in earth technology" 11 februari 1987, Dfl 15,00

IngeoKring publicaties: "Nieuwsbrief" oude nummers

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Kwitantie gewenst ja/nee?

LOCATION AND ACCOMMODATION

The conference and workshop will be held in spectacular surroundings in Loen, Western Norway. Hotel Alexandria has 200 rooms and a well equipped modern conference centre.
Suggested travel:
Oslo to Ålesund 1 hr by air
Ålesund to Loen 3 hr by bus
Note: The bus journey is spectacular, including two sub-sea tunnels, a ferry crossing, and travel through some of Norway's most beautiful fjord country.

LOCAL TOURS

Hotel Alexandria is located on the shore of Innvikfjord, a few kilometers below picturesque Lake Loen. This lake has featured dramatically in recent Norwegian history, with the loss of 135 lives caused by two major rock slides into the lake, which generated waves up to 50 m high in 1905 and up to 70 m high in 1936. The site of the rock slide will be visited following a short lecture giving some eyewitness accounts of these fateful events.

The Jostedal glacier, covering some 350 km², is mainland Europe's largest. It can be reached by two valleys involving only 30 and 45 minutes drive from Hotel Alexandria. We will visit the Briksdal glacier arm, arguably the most beautiful in Norway.

One whole day tour will be offered to accompanying persons. This includes a ferry boat trip up the famous Geiranger fjord and opportunities for local shopping. Note that summer skiing is available for those who might wish to extend their stay to the weekend.

CONFERENCE REGISTRATION

Please check the reply form and return by post as soon as possible.

BY ROAD

Geiranger 103 km
Otta 200 km
Balestrand 190 km
Måløy 90 km
Førde 110 km
Oslo via Otta 490 km
Oslo via Fagernes 460 km
Bergen via Lavik 270 km
Trondheim via Otta 440 km

BY AIR

Vigra Ålesund 145 km
Sandane 66 km
Førde 130 km
(distances from airports to Loen)

BY SEA

Express boat Bergen-Lavik/Rysjedalsvika
Express boat Bergen-Måløy.
Good bus connections to/from Loen

BY BUS

Express bus to/from Bergen Trondheim, Otta, Ålesund, Førde and Sogndal.
Nearest railway station: Otta 200 km.

ROCK JOINTS

A REGIONAL CONFERENCE OF THE INTERNATIONAL SOCIETY FOR ROCK MECHANICS

NBG ISRM

Loen, Western Norway
June 4 - 6, 1990

ORGANIZING COMMITTEE OF ISRM

Commission on Rock Joints

Dr. Nick Barton	Norwegian Geotechnical Institute
Prof. Neville Cook	University of California, Berkeley
Prof. Herb Einstein	Massachusetts Institute of Technology
Prof. Dick Goodman	University of California, Berkeley
Prof. John Hudson	Imperial College, London
Prof. Ove Stephansson	Luleå University of Technology

(President of ISRM Commission)

OBJECTIVES

The ISRM commission on Rock Joints is organizing two speciality conferences. The first conference, to be held in Norway in 1990, will be focussed on the behaviour of individual rock joints and discontinuities.The second conference, to be held in California in 1992, will be focussed on the behaviour of rock masses.

Rock joint and discontinuity behaviour impacts many branches of engineering including mining, dam foundations, tunnelling for hydro power and transport, petroleum reservoirs and nuclear waste storage. The subject is in a very active stage of development, and engineers, geologists and scientists involved in these developments are encouraged to attend.

CONFERENCE THEMES

1. Characterization - geological origin - morphology - continuity - coating - infilling.
2. Mechanical behaviour - shear strength - normal stiffness - thermal effects.
3. Hydraulic behaviour - flow rate - flow velocity - aperture description - channelling - superconductors - absorption.
4. Dynamic behaviour - rate effects - stick slip - reversed shear - cyclic loading.
5. Coupled behaviour - mechanical - hydraulic - thermal - dynamic
6. Constitutive models - analytical - empirical - computer friendly

Implicit in most of the above themes is the influence of joint or discontinuity size.

ISRM WORKSHOP ON SCALE EFFECTS (7-8 June 1990)

Dr. António Pinto de Cunha (LNEC) who is president of the newly formed ISRM Commission on Scale Effects will be organizing a workshop on scale effects in rock masses immediately following the conference on Rock Joints, which will be held in the same hotel.

Workshop themes:
Scale effects in the determination of:

1. Deformability and strength of intact rock, joints and rock masses
2. Hydraulic properties of rock masses
3. Internal stresses in rock masses

CALL FOR PAPERS (Conference and Workshop)

The following deadlines will be adhered to. Please assist the Organizing Committee by submitting material on time!

1st December 1988 First Circular and call for abstracts
1st October 1989 Submission of Abstracts
1st December 1989 Acceptance notified.
Second Circular with Conference Programme
1st February 1990 Submission of Papers
1st April 1990 Publication of Proceedings
4 - 6 June 1990 CONFERENCE
7 - 8 June 1990 WORKSHOP

Abstracts of proposed papers for the conference should consist of no more than 300 words and 3 representative figures. Abstracts should be sent to:

Norwegian Geotechnical Institute
P.O. Box 40 Taasen
0801 Oslo 8, Norway
Att.: Dr. Nick Barton

Abstracts of proposed papers to the workshop should be sent to:

Dr. António Pinto de Cunha
Laboratório Nacional de Engenharia Civil
101 Avenida do Brasil
1799 Lisboa Codex, Portugal

Acceptance of abstracts and papers, and theme allocation, will be the responsibility of the Conference Organizing Committee members:

Prof. Ove Stephansson	President ISRM Commission
Dr. Nick Barton	Member ISRM Commission
Per Magnus Johansen	Chairman, NBG (Norwegian Rock Mechanics Group)

Vrijdag de 13-e Borrel

Daar 13 oktober op een vrijdag valt, worden alle studenten, oud-studenten en leden van de ingeokring uitgenodigd om de narigheden van deze dag te vergeten in het Mijnbouw cafe "Het Noorden".

dus: Vrijdag 13 oktober, 17:00 uur,
borrel Ingenieursgeologie
Mijnbouwcafe "Het Noorden"
Noordeinde 5

Conferences, Seminars and Symposia

1989:

9-19 July — **28th International Geological Congress.**
Washington DC, USA.
Dr. Bruce Hanshaw, Secretary General 28th Int. Geological Congress,
P.O. Box 1001, Hendon, VA 22070-1001 USA.

8-10 August — **1st South-American Symposium on Landslides.**
Bogota, Colombia.
Topics: Methods for the Detection, Exploration and Monitoring of Landslides; Analysis and Evaluation; Prevention and Treatment; Research and Management Policies.
Juan Montero Olarte, Sociedad Colombiana de Geotecnia,

Apartado Aereo 057045, Bogota, D.E. Colombia.

13-18 August — **12th International Conference on Soil Mechanics and Foundation Engineering.**
Rio de Janeiro, Brazil.
Dr. L.J. de Moraes, 12th. ICSMFE, Caixa Postal 1559, 20.001-Rio de Janeiro, R.J. Brazil.

28-31 August — **Symposium on Rock at Great Depth.**
Pau, France.
Topics: Mechanical behaviour; Laboratory and in-situ testing; Methods of Analysis.
ELF Aquitaine, CSTCS-Bat.LS, F. 64018
Pau Cedex, France

3- 9 September — **2nd International Conference on Geomorphology.**
Frankfurt/Main, Germany.
Prof. Arno Semmel, Institut fur Physische Geographie, University of Frankfurt, Sencken- berganlage 36,
Postfach 111932, D-6000,
Frankfurt/Main, Germany.

4- 7 September — **International Chalk Symposium.**
Brighton, England.
Topics: General; Construction; Hydrogeology; Petroleum Engineering.
Brighton Polytic, Brighton BN2 4GJ, UK.

4- 8 September — **International Conference on Micromechanics of Granular Media.**
Clermont-Ferrand, France.
Topics: Geometry; Mechanical properties; Mechanics of grain assemblies; Fictive continuum, Relationship between fundamental approach and practical experience.
P. Gourves, C.S.U.T., Laboratoire de Genie Civil, Universite Blaise Pascal de Clermont- Ferrand II, Rue des Meuniers, 63170 Aubiere, France. Tel: 73 26 41 10.

11-14 September — **Progress and Innovation in Tunnelling.**
Toronto Ontario, Canada.
Prof. K.Y. Lo, Fac. of Engineering Science, Univ. of Western Ontario, London, Ont.N6A5B9, Canada

10-14 September — **Conference on Quaternary Engineering Geology.**
Edinburg, Scotland.
Topics: Case histories of a regional engineering geological nature; Constructional aspects of Quarternary sediments; Engineering implications of Quarternary effects, e.g. periglaciation, weathering etc.
Dr. J.A. Little, Dept. of Civil Eng., Heriot Watt Univ., Edinburg EH14 4AS, Scotland.

28-29 September — **Suolosottosuolo, International Congress on Geo-Engineering.**
Turin, Italy.
Topics: Environment and land; non-energetic mineral resources; Engergetic mineral resources; Underground water resources; Open pit exploitation and environmental rehabilitation; Soil and rock mechanics problems; Tunnels and new underground spaces.
Associazione Mineraria Subalpina, c/o Dip.o di Georisorse e Tettitorio del Politecnico, Corso Duca degli Abruzzi x 24, I-10129 Torino, Italy.

18-20 October — **IABSE Colloquium on Expert Systems in Civil Engineering.**
Bergamo, Italy.
ISMES, Viale Giulio Cesare 29, I-24100, Bergamo, Italy. Tel: 035-358 301.

19-20 October — **38th Geomechanics Colloquium.**
Salzburg, Austria.
Topics: Geomechanical Test Methods; Rock Mass Mechanics in the Mining Practice; Pressure Addits and Pressure Shafts; Control of High Rock Mass Pressures in the Tunnel and Adit Construction.
Osterreichische Gesellschaft fur Geomechanik, Paracelsusstr 2/III, A-5020 Salzburg, Austria.

26-27 October — **Seminar and Workshop on Creep Behaviour of Frozen Soil and Ice.**
Winnipeg, Canada.
Topics: Creep related to: Permafrost; artificially frozen soil; Ice forces; Ice covers on lakes and rivers; Spray ice islands; Rubble fields and glaciers.
Prof. L. Domaschuk, Civil Engineering, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.

6- 8 November

International Symposium on Trial Embankments on Malaysian Marine Clays - Predictions and Performance.
Kuala Lumpur, Malaysia.
Director General, Malaysian Highway Authority, Banguna Yayasan-Syed Kechik Bangsar, Peti Surat 1133, Jalan Pantai Baru, 59200 Kuala Lumpur, Malaysia. Tel: 2544033.

1990:

2- 6 April

3rd International Symposium on Pressuremeter.
Oxford, UK.
Topics: pressuremeter technology; Analysis interpretation; Applications in geotechnical design.
Dr. G.T. Houlsby, Secretary Organising committee, Dept. of Engeneering sience, Parks Rd., Oxford OX1 3PJ. UK. tel: 0865 273162

14-18 May

14th World Mining Congress and Exhibition.
Beijing, China.
Topics: Mining for the Future; Trends and Expectations.
Chinese Organizing Committee of the 14th World Mining Congress, 54 Sanlihe Road, Beijing, China.

28- 1 June

4th International Conference on Geotextiles and Geomembranes.
The Hague, Netherlands.
Topics: Bank and bed protection; Soil reinforcement; Properties and testing; Unsolved problems; Roads and runways; Drainage; Special applications; Environmental control; Reservoirs; Irrigation.
Secretariat of 4th Geotextiles Conf. c/o Holland Organising Centre, 16, Lange Voorhout. 2514 EE The Hague, The Netherlands, tel: 031 -70657850

4- 6 June

ISRM Regional Conference on Rockjoints.
Loen, Western Norway.
Topics: Characterization of joints, mechanical hydraulic, dynamic and coupled behaviour; Constitutive models.
Dr Nick Barton, N.G.I., P.O.box 40 Taasen, N-0801 Oslo 8, Norway.

10-13 June

2nd Symposium on Strait Crossings.
Trondheim, Norway.
Topics: Technology; Safety and Traffic Operaion; Social and Economic Effects.
Strait Crossings, Att: Mr. Vidar E. Storvik, Norwegian Society of Chartered Engineers, Kronprinsensgr. 17, N-0251 Oslo 2, Norway.

18-20 June — **ASCE Special Conference on Design and Performance of Earth retaining Structures.**
Ithaca, NY, USA.
Topics: Wall selection and performance; Mechanically stabilised systems; In-Situ walls, Waterfront retaining structures; Contracting practice; Gravity walls.
Dr. Phillip Lambe, Dept. of Civil Engeneering N-Carolina State University, Campus box 7908, Raleigh, NC 27695, USA.

6-10 August — **6th International Congress of the IAEG.**
Amsterdam, The Netherlands.
Topics: Engineering Geological Mapping and Site Investigation; Remote Sensing and Geophysical Techniques; Hydro-Engineering Geology; Surface Engineering Geology; Underground Engineering Geology; Engineering Geology of Land and Marine Hydraulic Structures; Construction Materials.
Dr. L. Primel, Secretary General IAEG, Laboratoire Central des Ponts et Chausees, 58 Boulevard Lefebre, 75732 Paris Cedex 15, France.

3- 7 September — **Tunnels and Underground Works.**
Chengdu, China.
Topics: Design and Construction of Railway Tunnels; Design and Construction of Metro and Urban Underground Works; Design and Construction of Hydro Tunnels; Rock Caverns for Storage; Use of Numerical Methods in the Tunnel Design.
Secretariate CCES, P.O. Box 2500, Bai Wan Zhuang, Feljing, China.

1991:

27- 1 June — **10th European Regional Conference.**
Florence, Italy.
Topics: Deformation of Soils and Displacement of Structures.
Ing. G. Baldi, Secretary, Associazione Geotechnica Italiana, Viale Regina Margherita 183, 00198 Roma, Italy.

27- 1 June — **9th Asian Regional Conference.**
Bangkok, Thailand.
Prof. A.S. Balasubramaniam, Secretary, South East Asia Geotechnical Society, Asian Institute of Technology, P.O. Box 2754, Bangkok 10501, Thailand.

26-30 August — **9th Pan Am Regional Conference.**
Santiago, Chile.
Mr. Luis Valenzuela, Secretary, SOCHIMSYF, San Martin 352, Santiago, Chile.

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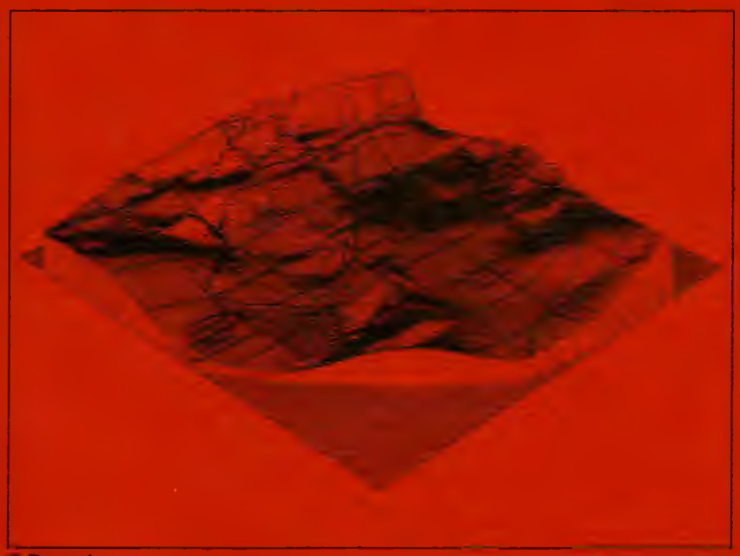

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Stationsplein 45 Postbus 29 080 3001 GB Rotterdam
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