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INGEOKRING

NIEUWSBRIEF

December 1988

NIEUWSBRIEF INGEOKRING

December 1988

Inhoud: Pag.

Nieuwsbrief van de Ingenieursgeologische Kring
Redaktie:
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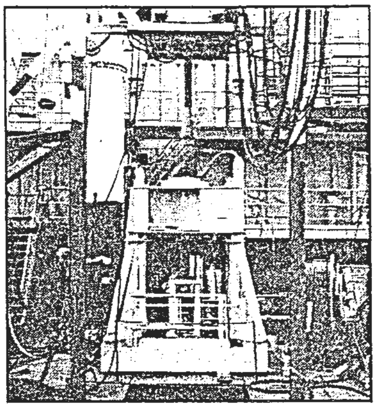

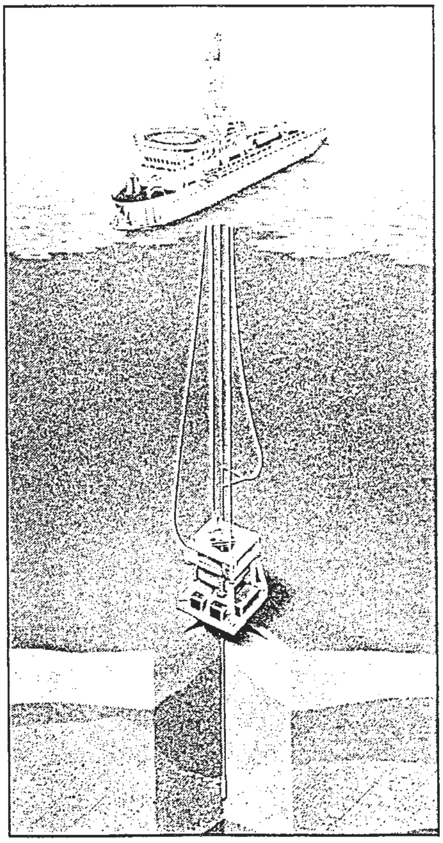

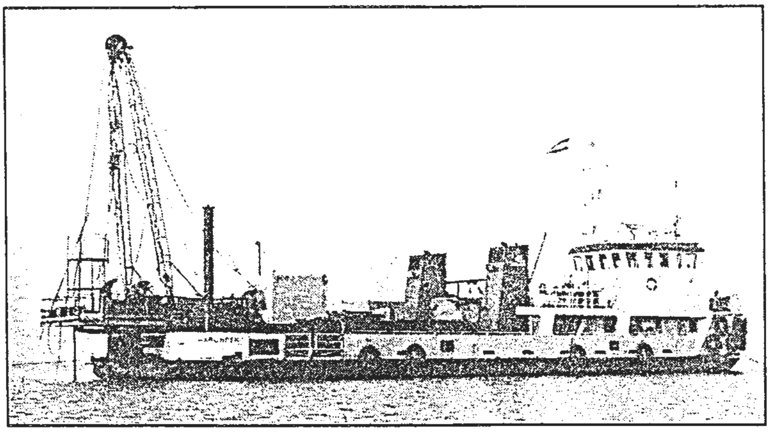

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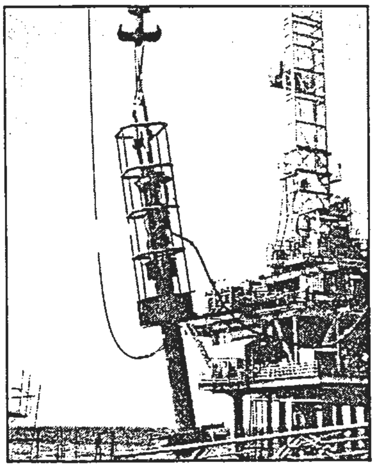

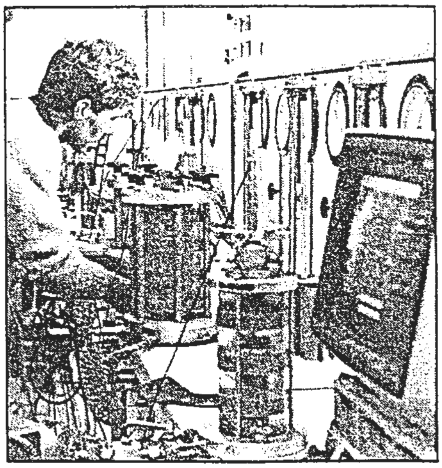

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Van de redaktie

Voor u ligt het vierde nummer van 1988. In dit nummer vindt u een verhaal over Ingenieursgeologie in Finland, verder een eerste aankondiging van het IAEG Congres, dat in Augustus 1990 te Amsterdam zal plaats vinden. Het financiele jaarverslag van de Ingeokring, wat goedgekeurd is tijdens de jaarvergadering, vindt u op pagina 5 en 6.
Wij willen u erop attenderen dat op 20 Januari de Open Dagen van de TU Delft, afdeling Mijnbouwkunde en petroleumwinning, plaats-vinden. De afdeling Ingenieursgeologie geeft op deze dag een presentatie over de lopende onderzoeken.
Het volgende nummer kunt u eind Maart verwachten. De verdere nummers van 1989 zullen in Juni, Oktober en December uitkomen.
De uiterste inlever datum van de volgende Nieuwsbrief is: 10 Maart.

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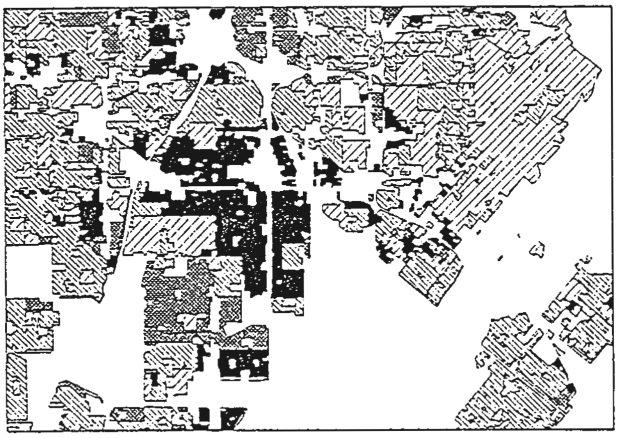

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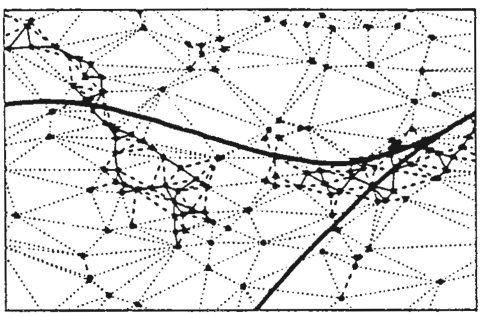

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Van het Bestuur..........

Het laatste nummer van de Nieuwsbrief voor dit jaar ligt voor u. Dat we terug mogen zien op een jaar dat redelijk gevuld is geweest met aktiviteiten wordt geillustreerd door het jaarverslag.
Dat de Ingenieursgeologie ook in algemene zin steeds meer geaccepteerd wordt als een belangrijke toeleverende wetenschap wordt geillustreerd door de inschakeling bij adviesstudies voor de opslag van niet verwerkbaar afval en de deelneming van de IG aan workshops die over dit onderwerp georganiseerd worden.
In dit verband is ook een definitie van IG, die door velen gehanteerd wordt, zeer toepasbaar:
"Engineering Geology is the study of the physical and mechanical characteristics of the earth's crustal components and their interaction on the environment, and the modifications imposed thereon by man's activities."
It combines (therefore) the sciences of geology, soil and rock mechanics, geomorphology and (geo)hydrology.

Steeds meer aspekten van onze samenleving worden mede benaderd vanuit het invalshoek van de IG. Hier ligt trouwens voor iedereen, die zich bezig houdt met dit vakgebied vanuit opleiding of vanuit de praktijk, een taak om het werkgebied in bredere kring bekend te maken.
Ook het IAEG Congres met tentoonstelling in 1990 zal hieraan belangrijk bijdragen.
In deze zin is het ook verheugend dat tijdens de afgelopen jaarvergadering van de Ingeokring unaniem is besloten een vertegenwoordiger van de DIG (Dispuut van de studenten Ingenieursgeologie in Delft) op te nemen in het bestuur van de Ingeokring.
Wij zijn ervan overtuigd dat de frisse inbreng van de DIG positief zal werken, nog afgezien van het werk dat zij nu al gezamelijk voor de Ingeokring verzetten, zoals de produktie van de Nieuwsbrief, gedetailleerde organisatie van symposia en bijeenkomsten van de Kring, de verwerking van de ledenadministratie, enz.
Ook vanaf deze plek een hartelijk welkom aan deze mensen, die binnen enkele jaren overal bij overheid en bedrijfsleven, nationaal en internationaal, een plaats zullen weten te vinden.

Tot slot aan u allen de wensen voor een prettige jaarwisseling en een gezond, voorspoedig en zakelijk waardevol 1989.

Voorzitter Ingeokring
J.E. Hageman

Financieel verslag en begroting van de Ingeokring

Tijdens de ledenvergadering van de Kring op 2 november j.l. te Amsterdam is het bijgaande financiele jaarverslag van de Kring over het 1987, na verificatie door de kascommissie, goedgekeurd.
Tevens werd de begroting van de Kring voor het jaar 1988 goedgekeurd.
Daarmee ging de ledenvergadering accoord met een contributie van f. 30.-- per jaar voor de Kring (studentenleden f. 15.--). De verhoging van de contributie met f. 10.-- houdt verband met de gestegen administratiekosten en de beoogde kwaliteitsverbetering van de Nieuwsbrief.
Daar het jaar 1988 ver is voortgeschreden werd voorgesteld, om verwarring te voorkomen, dat de contributies voor de jaren 1988 en 1989 tegelijkertijd te innen.
De ledenvergadering stemde hiermee in.
Bijgaand treft u dan ook acceptgiro's aan voor de betaling van de contributies van de Ingeokring over 1988 en 1989.
Indien van toepassing zullen deze vergezeld gaan met de acceptgiro's voor de contributies van IAEG en/of ISRM, eveneens voor de jaren 1988 en 1989.
U wordt dringend verzocht deze betalingen op korte termijn te voldoen, waardoor de administratieve werkzaamheden, zowel voor u als voor ons, tot een minimum beperkt kunnen blijven.

J.G. Bakker
penn. Ingeokring.

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Opgesteld: 1988-05-17

Geverifieerd 1988-05-25 door: ir. W.F.J. de Jager
drs. W. Vogel

ENGINEERING GEOLOGY IN FINLAND: ROCK ENGINEERING

Engineering geology covers a broad field of activities concerning the interaction between the earth and the construction. The discussion in this note is restricted to a general view about the activities in rock engineering in Finland.

The bedrock of Finland belongs geologically to the Fennoscandian shield (the Precambrian era) and is approximately 1000 to 3000 M.Y. old. After orogeny in the Precambrian era, already in early Cambrian, Finland was eroded to a peneplain. No deposits are present from the period between Precambrian and Quarternary. The bedrock in Finland is composed of igneous rock as granite, peridotite and gabbro, and of metamorphosed igneous and sedimentary rock as quarzite, gneiss, migmatite and schist. The bedrock is covered by a relative thin layer (10 - 30 m) of Quarternary deposits, e.g. sand, gravel, till, which are the result of erosion and deposition during and after the ice ages in the Pleistocene. The peat bogs are formed during the Holocene.

Due to the fact that the total soil thickness all over Finland is thin and because the topography of the bedrock is rather irregular, nearly all the surface constructions are faced with rock engineering. Civil engineering constructions worth to be mentioned are build during the last 20 to 30 years, this in contradiction with the mining industry which started about 300 years ago. Caused by economical growth and the technical development, both in civil engineering as in mining engineering, the amount and the size of the rock excavations at the surface and sub-surface are increased enormously since 1950. The mining industry concerns the production of:

- metal ores as copper, nickel, zinc, vanadium and cobalt ore;
- non-metal ores as limestone and soapstone;
- building material as crushed rock used as aggregate and granite blocks for ornaments.

The ores and building material are mined in open pits, quarries and underground mines e.g. sublevel stopes. In the field of civil engineering, the excavations are made for various use. Surface constructions are e.g. road and railway cuts, foundations, open pit for waste dump or waste water settlement ponds. Some examples are: cut and fill construction for a smooth alignment of the motorway to the east and to the west from Helsinki. With the pre-splitting technique the rock faces are smoothened and stabilized. In the sub-surface, excavations are made for the purpose of transport, storage etc.. Tunnels are build for the transport of water for consumption or cooling and for the sewerage, caverns are build for the storage of oil and bulk goods. Other constructions are: sand silos in rock, civil defense shelters, parking- and sport facilities [3]. These civil rock structures are concentrated in the southern part of Finland (figure 1), especially in and around the towns of Helsinki, Turku and Porvoo. Space in this area is sparce, and because the rock is of a good quality in general, it is of economical benifit to build underground space instead of surface constructions.

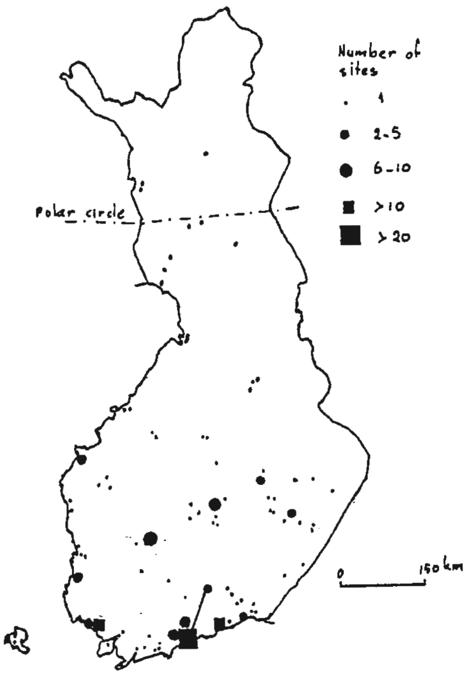

Figure 1. Amount of rockstructures in Finland build in the period from 1960-1986. (including open excavation > 50 000 m3)

The following table [2] gives an impression of the amount of underground volume, approximately 4 million m3 nowadays in the town Helsinki.

TUNNELS	LENGTH	VOLUME	CAVERNS	VOLUME
watertransport	36.8 km	407 000 m3	oil storage	955 000 m3
sewerage	42 km	418 000 m3	water storage	55 000 m3
railway	1 km	50 000 m3	sand silos in rock	50 000 m3
metro	8 km	500 000 m3	shelters	600 000 m3
multipurpose service	6.7 km	110 000 m3	other	105 000 m3
other	8.8 km	148 000 m3		

The rock in Finland is, comparing with other countries, strong and requires drilling and blasting technique for both surface and sub-surface excavations. This type of excavation technique is expensive, but the rock strength is of such a value that in proper design no expensive lining has to be installed. In some places rockbolting, grouting and shotcreting is needed to create the required stability. In Finland, the total excavated volume for constructions is 3 - 5 million m3 per year. In the mining industry, another 8 million m3 per year is excavated. The raw water transportation tunnel, the Pijnne tunnel, with a total length of 120 km and a cross-sectional area of 15.5 m2, is an example of the largest rock engineering projects in Finland. This tunnel, the longest of the world, transports water from the lake Pijnne to Helsinki and the surrounding municipalities and it was build between 1973 and 1982. Important factors in the design were to keep the tunnel as short as possible and to minimize leakage by avoiding broken rock zones. Another type of constructions of enormous dimensions are the large rock caverns which are needed for oil storage and for bulk goods. The national oil company of Finland, Neste OY, has in Porvoo (50 km east of Helsinki) a total of 4.8 million m3 underground space. Several large caverns are build since the last 20 years. In 1982 a complex of three caverns with a total volume of 800 000 m3 became operational [1]. Not only did the volume increase during the years but also did the form of the cross-sectional area, as can be seen in figure 2. Economical factors play a role in choosing the form.

New developments in rock engineering concerns the storage of municipal and industrial waste in rock or disposal of nuclear waste of low and medium level [4].

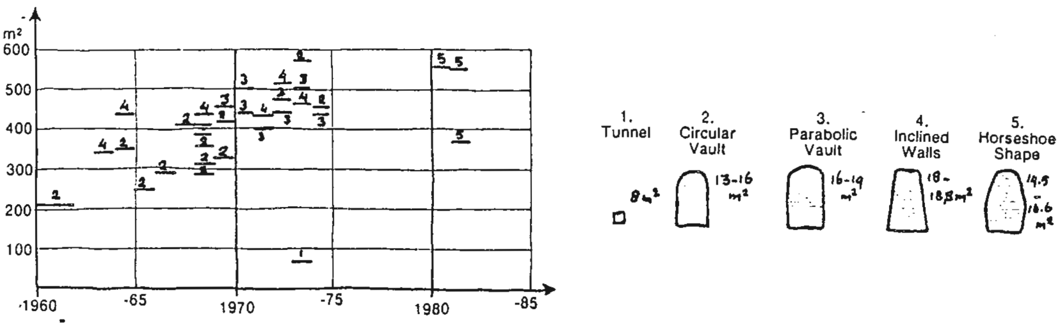

Figure 2 Development of cross-section area of unlined oil storage caverns in Finland between 1960 and 1983.

Together with increasing investments in rock constructions, activities in research and innovation of equipment and methods are raised to afford a better understanding of the behaviour of the rock, safety and a higher productivity. Two research institutes are: the Helsinki

University of Technology and the Technical Research Centre of Finland (Valtion Teknillinen Tutkimuskeskus), both settled in Espoo. Another institute worthwhile to be mentioned is the Geotechnical Department of the City of Helsinki. Besides these institutes, consulting, construction and mining companies are active in developing new methods, instruments and machinery for site investigation and excavation techniques. The expertise in rock engineering has been applied in Finland as well as throughout the world. In Finland, several associations are representing the companies and institutes e.g.: Finnminers which is active in the field of mining engineering, SKOL, an association of consulting firms, and the Finnish Tunneling Association. The latter association has recently published two books about rock engineering. Both books are recommended for those who like to read more about rock constructions applied in Finland. Both books are listed in the references.

REFERENCES.

1. Ignatius,Y., Johansson,S. and Ravaska,P. (1982). Rock mechanics: caverns and pressure shafts. Volume 2: Pressure tunnels/tunneling machines/underground storage. Proc. ISRM Symposium Aachen 1982. Wittke,W. (ed.). pp 923-934.
2. Roinisto,J. (ed.). (1986). Rock engineering in Finland. Finnish Tunneling Association. Helsinki. 188 pp.
3. Saari,K. (ed.). (1988). The rock engineering alternative. Finnish Tunneling Association. Jyvskyl. 207 pp.
4. Rauhiainen,P. (1986). Loviisa power station final disposal of reactor waste. Geophysical methods in structural study of the bedrock of Hstholmen. Report YJT-86-10, Imatran Voima OY. 75 pp.

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The Influence of Natural Discontinuities and Material Strength on the Safety of Calcarenite Mine Pillars

by: Ir. R. Vreugdenhil

Introduction

Southern Limburg is the only part of The Netherlands where Upper-Cretaceous rocks occur near the surface. These formations, containing layers of calcarenite and calcisiltite, are eminently suitable as building stone. The rock in these layers is fairly isotropic, strong enough for most construction purposes and can be easily mined by sawing-out using steel tools.

Mining for building stone has been going on since Roman times and apart from some limited quarrying to shallow depth, has been undertaken by the room and pillar method. The mining has been going on on a large scale until some thirty years ago, resulting in hundreds of kilometres of underground openings. Since large parts of the area, including parts of several cities, are underlain by abandoned mine workings, the question of strength and stability of these underground openings is of major interest. Recent collapses in the neighbourhood of Valkenburg showed once again that the presence of underground openings and the problem of their stability can not be ignored.

Therefore it seemed necessary to develop a formula to calculate mine stability, that would be applicable to the situation in Southern Limburg. The resulting formula was used in practice in the Geulhem workings, located close to and partly below the small town of Berg en Terblijt (fig 1).

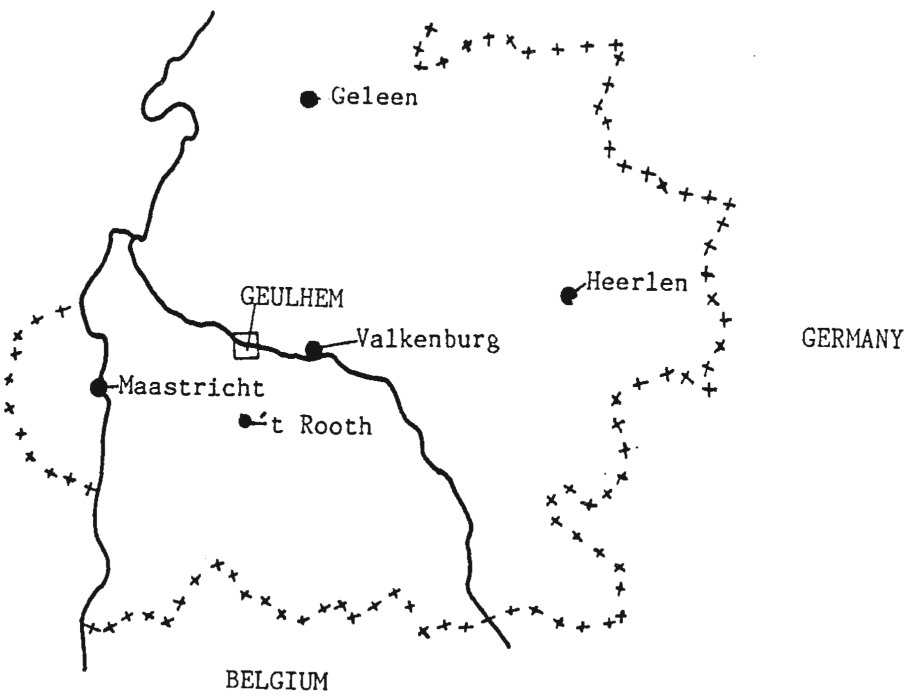


Fig 1 Location of Geulhem workings.

Past work

In past work the foundation has been laid of a correct and applicable method for the calculation of the safety factor of a pillar. Deibel et al. (1987) made use of the method of Goodman (tributary area method). The formulae used in this method have been determined empirically and been applied almost solely in coal mines.

R.v.Steveninck (1987) has adopted the formulae to make them meet the circumstances in Southern Limburg. The result of tests on artificial rock material (Durox) led to the following adjustments in N_{size} (the factor that relates the U.C.S. of a test sample to the strength of a cubical pillar) and N_{shape} (the factor that relates the strenght of a cubical pillar to the strength of the actual pillar) :

$$N_{size} = 1$$

and

$$N_{shape} = 0.935 + 0.690 * \log (width/height).$$

A comparison of the calculated safety factors using the formulae mentioned above, and the real visual classification of the Geulhem workings using a classification system (table 1) was reasonable, but susceptible of improvement.

Class	Description
1	Pillar without any cracks
2	Cracks occurring only in the corners
3	Cracks along roof/pillar and floor/pillar contact
4	Cracks on the entire pillar surface
5	"Failed" pillar, very extensive cracking

Table 1 Visual classification system.

Engineering geology of the calcarenites

Results of laboratory tests on the Maastrichtian Limestone taken from the ENCI-quarry are shown in table 2, divided into eight different geotechnical units. The results indicate that in general the calcarenites are weak, highly porous and low E-modulus rocks. The only exceptions are the hard-ground layers. In these parts (thickness commonly far less than 1 m) the calcarenite has been recrystallized and partly silicified. Porosity is often much less (20 - 48 %), compressive strength (up to 25 MPa) and deformation modulus (up to 5 GPa) much higher than normal.

In a more descriptive way Felder (1975) divided the Maastrichtian, as seen in the exposures in the quarry at 't Rooth (fig 1), into six zones, as mentioned below in order of increasing age.

MEERSSEN (A + B) - (more than 5 m thick) Generally coarse grained calcarenite, occasionally calcisiltite, with some fossil grid bands. No flints present.

NEKUM (C) - (about 10 m thick) Coarse grained homogeneous calcarenite except for the bottom one metre, which is fossiliferous and has flint. A "hardground" band divides Nekum from Meerssen.

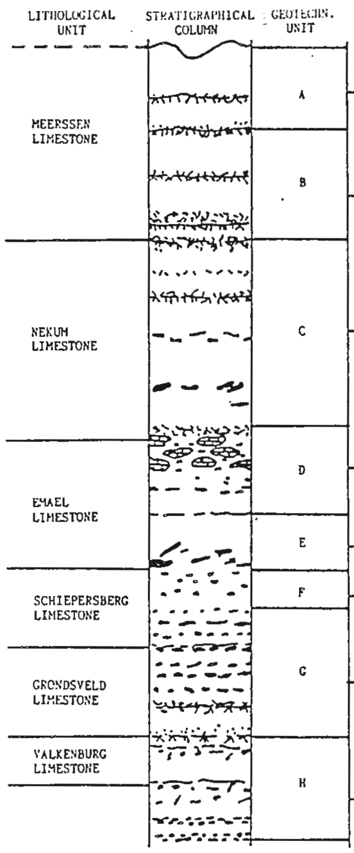
EMAEL (D + E) - (about 5 m thick) The top half consists of fine grained calcarenite, with concretions. The lower half is medium-fine grained with random flints.

SCHIEPERSBERG (F + part G) - (about 5 m thick) Medium coarse grained calcarenite with five distinct flint bands. The boundary between Schiepersberg and Emael is a fossil rich layer.

GRONSVELD (part G) - (about 5 m thick) Fine to coarse grained calcarenite with six flint bands.

VALKENBURG (H) - (about 4 m exposed at 't Rooth but believed to be more than 20 m thick) The section exposed is of medium fine grained calcarenite without flints.

Joints are relatively infrequent throughout these rocks, if not completely absent, and are particularly widely spaced at the levels where mining for building stone has occurred.



GEO TECH. ZONE	BULK VOL. WEIGHT (kN/m^3)	DRY VOL. WEIGHT (kN/m^3)	MOIST. CONT. (%)	POROSITY (%)	UNC. COMPR. STR. (MPa)			E-MODULUS (MPa)		
					DRY	SAT.	NAT.	DRY	SAT.	NAT.
A	17.0	13.2	26 30	46 50	2.6 2.8	1.7 1.9	1.3 1.9	820 940	650 670	700 900
GEULH.	**16.1 18.3**	**13.0 14.9**	**13.0 22.6**	**47**			**2.3 4.0**			**720 1430**
B	16.5	12.9	22 32	46 50	1.5 2.5	1.3 1.7	1.2 1.8	650 1050	420 580	420 580
C	16.2	12.6	23 31	47 51	1.9 2.5	1.0 1.6	1.3 1.9	500 1100	300 900	400 800
D	16.0	12.8	22 32	45 51	1.5 1.7	0.5 0.9	0.5 0.7	400 800	220 320	290 390
E	16.0	12.8	25	49	2.7	2.1	2.3	1150	920	900
F	16.0	13.5	18	49	4.2	2.0	2.3	4030	1690	1720
G	16.5	12.9	22 32	46 50	1.5 2.5	1.3 1.7	1.2 1.8	650 1050	420 580	420 580
H	18.1	14.8	15 27	32 36	4 8	2.0 2.8	2.7 3.3	1300 1900	600 1000	900 1100

Table 2 Stratigraphical column taken at the ENCI quarry showing lithological and geotechnical units. All parameters of interest of the different geotechnical units are mentioned with the parameters as found in Geulhem printed bold.

Present work

Underground survey

In the preceding investigation R. van Steveninck (1987) has gathered all information necessary for the calculation of the stability according to the method Goodman. The present investigation has been especially directed to the gathering of additional information for improvement of the used method. Attention has been paid to the presence and direction of discontinuities, the presence of solution features and the condition of the roof.

The mine is intersected by various joints which have two preferred strike directions:

- approximately 140^0 (NW - SE)
- approximately 050^0 (SW - NE).

The joints which strike 140^0 are very persistent and sometimes can be followed throughout the whole mine. The pattern is almost perpendicular to the overlying topography and might be influenced by it. In some cases three or more joints with the same direction are very close together (within the metre) and might be regarded as a fault zone, though no evidence of movement along the plane could be found. The joints which strike 050^0 are less persistent and are approximately parallel with the topography. Both discontinuities and solution features are mapped in fig 2a and b.

The solution features most found in the mine are organ pipes (earth-filled solution holes) which are normally the result of the weathering of a joint or faultzone. In some cases the nature of the overlying topography can be responsible for the presence of organ pipes (e.g. the dry valley through which the "Meldermunsterweg" passes; fig 2a).
The presence of organ pipes in a mine has some consequences:

- The area that an organ pipe occupies can not be counted as load bearing area.
- An organ pipe is water conducting and therefore the area around an organ pipe will be more saturated and U.C.S. will as a consequence be lower (Nienhuis, H. & Price, D.G.. 1988).
- The pressure from the ground contained in the organ pipe may cause pillar walls to bulge if it is close to the side of a pillar.

Only those organ pipes that could be positively identified have been noted, so staining of the calcarenite by iron-oxides, which points at the presence of infiltrating water, has not been taken as proof of an (developing) organ pipe.

2a

2b

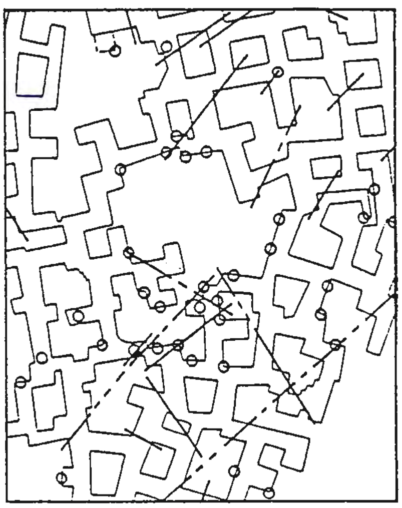


Fig 2a,b Discontinuities and solution features in two separate locations in the Geulhem workings. See also fig 3.

The roof stability is in most places defined by the thickness of a hard calcarenite layer below an overlying calcilutite layer. The bond between the two layers is very weak and is, when the hard layer is too thin or the width of the gallery too wide, responsible for the existing roof instability. The calcilutite layer reaches a thickness of at least 80 cm at some places and is of its own most likely strong enough to stabilize the roof. At some places the layer is seperated in two (a darker harder one and the most common greasy softer one) by a layer containing many non-fragmented shells. This layer seems to be another part that makes the roof instable.

The tensile cracks in the roof are almost always in the centre of a gallery and seem, as is shown above, not to be solely related to some sort of maximum span, as their presence is not restricted to wide galleries.

Material tests
The calcarenite has been tested in more detail to determine the variation of the U.C.S. and the E-modulus (at 50 % of the U.C.S. and the maximum). Samples have been taken on 26 places throughout the complete reasonably stable part of the mine (fig 3). The cores made of these samples (all taken normal to the bedding) were placed in a climate-room with 99 percentage of moisture content for more than a week to try and reach the correct (natural) moisture content. The moisture content of the samples reached an average of 19.0 percent, which differs by approximately one percent from the natural moisture content.

The results of the tests showed quite a large variation with U.C.S. ranging from 2.32 till 3.97 MPa and E-modulus at 50 % of the U.C.S. (approximately 300 times the U.C.S.) ranging from 0.68 till 1.40 GPa (table 3). The results of the U.C.S. have been used for a contourline map, showing the variation of this parameter throughout the mine (fig 4). The map shows that the calcarenite is weaker in the Western parts and seems to be corresponding with the inscriptions in the mine.

Model tests
Two model studies have been performed:

- The effect of a discontinuity on pillar stability.
- The significance of fracture patterns in terms of "failure".

A model study using aerated concrete (Durox) was undertaken to determine the effect of a discontinuity and its location on the stability of a pillar. Calcarenite itself could not be used for such a study because of its inherent inhomogenity on the scale of this model.
The Durox blocks have been placed between two Durox platens to simulate roof and floor conditions and avoid direct contact between the steel platens of the compression test machine and the Durox blocks and with this possible enclosure phenomena. The results of the tests have been plotted (fig 5). It shows clearly that the location of a discontinuity in a pillar is of importance and therefore should be included in the stability calculation as an influence factor.

The second model study was done to investigate the significance of fracture patterns in terms of "failure". For this two calcarenite blocks proportional to an average pillar in Geulhem, with dimensions as large as possible, so that the inhomogenity would play no role of importance, have been made. Again floor and roof conditions have been simulated by two Durox platens. The blocks were loaded slowly (2.5 - 3 hours till failure) and were continuously examined for developing fractures. The load was build up in a discontinuous way as the compression test machine was not able to do it in the required slow rate.
Fig 6 shows the result of one of the tests. Class 2 fracturing starts at about 70 % of the U.C.S., which corresponds with the results of Deibel et al. (1987).

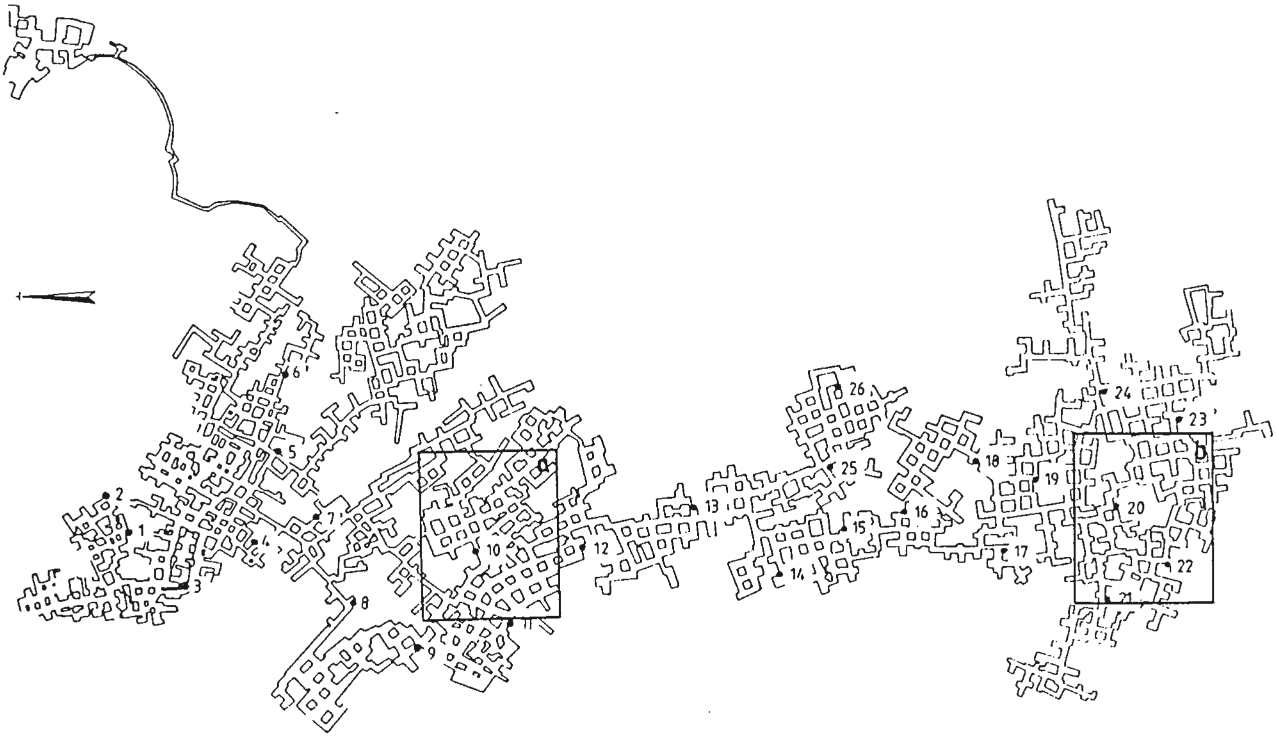


Fig 3 Map of total Geulhem workings. Numbers stand for sample locations; a and b stand for the two locations used as examples in fig 2a,b, 8a,b, 9a,b and 10a,b.

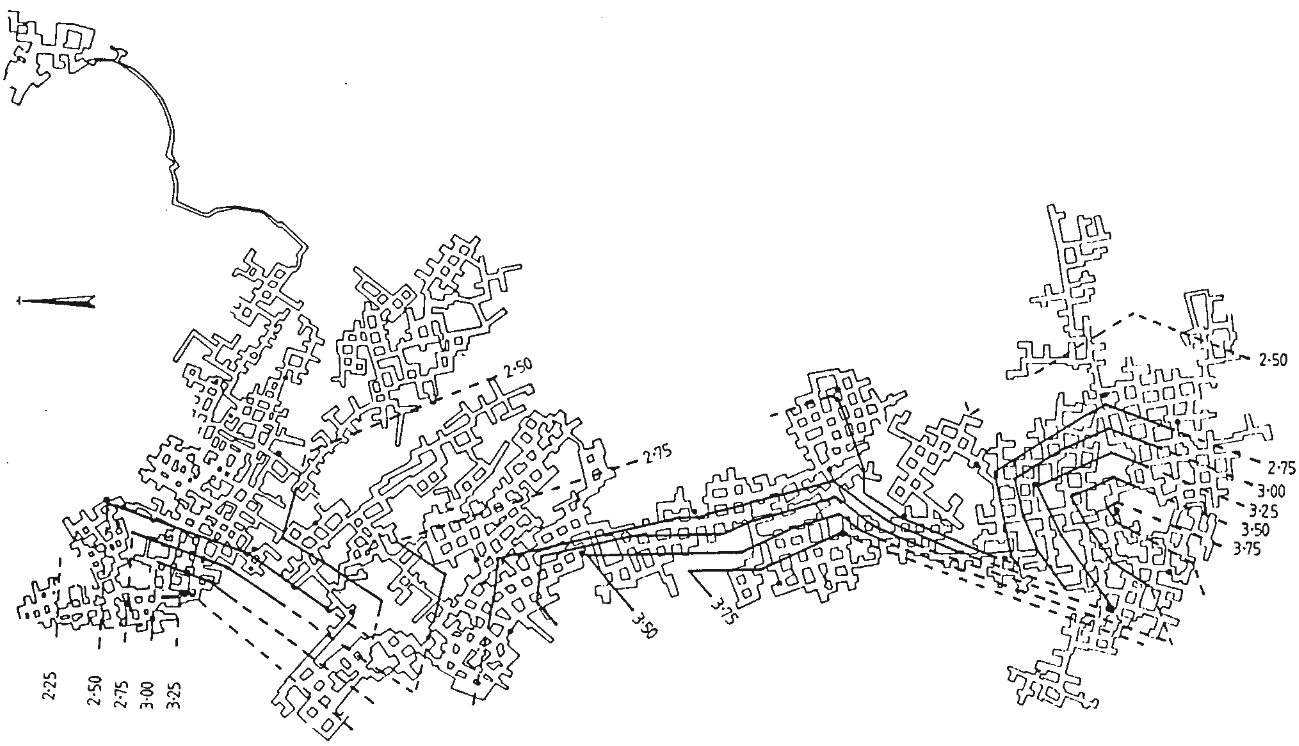


Fig 4 Map with U.C.S. contourlines.

Due to the fact that real fracturing only took place just before failure, classes 3, 4 and 5 of the classification system can hardly or not be distinguished. This leads to the conclusion that inevitable failure is reached at class 3. This conclusion must be made with some reservation, because of the different reasons for failure in reality and the model study. In the model study failure is attained by increase of the load, while in reality failure is the result of decreasing material strength under constant load.

Sample loc.	Number	U.C.S. (MPa)	E-mod. at 50% (GPa)	E-mod. max. (GPa)	Moisture content (%)
2	3	2.47	0.78	0.85	20.6
3	4	3.28	1.06	1.10	20.5
4	4	2.41	0.68	0.72	17.2
5	3	2.38	0.76	0.79	21.7
6	4	2.32	0.71	0.74	20.1
7	4	2.62	0.69	0.78	14.5
8	4	2.41	0.73	0.75	13.0
10	3	2.88	0.92	0.96	17.3
11	4	3.11	1.13	1.17	20.1
12	3	3.49	0.94	1.00	17.3
13	2	2.92	0.86	0.88	19.3
14	4	3.97	1.40	1.42	13.6
15	4	3.78	1.25	1.33	20.1
16	3	2.67	0.89	0.91	20.9
17	4	2.69	0.82	0.85	22.1
18	3	2.52	0.70	0.77	15.1
19	3	3.23	1.13	1.15	17.6
20	4	3.82	1.37	1.43	18.7
21	4	3.23	1.08	1.13	21.8
22	4	3.65	1.23	1.27	20.2
23	4	2.63	0.86	0.90	19.7
24	4	2.65	0.82	0.85	22.6
25	4	2.82	0.93	0.96	17.2
26	2	2.74	0.81	0.85	19.2

Table 3 Average values of laboratory results on Meersen limestone.

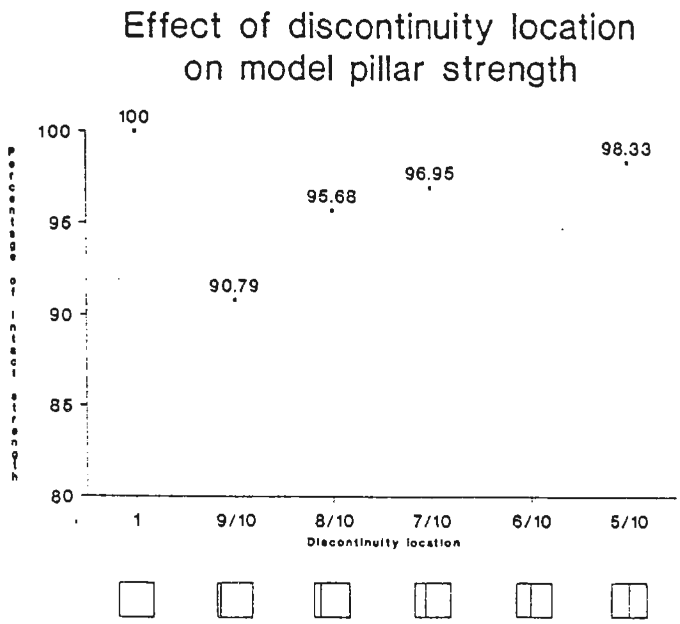


Fig 5 Result of discontinuity model tests.

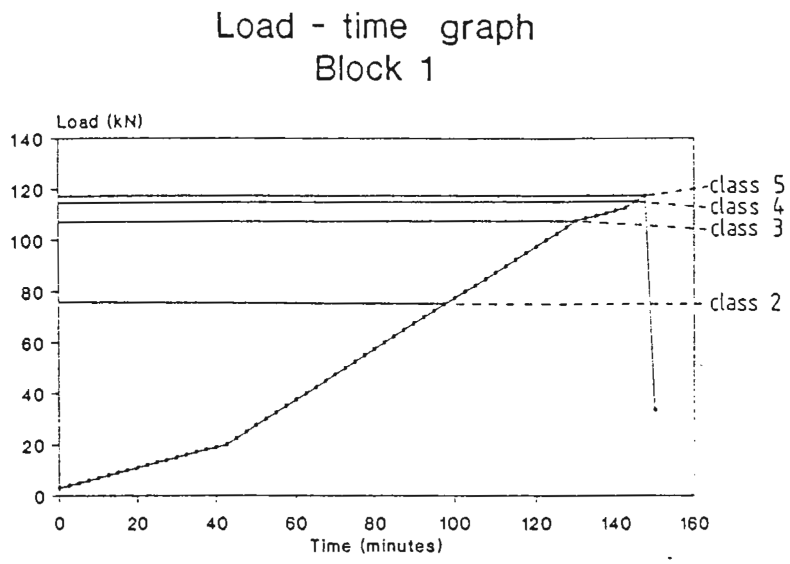


Fig 6 Result of study on relation fracture pattern - inevitable failure.

Evaluation of mine stability

Modifications to calculation

The procedure followed by R. van Steveninck (1987) to determine the safety factor of each individual pillar may be summarised as follows:

1 Plotting pillar locations and all needed dimensions

2 Determining pillar strength using the formula:
$S_p = UCS * N_{shape} * N_{size}$,
with N_{shape} and N_{size} determined as mentioned before.

3 Calculating the stress on each pillar using the formula:
$S = P * A_t / A_n$,
with P being the initial vertical stress at roof level, A_t the tributary area to each pillar and A_n the netto undamaged area of each pillar.

The ratio S_p/S then gives the safety factor of each pillar and can be compared with the visual classification. Modifications to this procedure are:

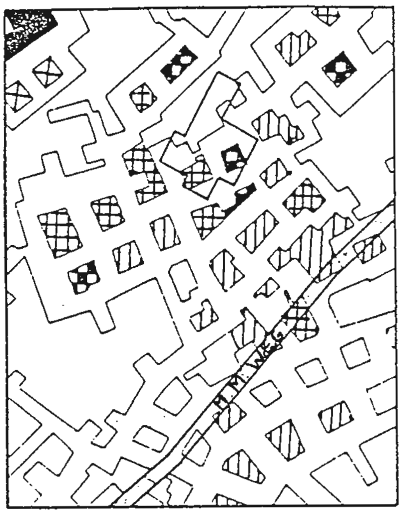
- UCS values have been determined by interpolation for each independent pillar
- the influence of the presence and location of discontinuities has been inserted
- the presence of organ pipes has been noted.

The structural diagram of the computer program and the used equations are given in fig 7.

Recalculated safety factors

The safety factors (s.f.) as determined with the computer program described earlier, can be better related to the visual classification system than in former work. This can be seen in the figures 8 till 10 showing the visual classification, the former s.f. and the new s.f. of the pillars in two separate locations. No trend can be seen in the difference of the s.f. Depending on the strength of the material and the presence of discontinuities the newly determined s.f. is higher or lower.
The average values of the different visual classes (fig 11) show that in case of class 1 and 2 the present s.f. is just a bit higher, but in case of the more important classes 3, 4 and 5 reasonably lower. Furthermore the differences in average values of the different classes are more pronounced. This may be seen as a proof of the usefulness of U.C.S. contourlines and the assimilating of the presence of discontinuities in the form of an influence factor.

8a



8b

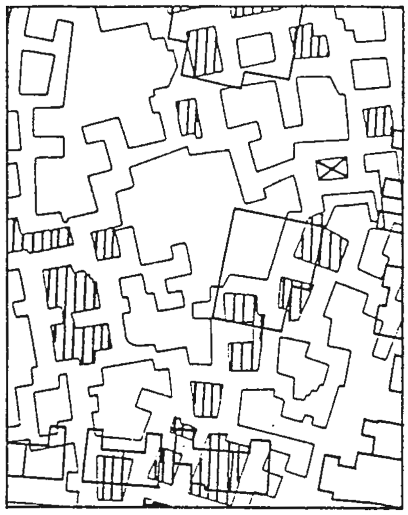
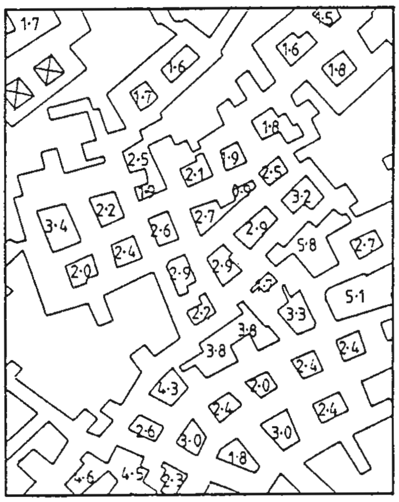


Fig 8a,b Visual classification of the pillars in two separate locations.

9a



9b

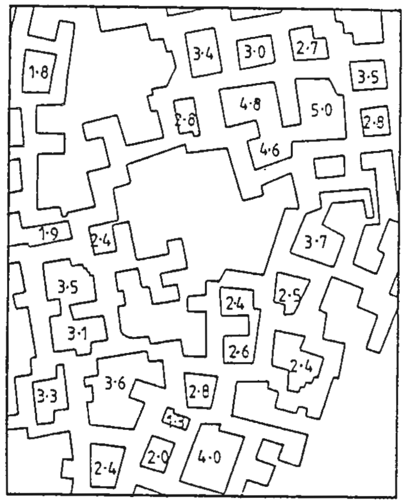
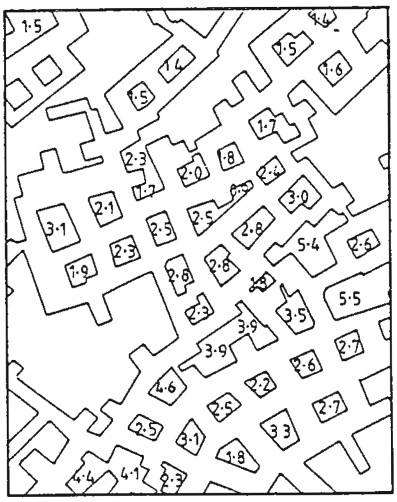


Fig 9a,b Safety factors of pillars as determined in former work.

10a



10b

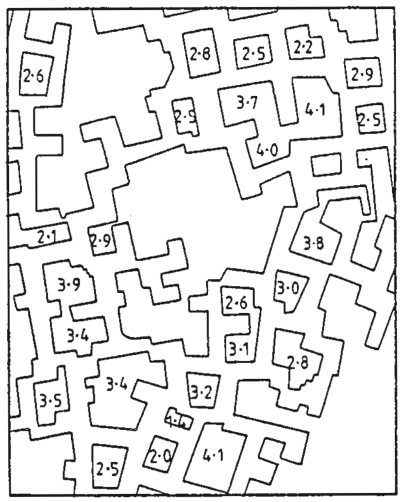
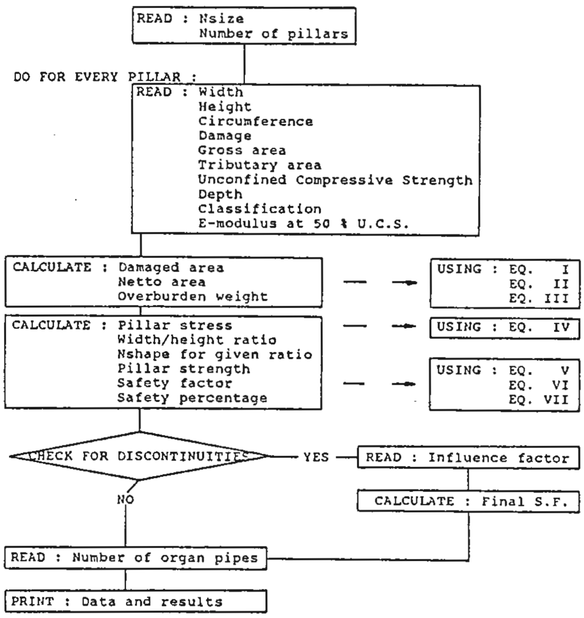


Fig 10a,b Safety factors of pillars as determined now.

Conclusions

The relation between visual classification and calculated safety factors now includes all parameters that can be given some sort of value. The classes of the classification system are more pronounced than in former work as a result of the use of an Unconfined Compressive Strength contour line map and the assimilation of discontinuity presence and location in the stability calculation. It is now possible to give a reasonable assessment of the safety, not only of a particular area, but also of a particular pillar. Still some improvements can be made, thinking of creep analysis (it is still not certain which fracture pattern may be seen as the start of inevitable failure as a result of decreasing material strength) and the effect that solution features exactly have on stability.



EQ. I : Lost Area = Damage * Circumference

EQ. II : Netto Area = Gross Area - Lost Area

EQ. III : a. Depth < 13 m.
Overburden Weight = Depth * 17.6

b. 13m < Depth < 33m.
O.W. = (13 * 17.6) + (Depth - 13) * 17.3

c. Depth > 33m.
O.W. = (13 * 17.6) + (20 * 17.3) + (Depth - 33) * 18.7

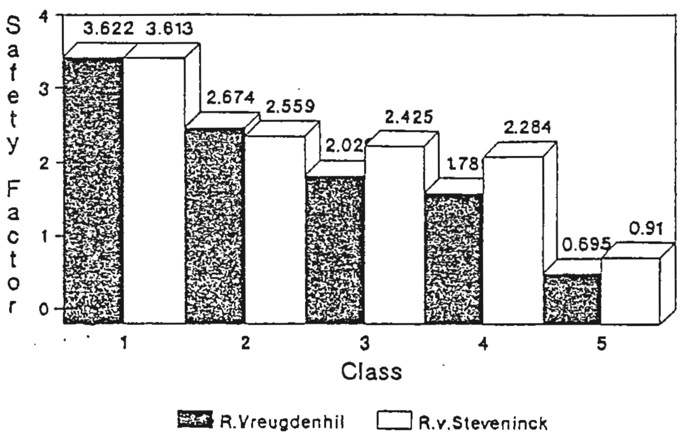
EQ. IV : Pillarstress = O.W. * Tributary Area / Netto Area

EQ. V : Pillarstrength = U.C.S. * (0.935 + 0.690 * log(W/H))

EQ. VI : Safety Factor = Pillarstrength / Pillarstress

EQ. VII : Safety Percentage = 1 / Safety Factor * 100 %

Fig 7 Structural diagram of used computer program, and used equations.



	Class	1	2	3	4	5
R.v.S.		3.61±2.89	2.56±1.42	2.43±1.36	2.28±1.15	0.91±0.46
R.V.		3.62±2.47	2.67±1.27	2.03±1.02	1.79±0.88	0.70±0.37

Fig 11 Comparison of former (R.v.S.) and present results (R.V.).

References

Beek, M.v. 1985. Stabiliteit van verlaten mijnen. Memoirs Centre of Eng. Geol. in The Netherlands No. 27: 209p.

Deibel, I.K., Dierendonck, M.v., Nienhuis, H. & Zuidberg, J.M. 1987. Stability analysis of part of the Geulhemmer Mine. Memoirs Centre of Eng. Geol. in The Netherlands No. 41.1: 200p.

Felder, W.M. 1975. Lithostratigraphy of the Upper Cretaceous and the Dano-Montian in Southern Limburg and adjacent areas (in Dutch). Toelichting geologische overzichtskaarten van Nederland, Rijks Geologische Dienst, Haarlem: 10p.

Mchihiyo, E.P., Vermeer, Th.W.M. & Vreugdenhil, R. 1987. Geotechnical investigation in the Curfs Quarry. Memoirs Centre of Eng. Geol. in The Netherlands No. 41.2.

Nienhuis, H. & Price, D.G. 1988. The scale effect with regard to the deformability of calcarenite. Geological Society, London. Field testing in Engineering Geology .

Price, D.G. & Verhoef, P.N.W. 1988. The engineering properties of and problems associated with the Cretaceous calcarenites of Limburg, Netherlands. Proceedings of the international Conference on Calcareous Sediments, Perth. Engineering for Calcareous Sediments.

Price, D.G. & Verhoef, P.N.W. 1987. The stability of abandoned mine workings in the Maastrichtian Limestone of Limburg, The Netherlands. Proceedings 23d annual Conference Engineering Group of the Geological Society, London. Engineering Geology of Underground Movements.

Steveninck, R.v. 1987. Past mining in the Maastrichtian limestone. Memoirs Centre of Eng. Geol. in The Netherlands No. 48: 135p.

Venmans, A. 1985. Instability in the Sint Pietersberg room and pillar workings. Memoirs Centre of Eng. Geol. in The Netherlands No. 28: 125p.

Verhoef, P.N.W. 1987. Stabiliteit van verlaten mijnen in de Limburgse kalksteen ("mergel"): een benadering vanuit de gesteente mechanica. Nieuwsbrief Ingeokring april.

Slope stability calculations
By R.D. Leonora
student of Engineering Geology

Introduction

In the past few years personal computers have made the calculation of the stability of slopes much less time consuming. The calculation of the stability using the Bishop method with a program developed by Verruijt [1] has found much use with the students of the section of Engineering Geology.
The Bishop method is only applicable for circular slip surfaces therefore a program was written based on the Janbu method for arbitrary shaped slip surfaces. On the following pages the Janbu method and the program are briefly discussed and are then followed by two examples.

Janbu method

With the Janbu method the determination of the factor of safety is based on the equilibrium of forces acting in the slope.
Assuming a known angle of internal friction, cohesion and groundwaterlevel the slope is divided into a number of segments of equal width for a chosen slip surface.

The factor of safety then follows from the formula : (1)

$$F=\frac{SUM(C*B+(W-UB+DX)*TAN(\phi)*SEC^2(\alpha)/1+TAN(\alpha)*TAN(\phi)/F}{SUM(W*TAN(\phi))}$$

where:

- F =factor of safety
- C =cohesion
- B =width of one segment
- W =upward force exerted by the groundwater
- DX =difference between intersegment shear force
- ϕ =angle of interal friction
- α =average grade of segment

The factor of safety, F, is multiplied with a correction factor f0. So the corrected factor of safety Fc is

$$Fc = F*f0 \quad (2)$$

The correction factor depends on the relation between depth and the length of the slide (fig 1) and whether the cohesion or the internal friction of the soil is zero. If neither the cohesion nor the angle of internal friction are zero then the correction factor is the average of the correction factor for a cohesion of zero and the correction factor for an angle of internal friction of zero (fig2).

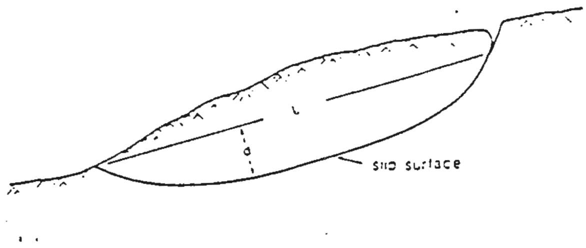


FIG 1

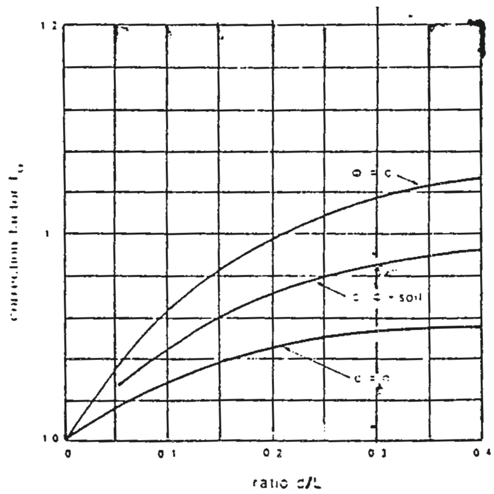


FIG 2

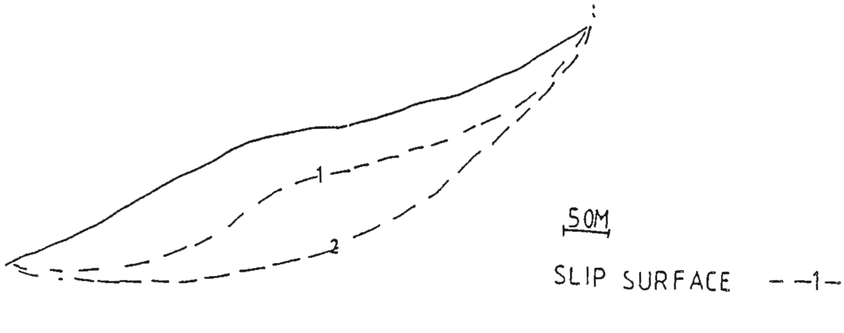


FIG 3

A number of programs based on the Janbu method and using the software Framework were written [2], the programs divide the slope into respectively 25, 50 and 100 segments and then determine the factors of safety for each case. The programs are an adaptation from a program originally developed by Bromhead [3].
Slope stability calculations can also be reversed in order to determine the angle of internal friction or the cohesion for a known factor of safety and slip surface. This is called back analysis. A program based on the Janbu method was written for this purpose.
The program determines for a known slip surface and cohesion the angle of internal friction at which the factor of safety is one.

Present day stability of the Gopfberg rock slide

The Gopfberg rock slide is located opposite the village of Mellau across the Bregenzer river, in the Austrian Alps, Western Austia. A large scale movement has taken place at the end of the last glacial period approximately 13000 BP. Cracks in a road near the toe of the slide as observed by van Westen [4] suggest the possibility of a new large scale movement.
The factor of safety for a number of potential slip surfaces and varying rock mechanical properties and a groundwaterlevel coinciding with the surface of the slope was determined (fig. 3). The results of the calculations are shown in table 1

TABLE 1
results of stability calculations
Gopfberg rock slide

Slip no.	D	GWL	C	ϕ	F
1	60	0	33	46	1.54
1	60	0	200	40.5	1.76
1	60	0	33	36	1.11
2	180	0	33	46	1.73
2	180	0	200	40.5	1.75
2	180	0	33	36	1.23

slip no = number of slip surfaces
D = maximum depth slip surface (m)
GWL = groundwaterlevel (m)
C = cohesion (Kpa)
ϕ = angle of interal friction
F = factor of safety

Table 1 shows that under the most adverse conditions the factor of safety of the rock slide would be 1.11.
This would qualify the slide as one of medium to low activity.Some movement may be expected but a large scale movement is unlikely.

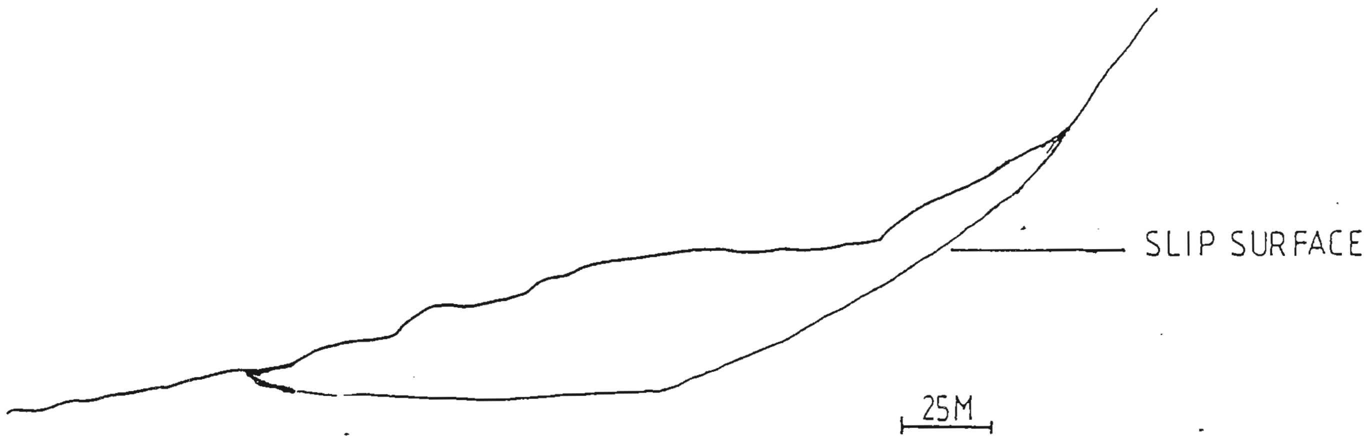


FIG 4 MAM TOR
POTENTIAL SLIP SURFACE

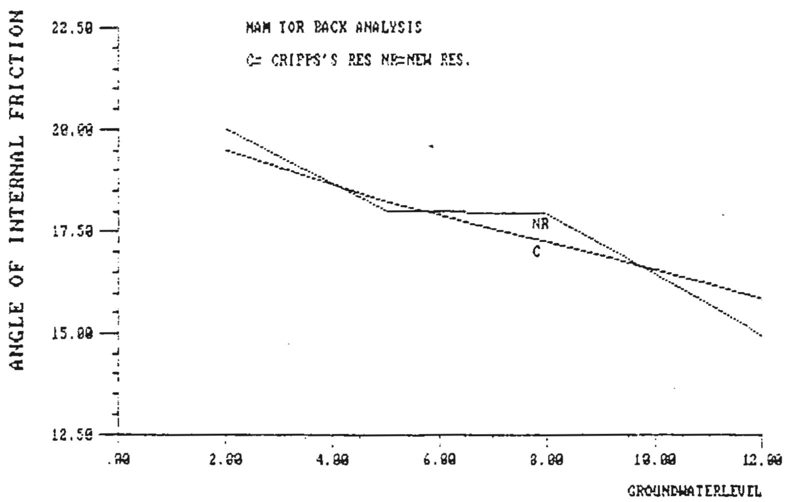


FIG 5

BACK ANALYSIS OF THE MAM TOR LANDSLIDE.

Cripps [5] made a back analysis of the Mam Tor landslide located in Derbyshire, Great Brittain. For a number of slip surfaces the angle of internal friction was determined for a factor of safety of one . Cripps's calculations were based on a method of back analysis using the Bishop method. The calculations were done for various groundwaterlevels. Cripps's calculations were repeated using a method of back analysis based on the Janbu method. Fig. 5 shows the combined results of the back analysis for various groundwaterlevels. Fig.5 illustrates that eventhough the two back analysis are based on different methods the results coincide quite well.

REFERENCES

1	A. Verruijt	Numerieke Grondmechanica Civiele Techniek TUD 1986
2	R. Leonora	Slope stability calculations: applications to natural slopes Delft University of Technology, Department of Mining and Petroleum Engineering. Section of Engineering Geology. 1988
3	E. Bromhead	The stability of slopes p 173-177 Surrey University Press 1986
4	K. van Westen	Stability analysis of Gopfberg rock slide (Mellau, Voralberg, Austria) Fysisch Geografisch en Bodemkundig laboratorium. University of Amsterdam 1986
5	C. Cripps	Notes on the landslide at Mam Tor University of Sheffield Department of Geology 1981

Open Dagen Mijnbouwkunde en Petroleumwinning, 20 en 21 Jan. 1989.

Deze keer worden de open dagen georganiseerd door de faculteit Mijnbouwkunde en Petroleumwinning, ter gelegenheid van het 75-jarig bestaan van de faculteit. In het gebouw van Mijnbouwkunde, Mijnbouwstraat 120 te Delft, worden exposities, demonstraties en audiovisuele presentaties verzorgt over het onderzoek dat aan deze faculteit gedaan wordt. Dit betreft: Oliewinning, Geofysica, Grondstoffenverwerking, Mijntechnologie en Ingenieursgeologie. De openingstijden zijn: van 10.00 - 16.00 uur. Op de volgende pagina's vindt u een aantal korte beschrijvingen van het onderzoek van de sektie Ingenieursgeologie dat op de open dagen gepresenteerd zal worden.

SLIJTAGE VAN DE TANDEN VAN SNIJKOPZUIGERS DOOR GESTEENTE

Abrasieve slijtage van snijkop-tanden is één van de belangrijkste kostenposten bij een baggerproject in gesteente. Het komt regelmatig voor dat voor een project het te verwachten "tandverbruik" onderschat wordt. Hierdoor worden verliezen geleden, die vaak in de miljoenen guldens lopen. Vandaar dat er in de baggerwereld op dit moment grote belangstelling bestaat voor methoden om slijtage beter te voorspellen. Die slijtage is afhankelijk van de abrasiviteit van de grond of gesteente soort. Abrasiviteit hangt af van de hardheid en scherpte (hoekigheid) van de mineraalkorrels, de korrelgrootte en de mate van binding (cementatie) tussen de korrels. Behalve de eigenschappen van het grond- of gesteente materiaal is ook de geologische opbouw van de te baggeren grond- of gesteente massa belangrijk. Om te komen tot een enigszins betrouwbare voorspelling van het tandverbruik is dus goede informatie over de geologische opbouw van de ondergrond en een gedegen kennis van materiaal-eigenschappen, zoals sterkte- en deformatiegedrag en mineraalinhoud noodzakelijk. Slijtage is, behalve van de abrasiviteit van gesteente, ook afhankelijk van de gebruikte werktuigen: type snijkopzuiger, geometrie van de snijkop en de tanden, de gebruikte snijkrachten en de werkomstandigheden. Het onderzoek richt zich in eerste instantie op de bepaling van de abrasieve capaciteit van gesteente materialen, waarbij getracht wordt fundamentele abrasie mechanismen ("twee- en drie lichamen abrasieve slijtage") te meten en de afhankelijkheid van deze typen slijtage van verschillende parameters (korrelgrootte, korrelvorm, sterkte, deformatiegedrag, snijsnelheid) te bepalen.

Informatie:

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AFSTUDEER PROJECTEN INGENIEURSGEOLOGIE MET TOEGEPASTE GEOFYSICA

Opsporing orgelpijpen met electromagnetische methodes

In de kalkstenen van Zuid-Limburg komen oplossingsholten voor; deze kunnen een gevaar voor mensen en structuren vormen doordat er plotseling een verzakking van grond in de holten kan optreden.

Verschillende geofysische methoden zijn gebruikt om de holten nog voor het inzakken op te sporen. Een hiervan is de electromagnetische methode (EM 34). M.b.v. een spoel wordt een magnetisch veld opgewekt, dit veld verandert in de grond en deze verandering wordt opgevangen door een andere spoel, de z.g. ontvangspoel. Verandering in het magnetisch veld is een maat voor de geleidbaarheid (dus watergehalte, mineraalinhoud, etc.) van de grond.

De geleidbaarheid wordt tot verschillende diepten gemeten. M.b.v. deze gemeten geleidbaarheid en door gebruik te maken van een computerprogramma, "3EMM", kan een model van de ondergrond worden opgesteld. De depressies op het kalksteenoppervlak, zijn op deze manier goed op te sporen.

Verontreinigd slib onderzoek met behulp van 3-D seismische methodes

Toepassing van de 3-D seismiek is vooral van belang voor de baggerindustrie voor het snel in kaart brengen van de onderwaterbodem en het schatten van de hoeveelheid baggerspecie.

Daarnaast is na het bekend worden van gevallen van ernstige vervuiling van waterbodems het noodzakelijk gebleken waterbodems aan een nader onderzoek te onderwerpen in het kader van het milieu, ter vergroting van kennis en inzicht in:

- de feitelijke kwaliteit van de waterbodem
- de bronnen en effecten van de verontreiniging op het milieu

Een belangrijk gegeven hierbij is de verspreiding van het na 1950 afgezette sediment en de dikte hiervan. Tot voor kort kon dit niet gebeuren met seismische methodes omdat de resolutie niet hoog genoeg was om slib-lagen in beeld te brengen. Er is nu echter een nieuwe techniek op de markt gebracht waarbij 3-D reflectie seismiek met hoge resolutie (aangevuld met bemonstering) gebruikt wordt om de waterbodem in kaart te brengen.

Om deze methode te toetsen is een afstudeerproject gecreerd in samenwerking met:
Rijks Waterstaat, Dienst IJsselmeerpolders (RIJP) en
Stema Survey Systems, die de volgende onderwerpen omvat:

- literatuurstudie naar kwaliteit, algemene opbouw en geologie van het Ketelmeer
- bestudering van de ruimtelijke verspreiding en kwaliteit van de sliblaag (IJm-laag) in het Ketelmeer
- reconstructie van het sediment patroon op basis van die kwaliteit
- vervaardigen van het dikte-patroon van het IJm-slib dmv. 3-D reflectie seismiek en controle hiervan dmv. boorgat gegevens
- het gebruik van een (Cam-Cad) geo-informatie systeem voor verwerking, analyse en presenteren van de gegevens
- rapportage

INGENIEURS GEOLOGISCH INFORMATIE SYSTEEM (EGIS)

Binnen de geotechniek wordt gewerkt met een grote hoeveelheid gegevens. Aangezien de mens, in tegenstelling tot een computer, zeer slecht in staat is een grote hoeveelheid gegevens te beheersen en te controleren, wordt door de afdeling ingenieursgeologie van de TU Delft getracht een informatie systeem te ontwikkelen, die de ingenieursgeoloog helpt bij de beheersing van zijn gegevens- en informatiestroom.

Het fundament van een informatiesysteem is het zogeheten datamodel. In het datamodel worden alle mogelijke gegevens en relaties beschreven en vastgelegd.

De ingenieursgeologische wereld zoals die is vastgelegd in het datamodel, wordt uiteindelijk geimplementeerd binnen een database management systeem.

Naast de database, bevat een informatiesysteem specifieke applicaties die gebruik maken van de gegevens die opgeslagen zijn en beheerd worden door de centrale database. Dergelijke applicaties worden aan de database gekoppeld zodat een modulair informatiesysteem ontstaat.

Het informatiesysteem bestaat derhalve uit de volgende eenheden:

- -de hersenen -------> de ontwerper van het systeem
- -het geraamte ------> het datamodel
- -het kloppend hart -> de database
- -de ledematen ------> applicatie eenheden / reken modules
- -de bloedsomloop --> de gegevensstroom

KAARTEN GENERERENDE MODULE

In de geotechnische wereld spelen kaarten een belangrijke rol, en vervullen meestal een dubbele functie:

1) opslag van gegevens
2) weergave van informatie

Doordat kaarten meestal gebruikt worden voor de opslag van (alle) beschikbare gegevens, zijn vele kaarten bijzonder onoverzichtelijk en moeilijk te interpreteren. Bovendien is manipulatie van gegevens die uitsluitend opgeslagen zijn op kaarten bijzonder lastig en tijdrovend, en in vele gevallen zelfs onmogelijk. Ondanks de nadelen zijn kaarten echter bijzonder geschikt voor presentatie van locatie gebonden gegevens.

De nadelen die kleven aan het gebruik van kaarten betreffende de opslag en de manipulatie van gegevens kunnen worden ondervangen door het inschakelen van computers bij het uitvoeren van genoemde taken (computers zijn namelijk bij uitstek geschikt voor de opslag en manipulatie van gegevens).

Bij koppeling van een "kaarten genererende module" aan een database management systeem wordt de opslag en manipulatie van de gegevens overgelaten aan het database systeem. Kaarten kunnen zodoende gebruikt worden voor het overzichtelijk presenteren van de beschikbare en benodigde informatie.

Voor ieder specifiek probleem kan een eigen kaart worden geproduceerd die uitsluitend de werkelijk benodigde informatie te zien geeft.
Kaarten worden zodiende eenvoudiger te lezen, en handiger in het gebruik.

Door de koppeling van een "kaarten producerende module" aan een database management systeem wordt het mogelijk om snel een overzicht te krijgen van de beschikbare informatie in een specifiek gebied.

P.M. Maurenbrecher M.Sc.

Review:

Penetration Testing 1988,

Vol. 1 International reference test procedures, Special Lectures and Technical Papers (Themes: Standard penetration test, dynamic testing, weight sounding test, dilatometer test and pressuremeter test.)
Vol. 2 Technical Papaers (Themes: Cone penetration testing) and Indexes.

Editor. J. de Ruiter
Publisher A.A. Balkema, Rotterdam
1076 pages, Cost: Hfl 225,- excl BTW, Hfl 238,50 incl 6% BTW

The publication forms the proceedings of the 1st International Symposium on Penetration Testing (ISOPT-1) held at Orlando, Florida last March, 1988. The preface to the proceedings state that ISOPT 1 follows the two previous European conferences on penetration testing ESOPT 1 and ESOPT 2. Both these conferences were regarded as a success and judging by the number of contributions ISOPT 1 can also be regarded as a success story. The symposium is sponsored by the U.S. National Society of the ISSMFE. The proceedings are divided into three parts. Part 1 on International reference test procedures covers the SPT (Standard penetration test), the CPT (Cone penetration test), the DP (Dynamic probing) and WST (Weight sounding test). The international reference test procedures would be very useful to the practicing engineer as they compare standards from various countries and also give an indication as to popularity of a particular test in different parts of the world and its application in site investigation. They would form useful specifications in site investigations and references in subsequent reporting. The test procedure specifications are supplemented by nine state-of-the-art "special lectures". These lectures together with the test procedures take up half the first volume and can be regarded as a very useful reference text-book on penetration testing.

Only two subjects could be considered as relatively new to penetration testing:

1. the Marchetti dilatometer, a spade shaped penetrometer tip with an expandable membrane (with recently developed versions having pore-pressure measuring devices) and
2. the pore pressure measuring facility on the cone penetration test.

Both these tests purport to test in the first instance deformation moduli of the soil and the second insitu pore water pressures. Both tests disturb the soil beyond failure. Such deformations are still little understood, though theories have been developed such as the expanded cavity theory which allows correlation of dilatometer and cone penetration tests with design soil parameters. For granular soils correlations are easily made but deformation in cohesive soils still requires further research (examples of such papers are Roque et al, "Basic interpretation of flat dilatometer tests" and Vermeer's and van den Berg's paper "Analysis of CPT for undrained clays" or Sagaseta's and Houlby's paper "Elastic-plastic flow around an infinite cone". Despite these drawbacks empirical correlations have been made so that both tests can be used to obtain a considerable wealth of parameters from moduli of deformation, insitu stress history, coefficients of consolidation and soil shear strength.

The majority of papers are on the cone penetration test (a total of 60 contained separately in volume 2). Of interest is the great variation of these papers, covering field experience of its use, comparisons with other tests, and papers covering more "exotic" cone testing. Exotic cone testing besides covering the pore-water-pressure measuring devices also covers electrical resistivity, seismic cone, nuclear density devices and free falling penetrometers.. Some comparative papers on the CPT are also found in volume 1, presumably because more emphasis was given on the SPT, DP, DPT and WST. Of these 60 papers only about six are from the Netherlands. To draw any conclusions from such statistics may be improper but it does indicate the popularity of the CPT as a penetration test over the other penetration tests (requiring a separate volume) and seeing international acceptance as a result of the large number of contributions from outside the originator country of the CPT, the Netherlands.

Despite the popularity of the CPT it is doubtful it will become a substitute for the other forms of penetration testing. Only a few papers were presented on the SPT, DP and WST and then usually accompanied with heavy dosis of CPT results for comparison. The merit of the tests is the simplicity of the equipment and hence their cost. Some forms of the DP test are easily transportable and are used as control tests for compaction (correlations with CBR). Most SPT articles are case histories in terms of interpretion of the N-value into a useful soil design parameter. One paper describes its use for obtaining shear-wave velocities from empirical correlations (one had hoped that the SPT would have been used as a sound source for measuring shear waves in combination with seismic equipment but this was not the case). This lack of sophistication has been made up by a paper by Ellstein on "Dynamic cone, wave equation and microcomputers: The Mexican experience", in which SPT simulates a micro-pile penetration. With the aid of the wave equation bearing capacities are obtained for the layers tested.

Only two papers were produced on the WST (weight sounding test, or Swedish Penetrometer). The WST probe penetrates under static loading applied by weights or the hydraulic ram from a rotary drill and by rotation. The double action makes for easier penetration in variable soils such as found in Scandanavia (for example quick clays overlying sands and gravels). This aspect as well as its simplicity and its possible use with rotary rigs are the tests principal attributes. The first contribution by Bergdahl and Ottosson correlates WST with other tests such as pressuremeter, CPT and soil parameters. The second, from Norway, by Rigg and Andresen describes recent developments using a heavy duty variant of the WST on rotary rigs.

One wonders from the proceedings if, in future, ISOPT will become ISOCPT. Only 20 years ago a similar conference would probably still have been dominated by the SPT. Testing, like any other product in the market place, does not become popular because it is a good test or even cost effective. The CPT has become popular possibly from a combination of factors: pile analogue, initial simplicity, novel applications and adaptations (such as, over the years, the addition of a sleeve, electronic instrumentation, down-hole probing devices, and in the last ten years the CPT resembles more and more down-hole geophysical logging devices without the need for the borehole). It is the versatility and the operation speed of the CPT which makes it popular. The versatility of the proceedings with its combination of international reference test procedures, special lectures (state of the art) papers and wide assortment technical papers should ensure that the first ISOPT publication and subsequent ISOPT publications should be as popular as the testing method it describes.

PMM

6th. International Congress of the International Association of Engineering Geology.

6 - 10 August 1990

RAI Congress Centre - AMSTERDAM

This edition of the Nieuwsbrief is a milestone in the history of the Ingeokring, for it contains a copy of the First Announcement for the 1990 IAEG Congress which is being organised by US .We first offered to host the 1990 Congress at the IAEG Council meeting in Moscow in 1984 and we now have it - in 20 months it will begin.

The First Announcement gives the scientific programme, which is very broad so that it is difficult to think of any applied earth science paper which cannot find a home under one or another of the themes or in one of the symposia.

A very significant part of the Congress will be the exhibition of equipment, technique etc. which will accompany the scientific programme. The themes for the symposia in particular provide specific objectives for the exhibition. Ingeokring members should know that it is proposed to offer one day registration for the symposia only, so that the numbers viewing the exhibition should be much greater than just the congress participants.

A great deal of work will be required to make the Congress a success. Most will be done by the various committees but every member of the Ingeokring can help by

* preparing a paper for the Congress
* encouraging others to attend
* encouraging companies to exhibit equipment, technique, software etc.

We will report on the progress of Congress organisation in the Nieuwbrief.

David Price
Chairman, Science Committee

4 December 1988

COMMITTEE OF RECOMMENDATION
COMITÉ DE RECOMMENDATION

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"25 YEARS OF ENGINEERING GEOLOGY"

The Netherlands National Group of the IAEG cordially invites you to the Sixth International Congress of the IAEG. This will mark the Silver Jubilee of the IAEG and is intended to give a broad review of developments in the total field of Engineering Geology.

SCIENTIFIC PROGRAMME: DATES AND THEMES

Monday, 6 August
Opening ceremony
'Engineering Geology of The Netherlands'

1 ENGINEERING GEOLOGICAL MAPPING AND SITE INVESTIGATION.
Including: engineering geological and environmental maps and plans; boring and sampling; laboratory and in situ testing and instrumentation; procedures, classification and interpretation for engineering design.

Tuesday, 7 August
2 REMOTE SENSING AND GEOPHYSICAL TECHNIQUES.
Including: aerial and terrestrial photography and photogrammetry; multispectral sensing and radar (including their applications in environmental and engineering geology); geophysics on land; geophysics overwater.

3 HYDRO-ENGINEERING GEOLOGY
Including: groundwater flow in dams, reservoirs, tunnels and excavations; reduction of groundwater flow by dewatering, injection and other methods; groundwater supply: methods and environmental consequences; groundwater pollution and waste disposal: environmental impact.

Wednesday, 8 August
Participants may either follow a technical excursion or attend symposia. Four symposia are proposed, each dealing in detail with a theme considered to be of great importance for Engineering Geology in 1990. The topics for the symposia are:
1 Computer use in Engineering Geology
2 Environmental protection, pollution and waste disposal
3 Coastal protection and erosion, including the engineering and environmental consequences of rises in sea level
4 Engineering Geology in the oil industry

Thursday, 9 August
4 SURFACE ENGINEERING GEOLOGY
Including: natural geotechnical hazards and the environment; foundations; stability of excavated slopes and embankments; infrastructure (roads, railways, pipelines, etc

5 UNDERGROUND ENGINEERING GEOLOGY.
Including: tunnels and shafts; large permanent underground openings; engineering and environmental problems caused by subsidence brought about by underground extraction of minerals, oil and gas; underground storage of energy, liquids and waste.

Friday, 10 August
6 ENGINEERING GEOLOGY OF LAND AND MARINE HYDRAULIC STRUCTURES.
Including: flood control and erosion protection: environmental impact; offshore structures and seabed stability; coastal protection and land reclamation; harbours, cause ways and breakwaters.

7 CONSTRUCTION MATERIALS.
Including: exploration; production - methods and enviro mental impact; testing and classification; problem materials.

SESSION ORGANISATION

For each theme there will be an invited 'Key-note Speaker' who will present a review of the State of the Art for the whole or part of each theme (30 minutes). Panel reporters will then review the papers submitted (about one hour). The remainder of the session will be devoted to discussion, giving about one hour to 'registered discussion' and about one half hour to spontaneous discussion. Papers submitted will not be orally presented, but the author(s) will have the opportunity to present the paper i 'poster form' outside the congress hall. Requirements fo posters and registered discussion will be given in the second announcement.

In the symposia a limited number of papers will be selectc for complete oral presentation by their authors; others may be presented as posters.

Proceedings will be published before and be available at, the congress. The second announcement will contain a li: of abstracts accepted. The deadline for receiving papers i February 1990. Papers will be refereed.

GENERAL INFORMATION

Languages
The official languages of the IAEG are English and French; papers and abstracts may be written in either language. Simultaneous translation will be provided at the Sessions.

Call for papers
Authors are invited to submit abstracts of less than 200 words, indicating the relevant theme, to the Congress Organisation Bureau. Authors of accepted abstracts will receive instructions for the preparation of a camera-ready paper. Abstracts accepted before August 1989 will be mentioned in the second announcement.

Key Dates

September 1989	Second Announcement
November 1989	Deadline for submission of abstracts
February 1990	Deadline for submission of papers
March 1990	Deadline for registration of exhibitors
May 1990	Deadline for registration of participants

Excursions and social programme
There will be an excursion to visit the Delta Works including the Eastern Scheldt storm surge barrier on August 8th. After the congress there will be short (two to seven days) excursions to sites of engineering geological interest in Western Europe. It is hoped that these will include a visit to the infrastructure works in France associated with the construction of the Channel Tunnel and the works being undertaken in preparation for the 1992 Winter Olympic Games in the French Alps.
There will be a full social programme for accompanying persons during the course of the congress.

Registration
Full information about registration costs and procedures, excursions and social programmes will be given in the second announcement.

Those who wish to be sure that they will receive the second announcement should return the attached reply card. Those who wish to receive a personal invitation to attend the congress should apply to the Congress Organisation Bureau. The Organising Committee will provide such an invitation without assuming any financial responsibility.

Access and accommodation KLM
The official carrier for the congress is KLM which flies between Amsterdam and every major airport in the world. Within Europe Amsterdam is easily reached by rail or road. Amsterdam has more than 200 hotels of all categories - in international terms Amsterdam hotels are comparatively cheap.

Exhibition
There will be an extensive exhibition including laboratory and surveying equipment, computer hardware and software, geophysical equipment, services and systems.

Grants and fellowships
A number of grants and fellowships will be awarded to help individual scientists, principally from developing countries, who wish to participate in the congress. Further details will be in the second announcement.

Addresses/Adresses

Venue Arrivée	Congress Organisation Bureau Bureau d'Organisation du Congrès
RAI International Congress Centre Europaplein 8 1078 GZ Amsterdam The Netherlands Telephone: +31 (0)20-5491212 Telefax: +31 (0)20-464469 Telex: 31499 raico nl	QLT/Congrex Keizersgracht 782 1017 EC Amsterdam The Netherlands Telephone: +31 (0)20-261372 Telefax: +31 (0)20-259574 Telex: 14527 congx nl

REPLY CARD
COUPON-REPONSE

Name
Nom ....

First Name
Prénom ....

Address
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City
Ville ....

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Country
Pays ....

☐ I wish to receive the second congress announcement including registration– and hotel reservation forms.
Je veux recevoir le deuxième bulletin du congrès avec les formulaires d'inscription et de réservation d'hôtel.

☐ I intend to submit an abstract entitled:
J'ai l'intention de présenter un exposé intitulé:

....

....

☐ I am interested in attending a post-congress excursion
Je désire participer à une excursion après le congrès.

Please indicate your choice:
Veuillez marquer votre choix:

☐ Excursion in North - West Europe lasting 2 - 7 days
Excursion dans le nord-ouest de l'Europe de 2 à 7 jour
☐ French Alps/Alpes françaises
☐ Channel Tunnel/Tunnel de la Manche

Signature ....

Date

Aankondigingen

Seacore Ltd. (UK) opent Seacore Continental in Den Haag.

Het in Cornwall, Engeland gevestigde Seacore Ltd. heeft per 1 Sept. 1988 een kantoor geopend op het Europese vasteland.
Dit kantoor, Seacore core Continental, houdt zich bezig met booraktiviteiten offshore, in kustwateren en in de binnenlandse wateren van het continent.

Onder deze aktiviteiten vallen o.a. de volgende diensten:

- Geotechnisch bodemonderzoek
- Exploratie van delfstoffen
- Het uitbrengen van adviezen op het gebied van boren vanaf het water.

Daarnaarst heeft Seacore Continental de beschikking over een aantal hefeilanden en over zelf ontworpen materieel dat ingezet kan worden bij boringen op zee.

Meer informatie over de onderneming kan worden verkregen bij:

B. Degen
Seacore Continental
Noordeinde 18 A
Postbus 81
2501 CB DEN HAAG

Telefoon : 070 - 65 60 73
Telefax : 070 - 64 99 16
Telex : 34349 palys nl

Aankondiging lezing

"Underground spaces and earth sheltered buildings", door Prof. ir. H.P.S. van Lohuizen en P.M. Maurenbrecher M.Sc., C.Eng.(TU Delft)
Verslag over congres en excursie gehouden in September 1988 te Shanghai, China.
Tijd :20.00, 2 Februari, 1988.
Plaats : Zaal E, Mijnbouwkunde, Mijnbouwstraat 120, Delft.

CONFERENCES, SEMINARS and SYMPOSIA:

1989:

25 January	Rock Mechanics Seminar. Delft, The Netherlands. Delft University of Technology, Faculty of Mining and Petroleum Engineering, Section Engineering Geology, Mijnbouwstraat 120, 2628 RX Delft, The Netherlands, phone 015-782543.
7-10 February	Int. Conf. on Tunneling and Micro-Tunneling in Soft Ground. Paris, France. Topics: Recent soft soil tunneling techniques; Micro-tunneling techniques; Instrumentation and field observation; Model and design methodes. Colloque International "Tunnels et Micro-tunnels", ENPC/DFCAI - Department International, 28 rue des Saints-Peres 75007, Paris, France.
22 February	Rock Mechanics Seminar. Delft, The Netherlands. Delft University of Technology, Faculty of Mining and Petroleum Engineering, Section Engineering Geology, Mijnbouwstraat 120, 2628 RX Delft, The Netherlands, phone 015-782543.
13-17 March	Int. Symp. on Frost in Geotechnical Engineering. Helsinki, Finland. Finnish Geotechnical Society-FGE89, Seppo Saarelainen, c/o VTT, Geotechnical Lab., SF-021150 Espoo, Finland.
22 March	Rock Mechanics Seminar. Delft, The Netherlands. Delft University of Technology, Faculty of Mining and Petroleum Engineering, Section Engineering Geology, Mijnbouwstraat 120, 2628 RX Delft, The Netherlands, phone 015-782543.
3- 5 April	Conf. of Geotechical Instrumentation in Civil Engeneering Projects. London, England. Topics: Earthworks and retaining walls; Buildings, Landslides and slopes; Offshore; Tunnels and underground chambers; Buried services; Dams. Instution of Civil Engineers, 1-7 Great George Street, London SW1 P 3AA England.

19 April	Rock Mechanics Seminar. Delft, The Netherlands. Delft University of Technology, Faculty of Mining and Petroleum Engineering, Section Engineering Geology, Mijnbouwstraat 120, 2628 RX Delft, The Netherlands, phone 015-782543.
15-17 May	2nd. Int. Symp. on Environmental Geotechnology. Shanghai, China. Topics: Effect of toxic and nucular wastes on soil/rock; Soil-water-gas interaction; Landslides, subsidence and sinkhole; Landfill contol systems; Ground improvement techniques; Groundwater contamination; Expert systems; Sampling and testing; Durability and protection of pavements and geostructural members in hazardous conditions. Prof. Sibel Pamukcu, Dept. of Civil Engineering, Lehigh University, Bldg 13, Bethlehem, Pennsylvania 18015 USA, Tel: 215 758-3220.
22-26 May	8th. Int. Strata Control Conference. Dusseldorf, F.R. Germany 8. IGDT, Stein kohlen bergbauverein, 4300 Essen 13, F.R. Germany.
25-28 June	Int. Conf. on Storage of Gasses in Rock Caverns. Trondheim, Norway. The Norwegian Institute of Technology, Studies Administration, N-7034 Trondheim, Norway.
26-28 June	Int. Conf. on Engineering Geology in Tropical terrains. Selangor Darul Ehsan, Malaysia. Topics: Various eengineering geologic aspects and problems specifically related to tropical terrains. Dept. of Geology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor Darul Ehsan, Malaysia.
13-18 Agust	12th. Int. Conf. on Soilmechanics and Foundation Engineering. Rio de Janeiro, Brazil. Dr. L.J. de Moraes, 12th ICSMFE, Caixa Postal, 1559, 20.001-Rio de Janeiro, R.J. Basil.
30- 2 September	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.

4- 7 September	Int. Chalk Symposium. Brighton, England. Topics: General; Costruction; Hydrology; Petroleum Engineering. Dr. R.N. Mortimore, Int. Chalk Symposium, Dept. of Civil Engineering, Brighton Polytechnic, Brighton BN2 4GJ, U.K.
10-14 September	Conf. on Quaternary Engineering Geology. Edinburg, Scotland. Dr. J.A. Little, Dept. of Civil Engineering, Heriot-Watt University, Edinburg EH14 4AS, Scotland.

<u>1990:</u>

6-10 August	6th. Int. Congress of the IAEG. Amsterdam, The Netherlands. Dr. L. Primel, Secretary General IAEG, Laboratoire Central des Ponts et Chausees, 58 Boulevard Lefebre, 75732 Paris Cedex 15,France. Tlx: LCPARI 200361 F.