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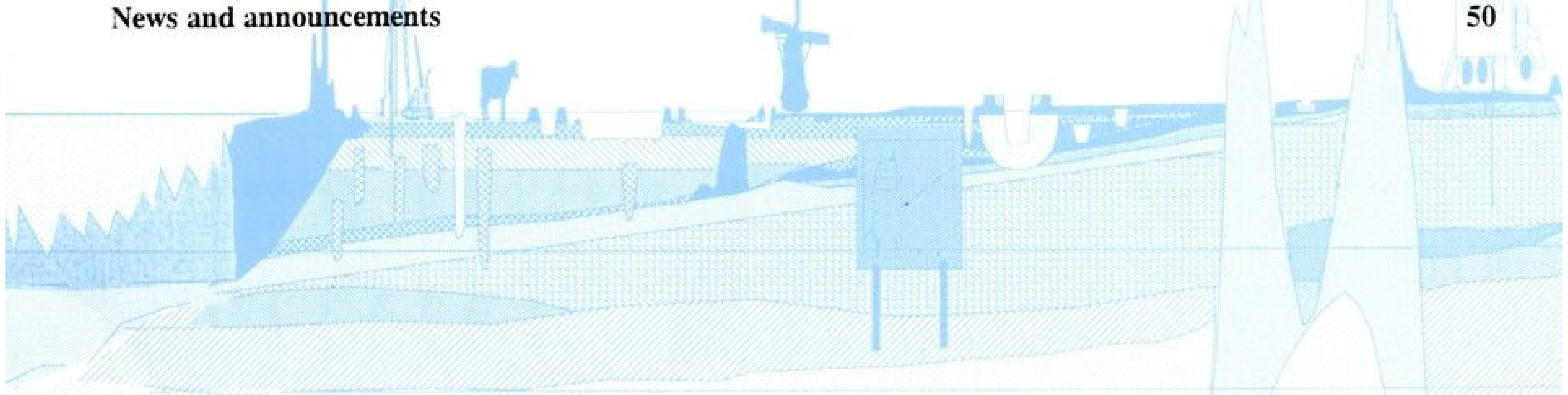
newsletter

No. 8 Summer 1999



Editorial

Dear readers

During the past months Ingeokring community has experienced happy and sad events together. One of the happy events was the celebration of a successful 25 years at a symposium- "25 years jubilee of engineering geology in the Netherlands". Other happy occasions are numerous excursions, seminars, and lectures organised by Ingeokring. Unfortunately, there were also sad moments we had to live. Regrettably we have lost two of our friends. Prof. David Price, the founder of engineering geology section of TU Delft, has passed away on 25 May. Another sad moment came with the loss of a young engineering Geologist; Ir. Taco Pieter Adriaan Wever at an age of 26. Several memoriams in this issue of the Newsletter reflect most of our feelings and remind you their lively, interesting personalities. I personally would like to thank for their contributions to the Ingeokring and would like to convey my condolences to their families. May God's mercy be with them.

We had to wait long until this issue of the Newsletter became ready for publication. As we have mentioned earlier the number of releases in a year is directly related to the number of your contributions sent to the Newsletter. It is our wish to release the Newsletter more frequently than before, therefore we kindly ask for more contributions from our readers. The editorial board has strengthen its position with the joining of Oscar Mooijman to the team. We will try to keep the Ingeokring Newsletter as a high quality, prominent publication.

The first contribution submitted to this issue is an article by Enno Kuipers on the Importance of geotechnical information in the assessment of environmental impacts due to large rail infrastructures. This article introduces the site characterisation and environmental impact predictions for the Noord-osstelijke verbinding. The author has personally involved in the characterisation studies and gives important messages how an engineering geologist can contribute to such projects, what are the potentials and what are the difficulties in assigning this task to an engineering geologist.

Another contribution takes us to the engineering geology of the Swiss Alps. Frank de Boer introduces the new railway tunnels through the Swiss Alps at Gotthard and Lotschberg locations. The article discusses the geology of two sites and gives the design aspects of the tunnels.

A short article by Hylke Jan Glass introduces the Mechanics of Granular Materials and explains the techniques for modelling the mechanical behaviour of granular materials.

In a review article, J.W.P de Bont and P.M. Maurenbrecher are revisiting the sessions in the symposium 25th years jubilee of engineering geology in the Netherlands. They provide a review of articles presented at the symposium and complement the review with some pictures taken during the scientific and social programs.

Dr. J. Rupke reports the engineering geological, geotechnical and constructional aspects of Souterrain (tram tunnel in Den Haag) based on the presentations and visit to the site during the Ingeokring Excursion.

A report of excursion to the second Heinenoord tunnel and of complementary lecture is presented by P.M. Maurenbrecher. This article provides an updated overview of the project and the constructional aspects of the tunnels. It summarises the design, excavation and construction stages and presents the problems encountered and the lessons learned.

Three memoriams by P.M. Maurenbrecher and several other Ingeokring members are addressed to Prof. David Price and Ir. Taco Pieter Adriaan Wever. The letter of Ingeokring board on the awarding of honorary membership to Prof. David Price is also included.

In the "In focus" section, J.W.P. de Bont introduces two prominent scientists who are familiar to many of us. Prof. Dr. Ir. Ed de Mulder and Prof. Dr. Jan Nieuwenhuis are the two guests of the "In focus" in this issue. The "book review" section presents the reviews of a book and a CD-ROM by Senol Ozmutlu.

In addition to all the listed sections above, the message of the chairman of the Ingeokring, thesis abstracts, recently published papers and the other standard sections make this issue of the Newsletter worth reading. I would like to thank to all of the contributors and hope to see you soon in the next issue.

Senol Ozmutlu

From the chairman of the Ingeokring

From The Chairman,

Sadly Professor David Price passed away on 25 May. It was known that he had a serious illness but his decease was still sooner then expected. In January the Board of the Ingeokring had decided to make David Price the first honorary member of the Ingeokring and we scheduled to celebrate it during the annual meeting in May. However, fate overtook David and therefore we went to David in England and officially handed out the honorary membership status. Michiel Maurenbrecher, Collin Davenport of the University of East Anglia, and Mrs. Valerie Price attended the occasion. David was in good shape and thanked the members of the Ingeokring for the honour awarded. He hoped that engineering geology in the Netherlands would flourish as it always done, and wished the Dutch community of engineering geologists a happy professional and sociable future. Champagne concluded the event. Afterwards we had a good time talking about old times, fieldwork and interesting new developments in engineering geology. The statue that memorises the honorary membership can be seen on the web pages of the Ingeokring: http://www.itc.nl/~ingeokri

It is needless to say that the message of the passing away of David only 10 days later shocked me and everybody else I have spoken to. Most of us are engineering geologist by the training of David and would not be in the profession and would not have our present jobs if he had not put every effort in making us what we are. We can only thank David for this and we will remember him forever.

Since April the Section Engineering Geology in the TU Delft has a new professor. Keith Turner, Professor of Geological Engineering in Colorado School of Mines in the States, has been found willing to take up a temporary position as professor in Engineering Geology in the TU Delft for 50 % of his time. Keith Turner has long-standing relations with the Dutch engineering geology society. Some years ago he spent his sabbatical in ITC, he co-operated on various research projects in the Netherlands, and co-operated in some jointly organised conferences. He has a long career in engineering geology from slope stability and geohydrology to computer assisted spatial modelling of the sub-surface. Keith taking up the position provides the necessary time to allow for further development of the Section in the TU. He has started his work in the TU during the TU and ITC fieldwork in Spain. It was immediately clear that his presence was going to be an asset. New ideas, new structures and new education have already been discussed during the fieldwork. Also for the engineering geology community at large in the Netherlands we can expect that new initiatives will keep engineering geology alive as it has been in the past. We wish Keith a wise and prosperous time in the Netherlands. In due time you will be able to read an interview with him in the Newsletter.

Concluding this mixed very sad and positive intro, I wish you all a good second half of 1999 and hope to see you at the annual meeting on 30 September 1999.

Robert Hack

Importance of geotechnical information for the environmental impact assessment of large rail-infrastructures

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Within the context of an Environmental Impact Assessment (EIA) the effects of a large rail-infrastructure can be large and complex. The design of a rail-infrastructure, if not all but for a substantial part, is determined by the characteristics of the subsoil. At the early stages of an EIA study, all the existing and relevant data are collected in order to characterise the subsoil in geotechnical and geohydrological terms. This can prevent wasted effort in design and investigation stages. Engineers must have knowledge on geology and civil engineering disciplines in order to interpret the available data accurately.

INTRODUCTION

In recent years there has been a growing awareness of the environment in the Netherlands in contrast to the growing economy. The planned infrastructures are subjected to environmental impact studies before the final design is implemented. Environmental Impact Assessments (EIA) for rail infrastructures incorporate the effects of the structure on the scenery, archaeology, liveability etc.. Many of these effects depend on the design of the structure, which in turn is determined by the characteristics of the subsoil. Therefore it is essential to obtain all available geological, geotechnical and geohydrological data during a feasibility investigation phase to prevent wasted effort in design and investigation stages

LARGE RAIL INFRASTRUCTURES IN THE NETHERLANDS

Dutch government is investing a lot of money to improve the rail-infrastructure in the Netherlands. One of the objectives is the construction of a new cargo rail-infrastructure, the “Betuweroute”, which starts from the port of Rotterdam and leads to the industrial hart of Germany, the Ruhr-area, and from there to the south-east Europe. A substantial part of this cargo transport route has to pass through the Northeastern parts of the Netherlands towards Germany (e.g. Hamburg) and north-east Europe. This transport corridor would exert extra pressure on the existing infrastructure of this area and probably be demanding for improvements of the infrastructure or even a new rail-infrastructure. The rail-infrastructure mentioned as the North-East link or “Noord-oostelijke verbinding” (shortly NOV), will diverge from the Betuweroute somewhere south of Arnhem heading for the German border east of Hengelo and Enschede (see figure 1). The feasibility study of this alternative corridor has been contracted to Holland Railconsult by the principal NS Railinfrabeheer B.V.

According to Dutch law the Minister of Infrastructure is obliged to execute an investigation on the expected benefits and drawbacks of a new or strongly adapted rail-infrastructure. The investigation starts with the analysis of the present and future situations without the intended rail-infrastructure. This step should be well documented and is often used as reference for further investigation. At the second step, all plausible alternatives of the infrastructure should be investigated and compared in an environmental assessment context. This assessment has been recently performed for the NOV.

One of the most preliminary phases of this project was the characterisation of the subsoil in terms of geotechnical and geohydrological properties and to give an indication of the vertical deformation and stability of the rail-embankment. Because the project covers a large area of interest there are many layers of different geological origin to be encountered. Most subsoil layers (the uppermost 50 à 100m) have been deposited during the Quaternary Period, which can be divided into the Pleistocene Epoch and Holocene Epoch.

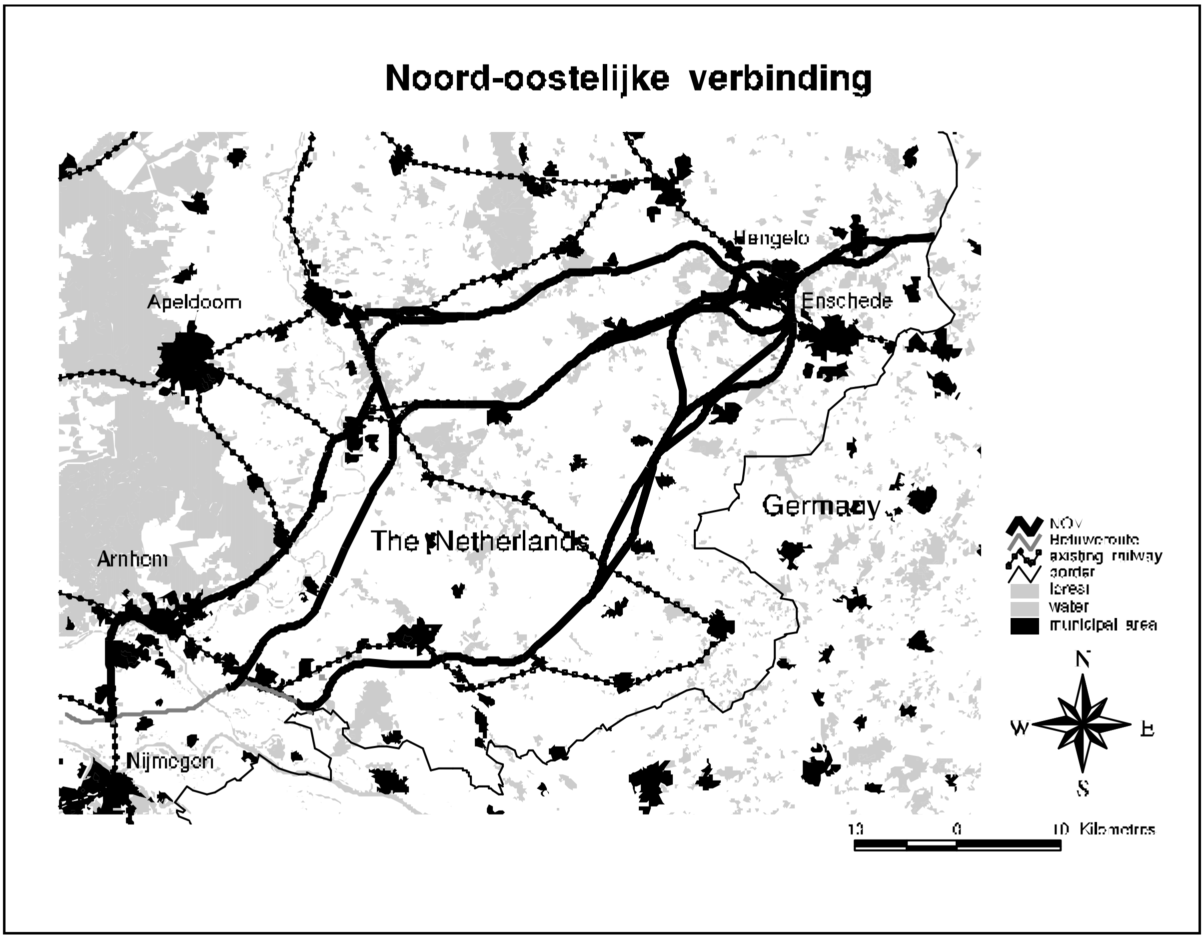

Figure 1 *Map of the alternatives of the Noord-oostelijke verbinding.*

GEOLOGY OF THE AREA

The southern part of the North Sea Basin, covering the present mainland of the Netherlands, has experienced a long and complicated geological history and is part of an extensive rift system. This rift system of western and central Europe started to evolve during the middle and late Eocene in the Alpine foreland and propagated during the Oligocene northward and southward. One of the larger branches of the rift system is the Rhine Graben rift system, which bifurcates in the north-west trending Roer Valley-Graben. During Miocene, Pliocene and Quaternary times an increase in differential settlement along the faults resulted in the accumulation of thousands of metres of sediment (see figure 2).

The Pleistocene was characterised by glacial and interglacial periods. Marine sedimentation took place during the earliest periods of the Pleistocene. Due to a regression fluvial sedimentation started to dominate with two major fluvial systems, the Rhine-Meuse system and an eastern German system. Both systems deposited sediments with a characteristic composition and mineralogy. These deposits did interfinger, where the Tegelen, Kedichem and Sterksel Formations were deposited by the Rhine-Meuse system and the Harderwijk and Enschede Formations were deposited by the eastern system.

During the Middle Pleistocene times the eastern German river system retreated from the area, and the Sterksel and Urk Formations were deposited by the Rhine-Meuse system. At least during two glacial periods, the Elsterian and the Saalien, large parts of the Netherlands were covered with ice-sheets. It was during this period when the present geomorphology of the Netherlands has been formed. Due to the moving land-ice from the north, large quantities of sediment were pushed in front of the moving ice into ice-pushed ridges. The weight of the ice pulverised rocks and other sediments into fine grained till. The following increase in temperature resulted in melt-water deposits over a considerable area in front of the land-ice. These glacial and fluvial-glacial sediments belong to the Drente Formation.

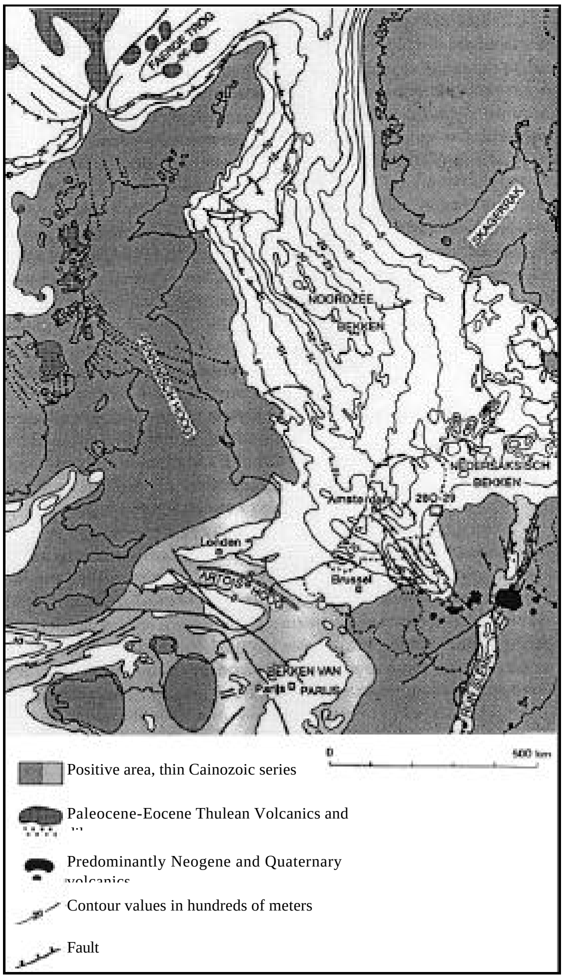

Figure 2 *Isopach map of Cenozoic Series in the North Sea Basin (after Ziegler,1982).*

The ice and sediment had blocked the Rhine-Meuse system in its northern course and consequently the system was forced to a western course. During this period the Kreftenheye Formation was deposited and the movements along the NW-SE stretching faults of the rift system gradually disappeared, but the general tectonic subsidence continued.

Temperature gradually increased during Late Pleistocene times and this trend was, after some shorter colder periods, continued during the Holocene. One of these colder periods at the end of the Pleistocene was the Weichselien. The land-ice never reached the Netherlands, but vegetation disappeared and the large areas were covered by aeolian sediments of the Twente Formation (cover sands). During the Holocene, the temperature increased and vegetation became dense in the area. Erosion stagnated and the geomorphology of the area was more or less fixed. Local fluvial deposition, like the Singraven Formation, occurred in small river valleys. Due to the climatic changes and pore drainage of the area, peat was formed over large areas, the Griendtsveen Formation, but it has been excavated by men for fuel purposes or for cultivating the landscape. Some areas were uncovered from vegetation and aeolian sediments were deposited like the Kootwijk Formation.

GEOTECHNICAL UNITS

In a very early stage of the environmental impact assessment a desk study revealed all available subsoil data. This data was to be gathered from the archives of Holland Railconsult. The result was a large quantity of data, ranging from exploration borings containing information about the hundreds of meters thick sediment (geological maps of the geological survey) to very shallow environmental borings, only giving information of the uppermost subsoil. All this information had to be analysed for quality and usefulness, and finally characterised for geotechnical and geohydrological maps and profiles.

The problem with soil characterisation for these kind of rail-infrastructures is their large horizontal extend compared to their vertical extend. Furthermore the subsoil information is denser in urban areas or nearby civil structures, whereas sparse in uninhabited land, leaving large gaps in the information along the infrastructures. It is even more complicated when the engineering geologist wants to predict the lateral continuity of soil layers. For geotechnical engineering purposes only the information from the upper 50m of the subsoil are relevant.

Geotechnical characterisation

For this preliminary phase of the railway design a global characterisation of the subsoil was required. In this part of the Netherlands some areas with distinct subsoil characteristics can be recognised:

- fluvial sediments (e.g. Rhine-river and IJssel-river),
- aeolian sediments (e.g. large parts of De Achterhoek),
- ice-pushed sediments (e.g. Hoge Veluwe),
- organic sediments (e.g. nearby Winterwijk), and
- pre-Quaternary sediments (e.g. nearby Almelo).

With the application of GIS techniques all the available data layers have been manipulated and converted into a geotechnical map. Figure 3 partly shows the resulted geotechnical map, which has been used as input for the design of the rail-embankment.

The main requirement for the design is that it meets all technical-constructional boundary conditions which may arise from the possible failure mechanisms of the construction. In the case of a rail-embankment on compressible subsoil, various deformation mechanisms play a role.
These are:

- horizontal deformation,
- vertical deformation, and
- shearing.

HORIZONTAL DEFORMATION

Rail-embankments on compressible subsoils generate horizontal and vertical deformations which in turn cause stresses in foundation piles near the earth structure. Vertical deformation may cause negative skin friction on the pile foundation, resulting in an extra pile load. Horizontal deformation in the compressible layer causes horizontal pile load. As the pile is generally firmly anchored in the underlying sand layer, bending stresses may result in excessive forces in pile and construction.

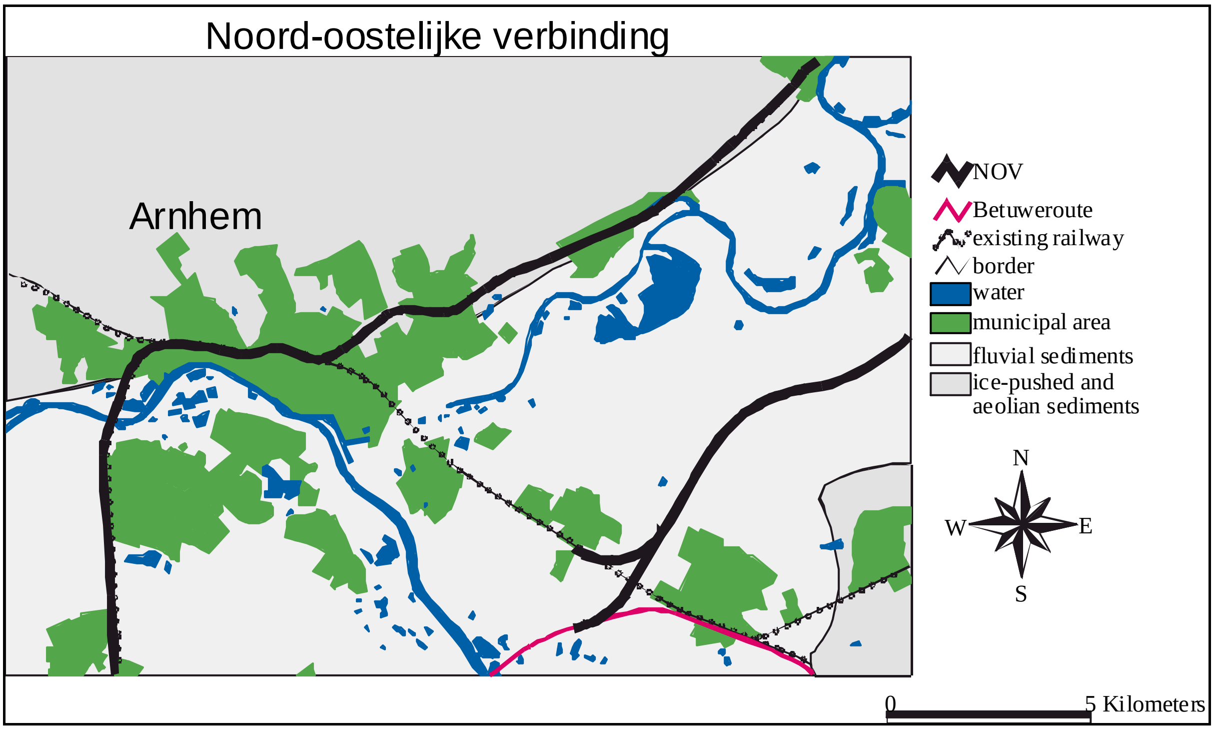

Figure 3 *Detail of geotechnical map of the Noord-oostelijke verbinding*

The thickness of the uppermost compressible layers of fluvial deposits has been determined to be maximal 6 meters. In spite of the relative stiffness of these sediments, horizontal pile loading is an aspect to consider with the construction of large earth structures.

VERTICAL DEFORMATION

Dutch Rail imposes high demands for railway structures. Most common used regulations are the “Ontwerpvoorschriften van Spoorlijnen” (OVS). In these regulations the requirements of track design, formation of the rail-embankments and ballast bed are clearly described.

Rail-embankments are mainly designed for the transmission of axle loads to the subsoil without causing unacceptable deformation or (differential) settlement. The railway track should exhibit a minimal level of deformation and an adequate bearing strength and sufficient stability.
Vertical deformations are stress deformation phenomena. Three criteria are applicable on the exploitation of railways:

- elastic deformation,
- time related deformation (consolidation), and
- instantaneous and non-elastic deformation.

If deformation is uniform there is most likely no problem for the exploitation of a railway. But differential deformation may result in damage beyond the limits of tolerance. Possible causes of differential deformation are an unequal load of the subsoil (e.g. the boundary of a civil structure and earth structure) or variation in the subsoil characteristics.

Elastic deformations

For relatively small deformations the soil is usually regarded as a linear elastic material, that obeys Hookes' Law. This means that the material behaves totally elastic under load. Elastic deformation will occur immediately after load application of, for example, the rail-embankment on the subsoil. This phenomenon is often referred to be part of immediate settlement. The axle load of a passing train will also produce elastic deformation. To reduce these latter deformations and to ensure guidance of the rails for the train, the rail-embankment and ballast bed should exhibit a minimum in bearing capacity or stiffness. Most tolerated vertical deformations of the rails due to a passing train is some centimetres.

An additional effect of the vertical deformations due to the load of a passing train, in combination with the roughness of wheel and rail, is the production of vibrations. These vibrations propagate from the track through the ground by means of compression waves, shear waves and surface (Rayleigh) waves (see figure 4). Each type of energy will decrease with the distance from the track due to dispersion and energy absorption in the ground. Emission in buildings is normally harmless to buildings as such, but they can be very annoying for people living there.

Due to a more intense use of the current rail-infrastructure, the heavier trains, and the higher train speeds there is an increased annoyance of perceptible vibrations due to railway traffic. Most annoyance is caused by the emission of Rayleigh waves. These possible, negative effects have been added to the list of important aspects of an environmental impact assessment of new rail-infrastructures. Holland Railconsult has developed a validated model in order to determine railway induced vibrations for a large arsenal of different situations. The dynamic subsoil characteristics, retrieved from the geotechnical map, were important for a good prediction of the vibrations and the related, possible, annoyance.

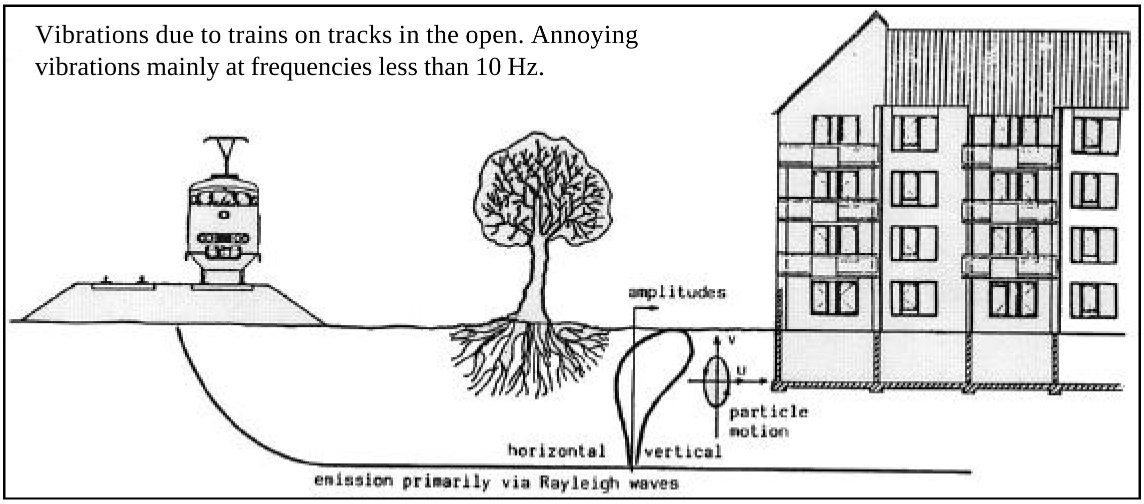

Figure 4 *Vibration propagation by railways in the open (after Esveld, 1989)*

Time related deformation

Time related deformation might not necessarily be a problem for the exploitation of a railway, although costs can increase enormously due to the maintenance of the track. The absolute maximum settlement allowed is about 0,30m a year, but a frequently accepted and preferred maximum settlement is 0,20m during the first 3 years of exploitation.

Connections between the rail-embankment and pile founded civil structures demand particular care. Civil structures almost always exhibit different settlement behaviour from rail-embankments. Widening of existing railways could also inflict this principal problem.

Time related deformation can be controlled to some extent by the use of e.g. vertical drainage, phased construction of the embankment or (in combination to prevent instability or low bearing capacity) the use of cunnetes. But variation in the thickness of compressible layers can lead to differential settlement. This problem is most likely to occur in those areas dominated by fluvial deposits.

Before man started to influence river patterns by building dikes, the sedimentary environment of the rivers was very dynamic and characterised with a wide variety of sediments. Lateral continuity of these sediments is difficult to predict in these areas and because of the abundance of clay and peat deposits, fluvial sediments can be determined as “problem areas”, whereas cover sands mostly cause no problem. The aeolian sediments consist of well-sorted sands and cover large areas. In an earlier edition of the Ingeokring Baardman (1996) has described the problems with prediction of lateral continuity of alluvial sediments.

Instantaneous, non-elastic deformations

More problems and damage will be caused by instantaneous deformation. In the area of Enschede there has been a long period of mining activities. By the end of the previous century, salt was accidentally discovered during drilling for groundwater at a depth of 210m. In 1918 the first extraction company was founded and its successor Akzo-Nobel is still mining in the area at a large scale.

The salt is extracted by solution techniques of which the negative effects have been underestimated in the past. Due to the extraction without any prevention methods, subsidence of up to 5m in short periods was not uncommon. The collapse of a cavern has resulted in large gap at the surface (sinkhole). Nowadays Akzo Nobel is more cautious and is mining according to the room and pillar method. Nevertheless subsidence is inevitable but minimised to a total of 0,2m (yearly 0,02m). Modern techniques consist of three borings in line, with a distance of 40m in between. Vertical deformation is concentrated near the borings resulting in differential settlement of 0,2m within the distance of 120m at surface level.

Several alternatives of the NOV cross the mining area of Akzo Nobel, where both ancient and modern excavation techniques have been used. The potential sinkhole subsidence and the involved damage to the rail-infrastructure or even the loss of lives may obviously not favour these alternatives.

SHEARING

Important in railway engineering is the stability of the embankment. A loss of equilibrium can occur in soil of low bearing capacity or in high and steep slopes. Sliding surfaces along which shearing occurs can in principle be of any kind, but in practice they often seemed to be curved. The risk of low stability due to shearing can be lessened by e.g. consolidation of the subsoil, the use of light weight material, making the slope more gradual by, for example, the raising of supporting shoulders, cunettes or by lowering the groundwater table. The shoulder is often to be crossed by machines in the course of maintenance of the track, but has the disadvantage of space occupancy and thereby the acquisition of more land.

Groundwater, playing an important role in all fields of geotechnical engineering, becomes a dominant factor in the case of railway engineering. To prevent problems, like instability, due to excessive pore water pressure in the embankment or differential freezing, the railway track should be constructed at least 1,70m above the groundwater table. This distance is determined by:

- the distance between the railway track and top of the embankment body (0,70m),
- the extra safety regarding groundwater fluctuation and water storage (0,30m), and
- the annual frost intrusion in the Netherlands (0,70m).

To provide good drainage of the water, the embankment formation and material is submitted to high standards according to the OVS.

Sections of railways in areas with for example a natural or historical interest are being laid more and more in cuttings, using the natural slope of the soil if the space is available. If the groundwater level in the areas of question is high, it will have to be lowered and a polder system is the result. Lowering the groundwater level can have adverse environmental effects, such as subsidence of buildings or damage to crops.

ENVIRONMENTAL IMPACT ASSESSMENT

The effects of the railway design which are determined and described in the environmental impact assessment, are large but also complex. If for some geotechnical reason the rail-embankment is high above the surrounding ground level (without adjustments) more people in the area can be disturbed by noise of railway traffic than in the case of a low constructed embankment. The reverse is more or less applicable for the annoyance due to vibrations, because of the increasing stiffness of the track.

After the preliminary geotechnical investigations it was advised to use supporting shoulders and cunettes to provide sufficient stability and bearing capacity in areas with compressible soils although there was no reason to exceed the maximum shoulder of 3,0m according to the OVS. An immediate consequence of this advise is the demand for a larger construction area. Therefore a larger area to be purchased, more construction materials and time are required and more material need to be excavated and investigated for pollution rate. From a geotechnical point of view, the alternatives crossing compressible subsoil would be more expensive in construction and maintenance than the alternatives crossing the well sorted aeolian sands in the eastern parts of the area.

Another aspect is the vibrations induced by railway traffic. The annoyance due to heavy cargo transport is to be expected on compressible soils according to calculations and measurements. These possible effects also depend on the population density near the infrastructure and construction method of the nearby buildings.

The construction of the railway in cuttings or tunnels can have an adverse effect on the groundwater flow or groundwater level, but may create benefits regarding to e.g. safety, annoyance due to noise and vibrations. The majority of cuttings are necessary in the sloping landscape near the Hoge Veluwe (north of Arnhem) or near the German border or in those landscapes with high a scenic value. The geohydrological impact of these cuttings has been determined with the geotechnical map.

CONCLUSIONS

The assessment of the Noord-oostelijke verbinding has been accomplished on existing soil data. Because of the importance of the geotechnical data, as has been indicated for the alternatives in the mining area, it can be critical to gather all relevant data in the preliminary phase of the design process. Knowledge of geology and civil engineering are indispensable for the interpretation of the data.

The gathered data may give a good indication of technical-constructional aspects, which might effect the environmental aspects and costs of the rail-infrastructure. Alternatives crossing the compressible soil layers near the large river systems of the Rhine and IIssel, are expected to be more expensive from a geotechnical point of view than those alternatives crossing incompressible soil layers (cover sands) to the east.

The dynamic subsoil characteristics, retrieved from the geotechnical map, were important for a good prediction of the vibrations and the related, possible annoyance.

The gathered data also give a good indication of the additional information needed for a next step in the design process. The use of GIS can be very helpful in the storage and presentation of old and new data.

The effects of a design or adjustment of the design can be complex. All effects are weighed in the environmental impact assessment with plusses and minuses and the results are presented in a report to the minister. In this report the most economic and most environmental alternatives are presented, but the final decision which alternative will be worked out, is made by the government.

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David Price: Last farewells?

13 May 1999

David Price’s lymph cancer was spreading and the chemo-cure of about a year earlier was not successful unless one argues that it may have extended his life by a year or so. He is now in a nursing home as his breathing is giving problems and I heard from Collin Davenport that he is very weak. David looked healthy when he gave his animated presentation at Delft last December in celebration of 25 years IngeoKring, though I recollect the cancer had started doing its final damage. David was for the last time in Holland in January to give his regular lectures at IHE. Robert Hack, in Spain a week earlier, had phoned David in connection with presenting him with the first honorary membership of the IngeoKring. We heard there that he had been transferred to a nursing home. A fax of 5 May to Robert from Collin confirmed that David did not have much time left. Robert phoned me early Sunday: He would be returning to Spain on Monday and fly EasyJet to Luton on Friday. By Monday it was clear I would have visit David as well. Manage to purchase at Schiphol a Messias Bach wine from Penedes: a wine we had drunk often enough at the California Garden Hotel in Salou. Besides, the name Bach was always a great one for choral singing , and so was David. Once at Norwich airport I wait for Collin. We had arranged to see David this same afternoon. I follow Collin through school rush-hour Norwich south along A11 then leave at exit for Wymondham followed by another turn into a familiar sounding road called Orchard Way. When Orchard Way makes a sharp turn right and also appears to go straight-ahead we reach the house of David and his wife Valerie, a small terraced estate house with the advantage that is very near to the old picturesque town centre of Wymondham. We have tea. Valerie has not changed in the intervening seven years I have seen her last. She recently been awarded a bachelor of arts degree from the Open University in Historical Art and is continuing now with the Masters. After tea we leave for Norwich, retracing the road we had come from, but turn left into a very wooded suburban road. Collin calls it burglars’ alley because the open accessible gardens of the houses with hedgerows hide each other and burglars from view. Towards the end we reach the hospital. We pass a window and I see someone sitting in a chair “He is sitting in a chair: that is good” says Valerie. I conclude that that must be David; hair loss and swelling under his chin makes him look like a Bohemian gourmet. He is reading a book, by its appearance, a book he must have read before (science fiction). He is cheerful and greets one almost benignly and slightly apologetically, “How are you?” he asks. I cannot exactly greet him in the same way, so I opt for “How are you keeping?” is about the best I could muster. I give him the card from our section in Holland which Heleen van IJssel-Hagen had arranged. I had put all the names of all the Engineering Geology staff members on it: substantially more than when I joined the section in 1986. It has started raining. I give David the bottle of wine and Dutch cheese biscuits and a book I had purchased in Vancouver during the last IAEG congress visit called “The Dechronisation of Sam Magruder” by Gaylord Simpson an old professor of palaeontology from Havard. It is science fiction with a forward by Arthur C. Clarke and an epilogue by John Gould. The book and the cheese biscuits are given to Valerie to take home to use later and the wine stays.

We discuss his book (one of the reasons for the visit). He would like Robert to check a section on tunnels. He would like me to look at the section that has to do with leakage in dams involving one of the popular “games”- practicals set to students. He also mentioned the geology map for this practical which he drew one Christmas at Wymondham; “cannot locate the original, it should be at Mijnbouw”. David is curious to know why all the fuss with regard to Robert’s visit tomorrow. He does not know he is being awarded an honorary membership.

We say goodbye and return to Wymondham. Valerie is going to choir practice. I book a room in the Abbey Hotel and discuss with Collin David’s book over a pint in the bar.

Friday 14th May

I try on and off to contact Robert through his mobile: to book a room at hotel and his expected time of arrival. Eventually I am contacted: Robert is delayed but on his way. I walk over in the afternoon on a warm summery day to Orchard Road. Collin was there and I join him and Valerie for some tea. Robert arrives and he has his dosage of coffee; he had mistakenly taken the A505 west instead of east. We leave for David. He was still in his ward so we waited for his in a pleasant reception lounge with French windows overlooking a small garden. David was wheeled in wearing a special, thickly striped pyjama looking shirt. It was the football team shirt in a match played between the Engineering Geology staff and local football team of 1989 in Pont de Suert, northern Spain. David said he was pleased that Robert had made a special effort to come and visit him. Robert then made a speech on behalf of the IngeoKring to express the gratitude of its members for what David had done to establish engineering geology in the Netherlands and to give it its special slant to the outside world. That all his graduates can find work in the Netherlands in the same discipline is no mean achievement. The IngeoKring had been for sometime discussing setting up an honorary member award and once this was established there was little discussion who should be its first recipient. A certificate was then presented and a photo of the award itself- a mobile-sculpture, not unlike David's "IG" monogram on the engineering geology ties. The sculpture consists of a large curved C or G with a stone suspended from its apex. Unfortunately, travelling by plane, it was not possible to take the sculpture along. Collin then opened a bottle of Champagne to celebrate. The visit ended on a somewhat optimistic note when David said one of the nurses had told him next week he would have to undergo some walking therapy. Valerie and Collin saw to it that David was wheeled back to his ward. Walking past the window David was, as yesterday, intent on reading a book. Science fiction?

We return to Wymondham and have a discussion in the Abbey Hotel lounge with regard to David's book. That evening we went out to dinner at a country club type complex called Park Farm situated along the old A11 to Norwich. Pat, Collin's wife joined us. Park Farm is one of David's favourite eating out establishments.

25th and 26th May

Ten days later I received a phone call from Collin who said David had died peacefully early morning that same day. I seek solace in David's old room 110 where Peter Verhoef and old graduate of David's, Mario Niese, are in discussion. We reminisce. I phone Valerie on the Wednesday. She seemed calm and businesslike about it all. The funeral would be next week Friday 4 June. A bank holiday and a strike by funeral personnel meant the funeral could not be earlier.

4th June

Early on the Friday a group of us met at the parking place at Mijnbouw to travel to the UK; Heleen van IJssel Hagen, Keith Turner, Peter Verhoef, Willem Verwaal, Arno Mulder and myself from the engineering geology section and Ronald de Heer from IHE . We all travelled in Willem's new space wagon and the newly establish high speed Stena catamaran ferry to Harwich: a bit of science fiction becoming reality. The drive to Norwich was unhurried mostly on country roads. We stopped for lunch in Wymondham at a very old pub adjoining the Abbey Hotel. Robert and Hanneke had come separately and were staying at the hotel. After lunch in mild sunny day we drove on to Norwich to the crematorium where already a number of friends and colleagues of David had gathered: Ian Higginbottom (old colleague from Wimpey Laboratories), Sir John Knill and his wife (Sir John had given early engineering geology lectures at TU Delft and recommended David to the newly established post of engineering geology at Delft), Alistair Lumsden (colleague from Leeds University), Collin and Pat Davenport (colleague from Wimpey Laboratories and University of East Anglia where David also lectured), Mike deFreitas and Christine Buthenuth (both Mike and Christine are from Imperial College where David also was a visiting professor). The funeral cortege arrived promptly with Valerie, David's daughter Sarah and her husband George and the older of her two children David's grandson George named after his father and grandfather (remember David's second name is also George). There were further friends from Holland who were in the choir and together with the present choir which David and Valerie joined on his retirement the service hymns were sung with particular gusto and beautifully in tune. The David and Valerie's vicar gave the traditional Church of England funeral oration. Robert Hack representing the Netherlands and Collin Davenport gave further orations. Robert mentioned how his old student habits he had developed in Leiden had to change; something to do about attending lectures! Collin also had an anecdote or two, but I always remember David's amusing story about managing the then junior geologist at Wimpeys during the survey of the rock face being stabilised beneath Edinburg Castle. While David sat behind a window in a warm office smoking his inevitable cigarette and drinking a cup of coffee with a pair of binoculars and a walkie-talkie he directed the movements of Collin. Collin moved along the scaffolding, in the cold, with a paintbrush, paint pot and a walkie-talkie to dab the location for the next rock-anchors that had to be installed. I had a feeling David was up there directing his last tribute that afternoon in a not too dissimilar manner.

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Book & CD-ROM review

3D Geoscience Modeling: Computer techniques for geological Characterization
Simon W. Houlding (1994), Springer-Verlag, Berlin/Heidelberg/New York. pp. 309. ISBN 3-540-58015-8, Price: DM 148, 112 figs., 81 in color

Practical Geostatistics, Modeling and Spatial Analysis
Simon W. Houlding (1999), Springer-Verlag, Berlin/Heidelberg/New York

Since its first publication in 1994 the book "*3D geoscience Modeling - Computer Techniques for Geological Characterization*" has served as a definitive reference to geoscientists involved in 3D geoscience modeling. Surprisingly this important reference has not been reviewed before for the Ingeokring Newsletter. Recently, the author of the book has prepared a CD-ROM courseware titled "*Practical Geostatistics - Modeling and Spatial Analysis*". I have volunteered to review the CD-ROM courseware prior to its release by Springer-Verlag. The parallelism in the contents of the book and CD-ROM courseware allowed me to combine my comments on these two publications in a single review article.

3D Geoscience modeling defined in the book refers to the computerized characterization of the geological subsurface. This characterization process includes the interpretation of the subsurface geology, geostatistical prediction, and the information visualization. Geological interpretation involves the definition of the subsurface geometry including discontinuities, unit boundaries as discrete, irregular, discontinuous entities. Geostatistical prediction is the process of analyzing and estimating the spatial variability of the engineering parameters in a pseudo-continuous fashion (e.g. geomechanical properties, mineral grades, etc,.) within the volume of interest. The visualization process is the graphical display of various data types and the results of interpretations and predictions in 2D and 3D.

The book is divided into two parts: part 1- computer techniques for geological characterization, and part 2 - applications

The first part of the book begins with a general discussion of computer techniques which are conventionally applied in the geological characterization process. After an analysis of the strengths and limitations of these conventional computer approaches, the author gives the specifications of an effective computerized 3D geological characterization process. The 3D geological characterization process in general and the complications which this process creates in computerization require a new integrated approach to 3D modeling and analysis. In this new approach the geological entities are stored and modeled in computer environment in the same way we define them, the inconsistencies and errors in interpretations and predictions are highlighted, and the associated uncertainties in the results can be quantified as a measure of risk in using the modeling results.

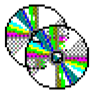
The text of Chapter 3 discusses the range of tools and techniques of computer graphics and geostatistics that are required for effective 3D geoscience modeling. In Chapter 4 the author proposes various data types and structures that are appropriate for the 3D representation and modeling of different types of geoscience data. These data types include hole data, map data, volume data, grid data, and sample data, all of which may originate from different site investigation, mapping, and sampling campaigns. The spatial data analysis techniques and their use in geostatistical modeling are introduced in Chapter 5. In Chapters 6 and 7, the geometrical modeling of geological volumes is treated using two different approaches. The first approach is the interactive component modeling which is traditionally used in mining discipline. The second approach is the surface based volume definition using Irregular Triangulated Networks

(TINs). The geostatistical prediction and spatial analysis techniques (Chapters 8 and 9) introduce among others the kriging methods, volumetrics calculations and visualization techniques. The uncertainties and risk calculations and their implications in sampling schemes are presented at the end of part 1.

The second part of the book presents some application case studies where the ideas presented in part 1 are implemented in a computerized system for the solution of some geoscience problems. The application examples are taken from various geoscience disciplines. The first case study is the application of 3D geoscience modeling in the solution of an environmental engineering problem where the assessment of subsurface soil contamination is required. The second case study is the geotechnical characterization of a site for the disposal of hazardous waste and the design of underground repository. The third example is a mining application where the evaluation of an ore deposit is presented and suitable plans for underground mining are designed. The fourth case study is related to reservoir engineering where the characterization and development planning for a small oil reservoir are presented. The last example application is the geotechnical characterization for an underground powerhouse excavation.

The last chapter of the book includes the authors ideas on the new directions in spatial prediction, modeling and database management techniques. According to the author, splining techniques for volume representation, conditional simulation and stochastic methods in spatial predictions, and direct geostatistical prediction of irregular volumes are the main emerging techniques where the 3D geoscience modeling will be focusing on to.

Overall, this 309 pages book with 112 figures and illustrations is a good reference for both students and professional geoscientists. Readers should be aware however that the examples given in the book come from a single 3D modelling system (Lynx). This package is based on a somewhat unique 3D data structure and therefore users of other packages (e.g. goCAD, Datamine, Vulcan, etc.) may find that some important topics are omited (eg. ability to perform Boolean operations on 3D TINs) whilst other aspects covered are not relevant to several other packages. Despite these limitations this book provides a very good overview to the theory and application of 3D modelling in the geosciences. In terms of contents and the style of presentation the book also reflects the twenty years experience of the author in various geoscience projects.



Thanks to information technology we can now have volumes of book information on electronic media like CD-ROMs with the comfort of a multitude of navigation options. The CD-ROM: *Practical Geostatistics, Modeling and Spatial Analysis* is one such product which many geoscientists will enjoy browsing through. It contains more than 500 linked documents and will serve as a valuable application reference. The contents of the CD-ROM are well suited to students as well as professional geoscientists who want to immediately proceed with the application of geostatistical techniques in 3D geological characterization process following an introductory level of geostatistical theory. The author emphasizes that "it is not the aim of *Practical Geostatistics* to produce specialist geostatisticians!", rather the design of *Practical Geostatistics* is focused on the practical applications of geostatistics for achieving a particular geoscientific objective.

Following an introduction to the basic concepts, origins, and applications of geostatistics in the geosciences, the data types and structures required for 3D geostatistics are presented. The next chapter in the hierarchy is the discussion on the basic concepts and theory of geostatistics including semi-variogram analysis and semi-variogram models. The influence of subsurface geology in geostatistical predictions is presented in the chapter titled "Integration of Geology with Geostatistics". The following two chapters analyse the difficulties in the practical application of geostatistics, and handling geostatistical uncertainty and probability. The chapter on visualization and spatial analysis introduces the techniques of visualizing characterization results and the tools to further analyze and quantify the results in volumetrics calculations, excavation designs, and volume intersections. In the next chapter, the author analyses the practical data management issues in site investigation stage and the implications of data quality and data content on the results of subsurface characterization. The last chapter in the document hierarchy is the introduction of four case studies. These application examples illustrate the use of geostatistical techniques in geoscience projects. Four example applications are taken from mining, environmental, and geotechnical engineering disciplines enhanced with figures and summary explanations of the project.

The layout of CD-ROM is similar to a book layout. Clicking on the cover document links you to the table of contents which lists 9 chapters with the sections. Each chapter is composed of summary documents, main text documents and review documents with appropriate links. The text documents are supported by linked figures, images and definition documents. The review documents are a list of multiple-choice questions which allow you to interactively check your knowledge on presented material in each chapter. In addition to your browsers navigation functionality, *Practical Geostatistics* also includes its own navigation icons which provides more options in moving from one document to another. The figures in the text documents are thumbnailed and linked to full size figures stored in separate documents, which open in their separate figure windows. This makes the navigation more efficient and allows an easy reading by viewing text and figures simultaneously. The hierarchical structure of the CD-ROM: Practical Geostatistics allows access to documents, figures, summaries, reviews from different levels depending on the readers preferences. The links between summary documents allow you to get an overview of the subjects discussed in the text documents. The links between the text documents and figures support both the understanding of a theory and its application in case studies. One of the linked navigation icons is the document navigation table which is always accessible from the navigation bar on the left of the browser window, and provides direct access to the main documents from anywhere in the navigation tree.

In short, *CD-ROM: Practical Geostatistics, Modeling and Spatial Analysis* is an effective reference to the application of geostatistics in 3D geological characterization. The layout of the CD-ROM allows multi-level progression through summaries, theoretical explanations, application examples, and interactive reviews with links manageable from built-in navigation tools. The hypertext document format makes *Practical Geostatistics* accessible from any standard Internet browser independent of platform and allows readers to set their choice of font sizes and colors. The summaries and case studies with more than 300 images provide good presentation material that can be used for classroom teaching. The source data directory included in the CD-ROM provides an opportunity for the readers who has access to appropriate software tools to try out the presented case studies on their own computers. One slight criticism is that, the contents are rather restricted to consideration of 3D geostatistics and do not give any examples of the use of geostatistics in 2D GIS and image processing packages.

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Excursion to Souterrain (Tram tunnel Den Haag)

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After all the commotion in the press about the mishap during the construction of the subterranean project of the "Tram tunnel" in the centre of The Hague a group of some 35 engineering geologists and students availed of an instructive presentation by Ir. S.F. de Ronde (SAT engineering) and Ir. M. Smits (Fugro) followed by a visit to the two sites where stations are being built. A short listing of the main highlights of objectives, design and geotechnical nature kept us busy; the insurance consequences of the "blow-out" prevented however further discussions of this topic.

Ir. de Ronde gave the public setting: Increasing capacity of public transport along the inner city ring connection could only be reached by going underground. The Souterrain underground link is expected to help releasing the heavy tram traffic load after the year 2001. With the combination of tunnels, underground stations and car park floors, Souterrain forms an underground living says Ir. de Ronde (Figure 1). The underground stations are designed to receive daylight and are equipped with advanced signalisation systems for routing the car traffic.

In the midst of a living and busy commercial area loaded with cables, ducts and a minimum of disturbance also to existing foundations added up to a complicated manifold organisation incorporating all construction, local economic and public interests. This meant a construction method of wall-roof method making use of sheet piling (vibration problem) or concrete in situ produced slabs reaching to depths of over 18 metres below NAP.

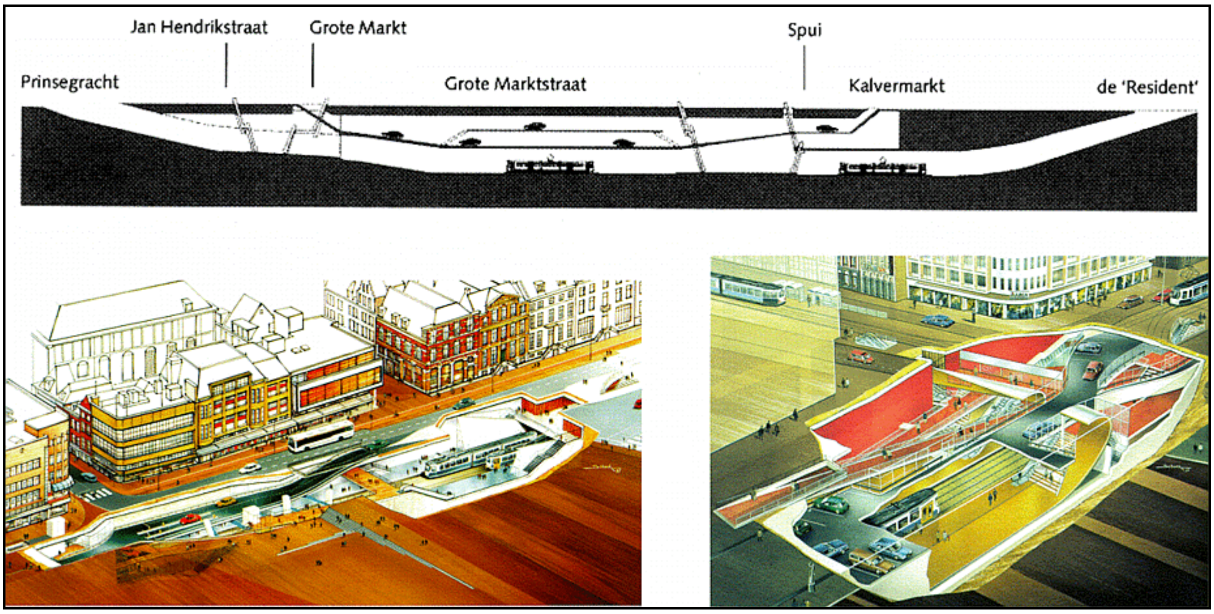

Figure 1*. Souterrain; the Grote Markt/Kalvermarkt underground link (above), Station Grote Markt (lower left) and Station Spui (lower right).*

Ir. Smits then gave an overview of the main geological/geotechnical constraints and alternative construction methods.

The major part of the city centre is underlain by a system of marine sandy/silty beach barriers; In the low troughs between these we find a topsoil of one to two metres thickness of so-called "Holland veen" (peat). The base of the sandy beach barriers at around 16 metres below NAP normally consists of a peat layer of some 0,30 metres. This thin layer acts as a critical impermeable boundary. In some places this layer is absent and lacks the hydraulic confining characteristic. Due to these varying geological conditions solutions providing geotechnical answers change over short distances.

The construction method has involved, first the installation of diaphragm walls, then the building of the roof took place and the earth could be excavated (Figure 2c-e and Figures 3 and 4).Vertical stability of the construction then had to be assured during excavation by anchoring and top-loading. The excavation depth is around -10 NAP but changes from one profile to the other (Figure 2b).

In the main part of the tunnel a method of grout arching connecting the foot parts of the walls was used. The main reasons for applying this method was to gain water tightness in the excavation pit, and to act as strut for stability of opening against horizontal pressures exerted by adjacent buildings, and to withstand ground water pressure.

The system depends however on a successful tightness of overlapping grout columns. This meant an enormous amount of overlapping concrete piles which were installed by perforated rotating pipe with pressurised jet grouting (Figure 2a). A failure occurred last year when in-flowing groundwater started carrying sand and silt from underneath the grout arch and piping evolved eventually reaching even the surroundings. Repair could only be found in extra grouting under the arch.

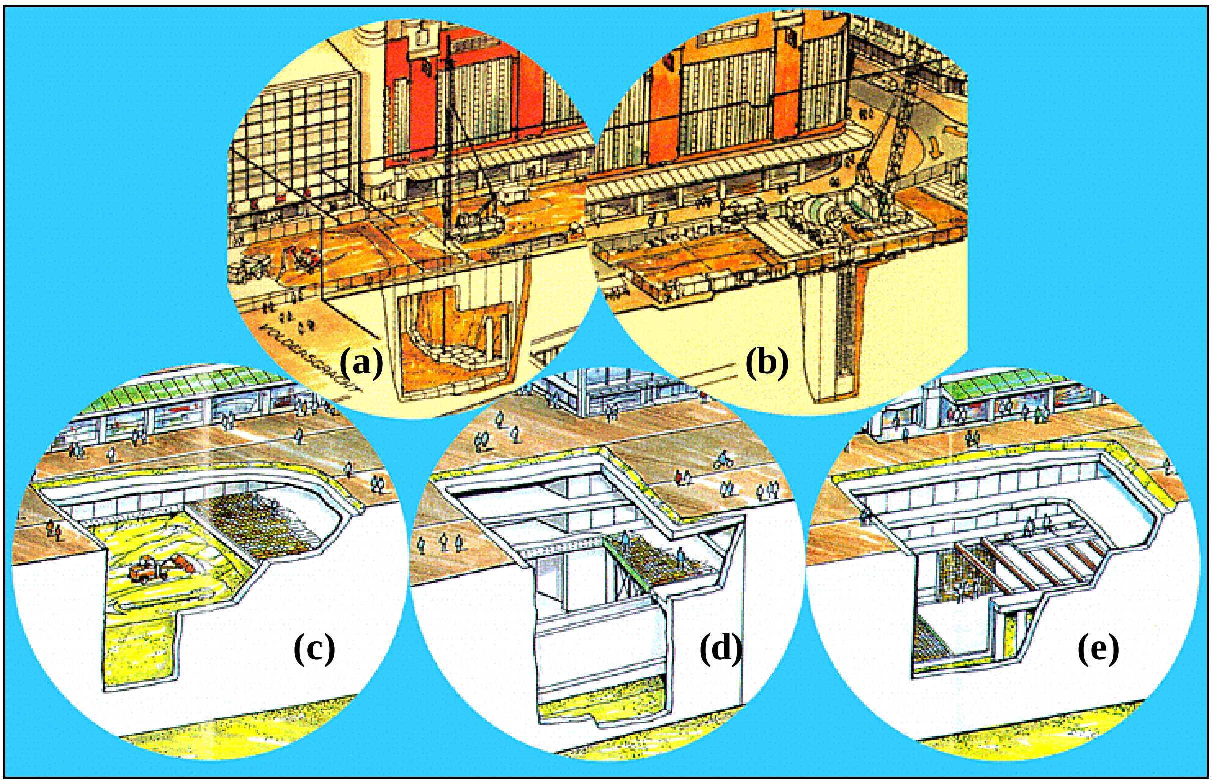

Figure 2. *The construction stages: a) installation of jet grout arch, b) installation of diaphragm walls, c-e) excavation and roof construction*

At the end of the presentations the following questions from the audience were answered by the speakers:

Q1. The number of sections, and the criteria?

A1. The number of sections was decided on the basis of the number of buildings adjacent to the excavation.

Q2. Would a different construction technique (e.g. freezing) be more feasible?

A2. No, the cost would be 3 times higher. Moreover the freezing method might have caused foundation problems to the adjacent buildings.

Q3. If geotextile could be used to prevent piping?

A3. This method was tried but did not successfully work since the leakage has diverted to alternative paths. This might be due to the vibrations caused by trams passing at about every minute.

Ir. S. F. de Ronde with broad engineering experience has made several comments on the management of projects as such Souterrain. According to Ir. de Ronde every solution for a problem at the beginning stages of a project looks to be a good solution. It is only after some months of detailed engineering that an engineer sees that the solution is probably not better than earlier solutions. In addition, the civil engineering projects in urban areas have to be implemented with a fixed budget. Therefore your engineering solutions have to be attained within your limited budget.

We were eventually left with this question of diagnosis of geological conditions. It is praiseworthy that construction proved to have caused less than 0,5 cm settlement in the adjoining buildings often less than 5 metres away from the excavation.

The visit to the two sites (2 planned stations) illustrated the clean and efficient organisation of the construction (Figure 4). The city of The Hague hopefully will keep it likewise during future use!

Figure 3. *Inside view of the station construction.*

Figure 4. *Ir. de Ronde, Dr. Robert Hack and a group of Ingeokring members visiting the construction site.*

Taco Pieter Adriaan Wever

Readers of the national newspapers of 13 and 14th July may have read that two students of the Delft Students Society aero-club were killed in a gliding accident on 11th July in Joiny, France south east of Paris, followed by announcements of their deaths in the newspapers of July 19th. One of the "students" was Taco Wever who had recently graduated as an engineering geologist in May of this year. Taco was born in Gronigen on 19 May 1973 and moved to Almelo in 1976 where he spent his school years first at the Vrije School and later VWO where he graduated with 8 subjects in 1992. His enthusiasm for sport manifested itself during his youth in judo, swimming, football, rowing, speleology, mountain climbing, and sailing (in which he was also an instructor). Healso had a musical talent playing both cello and saxophone. With the scouting organisation he had climbed the Gran Paradiso in Italy. The first tragedy to befall the Wever family was in 1988 on the death of Taco's mother. To bridge the loss of his mother in these formative years Taco's father Jan persuaded Taco to guide him and Taco's younger brother, Andries, to climb the Grand Paradiso a second time.

With all these sporting activities it is little wonder that Taco had, as a student, an engaging personality. Though he came to study in Delft in 1992, it is not until the third year that students specialise in choice of five different directions. Taco chose Engineering Geology, which is not surprising knowing his penchant for adventure in the environment. He also had enthusiasm for the mining industry, where he did his stint for practical industrial experience in the Germany coal mines in 1993. In engineering geology he manifested himself straightaway, at least in my early morning lectures by appearing regularly five minutes late. This, I learnt later, despite that he almost lived next door to the faculty. At the end of the lectures he was one of the few students would ask questions just to make sure that he had not misunderstood or missed out on the material presented. His world seemed to expand globally in a north-south direction between the longitudes 0 and 20° during the last four years of his time at university. Early trips were with the "first year" excursion to Belgium, Luxembourg and the Eiffel/ Rhine graben region of Germany. This was followed by excursions to Vesc, in France for field geological mapping. He joined the 1997 engineering geology field work in Spain, which, incidentally, was the last year Professor Price joined the group. Unlike previous years the students and some of the staff travelled by coach to Spain, all the way to Salou just south of Tarragona. Taco showed great enthusiasm for the fieldwork. Not unlike the period in which I knew him during the slope stability lectures, he was keen to try out and develop new, simple field tests in the less interesting Quaternary outwash planes between the mountains and the shore that we were mapping for the first time that year.

The travel bug stayed with him despite the fact thathe almost had to cancel the DIG (Dispuut Engineering Geology- the Delft Students engineering geology society) excursion to South Africa by getting involved in a motorbike accident. Motor-biking and gliding were his latest passions that he took up while in Delft. He did continue with rowing for LAGA, the Delft Students Society rowing club. A first motorbike accident was with another engineering geology graduate, Milcar Vijlbrief, who shared his student house, from which he survived with a few scrapes. In the second accident, which was caused by the other party, he broke a leg, but after deciding he was recovering fast enough he joined the trip to South Africa. The trip is extensively reported on a CD-ROM publication titled "South Africa Study Tour Book, 1997". His contribution is the report on the conference "First South African Rock Engineering Symposium" that was attended during the first days of the tour in Johannesburg . One tour he had to miss out on, though he did is best to take part by getting up early (5 am), was the visit to the Westonaria Gold Mine (WAGM) located in the Westonaria District in the Gauteng Province. Unfortunately, despite coming along, Taco had to remain on the surface while the rest of the group went below for the 2750 m deep experience. Undaunted he visited the facilities above ground inspecting the miners' quarters and their messing amenities, in the latter instance he had a tasting session of the food being offered for lunch for his approval- cooking and food being yet another interest of Taco.

During the South African trip, back in Europe arrangements for a joint project had been finalised, known as H-SENSE: Harbours- Silting and Environmental Sedimentology, a research project funded by the European Commission Directorate General for Transport DG VII which was due to start on the 1st January 1998. The project was jointly set up between Gothenburg University, University of Bergen, Imperial College, London (later transferred to the Nottingham Trent University), Delft, the Technical High School Sogndal, the Geological Survey of Latvia, University of Latvia, the Swedish Geotechnical Institute, and the Port of Gothenburg. Taco answered a call for a student to participate in the project for his MSc thesis which he successfully completed a year later. The project certainly catered to his adventurous nature and desire for travel. The first trip involved travelling in February with the Engineering Geology section bus loaded with geophysical survey equipment from GeoCom BV, from the Hague to Bergen and later over-land through tunnels and over mountain passes subjected to blizzards to Gothenburg. His usual inquisitiveness, this time directed at GeoCom's Ben Degen and Vincent Riekerk (surveyor), ensured that he mastered the operation of the equipment within a very short time. If not working with the geophysical equipment it was not surprising that he managed to persuade the captain of Bergen University's 600 HP survey vessel to relinquish the steering wheel (a type of joy-stick) so that he could have a go, and at full speed! During this trip Taco appeared to always obtain the room key at the hotels we stayed at to the most luxurious rooms. My explanation to Ben Degen that the student is "king" these days he did not find convincing. In June the Dutch contingent return minus Vincent to Norway, this time in milder, sunnier weather to Sogndal along the deepest and largest fjord, the Sogne Fjord of Norway for one of the regular meetings between the H-SENSE participants. Taco reported the results from the TU Delft survey at this meeting.

The last day at Sogndal we switched to a delightful hotel fronting the fjord and could make use of the hotel's rowing boat. Little did I realise at the time that Taco had rowed in competition, as most of the time he and Ben Degen made use of the earthenware Dutch Gin bottle I had taken along for the occasion while I rowed! In many ways Taco remained remote despite being sociable and even talkative: he said little about himself. Travelling through one of the deep tunnels in Norway, Ben gave Taco his portable telephone and suggested he phone home to tell his parents where he was phoning from on the excuse "see if it works in these tunnels". He got his mother on the phone and had quite an animated talk; later we learned as we exited the tunnel that it was his stepmother. In September Taco went to Barcelona to give a presentation on H-SENSE at the fourth annual symposium of the European Environmental and Engineering Society. Though he always appeared to radiate confidence, I am told, he was initially nervous until one of the co-authors, Ben Degen, who was also there suggested to talk about everything else except what is written in the paper! The presentation went very well. During the whole MSc-degree period GeoCom employed him so that use could be made of the geophysical computer facility when it was not being used on other projects. By November sufficient analyses had been done to write a paper for the 13th European Conference on Soil Mechanics and Geotechnical Engineering that was being hosted in the Netherlands in 1999. As a result of the paper Land en Water invited an extended abstract on the subject for their June publication. Some of the results were also presented at the 25th anniversary symposium of the IngeoKring, which was attended by Professor Price. He came to me later asking if he could have some of the material for the book he was writing. It is not often that a student has a number of papers to his name before completion of his MSc thesis, let alone, giving a presentation at an international symposium.

In January Taco seems to have made a supreme effort in combining a number of activities. Firstly he joined the GeoCom personnel outing on their trip to Morocco, in which he acted as master of ceremonies (in evening dress) at their Bedouin dinner somewhere in the desert outside Marrakech. Back in the Netherlands he finalised and printed his thesis. This was followed by assisting in the running of the H-SENSE Delft group visit at the end of January which culminated on the VIP catamaran "gin palace" site-seeing boat of the Havenbedrijf Rotterdam excursion of Rotterdam Harbour. I can not remember if, by the end of the trip, Taco was manning the boat. The vessel did exceed Bergen's survey vessel in speed. Two weeks after the H-SENSE meeting he gave his thesis presentation which by this time must have been, for him, a bit of an anti-climax having presented the results of his work on so many previous occasions. At one point it seemed he had even usurped the project; the local newspaper of Sogndal reported on the 1998 visit - and who would be featured as principal person: non other than Taco Wever.

I was curious to see how he would develop in later life having been able to attract so much publicity. He became a qualified engineer in May and joined his uncle's company Well Engineering Partners BV in The Hague. I had not expected in July that he would have featured in the national newspapers the way he did. I have great admiration for his father Jan, stepmother Bea, his two older brothers Rutger and Mattijs and one younger brother Andries, who is also a student here at the faculty, and his uncle T.W. Bakker (who like Taco is a graduate of the faculty) in the way they have coped with the loss of Taco, and I now can understand from where Taco inherited his engaging and admirable character traits.

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AlpTransit - New railway tunnels through the Swiss Alps

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Switzerland has a long history of tunnelling in mountainous areas. As more and more traffic crosses the Alps, and awareness of the environmental values of the Alpine region increases, several new tunnels are being constructed. With these new tunnels, traffic will be able to pass the Alps quicker, combined with a considerable decrease in air pollution and noise. The new tunnels are much longer than the previous ones and at a much deeper level. The engineering geological aspects of these tunnels were dealt with at the symposium Geologie AlpTransit in Zürich, which the author attended in February 1999.

INTRODUCTION

Around the turn of the 19th century, the Swiss started constructing long railway-tunnels to cross the Alps from north to south. These are the Gotthard- (1882), the Simplon- (1906) and the Lötschberg-tunnel (1913). In the 1970's increased traffic led to proposals being made for a new railway-tunnel through the Gotthard Massif. Instead of a new rail link however, a road tunnel was built which was opened for traffic in 1980.

At present, 20% of the traffic that crosses the Alps passes through Switzerland. Traffic congestion already occurs regularly and as the traffic is expected to increase in the future, new measures have to be taken. The Swiss government however also wants to protect its Alpine environments by restricting the passage of heavy freight trucks through the Swiss Alps.

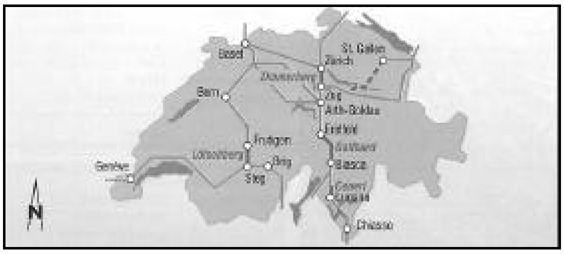

Figure 1 *Location of the new tunnels.*

The solution consists of two major new railway lines through the Gotthard- and the Lötschberg-massif. The core parts of these lines are the Gotthard-base- (57 km) and the Lötschberg-base- (35 km) tunnels. Also, the Gotthard-line has a number of smaller tunnels, such as the 10 km long Zimmerberg-tunnel near Zürich and the Ceneri-tunnel in the south.

These railway lines form the major part of the modernisation of the Swiss railway-infrastructure for the 21st century, with total project costs amounting to 30.5 billion SFr (approx. 41.5 billion Dfl).

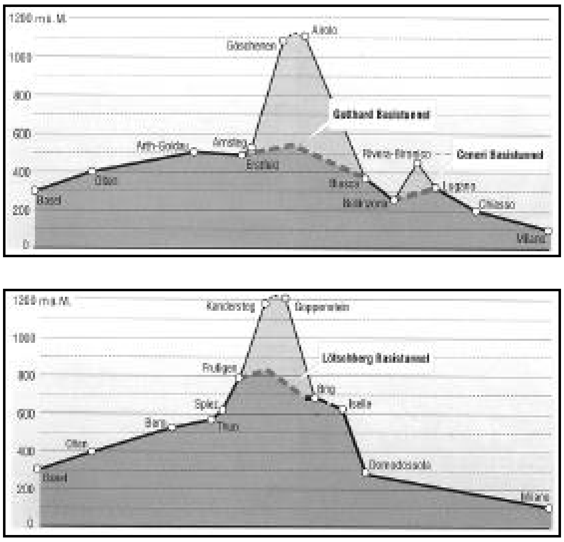

Figure 2 *Difference old and new railway lines, Gotthard (above), Lötschberg (below).*

The new lines will have to carry heavy freight quickly from the north to the south of the Alps. The tunnels will cross the mountains much deeper than the old tunnels, so that the trains will not have to climb much and can maintain optimal speed. For example, the new Gotthard-tunnel with a maximum elevation of 550 m above sea-level will become the lowest crossing of the Alps. At no point does the gradient of the railway-line exceed 12.5‰. Also, bends with a curve radius under 4000 m are largely avoided. This means that freight trains can travel through the tunnel at 160 km/h, while passenger trains can pass at 250 km/h [3].

GOTTHARD-TUNNEL

The new 37 km-long Gotthard railway tunnel will become the longest rail tunnel in the world. The tunnel will be part of the connection between the city of Zürich and Northern Italy.

The tunnel will consist of two separate tubes of 9.40 m diameter, interconnected every 325 m by a cross-passage. The construction will start from the two portals and from three intermediate starting points. The tunnel is scheduled to open for railway traffic in 2011.

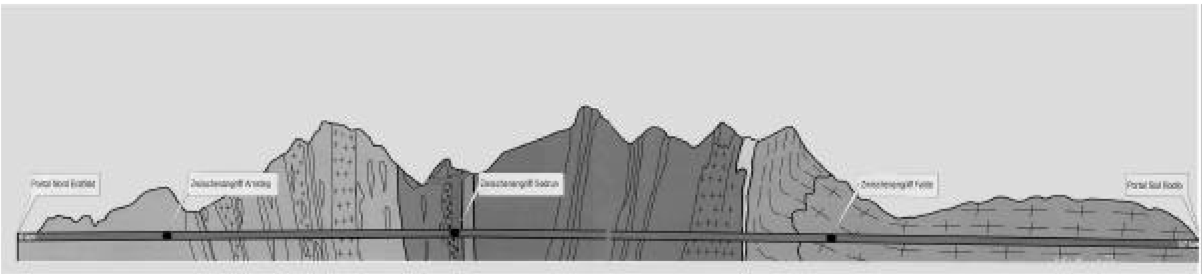

Figure 3 *Geological Cross-section through the Gotthard tunnel.*

Geology

The geology of the tunnel is dominated by crystalline formations of the Aar-Massif, the Gotthard-Massif and the Penninic Gneiss-zone. Between these formations, the tunnel crosses vertically dipping sedimentary rocks. Most of these rocks are very favourable for tunnel construction. At two sections, the Tavetscher Zwischenmassiv ("in-between-massif") and the Piora-Zone, the Swiss geologists and engineers however do expect severe difficulties.

Piora-Zone

The Piora-Zone consists mainly of calcareous dolomites of Triassic age. At the tunnel-level also anhydrite can be encountered. The rocks were heavily sheared during the alpine orogeny and have lost most of their cohesion. The permeability of this zone is very high and may be endangering the construction of the Gotthard-tunnel.

From the interpretation of the preliminary investigation it was concluded that the Piora-Zone could have originated from two different tectonic regimes; a simple synclinal fold of autochthonous origin (shallow), or a continuous, deep vertical separator between the Gotthard-massif and the Penninic Gneiss-zone. The investigations proved that the Piora-Zone was formed latter. From a number of bore-holes, and a pilot-tunnel at 300 m above the train-tunnel, it appears however that the tunnel will pass just below the critically weak rocks of the Piora-Zone.

Tavetscher Zwischenmassiv

The Tavetscher Zwischenmassiv (TZM) is a crystalline massif consisting of a mixture of different rock-types: Gneisses interchanged with weak phyllites and slate. These form a steeply dipping alternation of strong and weak rocks.

The Gotthard tunnel will pass the TZM about 800 m below the village of Sedrun. It was decided to tackle the geologically difficult sections as early as possible. Therefore, the construction starts in the TZM at Sedrun as well as at both tunnel entrances. Because most of the TZM is obscured by loose material (soils, rock debris, etc.), there was a need to make borings to get a better understanding of the geological situation.

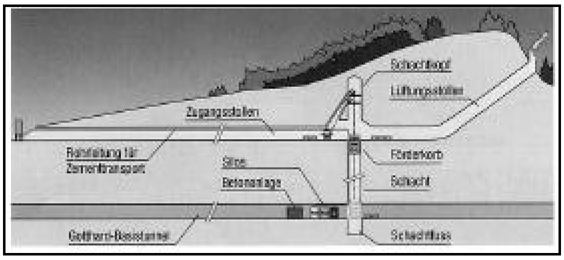

Figure 4 *Ventilation / building shaft Sedrun.*

A total of five borings were made with lengths of 550 to 1750 m. It turned out that the southern part of the TZM is marginally influenced by brittle fracture-zones, whereas the northern part is heavily fractured, consisting mainly of phyllites, slates and zones with ductile gouge (kakirite). Over 70% of the northern part turned out to be fractured.

The results of the borehole site investigation has provided the necessary information to construct an 800 m-long pilot shaft down to tunnelling level. This shaft will also be used as a means of ventilation of the tunnel. Building of the shaft commenced in August 1998 and is scheduled to finish in 2001 ([1], [4]).

Construction of the Gotthard-tunnel

In parts with strong, stable rock the excavation will be made with tunnel boring machines (TBM). These are designed to achieve a maximum daily progress of 20 m. Of the total 57 km of tunnel length, 50 km will be excavated with TBMs. The remaining 7 km represent weaker rock-types, such as the TZM and the Piora-Zone, and these have to be excavated with conventional drilling and blasting techniques. Also roadheaders can be used in these regions of low rock strength.

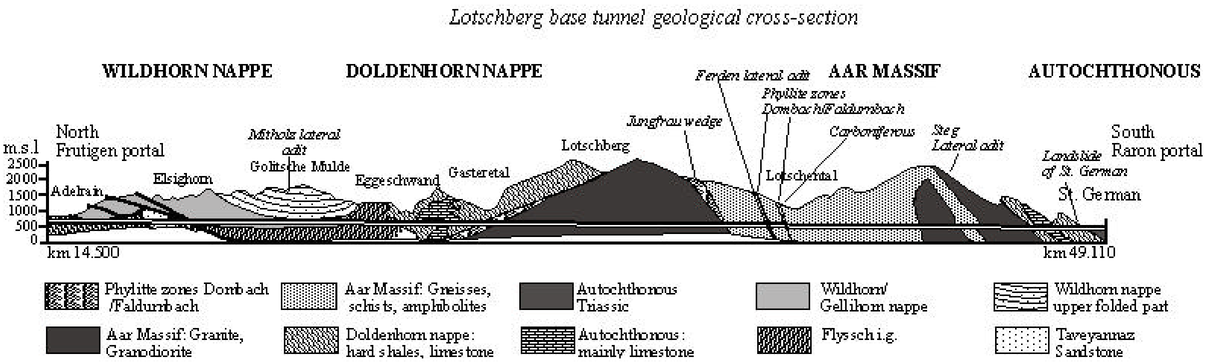

Figure 5 *Geological cross-section through the Lötschberg-tunnel*

LÖTSCHBERG-TUNNEL

The 35 km long Lötschberg tunnel, together with the already existing Simplon tunnel, will become the second new major railway crossing through the Swiss Alps, connecting Bern to northern Italy. As with the Gotthard-tunnel, the Lötschberg-tunnel will be constructed from two portals and three intermediate starting points.

Geology

The geology of the Lötschberg tunnel consists, from north to south for the first 13 km, of sediments of the Helvetic Nappes followed by the crystalline Aar-Massif and its southern autochthonous sediment-cover. The Gotthard Massif, which is causing difficulties at the site of the new Gotthard tunnel, is not found in this region. In general the conditions for tunnelling are considered favourable. From the previous geologic investigations, most problems were expected in the northernmost part of the tunnel. Therefore, an exploration tunnel was driven through the sediments of the Helvetic Nappes. This tunnel was excavated with a TBM, and after two years of drilling the work was completed in 1997. The results show that the geology is more favourable than expected.

The depth of the Kandertrough, a deep gravel-filled valley, which is situated above the planned tunnel path was a concern to the geologists as well. A century ago this trough caused a major accident in which the old tunnel was flooded and several tunnel-workers were killed. To avoid possible problems it was decided to change the route of the tunnel so that now it has a rock-cover of 600 m or more.

Design and construction of the Lötschberg-tunnel

The Lötschberg-tunnel is constructed as a two tube system. To reduce costs, the northern 8 km of the tunnel will have only one rail tube. This is possible because of the already completed exploration tunnel. This tunnel will serve as a rescue and service gallery in the operational phase. The construction will commence from the two portals and three intermediate adits. The tunnel-tubes will have a diameter of 9.50 m and are interconnected every 333 m by cross-ways.

For the main part, the excavation of the Lötschberg tunnel will be made through drilling & blasting. Next to this, tunnel boring machines will also be used [6].

GENERAL

In the case of the new Gotthard and Lötschberg railway tunnels tunnelling will take place at around 2000 m below surface. As the construction will in part take place in hard rock formations, the design engineers are seriously taking into account the possibility of rockburst. At the AlpTransit symposium mining experts from Canada and South Africa were present to share their knowledge about rockburst in deep mines.

Also, the temperature of the rock at these depths is a concern for the excavation of the tunnel. However, because of groundwater circulation and the steep relief of the mountains, the ground temperature will not exceed 45°C.

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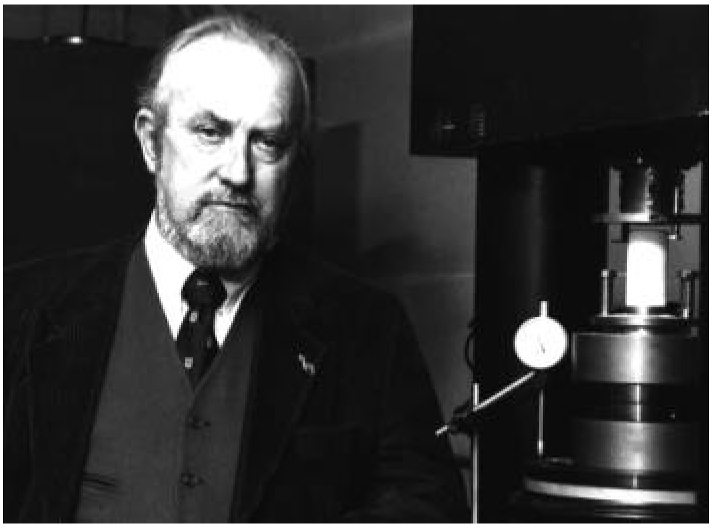
David Price - Honorary Member of the Ingeokring

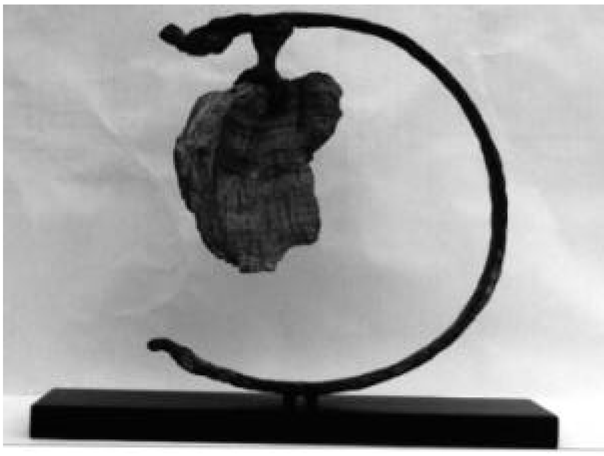
The board of the Ingeokring has decided that Professor David G. Price should become the first Honorary Member of the Ingeokring. David Price has been the Professor in Engineering Geology in the Technical University in Delft from 1975 to 1993.

Members of the Ingeokring who contributed exceptionally to the science and development of engineering geology, and who have exceptionally contributed to the work of the Ingeokring, can be awarded the status of "Honorary Member of the Ingeokring". The Honorary membership is commemorated with a statue with inscription.



In 1975 David Price became the Lecturer in Engineering Geology at the, at that time still called, Faculty of Mining in the Technische Hogeschool in Delft. The original idea of the Hogeschool was that Engineering Geology was only supposed to be a final "afstudeer" option with just two staff members. In due time, however, the work David did was recognized as being important for the Dutch Civil Engineering industry. Consequently the two men became the Section Engineering Geology and grew into one of the major sections of the Faculty of Mining. His lecturing was recognized as original and very illustrating for the work an engineering geologist is supposed to do. Also the scientific work of Price has been recognized throughout the world as of major importance for engineering geology and related disciplines. Research projects and supervision of Ph.D. students in subjects such as stability of underground excavations in weak limestone, stability of slopes, wear of dredging cutters, engineering geological mapping and many more have lead to renowned publications and changes in the practice of engineering geology. Consultancy projects strengthened this further and caused expansion of the name of the Section Engineering Geology.

Apart from the work done related to University David Price was also active in the international forum. Many symposia and conferences had David Price as chairman, keynote speaker or otherwise in an honorary position. The organization of the congress of the International Association for Engineering Geology and the Environment (IAEG) in Amsterdam in 1990 was the ultimate recognition of the level engineering geology had achieved in the Netherlands. David Price has always supported the Ingeokring. He has been present at most of the functions organized by the Ingeokring and often played an active role in the Ingeokring.



David Price has not done everything alone. Many other Dutch engineering geologists have also had their role in setting up and broadening engineering geology in the Netherlands. However, the Board of the Ingeokring judged that the work of David Price has had an exceptional impact on engineering geology in the Netherlands and that he has been for a large part responsible for the level engineering geology has reached in the Netherlands. Without the input of David Price engineering geology in the Netherlands would not have been what it is today. Therefore the Board wanted to honour him formally and decided to elect David Price as the first Honorary Member of the Ingeokring.

The election took place in January of this year and it was scheduled that the formal installation of David Price as Honorary Member would take place during the annual meeting in May 1999. However, fate overtook David and us and we had to change plans. The formal installation was done in England on 14 May 1999. The Honorary Membership is commemorated with a statue with inscription. This statue is made by Helga Ephraim-Felius. The text on the inscription is:

Prof. David G. Price - Erelid Ingeokring. 14 mei 1999

Honorary Member Dutch Association for Engineering Geology

The Board of the Ingeokring

Mechanics of Granular Materials

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Granular materials consist of an assembly of grains which are in contact and surrounded by voids. Following this definition, granular materials can be identified in many engineering fields. For example, granular materials like sand, gravel and fragmented rock play an important role in geotechnical engineering. But the origin of granular materials is not necessarily natural: synthetic granular materials are observed during many stages of industrial processes involving powders. Hence, granular materials have been studied extensively. Often description of the spatial structure and characterization of the mechanical behaviour are sought. By studying these aspects, inferences about properties or processes can be made.

The mechanical behaviour of granular materials depends on the spatial arrangement of the grains and the interaction between the grains. In order to model the mechanical behaviour, it would seem that every grain has to be considered separately. This is probably beyond even the most sophisticated computer. In addition, the interaction between grains, expressed in terms of frictional forces, would have to be represented faithfully. Given these daunting prospects, simplifications have been sought.

A promising idea was to identify representative units in the granular material. Assuming that a model for the mechanical behaviour of a unit is available, the deformation of the material can be predicted. In practice, however, the assumption that a granular material can be treated as a collection of equivalent units is in contradiction with the generally heterogeneous nature of granular materials. Consequently, generalized models for the mechanical behaviour of units are required. Such models, essentially capturing macroscopic deformation behaviour, are based on the theories of elasticity and plasticity. Adopting such models has paved the way for performing Finite Element Method (FEM) simulations.

Various types of FEM simulations have been developed. The standard method is to consider the deformation of each FEM element as a whole. However, FEM elements do not necessarily coincide with the structural units inside the granular material. Perhaps more seriously, standard FEM is not capable of reproducing certain known effects like so-called strain softening. Hence, an interesting alternative FEM method allows each point inside an element to deform by translation or rotation. This extension takes grains into account more realistically but obviously ignores the presence or influence of voids.

In order to reduce the shortcomings of FEM simulations, Distinct Element Method (DEM) simulations have been developed. With DEM, the micromechanics of an idealized assembly of particles is considered. For convenience, particles are usually represented by spheres in 3D or disks in 2D. The forces acting on each particle are balanced, leading to a system of N equations for N grains. The general appearance of the force balance is as follows:

$$\underline{\underline{M}}\,\underline{\ddot{x}} + \underline{\underline{C}}\,\underline{\dot{x}} + \underline{\underline{S}}\,\underline{x} = \underline{F}$$

where M is the mass matrix, C the damping matrix, and S the stiffness matrix. $\underline{x}$ and $\underline{F}$ are the incremental displacement and force vectors respectively. It should be noted that damping is typically represented by the viscosity while the stiffness is characterized by the elasticity modulus. A relatively straightforward solution is obtained in the quasi-static mode, where the incremental displacements are found by solving $\underline{x} = \underline{\underline{S}}^{-1}\underline{F}$.

The original objective of DEM was to identify an appropriate micromechanical model for use in FEM simulations. Unfortunately, this goal has not yet been reached. This indicates that, presently, simulations cannot make experiments redundant. In fact, the development of more sophisticated measurement techniques runs parallel to the development of simulation theory. Recent innovations in the measurement techniques have lead to more accurate characterization of the shape of grains and the structure of assemblies of grains before and during application of stress.

In practice, theory and experiments are focussed on static or slowly deforming granular materials. An interesting challenge remains the modelling of rapidly flowing granular materials. A common example of granular flow is the motion of grains entrained in a liquid. Two distinct regimes can be identified: at low solid concentrations, the flow properties will be determined by the inertia of the liquid, whereas, at high solid loadings, the interactions between the grains are dominant. The latter can be modelled with an interesting approach proposed by Bagnold.

More details on all aspects discussed in this review are described in ref. 1, a recent publication compiled by 35 scientists. The book provides a comprehensive overview, albeit from a fundamental point of view. Less recent overviews are given in refs. 2 and 3. A case study of the deformation of a synthetic granular material can be found in ref. 4.

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Review: Symposium Engineering Geology and Infrastructure

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Many Ingeokring readers will remember the symposium organised in December the 10th last year on the occasion of the 25th anniversary of the Ingeokring, titled "Engineering Geology and Infrastructure". The symposium, well attended by nearly 140 people, was held in the auditorium of Delft University of Technology. Interesting presentations were given by a selection of people whose professional occupation runs within the field of Dutch engineering geology. An overview of the symposium is given here for those readers who could not attend to this occasion and therefore could not be reminded of the state of the art of engineering geology after 25 years of substantial growth and progress in the Netherlands.

REVIEW AND PREVIEW OF ENGINEERING GEOLOGY IN THE NETHERLANDS

Professor Emeritus David Price, known by all as the person who brought engineering geology to The Netherlands, shared some of his professional and personal memories in an amusing opening speech *Engineering Geology in The Netherlands - A Review*. During that speech he showed some slides of himself as a young field geologist in an age that for many present appeared to be the distant past. At the end of the day Peter Verhoef, momentarily running the day to day business of the engineering geology section at the sub-faculty of Applied Earth Sciences, presented his view upon the future of Dutch engineering geologists in the closure speech *Engineering Geology in The Netherlands - A Preview*.

In the evening a diner plus party was organised by the engineering geology students chapter, the DIG (Dispuut Ingenieurs Geologie). The party was held at Societeit Phoenix and highlighted the musical talents that seem inherent in many of our engineering geologists; Ger de Lange played saxophone with his band. Photographs commemorating the party and the symposium are shown throughout this review. Each of the presentations given during the day is summarised in the remainder of this article.

ENGINEERING GEOLOGY FOR COASTAL INFRASTRUCTURE

Three examples of infrastructural works in coastal regions were discussed by Herlinde Mannaerts, to explain her vision on the importance of engineering geological knowledge being present when designing coastal infrastructure. The "Europipe Landfall" project involved the construction of an offshore pipeline running through the German Wadden Sea. Subsurface models were mainly based on "CPTU-signature" (CPT plus pore pressure measurement) interpretation. The "Oman LNG Port" was build for gas export using large tankers. A jetty had to be designed in combination with an onshore pipeline. Results from land-surveys were used to adjust the near-shore investigation programme. The latter was largely performed using boreholes. The third project, "Breakwater in the Middle East", was not fully completed at the time. Stability calculations included liquefaction potential and expected settlement.

SITE INVESTIGATION FOR THE STUDY RELATING TO THE CONSTRUCTION OF MAASVLAKTE 2

Caroline Suykerbuyk presented the feasibility study that was performed for the Maasvlakte 2, an alternative to solve future space-shortage in the port of Rotterdam. An onshore seismic survey in combination with several CPT's and boreholes has been carried out. The results showed that clay layers with a thickness of 2m or more can be detected using geophysical techniques up to a depth of NAP-80m. Based on these preliminary results the decision was made to extend the survey offshore (not yet performed). This implies that several test surveys with different configurations shall be performed offshore to figure out what configuration shows to give the best results. Finally the main survey is to be performed with that particular configuration.

UNSEEN FEATURES JEOPARDISE UNDERGROUND CONSTRUCTION

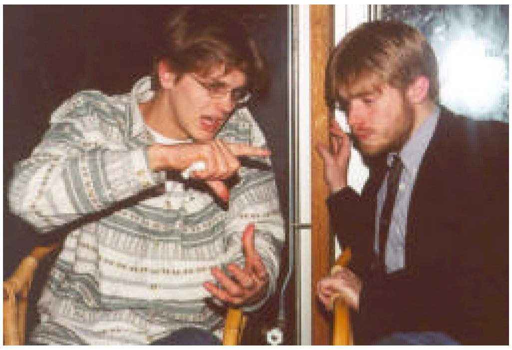
Frans Barends discussed in his presentation the difficulties in risk assessment related to underground construction in the Netherlands. Such risk assessment is as good as the techniques used to measure soil properties and quantify soil behaviour. He concluded that apart from improvement in the detection methods more information is needed on the variability of the geology and stochastics and uncertainty of models. Two projects are brought to attention to argument the ideas described above. TBM-techniques are very susceptible to major problems occurring at the tunnel face, as was proved during construction of the 2nd Heinenoord Tunnel. A blow-out probably due to an imperfection in the top layers, caused by the removal of an anchor pile associated with the construction of the 1st Heinenoord Tunnel, forced a delay of several weeks. Accurate measurements at the tunnel face are necessary to detect such small geological varieties. The second example is the Wilhelmina metro station in Rotterdam, where a sudden collapse occurred of (part of) the grout-column retaining wall. For months the wall seemed to behave properly, but apparently regressive erosion was taking place in the sand layer below the clay that formed the bottom of the building pit. With time erosion reached the retaining wall where fracturing of the grout columns took place under the high water pressure drop. Again more specialised monitoring may have foreseen this event.

IMAGING THE SUBSURFACE BY USING A TUNNEL BORING MACHINE AS A SEISMIC SOURCE

Tunnel boring machines perform best when they are continuously in operation. Therefore all available techniques to detect sudden geological or man-induced imperfections in the expected geology at the tunnel face beforehand should be investigated. Geurtje Swinnen explained the possibilities of applying one of these techniques: analysis of reflected seismic signals induced by the TBM. During construction of the 2nd Heinenoord Tunnel measurements were taken and analysed. Geophones placed at the surface as well as on the hydraulic jacks of the TBM give a good indication of the type of signals that are transmitted. It appears that several systems on the TBM can serve as a reliable source of seismic signals. However, more thorough understanding of the exact origin of the signals is required for future research.

NEUROFUZZY MODELLING APPROACH TO IMPROVE THE PERFORMANCE PREDICTIONS OF TUNNEL BORING MACHINES

Neurofuzzy modelling is a combination of fuzzy logic, able to deal with uncertainties and decision making, and neural nets, able to recognise patterns and adapt to changing environments. Mario Alvarez Grima presented the results of an investigation on the applicability of these systems in predicting TBM performance. A model was developed to forecast the penetration rate of a TBM with several input parameters (UCS, CFF, tunnel diameter, torque, revolution rate, etc.) and several rules. The rules indicate what the penetration rate will be when a certain combination of input parameters are located in a certain domain. The model was now assessed using a training set and then tested using a checking set, both part of a database with information of over 640 TBM-projects in hard rock. It turns out that the model performs better than traditional statistical methods based on regression analysis. The study shows how knowledge build up over the years of different projects can be combined in order to use that knowledge for prediction purposes in future projects.



THE GEOTECHNICAL MODELLING OF DEEP UNDERGROUND STATIONS IN AMSTERDAM

The North-South metro line in Amsterdam is to be built through the city centre with stations up to 30m depth. According to Jurgen Herbschleb these stations are located in complicated geological settings with difficult soil conditions. As a further requirement existing pile foundations are not to be influenced by the construction of the metro line. Using three different FEM packages (FLAC, DIANA, PLAXIS) models were tested with the same type of input. It was decided that PLAXIS should be used for the design modelling of the building pits, while DIANA is to be used to model the influences of the TBM with which part of the alignment shall be excavated. Grout struts, a grout injected soil layer over the full length and width of the building pit, will be used to minimise deformations of the diaphragm walls.

H-SENSE: HARBOUR SILTATION AND ENVIRONMENTAL SEDIMENTOLOGY: INVESTIGATING MOBILITY OF HARBOUR CONTAMINATED SILTS

A seismic reflection survey has been carried out in the harbours of Bergen, Norway, and Gothenborg, Sweden. The survey, as discussed by Michiel Maurenbrecher, was meant to reveal information about the exact locations of contaminated sediments. Furthermore the amount to which these sediments are being redistributed due to disturbance by, for example, ship drag and anchoring was quantified. It can be concluded that even during small time gaps, in the order of days, some shift of sediments can already be noticed. Within both harbours the thickness of the top layer shows high variability. This variability is influenced by the distances between different traverses, the intensity of shipping and river hydraulic processes.

GRAPHICAL EVALUATION OF SPATIAL LANDFILL SETTLEMENT DATA

A former dump site for harbour dredging waste products in Rotterdam is now used as a landfill for contaminated soil. According to regulations the bottom of the contaminated material should be above groundwater level. During the infill of the landfill settlements will be induced in the order of 3 to 5 meters. Settlement has been monitored until now. Rodian Spruit investigated these data in combination with a large number of CPT measurements. It turned out that the degree of filling and presence of sand layers are the main influential factors in settlement processes. Different correlations were found using graphical representations of the measured and calculated data, which would not have been found without such a representation.

25 YEARS OF SUBSIDENCE IN THE NETHERLANDS- THE GROWING IMPORTANCE OF ENGINEERING GEOLOGY IN COASTAL LOWLANDS

Subsidence in the Netherlands is of major importance for future habitability of the country. Several factors influence the subsidence (post-glacial rebound, gas extraction, consolidation, etc.).

Ger de Lange discussed the importance of 'engineering geology in environments as the Netherlands. Starting with the construction of dikes all types of subsidence-related geological problems and their engineering solutions are brought to attention. From these descriptions it was concluded that accurate measurements can only result in a good understanding of the subsidence mechanisms; if the underlying engineering geological aspects are known. At present mainly empirical methods are used, but current research will eventually replace these methods by a more generic subsidence analysis.

THE IMPORTANCE OF ENGINEERING GEOLOGICAL CONSULTING DURING VARIOUS PHASES OF TUNNELLING: A CASE STUDY OF THREE ALPINE PROJECTS

W. Wieser presented three less Dutch, but very interesting case studies on tunnelling in the Alps. Each of these case histories provided information on specific engineering geological tasks related to a certain geological setting and different stages of tunnelling. The first project was the reconstruction of a railroad in Vorarlberg, Austria. An alignment study was performed using aerial photography, existing maps and information on hydrogeological conditions, geological hazards, etc. In combination with accurate rock mass descriptions, an engineering geological map was constructed giving insight in the quality of several alignment-options. The second project is a road bypass tunnel in Graubunden, Switzerland. Here the main concern was an environmental impact study, for which a number of items were investigated (hydrogeology, presence of geological monuments, waste disposal sites and extractable raw materials). During construction of the tunnel the environmental impact was monitored; results were satisfactory. The last case study was a railroad bypass tunnel in Tyrol, Austria. This tunnel had to be constructed to guarantee a maximum traffic speed of 90kph along an existing railway line. The tunnel had to be designed, while the alignment was already chosen. In relation to the engineering geological conditions (ranging from soils to sedimentary and crystalline rocks) different support strengths were used. The tunnel was excavated according to NATM principles.

THE ADDED VALUE OF THE ENGINEERING GEOLOGIST FOR INFRASTRUCTURE PROJECTS: HOW VISIBLE IS THE ADDED VALUE?

This question is answered by Waldo Molendijk in his presentation. In addition to Price's statement that 'an engineering geologist is a specialist in not specialising him- or herself' he states that 'an engineering geologist who remains a generalist will have a hard time to prove his (added) value'. With that he argued that in this country not many possibilities are offered to be employed as a true engineering geologist in the altruistic sense of Price's definition. Technical design of constructions and foundations is in the Netherlands almost completely performed by civil engineers. The applied methods are based on experience, knowledge and therefore result in conservative design. For engineering geologists to be able to stimulate non-traditional initiatives, they have to introduce themselves as civil engineers. Recent large infrastructural projects, with foundations and excavations to greater depths, do give an impulse to the general vision on engineering geology.

APPRAISAL OF STICKINESS OF NATURAL CLAYS FROM LABORATORY TESTS

A major problem in the excavation of clayey soils is their stickiness on metal parts of mechanical tools. This property can be described in terms of adhesion and adhesive friction. Anne-Marij Kooistra wrote in her paper, that was not presented at the symposium but included in the proceedings, that a proper description of the behaviour of clay when excavated, requires a subdivision in three possible shearing methods (shear along metal-clay-contact, shear surface within clay, shear zone instead of surface). Models for each of these cases were constructed and tested using shear box tests under different conditions (pressure, amount of water, type of clay, etc.). It appears that determination of clay mineralogy, cation exchange capability and 'sticky limit in addition to the usual clay characterisation is crucial when assessing risks of sticking and clogging in excavation machinery.

QUESTIONS AND CLOSING REMARKS

At the end of each presentation question and answer sessions were held, but unfortunately no record was kept of these exchanges. For those that participated in the discussions and can remember their question plus reply please send a contribution to be published in the next issue. One question associated with the presentation on the H-sense project by Michiel Maurenbrecher was from Imke Deibel about predicting physical values such as densities from the acoustic signal. She warned that such predictions would not be as accurate as those based on sampling. Michiel agreed with her and said that this work was started by researchers at Florida University, who had published several papers correlating seismic geophysical profiles with densities and sediment type. These are based on predominantly empirical values and require a lot more data before one can use such values with confidence. They can be used to obtain an indication of variability of densities and grading, but should not substitute for physical sampling; at most, they could influence the location of sampling.

The organisers are to be congratulated for holding a well attended symposium of which the different sessions were chaired by familiar faces associated with Ingeokring's previous 25 year history: Erno Oele, Niek Rengers and Jan Nieuwenhuis. Chairman of the day was Martin van Staveren.

A bored but not boring tunnel: Visit to Heinenoord and lecture

Report and translation (of talk given by Ir. Eelke Negen) by P.M. Maurenbrecher
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A joint visit was held on Wednesday 28 October 1998 to the Second Heinenoord Tunnel Visitors' Centre. This visit follows the recent completion of the tunnel and about three previous visits during its construction (see an earlier report IngeoKring Newsletter No. 4 Autumn 1996: "Visit to the first bored tunnel in the Netherlands: The second Heinenoord Tunnel"). This will probably have been the last visit unless one is lucky to receive an invitation to its opening in September 1999 when all the finishing details are complete: of more interest to architects then engineering geologists. The report is based on the transcript of "translation notes" taken during the talk given by Ir. Eelco Negen of the Tunnel design group of the Public Works Department. Wendy, our hostess from the visitors centre, welcomed the audience. After a good cup of warm coffee (the weather was cold but luckily, in extraordinary wet season extending from September 1998 to April 1999, turned out to be a sunny afternoon) she turn down the blinds to give first a video presentation followed by Eelco Negen's talk. Eelco's talk comprised of an introduction: why a tunnel?, Who was involved?, Design aspects: a city bored tunnel in the country underneath water?, Its construction: especially how not to do it when the second tube was driven back north. Tests and experimentation: the first research tunnel in the Netherlands. What is its present progress?, and finally; as can be expected new ideas, developments and experiences generate questions!

INTRODUCTION

The questions often asked: why a bored tunnel? Or, for that matter, a second tunnel? The second question has an obvious answer: Mainly to separate slow traffic such as agriculture (tractors) and cyclists from the existing tunnel which suffers, as a result, from long traffic queues.

The idea to use a "bored" tunnel was to gain experience; a Netherlands prototype, though such a tunnel was not really necessary at the Heinenoord location. An added bonus was that as a research project the tunnel could start straight away.

The second bored tunnel, the Botlek railway tunnel in Rotterdam harbour is now starting; this is more in soft clay and peat deposits combined with a high water table.

The first proposal was to make a sunken tunnel but at the time (1990) it was postponed due to insufficient funds.

- In 1993 again a start was made proposing a bored tunnel.
- 1994 an initial design was made.
- 1995 the project received the go-ahead, resulting in a more detailed design and start of construction.
- September 1999 the project is due for completion.

Structurally a bored tunnel is best kept circular to distribute loading-stresses evenly. In Japan they have bored tunnels that begin to resemble the more efficient box shape, but they have been made for relatively short lengths. The bored tunnel has to be deeper than an immersed tunnel to prevent buoyancy from causing it to rise. At least one times the tunnel diameter of ground is required to keep the tunnel tube in place and to ensure stability of the cutting face. For an immersed tunnel this is not necessary: as either piles to anchor sections are used or sufficient thickness of concrete is added to keep the tunnel sections weighted down by gravity.

For a bored tunnel a shaft has to be built first to be able to start the boring process. A tunnel bore machine (TBM) has to be designed and installed to suit not only the size requirements but also the soil conditions.

Various organizations are involved in such a multi-facet project. This resulted in, just for the contractors only, an umbrella joint-venture company named "Tunnel Combinatie Heinenoord" (TCH). The client is the Ministry of Transport and Public Works (Verkeer en Waterstaat). The design and inspection is carried out by the Public Works Department, the Rijkswaterstaat in combination with the contractors consortium. The contractors entered into a design and build agreement. Ultimately this make the consortium, Tunnel Combinatie Heinenoord (TCH), responsible for faults in both the design and the construction. COB (Centre for Underground Construction) looked after much of the testing, instrumentation, monitoring and experimentation. The TCH had amongst others, Wayss und Freitag tunnel constructors and designers from Germany which has since become part of the Hollandse Beton Groep (HBG) at Rijswijk. Much of the COB work, or alongside the COB was metro-line consortium Noord-Zuid Lijn Amsterdam (North-South line, Amsterdam) N-Z Lijn. The tunnel bore machine was constructed by Herrnknecht AG from Germany.

Photo 1. *Steel-box frame lifting gear*

DESIGN OF TUNNEL

The approach ramp starts at 260m south of the tunnel portal followed by 945m tunnel and then 275m north ramp, resulting in a total length of 1350m. The approach ramps are relatively steep as they are to be used by tractors. For cyclists lifts and escalators are provided to reach ground level.

The deepest point is -28.5m below NAP: (ordnance datum corresponding approximately to mean sea level). The deepest level of the tunnel road paving is -26.5m NAP. The external diameter is 8.3m and internal diameter is ~7m.

Lining

Each ring has one or two key elements. They are 1.5 m wide and have a rubber seal to make the joints water proof. Notches cast into the lining elements ensuring they are properly connected. Special vehicles and lifting gear was made to transport the elements from the casting yard storage area to the tunnel face. Hoisting was from a cubic steel frame with lifting gear situated on the top beam rails on which the wheels at the base of the column legs rode.

TBM and excavation process

The TBM consists essentially out of an excavation chamber, the work chamber where hydraulic jacks are situated, operators' cabin with driving and monitoring console followed by generator and ventilation housing.

The excavation process consists of bentonite under pressure to support the tunnel face. The pressure is critical in that it must not be too high to prevent blow out and not too low to cause collapse of ground from the tunnel face into the excavation chamber. In the latter instance the collapsed ground would prevent further rotation of the excavator wheel. The bentonite is circulated to transport the scrapped ground soils to a separator unit, from where the bentonite is returned and supplemented from a buffer. The bore process is stopped about every 45 minutes, allowing retraction of the jacking arms and installation of the concrete lining segments (another 35 min), before resumption of boring. Because the shield has a larger diameter than the lining ring, the gap left between the lining and the soil is pressure-grouted with a mortar mix. This is to prevent settlement from taking place and for a good support of the lining.

To inspect the cutting cutter bits the bentonite pressures and levels have to be dropped sufficiently to expose part of the rotating arm. Divers then enter the chamber to both inspect and replace any worn cutter bits. The wheel has to be rotated to inspect all of the cutter bits.

Linings and face support

The lining installers use special lifting gear (erector) to insert the segments to complete the ring. The jacks connecting the shield to the lining are used to first push the ring tight against the previous ring before tunnelling proceeds further. The lining segments are temporarily bolted to previous lining segments. Once a number of rings have been placed the bolts are then removed. The walk into the tunnel showed that the lining bolts in the initial 20 to 30 m of tunnel have been left in place. Extra external tie bar reinforcement was also seen. These take up tension stresses that may develop as a result of differential movement of the shaft portal and the tunnel tube.

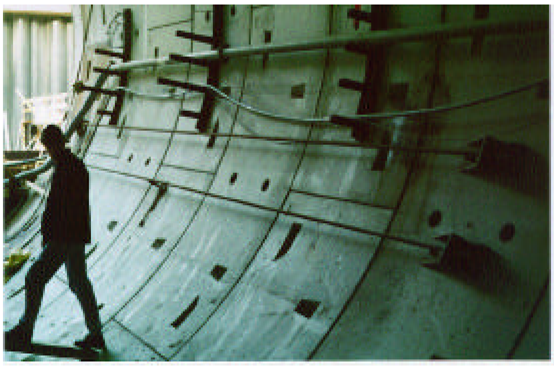

Photo 2. *Tie-bars at North portal tunnel driven south*

The shaft retaining walls consists of tubular and sheet piles except at the location of the tunnel portal where an opening was left infilled with a weak mortar. The mortar is strong enough to prevent ground water inflow and retain the soil behind it but sufficiently weak to allow the TBM to excavate. The sealing grout is similar to that used for the underground tramway in The Hague; no problems were experienced at Heinenoord, compared to the significant leakage that occurred in the tram tunnel.

Other techniques that were examined involved ground freezing which would have been a feasible alternative but was not tried.

EXPERIENCE CONSTRUCTING THE FIRST TUBE

The production curves for the first tunnel tube shown schematically indicate that there were two significant delays closely following each other, both occurring in June 1997. A massive rubber ring forms a seal between the shield and the lining. Despite this precaution in June 1997 tens of cubic metres inflow of water and ground occurred. An inflatable rubber ring resembling the inner tuber of a bicycle wheel was inflated to stop the leak. The cause of the leak was attributed to weak ground. Boring operations could not proceed further until the tube was deflated. A new seal was developed by pumping in grease between the annular opening of a pair of newly installed steel brush rings. A question from the audience was asked how one could install these during construction? The outside was first stabilised by grouting before exposing the shield behind the last but one ring section to install the brushes (A sample of the rubber and the brush ring was passed around for the audience to inspect).

After boring was resumed pressure loss occurred at the tunnel bore face. The pressure loss could not be compensated by increased pumping of bentonite slurry. An attempt to drive past the weak zone was considered but was not possible as the hydraulic jacks were, unfortunately, extended to their limit. What does one do in a situation such as this? Brainstorm as to what to try next!

Suggestions that were made:

- freeze the soil/water at the tunnel face,
- install sheet piles as with the shaft portal wall

It was decided to use the freezing technique, though to start with, it was also decided to stabilize by infilling the funnel shaped hole that extended from the river bed to the top section of the tunnel face. This was done by placing clay balls and special bentonite swelling pellets. The last part of the infilling consisted of sand placement.

The next stage was to remove the collapsed soil that had choked the excavator chamber using flush techniques. The pressure build up was kept equal to the outside hydraulic head. Partial forward and backward rotation of the excavator wheel was possible; in this way the tunnel slowly progressed forward when suddenly the pressures at the face could be increased further and the tunnel could resume normal boring without having to resort to freezing.

Photo 3. *TBM about to start second tube*

The "post mortem" as to what had happened was that the tunnel face consisted of a collapsed zone beneath which was a very stiff clay of the Kedichem formation. This clay was sufficiently strong not to collapse as well when the pressures dropped. The loose material above was unexpected. It is now believed to be present there as a result of a temporary anchor pile which was installed during the construction of the first Heinenoord Tunnel.

The pile was presumably connected with cables to keep floating elements in position for the first tunnel before they were immersed and secured to the river bed. On removal of the anchor pile loose material was allowed to accumulate in the opening left behind by the pile.

The first graph in Figure 1 shows predicted and actual production lines. The lower rates at the start was attributed to a learning process after which progress was more-or-less the same as the predicted 10 m/day until the June 1997. The inflow caused significant delay as did the bore-face partial collapse. After rectification the bore rates were re-established.

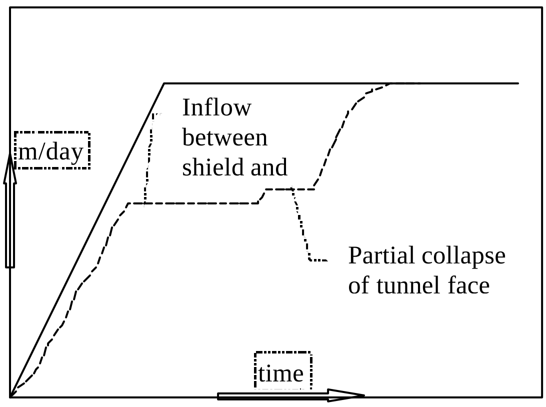

Figure 1. *Production first tunnel tube*

EXPERIENCE CONSTRUCTING THE SECOND TUBE

The tunnel lining elements were adjusted to give more play at joints: this was achieved by rounding off the edges on the notches. As a consequence very little damage was encountered as elements were allowed more movement to adjust to each other and presumably dissipate stresses.

The TBM left the shaft on the south side in horizontal direction, and not, as was in the first tube at a slight dip. This was found to give less problems with steering as, was the case, again, with the tube No. 1.

The production curve, was as a result, on average almost identical to the predicted production (Figure 2). In fact production in places exceeded 10m/s so that slower production at the start and later during its passage through the Kedichem clay formation could be compensated. (The "slurry" TBM is more suited to sandier soils, for which this machine was designed).

TESTING AND EXPERIMENTATION

Two interested parties in experimentation and testing of this project are COB and NZ-Lijn Amsterdam.
COB (Center Ondergronds Bouw: Centre for Underground Construction) was responsible for organizing research into stresses that built up in the soils and likelihood of settlement. COB also recorded the experiences of the tunnelling method and design.

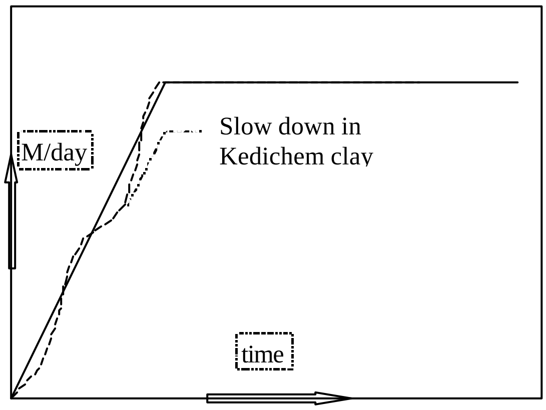

Figure 2. *Production second tunnel tube; Production of the tunnel was estimated at 10m/day.*

NZ-Lijn Amsterdam (The North-South (metro) Line Amsterdam) was responsible for the studies that simulated conditions in Amsterdam. To do this part of the ground along the tunnel route was reconstituted to resemble the soil profile in Amsterdam. Further simulation required inserting piles as well as other foundations. Those foundations expected to be encountered along the NZ-Lijn route. The measurements from the instrumented piles and soils are then used to calibrate and fine-tune finite element models. In other words: earlier predictions did not correspond with what was measured. The video shown in addition to the talk has included an explanation of how a centrifuge of Delft Geotechnics was used to model the behaviour of piles close to bored tunnelling behaviour. (See an earlier report IngeoKring Newsletter No. 4 Autumn 1996: "In focus: Joost van der Schrier" and "Visit to the first bored tunnel in the Netherlands: The second Heinenoord Tunnel" and Schrier et al. 1993 in "Engineering Geology in The Netherlands").

Some tests were done on tunnel lining elements using steel fiber reinforcement instead of the more tradition steel bar reinforcement. The advantage is that the fibers are mixed in with the concrete in the batching plant. At first very little distress was apparent. When the fractures did occur these appeared to be finer and smaller compared to the more traditional reinforced concrete elements. In the high stress areas some leakage was observed, though this was not serious. On the whole the use of steel fiber reinforcement appears to be very successful.

PRESENT STATE OF THE PROJECT

The main contractors have completed most of the work. The final stage up to the completion next September has become more management intensive as many subcontractors are needed to complete all the varied details and installations associated with a tunnel operating day-to-day traffic:

- Pump cellars/sumps (for run-off)
- Operation buildings
- Tunnel finishings: paving, tiling etc
- Fixtures: lighting
- Escalators, lifts
- Road and traffic signs
- Surveillance systems
- Piping/ utilities, etc.

QUESTION TIME

The first question was: When are the bolts holding lining elements removed ? These are removed when the grout has set behind the lining.
Further questions were:

Has continual lining cast insitu been considered? This was not used at Heinenoord but is certainly being investigated as future tunnel lining method.

How does one create a bend/corner in the tunnel? Eelko said that this was usually demonstrated using the carton from the toilet roll: if one cuts it slightly skew and then turn twist the toilet roll halves along their axis in opposite directions you will find that they cannot remain in a straight line if they keep touching. A similar principle is used to shift the rings of the tunnel lining to create a bend.

How sharp can the corners be made? This depends by the amount of "lucht-maat" meaning "gap" between the TBM shield and lining. The range of gradients in this gap is from 0.5 to 1.4%.

Epilogue

ICE (Institution of Civil Engineers, Netherlands Members section) note of thanks: ICE (who have held both meetings jointly with the IngeoKring of the KNGMG) have been here at the start and completion of the tunnel: to our surprise it appears to have been completed faster than one had expected which goes to say something of the high quality of the engineering that went into this project, and the presentation certainly reflected this. The ICE appreciate the trouble the speaker and the consortium Project Tweede Heinenoord tunnel have gone to make this a worthwhile afternoon, and, sadly in some ways, possibly the last one. However, there are many new pioneering tunnel projects starting soon: Botlek bored railway tunnel and the Westerschelde Tunnel both in different ground conditions and dimensions to that of Heinenoord. All 20 visitors agreed with loud applause and hopefully the traditional bottle of red claret presented to Eelko Negen (and another to Wendy of Tweede Heinenoord tunnel) is of some compensation for their efforts.

Photo 4. *North tunnel portal; TBM already dismantled*

After the lecture the visitors were shown by Wendy to the site of the tunnel north entrance. Despite the very stormy weather bringing gale-force winds and heavy rains, the afternoon was surprisingly mild with some sunshine breaking through offering photo opportunities. The tunnel boring machine, which took about three months to install, was dismantled within a two weeks and transported back to Herrnknecht. It remains the property of the tunnel consortium. If no new buyer or use can be found for it, Herrnknecht will purchase the machine back from the consortium and use its parts in new machines.

The tunnel cost ƒ280m which is a lot cheaper than usual ƒ50000/m quoted for tunnels. The lower costs are probably, in part, because the tunnel has been limited to local farm traffic and cyclists require less demands than normal vehicle traffic. (size, ventilation etc).

The first tube tunnel was accessible allowing close-hand inspection of the lining. As mentioned earlier interesting structural features included; the horizontal tie bars which spanned the first five to six lining rings as if to hold back either the tunnel portal from moving out or to keep the elements from buckling when the hydraulic jacking system was applied once the TBM shield had been sufficiently progressed into the tunnel.

Further into the tunnel, probably beneath the experimental/testing area, instrumentation perimeter, cable ducts, etc., were seen. These probably are giving information on stresses and strains in the lining as well as general radial deformation.

Photo 5. *Where tractors and local traffic enters from the south: south ramp*

Photo 6. *North ramp not yet tractor ready.*

Ir. Eelke Negen, who gave the talk, works at the Ministerie van Verkeer en Waterstaat (Ministry of Transport and Public Works), Directoraat-Generaal Rijkswaterstaat (Directorate-General State Public Works), Bouwdienst Rijkswaterstaat (Construction-service State Public Works) Hoofafdeling Droge Infrastructuur (Head section Dry Infrastructure), Afdeling tunnelbouw, Constructeur-Statisticus (Section Tunnel construction: Structural Engineer- Statistician) Griffioenlaan 2, Postbus 200000, 3502 LA Utrecht Tel: 030 2857743, Fax: 030 2897418,
E-mail: e.negen@bwd.rws.minvenw.nl

In focus: Ed de Mulder and Jan Nieuwenhuis

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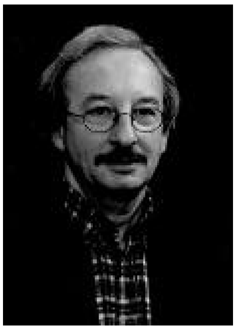
Both Ed de Mulder (51) and Jan Nieuwenhuis (59) are professor at Delft University of Technology, faculty of Civil Engineering. Ed has, apart from his work at NITG-TNO, been associated with the university since July 1998 teaching subsoil quality management, while Jan is head of the hydraulic research department. He started teaching soil mechanics at Utrecht University over ten years ago, a job which he has continued to perform until today.



Ed de Mulder studied geology at Utrecht University. For his PhD he went to the Ionic islands off the border of Greece, where he investigated the stratigraphy of Tertiary rocks. For the last twenty years he has been working at the Netherlands Institute of Applied Geosciences TNO (former National Geological Survey). He has been involved in the mapping of the north-western part of the Netherlands and studies related to the Eastern Schelde dam and the Markerwaard polder. Furthermore he investigated the possibilities of radioactive waste disposal in salt domes. He has been and still is strongly involved in the subsurface study of cities. He chairs a European network on this issue and has developed an urban geoscientific information system, known as OGIS.

Ed states that his geological background has always helped him during the different projects. The relationship between society and subsurface is what attracts him in engineering geology. Discussing case-histories and explaining the already gained knowledge about the Dutch deltaic deposits are what he tries to transfer to his students as well. Although foreigners tend to have high respect for the Dutch hydraulic engineering works, he does not see much interest from abroad in the engineering geological aspects of these works. Ed agrees that at present and even more in the near future opportunities are there for Dutch engineering geology students to work on interesting projects within their own country. He regrets that many students still tend to be focussed on hard-rock geology instead of soft soils as found in the Netherlands.

Jan Nieuwenhuis graduated in physical geography and soil mechanics at the geology department of the University of Amsterdam together with the civil engineering department of the Delft University of Technology. Due to this combination of disciplines he has been able to witness the beginning of engineering geology in the Netherlands. After a year of research in Grenoble he studied landslides in the French Alps for his Ph.D. Before becoming a professor at Utrecht and later at Delft he has worked for Delft Geotechnics for eighteen years. Here Jan was mainly occupied with soil mechanics, but during his work at Utrecht his interest in geology was renewed and he wanted to express this by teaching related subjects at Delft.

When asked what surplus civil engineers expect from engineering geologists, Jan states that mainly the knowledge about earth forming processes and therefore the ability to know what to expect at a certain geomorphological setting is valuable, not only abroad but as well within the Netherlands. In relation to that he agrees that students often lack much knowledge on pure hydraulic and soil or rock mechanical computations, when compared to civil engineering students. This of course influences their view on engineering geologists. His vision of engineering geology in the Netherlands is indeed one of a large spectrum of courses with focus on a few main research disciplines. In this respect Jan gives the example of microtectonic processes influencing large Dutch hydraulic works more than many people know. He would like to see more research undertaken in relation to such geotechnical aspects of the shallow subsurface.

David Price remembered

With a group of students from ITC and TUD we did in 1989 fieldwork in Pont de Suert, on the south side of the Pyrenees. It would be the last time to do fieldwork in this area. David was not satisfied with the system used so far for rock mass classification. In the new area, around Fals et, he wanted to use a better system. He asked me to join him on a Sunday afternoon. Around Pont de Suert we visited several outcrops, we took measurements, and he wrote down values for a number of parameters. Next we drank coffee (very important!), he added up his results, and modified the weights of the parameters a few times. We went back to the outcrops, drank coffee again, changed the parameters again. In this way we spent a large part of the afternoon. His aim was that the final figure he found for the different outcrops would match with his engineering judgement of the rock mass. In 1990 we started to do fieldwork in the area around Falset. Robert Hack had with David made a form for the students on which the rock mass classification system was applied. Since then the system has been extended and modified a number of times. But I still have the feeling that on that nice sunny afternoon in Pont de Suert I stood at the cradle of what finally resulted in the Ph.D. thesis of Robert Hack: the SSPC-system. Characteristic for the way of working of David Price was that he did not really approach his problem in a "scientific" way. He collected data in the field, and applied the trial-and-error method until the result and his engineering judgement were matching.

Ir. Wolter Zigterman
ITC Delft

The first time I got more closely involved with David Price was the moment I went to fieldwork in Spain. Not the fieldwork itself was the reason, but my proposal to do an M.Sc. topic in the combined field of Fractals, Chaos Theory and Rock Mechanics. David, being a man practice but also a man with an open mind, would decide on his approval during this fieldwork. Although he did say yes, indicating that he might see some practical applications, this was not the most important involvement with David.

On the morning of April 23 1992 I had just received a fax from my brother indicating that we had had an 5.9 magnitude earthquake in the Netherlands. Knowing that David had a special place in his heart for earthquake engineering I approached him during breakfast and announced the earthquake. Assuming that I was ALWAYS the practical joker of the group he did not believe me ! Fortunately, at the end of the day, being a real scientist, he had confirmed the earthquake from other sources and discussed the information in my fax in more detail. In the end this rememberable moment was possibly one of the reasons that I started my Ph.D. with this earthquake as topic.

May we soon see the result of his life work recorded in HIS book on Engineering Geological Practice.

Ir. Ard den Outer
Hét Ingenieursbureau
Gemeentewerken Rotterdam

Lunching with David Price

There are many facets about David. One can say it is a wonder he lived to be 67 years. The only reason I ate at the DISH was because of David. He always ate warm at lunch at said he just had a sandwich in the evening with Valerie. David was not a gastronome. His favourite eating out venue was Van der Valk, Voorschoten where he ate with Valerie every Saturday lunch. The DISH or David Price luncheon club had regulars: myself, Robert Hack, Sally Barritt and Collin Reeves. Why a wonder at his relatively long longevity? His food was cholesterol rich, i.e. omelettes with chips dosed with a blizzard of salt before he even tasted the food. To compensate slightly he often has a glass of house wine. For afters he always had a cigarette. The lack of gastronomic interest was more than made up in conversation. Anecdotal: Canoeing down a river in Papua New Guinea: Someone tried clambering aboard on the canoe at night; you didn't wait to find out who, just shoot in that direction. Music: debates between medieval coral singing and opera. Research: David remained essentially a rock man and, indeed, Robert thesis formed often part of lunch-time discussion. TU Delft professorial colleagues.not unlike Shakespearean intrigue. And if he was not lunching at ITC, Heleen van Yssel-Hage, his secretary never seized to wonder at the single Mars-bar that constituted his lunchtime break plus reading of a science-fiction novel.

Pieter Michiel Maurenbrecher
TU Delft, Faculty of Applied Earth Sciences,
Section Engineering Geology

Thesis abstracts

This section is aimed at the introduction of M.Sc. (Ir.) level research at the Engineering Geology divisions of the Faculty of Applied Earth Sciences, Delft University of Technology, and that of International Institute for Aerospace Survey and Earth Sciences. We will include abstracts of two randomly selected theses in each volume. Our intention is to give some idea to the geoscience community about the type, and diversity of research undertaken in engineering geology sections of these two institutions.

A generic UDEC model for rock joint shear tests, including roughness characterisation

C.M.D. Kerstiens
Delft University of Technology,
Faculty of Applied Earth Sciences,
Section Engineering Geology

At the Laboratorio Nacional de Engenharia Civil in Lisbon, Portugal (LNEC) and the Technical University of Delft in Delft, the Netherlands (TUD), research was done for the development of a generic UDEC model, that simulates rock joint shear tests specifically to the roughness of the tested discontinuity. The scope is research on the behaviour of discontinuity roughness during shear tests. The simulations made with the model in the program UDEC were compared with shear tests performed at the TUD and LNEC. In addition, a general evaluation of the performance of the shear test devices in these laboratories was made.

The first part of the thesis presents a literature review on the topic and an overview of the laboratory test procedures and of the UDEC program. The second part of the thesis discusses the evaluation of the shear equipment and the shear test modeling in UDEC.

For the general evaluation of the shear equipment, two identical sets of specially samples with ISRM roughness profiles were molded with dental plaster. A series of shear tests was conducted at the direct shear test devices in Lisbon and Delft. The results are evaluated for general observations during testing, dilation and shear strength measurements.

For the representation of the discontinuity roughness in the UDEC model, a special roughness model, which uses a distinction between large and small scale roughness, is developed with the use of Fast Fourier Transformations. The large scale part of the roughness model is represented geometrically in UDEC, and the small scale part uses internal parameters of constitutive models in UDEC. The shear test UDEC model is developed with use of UDEC's internal program language FISH. For the evaluation of the model, 181 simulations were run and compared to 46 laboratory shear tests.

Characterization of the geotechnical properties of rock material for production purposes

J.S. Ajalu
International Institute for Aerospace Survey and Earth Sciences, Section Engineering geology

With the ever increasing demands for good quality construction materials, coupled with the dwindling resources, there is need to effectively control the quality of these materials right from the source. Previous research has shown that there is good correlation between in situ geotechnical properties in the quarry and the resulting product. Furthermore, a correlation between equotip hardness values and some rock material properties such as the unconfined strength, have also been established.

The present study was undertaken in a sandstone quarry found in Rieudotte, central part of Belgium. The main objectives were: to study the variations of the rock material properties in a quarry, to establish a link between the variations and the sampling intervals, and to assess the usefulness of geostatistical methods for quarry and other in situ sampling optimisation.

The field measurements were undertaken using equotip hardness tester along a selected section of the quarry. Typical samples were also taken for laboratory analysis. Using the laboratory results, correlations between the equotip values and some rock material parameters such as the unconfined compressive strength, tangential modulus of elasticity, density, water absorption and accessible porosity were obtained. The variations in these correlated properties was assessed using equotip measurements.

The equotip measurements were analysed using different measures of spatial continuity. The variogram models to describe the spatial continuity and for estimation purposes were developed. The semivariograms revealed that the variation in the quarry is anisotropic with very high variability in the vertical as compared with the horizontal direction. Based on this analysis, the shale is found to be more variable than the sandstone. An estimation at unsampled locations was performed using block kriging. Reliable estimates were obtained leading to the characterization of the site into different geotechnical units. The error associated with estimates was assessed and found to be within tolerable limits. The error analysis provided a good indication of the variability and sampling reliability. For future sampling in this quarry, optimum sampling intervals of 4.0m by 0.3m in the direction of maximum and minimum continuity respectively, were obtained. Furthermore, a methodology for in situ sampling optimisation has been proposed.

It is concluded that geostatistical methods are useful in quarry and other in situ sampling optimisation. However, it is noted that the success of their applications rest on the deployment of a correct methodology in data acquisition, analysis and interpretation. Although this research has been demonstrated on a sandstone quarry, it is recommended that the methods developed here be extended to other formations like limestone, granite, and others.

CALL FOR CONTRIBUTIONS TO THE NEW SECTION:

“Amazing Projects”

The contributions to this section should bring to the readers notice the “unusual aspects” of the projects that you take part in or that you have read in a magazine, journal, book or in a newsletter. The “unusual aspects” of the project can include scientific, technical, financial, legal, social etc., extremes. For example, the unusually high or low values measured in an experiment or the very expensive or very cheap contracting of a project, or examples of very bad or very good decision making in an engineering problem etc.

Recently published papers

Most members of the Ingeokring are working in the field of Engineering Geology and related fields of expertise. By virtue of the interdisciplinary character of Engineering Geology the topics of work and study of the members of the Ingeokring range widely, and as a result their work is published in journals and proceedings of different nature. Because of this, not all publications come to the attention of the different members. To ease the access to the publications of different Ingeokring members, the authors of recently published papers are given the opportunity to present a short abstract (15 lines) of their publication, in the Newsletter. In addition the authors should give a name and address, to which persons that are interested can respond to for more information.

Forecasting Rock Trencher Performance using Fuzzy Logic

Int. J. of Rock Mech. and Mining Sciences (accepted for publication, in press).

To study the performance of rock cutting trenchers, data on the excavation and tool consumption rate of one type of trencher, the Vermeer T-850, were gathered on sixteen sites. The data assembled were compared with the rock characteristics by studying the trench geology and performing rock engineering tests on samples. This study aims at more reliable predictions, by developing better methods to handle the data, which are commonly of an imprecise nature. To reach this goal fuzzy set theory has been selected and successfully implemented. A Fuzzy Expert System model has been developed to predict the bit consumption and the excavation rate of the T-850 trencher. The results obtained so far are promising and the model is in the verification stage.

M. Alvarez Grima and P. N. W. Verhoef
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Neurofuzzy modelling approach to improve the performance predictions of Tunnel Boring Machines

Published in Engineering geology and infrastructure: the added value of the engineering geologist. Proceedings of the 25 years jubilee symposium of engineering geology in the Netherlands Delft, 10 December 1998, p 37- 49.

In this paper the first results of a study into the application of neuro-fuzzy techniques to model the performance of tunnel boring machines are presented. A data base of over 640 TBM projects in rock has been used. It is shown that this method gives better results than other, more conventional, modeling approaches. Fuzzy set theory, fuzzy logic and neural networks techniques seem very well suited for typical engineering geological applications. In conjunction with statistics and conventional mathematical methods hybrid models may be developed that may prove a step forward in the practice of ground engineering.

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Faculty of Civil Engineering, Department of Applied Earth Sciences, Section of Engineering Geology, Delft University of Technology, The Netherlands, Mijnbouwstraat 120, 2628 RX Delft.

Fuzzy model for the prediction of Unconfined Compressive Strength of rock samples

Int. J. of Rock Mech. and Mining Sciences (accepted for publication, in press).

A data driven approach to the modeling of unconfined compressive strength of rock samples is presented. Fuzzy logic approach is used to represent a non-linear relationship as a smooth concatenation of local linear submodels. The partitioning of the input space into fuzzy regions, represented by the individual rules, is obtained through fuzzy clustering. The numerical results are compared with a conventional statistical (multi-linear) model. It is shown that the fuzzy model is not only more accurate but as opposed to other black-box approaches (such as neural networks), it also provides some insight into the non-linear relationship represented by the model.

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(1) Faculty of Civil Engineering and Geosciences, Department of Applied Earth Sciences, Section of

Engineering Geology, Delft University of Technology, The Netherlands.
(2) Department of Information Technology and Systems, Control Laboratory, Delft University of Technology, The Netherlands.

Application of Neural Networks for the prediction of the Unconfined Compressive Strength (UCS) from Equotip hardness.

Int. J. of Rock Mech. and Mining Sciences (accepted for publication, in press, Vol. 36 (1) p 29-39).

This paper presents the application of a neural network for the prediction of the UCS from hardness tests on rock samples. To investigate the suitability of this approach, the results of the network are compared to predictions obtained by conventional statistical relations. The network was trained to predict the UCS based on the hardness, porosity, density, grainsize and rock type information of a rock sample. A dataset containing 194 rock sample records, ranging from weak sandstones to very strong granodiorites, was used to train the network with the Levenberg-Marquardt training algorithm. Two sets, each containing 17 rock samples were used to validate the generalisation and prediction capabilities of the network.

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News and announcements

MESSAGE OF THE OUTGOING PRESIDENT OF IAEG
Paul G. Marinos

Dear colleagues, dear friends,

It has been a privilege and a great honour to serve as President of the International Association of Engineering Geology for the past 4 years. I am pleased to report that 1994-1998 were years stimulating and productive, years of many achievements for IAEG. The Executive committee elected in Lisbon in 1994 is today pleased to report that all goals defined at that time were accomplished, but major changes took place, as well.

Change of the name of the Association
A modification of the name of the Association was decided with a very limpid majority. Since 1997 IAEG is the INTERNATIONAL ASSOCIATION FOR ENGINEERING GEOLOGY AND THE ENVIRONMENT, more clearly reflecting now our involvement to the Environmental protection and the proper appreciation given by Engineering Geologists to Environmental issues. However, we considered very important to retain the emphasis on "Engineering Geology" and the original objectives of the Association as a learned society in the Geotechnical domain, in engineering construction and in development.

By-laws
The Executive Committee prepared and the Council of the Association adopted in 1996 the new By-laws which, associated with the new Statutes of 1992, accomplish many new policies and procedures.

IAEG journal
A new period for the IAEG journal, the bulletin of Engineering Geology and the Environment, has started. The journal will soon appear quarterly and it is now published by Springer. Springer has already increased the number of subscribers and visibility of the Bulletin among non members. The Bulletin will always remain part of the subscription fees to the Association, being by far a non expensive journal for our members. The new editor-in-chief Dr Brian Hawkins and the co-editor Professor Roger Cojean guarantee the development of our journal in the rank of the most prestigious journals in the field. Please contribute by sending quality papers to our journal. An additional exciting development is that an electronic publication of all bulletin articles is available on Springers' searchable LINK Internet site: http://link.springer.de/ ; other facilities are also available through this site.

Membership and National Groups
Although nowadays a clear decline in membership can be observed in many scientific societies, due to severe economical constraints, the Association succeeded to keep its overall figures intact, if not slightly increased. We count more than 5600 colleagues as members. The Executive Committee did a lot of promotion, gave assistance and strengthened relations in many countries world-wide. During my term I have travelled a lot; I visited IAEG national groups and I tried to identify key leaders and encourage them to act in countries where no IAEG activities were present. I have visited Albania, Belgium, Bulgaria, Canada, Croatia, China, Cyprus, Denmark, Egypt, France, Germany, Hungary, Indonesia, Italy, Japan, Malaysia, Morocco, Nepal, Norway, Portugal, Romania, Singapore, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, United Kingdom, USA, Yugoslavia. Besides promoting IAEG matters, these visits were very enjoyable because of the reception I received and great hospitality; I would like to thank all these groups and colleagues.

Recent years' discussions with our USA colleagues resulted to have AEG as our USA National Group; we expect therefore more members from that big community of Engineering Geology which, so far, had a very restricted presence in IAEG. Both John Peck, the AEG president and myself believe that the collaboration between IAEG and AEG will provide many rewards for both organisations and members. Many thanks to our Group chairman, Professor Christopher Mathewson, for his effective contribution.

I am very satisfied by the results of the activities of the Executive in spreading the Engineering Geology cause. Ten new National Groups were accepted and welcomed during last four years: Georgia, Estonia, Iran, Lithuania, Malaysia, Mongolia, Nepal, Pakistan, Senegal and Singapore. We are also very pleased to welcome back to activity Indonesia and Yugoslavia. We are trying also to reintegrate these groups which being silent for a long time are temporarily absent.

Congresses and Symposia

IAEG National Groups organised a number of very successful Symposia.

In Beijing, in 1996 our Chinese group succeeded to present an excellent series of theme Symposia in the frame of the 30th International Geological Congress.

The Athens Symposium, in 1997, was a landmark for IAEG. With more than 750 participants and 5 volumes of proceedings, we underlined the contribution of Engineering Geology to the Environment and we reinforced our position in IUGS, developing at the same time our good relations with all other sister societies which were all represented by their Presidents. President of IUGS Dr Robin Brett defined IAEG as a “very strong organisation”

We also had a great activity in co-sponsoring other international conferences and symposia promoting IAEG international presence and collaboration or by having an official participation in national meetings, assisting local scientific bodies to promote Engineering Geology:

- Copenhagen, Denmark, 1995: The interplay of Geotechnical Engineering with Engineering Geology (ISSMGE conference);
- Maltahaza, Hungary, 1995: Geosciences for environmental planning (UNESCO Workshop);
- Taormina, Italy, 1995:The fragile Town in Italy;
- Peveragno, Italy, 1995: International meeting for young researchers;
- Trondheim, Norway, 1996: 7th International Symposium of landslides (Together with ISSMGE);
- Adelaide, Australia, 1996: 7th Australia and New Zealand Conference on Geomechanics
- San Jose, Costa Rica, 1996: 4th Latin-American Symposium on urban geohazards
- Cernobio, Italy, 1996: Water resources and the Environment
- Tokyo, Japan, 1997: 1st Asian Symposium on Engineering Geology
- Istanbul, Turkey, 1997: International Symposium on Geology and the Environment
- India, 1998: International Conference on Hydropower
- Stockholm, Sweden, 1998: international Symposium on underground construction in modern infrastructure (with ISRM)
- Naples, Italy, 1998: 2nd International Symposium on hard soils-soft rocks (with ISRM and ISSMGE)
- Our main every 4 years gathering, in Vancouver in 1998, was a success. Many participants, quality papers. We are very pleased that our next Congress in 2002 will take place in Durban, in the African continent, where the Association will meet for the first time.

But till then, a lot of conferences are already planed, waiting for your participation and contribution: From Nepal and Malaysia in 1999 to Russia and Finland in 2001 trough our official participation in two big events in 2000, the GeoEng2000 in Melbourne and the 31st IGC in Rio.

Commissions

Commission work was continuing and some of the Commissions presented published reports, as the commission on Waste Disposal and that of Geological Mapping. Commissions form the backbone of any Society and more activities must be planned in the next years. In this perspective we are very pleased that this Executive have encouraged and the Council accepted two new Commissions: on aggregates and on collapsible soils. All the best wishes for the new chairmen, Lars Persson and professor Ian Smalley. Colleagues, experts on these matters and all National Groups are strongly invited to contact the Commissions and contribute. Commissions are urged to make available and publish their work in reasonable time.

Fees and Finances

The tight economical management from the Executive and mainly the excellent work of our treasurer Michel Deveughele, allowed a positive result and to keep static, during all years of our term, the cost of joining the Association. Restricted, but welcome, support from UNESCO and IUGS was entirely given to support participation from developing countries. Since 1999 differential fees will be applied with no change for low income countries and a slight rise for the rest, which is associated with the change of the status of publication of our journal. This policy to help developing countries reflected also to the participation fees for some of our Conferences.

It is however obvious that revenues cannot come from individual fees alone. IAEG needs to be supported more by its industrial and commercial sector. The policy started by past president Ricardo Oliveira, to increase associated membership, must be intensified. Advertising seems a very attractive source of revenue too, but we rather put little attention during these last years. Advertising of technical products and services is also a service to our potential supporting members.

Big part of the expenses of the offices of President, Secretary General and Treasurer were generously taken by the Greek and French universities and laboratories hosting these officers. We are grateful. The President covered all additional expenses by personal sources.

Communication

The world-wide distribution of an informative flyer on IAEG profile helped to increase awareness among non-members and third parties. A Spanish publication will greatly help in Latin America. The electronic communication will largely help the direct interaction with National Groups and members and increase membership. A Web site has been installed in my home University: http://www.civil.ntua.gr/IAEG.htm and is soon expected to be operative in our Secretariat, in Paris.

Sister Societies

For many years we have had a special relationship with sister societies in rock mechanics (ISRM) and soil mechanics (ISSMGE). My understanding is that during these last years this collaboration was much evolving and effective, based on a mutual respect basis. Nowadays the role of Geology and the geological restraints are broadly recognized by soil and rock Engineers; Engineering Geologists also understand now better the geotechnical demands. Our Association and the collaboration with the sister societies has contributed well to that situation. I had the opportunity to meet many times, in Cambridge, Athens, Turin, Singapore, and Kobe, with my colleagues the ISRM president professor Shun Sakurai and the ISSMGE president professor Mikele Jamiolkowski. This collaboration was not only effective but also most enjoyable. We faced all matters of common interest with an open mind and we greatly developed the co-sponsorship of events and mutual close communication. We are now looking for an interplay in commission work. The climax of this relationship is expected in Melbourne, in 2000, where all three Societies will meet for the big conference GEOENG2000. Additionally recently liaisons have started in good shape with the International Tunnelling Association (ITA). This Association, as well as the International Commission of Large Dams (ICOLD) and the International Association of Hydrogeologists (IAH) are invited to join. With IAH we introduced a very good channel of communication, we co-sponsored events, and mutually diffused invitations for membership. Together, first with Dr. John Moore and after with Professor Michael Knight, past and current IAH president, as well as with Dr Andrew Skinner IAH Secretary General, we had many fruitful and pleasant meetings. We also continued to support the significant activities of the IUGS Commission COGEOENVIRONMENT.

Awards

IAEG statutes regarding the Hans Cloos price and the Richard Walters medal were fully honoured. Professor Ricardo Oliveira and Dr Owen White join now our prestigious Hans Cloos list of awardees. A suggestion to offer a honorary membership to signor members of the Association having offered long lasting and exceptional services to the Association, will be discussed by the new Executive.

Word of thanks

In closing, I take pleasure in thanking a big group of people I have greatly enjoyed working with for these last four years.

Firstly the numerous key persons in National Groups and our Commissions. Thank you for your hard work and tolerance of my urgings. Secondly to colleagues on the Executive: Cobus Venter (Africa), John Gartner (North America), Jose Sevilla (South America), Wang Sijing (Asia), Warwick Prebble (Australasia), Edmunt Krauter (Europe) and Brian Hawkins (Europe). I had a lot of effective meetings during all my term. Your generous help, enthusiasm, and contribution have been much appreciated. A vote of thanks to Ricardo Oliveira, Marcel Arnould and Michael Langer, our past presidents for the many useful discussions I had and the share of their experience. A warm thanks to Michel Deveughele and to Louis Primel for their outstanding service to the President and the Association. My sincere thanks to the National Technical University of Athens for its support. Finally, I want to report to my wife Catherina, not only for her understanding, but for her continuing support and encouragement as well.

A new Executive has been elected last September and is operating the Association since January 1st. The future of IAEG looks very bright. The Association will be well managed by a board from well known colleagues, many of them having efficiently served the Association from other positions in the past, headed by professor, academician, Wang Sijing. I wish every success.

I really enjoyed these four years and I am grateful for the opportunity to have been president of IAEG. Thank you all very much.

Athens, January 1999

Paul G. Marinos

2ND BGS INTERNATIONAL CONFERENCE ON GEOENVIRONMENTAL ENGINEERING: GROUND CONTAMINATION - POLLUTANT MANAGEMENT AND REMEDIATION

London, UK, 13-15 September, 1999

Topics: Risk assessment and management, transport, persistence and fate of chemicals, landfilling and engineered barriers, containment and remediation, recycling and reuse of waste materials, detection and minitoring, contaminated ground and constructed facilities.

Correspondence: Ms. C. Summers, conference secretariat, Cardiff School of Engineering, PO Box 917, Newport Rd, Cardiff, CF2 1XH, United Kingdom. Tel/Fax: +44 1222 874421
E-mail: Summers@Cardiff.ac.uk

1999 YOUNG GEOTECHNICAL ENGINEERS CONFERENCE (YGEC '99)
Santorini, Greece, 23-25 September, 1999

Organised by: the Hellenic member society of the ISSMGE

Topics: laboratory and field testing, soil modeling verified with laboratory tests, geotechnical case studies including field measurements, geotechnical design supplemented with monitoring actual performance, etc.

Correspondence: Prof. Michael Kavvadas
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http://www.civil.ntua.gr/kavvadas/

THE SECOND INTERNATIONAL SYMPOSIUM ON PRE-FAILURE DEFORMATION CHARACTERISTICS OF GEOMATERIALS (IS TORINO 99
Torino, Italy, 26-29 September, 1999

Organised by: The Politecnico di Torino (Department of Structural and Geotechnical Engineering), Under the auspices of The International Society for Soil Mechanics and Geotechnical Engineering, TC29 on Stress-Strain Testing of Geomaterials in the Laboratory and The Italian Geotechnical Society

Topics: Innovation in soil testing, Laboratory and in situ tests (static, wave propagation and dynamic tests), Evaluation of sample disturbance, Reconsolidation techniques, Advantages and limitations of seismic tests, Stress-strain behaviour, Soil models, Parameter assessment, Validation of soil models, Applications and Case Histories, Prediction and backanalysis, Monitoring criteria, Design criteria.

Correspondence: Prof. R. Lancellotta (Chairman), Prof. D. Lo Presti (General Secretary)
Department of Structural and Geotechnical Engineering, Politecnico di Torino, C.so Duca degli Abruzzi 24, 10129 Torino, Italy
Tel: 0039 011 5644842, Fax: 0039 011 5644899
E-mail: diego@geohp.polito.it

INTERNATIONAL SYMPOSIUM ON ENGINEERING GEOLOGY, HYDROGEOLOGY AND NATURAL DISASTERS WITH EMPHASIS ON ASIA
Kathmandu, Nepal, September 28-30, 1999

Organised by Nepal Geological Society under the sponsorship of International Association for Engineering Geology and Environment (IAEG) endorsed by International Decade for Natural Disaster Reduction (IDNDR) Secretariat.

Topics: ENGINEERING GEOLOGY: site investigation techniques, large scale structures (dams, bridges etc.), underground excavations (tunnels, mining etc.), slope stability, foundations engineering, irrigation structures, construction materials, engineering geology and the environment, soil erosion, HYDROGEOLOGY: water supply, irrigation, groundwater pollution, groundwater resources and management, NATURAL DISASTERS: flooding, landslides and debris, earthquakes, cyclones, volcanic eruptions, glacial lake outburst flood (GLOF), disaster management.

Correspondence: Nepal Geological Society, P.O. Box 231, Kathmandu, Nepal, Tel: (977) 1 416 386, Fax: (977) 1 416 870,
E-mail: ngs@wlink.com.np

12TH AFRICAN REGIONAL CONFERENCE ON SMGE: GEOTECHNICS FOR DEVELOPING AFRICA
Durban, South Africa, 25-27 October, 1999

Topics: Waste management, transportation geotechnics, foundation engineering, monitoring, laboratory and field testing, education, training and research, environmental geotechnics, design and analysis methods, soil improvement, geotechnics for low cost housing, case studies, mining geotechnics, lateral support.

Correspondence: C&P Conference Organisers, Private Bag X37, Greyville 4023 South Africa.

Tel: +27 31 3032480
E-mail: cpdbn@dbn.lia.net

INTERNATIONAL SYMPOSIUM ON SLOPE STABILITY ENGINEERING: GEOTECHNICAL AND GEOENVIRONMENTAL ASPECTS
Matsuyama, Japan, 8-11 November, 1999

Topics: Site investigation, stability analysis of soil and rock slopes, effects of seismicity and rainfall, design strength parameters of natural slopes, effects of land development, slope stability of waste materials, stability of landfills, stabilisation of remedial works, reinforced steel slopes, probabilistic slope stability, landslide inventory and landslide hazard zonation.

Correspondence: Professor Takuo Yamagami, General Secretary, Department of Civil Engineering, The University of Tokushima, 2-1 Minami-josanjima-cho, Tokushima 770, Japan.
Fax: +81 886 56 7319
E-mail: Takuo@ce.tokushima-u.ac.jp

AIT 40TH ANNIVERSARY CIVIL AND ENVIRONMENTAL ENGINEERING CONFERENCE – NEW FRONTIERS AND CHALLENGES
Bangkok, Thailand, 8-12 November, 1999

Topics: Water Engineering and Management, Structural Engineering and Construction, Transportation Engineering, Geotechnical and Geo-environmental Engineering, Environmental Engineering, Natural Resources Development, Disaster Reduction, Prevention and Mitigation and Urban and Rural Environment

Correspondence: Dr. A. S. Balasubramaniam, School of Civil Engineering, AIT, PO Box 4, Klong Luang, Pathumthani 12120, Thailand.
Tel: 662-524 5519, 662-524 5508, Fax: 662-516 2126, 662-524 5523
E-mail: bala@ait.ac.th

5TH INTERNATIONAL SYMPOSIUM ON FIELD MEASUREMENTS IN GEOMECHANICS
Singapore, 1-3 December, 1999

Organised by: Department of Civil Engineering, National University of Singapore, Supported by Centre for Soft Ground Engineering, Department of Civil Engineering, National University of Singapore, NTU-PWD Geotechnical Research Centre, School of Civil and Structural Engineering, Nanyang Technological University

Topics: New Technology and Developments in: Field Measurements, Recent Innovations, Geographic Information Systems, Optic Fibre Systems, Advanced Electronics Equipment, Remote Sensing and Data Capturing, Geophysical Methods, Management of Instrumentation in: Geomechanics, Data Collection and Management, Analysis and Interpretation - Feedback from Monitoring to Theory in Geomechanics, Early Warning of Dangers and Potential Failures, Quality Control, QA/QC issues, Case Histories with Data Interpretation and Back-analysis to compare Theory to: Performance, Deep and Shallow Foundations, Deep Excavations and Retaining Wall Structures, Soil and Rock Slopes, and Dams, Underground Openings and Tunnelling, Land Reclamation and Related Works, Geo-Environmental Instrumentation, Geosynthetics Performance Instrumentation, Large-Scale Construction Projects

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INTERNATIONAL CONFERENCE ON OFFSHORE AND NEARSHORE GEOTECHNICAL ENGINEERING
Panvel, India, 2-3 December, 1999

Topics: Behaviour of marine and problematic soils, analysis and design of foundations, laboratory and field testing, deep water soil investigation, instrumentation, model studies, waterfront structures, case studies

Correspondence: K. S. Prakasha, Institute of Ocean Technology, ONGC Complex, Phase-II, Panvel, Navi Numbai - 410221, India.
Fax: 91 22 745 3692
E-mail: icot@bom33.vsnl.net.in

ICASP8*1999
Sydney, Australia, 12-15 December, 1999

Organised by: Civil Engineering Risk and Reliability Association and Department of Civil, Surveying, and Environmental Engineering The University of Newcastle, Callaghan, NSW, 2308, Australia

Topics: uncertainty and risk in all aspects of civil engineering, safety and reliability of civil engineering systems, probabilistic structural mechanics, structural engineering, materials engineering, environmental engineering, geomechanics and risk analysis with an emphasis on applications to all types of civil engineering systems.

Correspondence: ICASP8\0251999
Department of Civil, Surveying and Environmental Engineering, The University of Newcastle, Australia, 2308
Tel: +61 2 4921 6042, Fax: +61 2 4921 6991
E-mail: icasp8@mail.newcastle.edu.au

SYMPOSIUM ON THE APPLICATION OF GEOPHYSICS TO ENVIRONMENTAL & ENGINEERING PROBLEMS (SAGEEP)
Arlington, USA, 20-24 February, 2000

Topics: Airborne geophysical surveys, Application of GIS to Environmental and Engineering Problems, Archaeology, Borehole techniques, Forensic geophysics, Geomechanics and rock properties, Geophysics as an element in disaster response (Honduras, Colombia, etc.), Ground-Penetrating Radar, Landfill characterization, Mapping voids and cavities, Mining, Processing, interpretation, and modeling, Radioactive waste disposal, Seismic surface waves and ultra-shallow seismic reflection, Shallow-water, transition zone sea-floor characterization, Toxic waste management and mitigation, UXO and land mine detection

Correspondence: Lynn Cramer
ExpoMasters
7632 E. Costilla Avenue, Englewood, CO 80112 USA
Tel: (303) 771-2000, Fax: (303) 843-6232
E-mail: LCRAMER@compuserve.co

ISRM EUROCK 2000
4TH NAT. SYMP. FOR ROCK MECHANICS AND TUNNELLING
Aachen, Germany, 27-30 March, 2000

Topics: Fundamentals, Underground construction, Underground storage, Preservation of natural stone monuments

Correspondence: R. Thiel
German Geotechnical Society,
Hohenzollernstrasse 52, D45128
Essen, Germany

AMHERST 2K
PERFORMANCE CONFIRMATION OF CONSTRUCTED GEOTECHNICAL FACILITIES
Amherst, USA, 9-12 April, 2000

Organised by: The University of Massachusetts and Geo-Institute

Topics: the means of confirming the performance of all types of constructed geotechnical systems, geotechnical property determination, design methodologies, life-span performance of the system.

Correspondence: Donna Carver
E-mail: dcarver@ecs.umass.edu

26TH GENERAL ASSEMBLY OF THE ITA
Durban, South Africa, May 13-18, 2000

Organised by the South African National Council on Tunnelling (SANCOT), the South African National Group on Rock Mechanics (SANGORM), the South African Institute of Mining and Metallurgy (SAIMM), and Lesotho Tunnelling Society (LTS).

Topics: Tunnels under pressure.

Milestones: Contact conference secretariat.

Correspondence: Sam Moodley, Conference Co-ordinator, World Tunnel Congress 2000, SAIMM, P.O. Box 61127, Marshalltown, 2107 South Africa, Tel: 27 11/834 1273/71, Fax: 27 11/838 5923 or /833 8156
E-mail: saimm@tradepage.co.za

1ST CENTRAL ASIAN GEOTECHNICAL SYMPOSIUM
Astana, Kazakhstan, 25-28 May, 2000

Topics: Geotechnical problems of construction, architecture, and geo-environment on boundary of 21st century

Correspondence: Professor A Z Zhusupbekov
Karaganda Metallurgical Institute, 34 Lenin Avenue, Kazakhstan, Temirtau, 472300
Fax: +7 3213 916280
Email: karmeti@kazmail.asdc.kz

SOFT GROUND TECHNOLOGY
Noordwijkerhout, The Netherlands, 28 May - 2 June, 2000

Organised by: United Engineering Foundation, co-sponsored by the ASCE Geo-Technical Institute

Topics: Soft Ground Characterization: Soft Ground Microstructure, Site Characterization Methods for Soft Ground, Laboratory Test Methods, Mechanical Stabilisation: Embankments on Soft Soil, Lightweight Fill, Settlements and Stability of Soft Ground, Geosynthetics, Chemical and Thermal Stabilisation, Tunnelling in Soft Ground, Environmental Aspects of Soft Ground: Remediation Techniques for Soft Ground, Waste as an Engineering Material

Correspondence: United Engineering Foundation Conferences
Three Park Avenue, 27th Floor - New York, NY 10016-5902
Tel: 1-212-591-7836, Fax: 1-212-591-7441
E-mail: engfnd@aol.com

ISOPE-2000
THE 10TH (2000) INTERNATIONAL OFFSHORE AND POLAR ENGINEERING CONFERENCE & EXHIBITION
Seattle, USA, 28 May - 2 June, 2000

Organized by: the International Society of Offshore and Polar Engineers (ISOPE)

Topics: Coastal Engineering & Remote Sensing, Computational Mechanics, Mechanics, Structures & Reliability, Deep-Water /Ocean Systems & Technology, TLP, SPAR, FPSO & Compliant Structures, Risk, Safety and Reliability, Impact, Damages, Subsea Systems & Operations, Earthquake Engineering, Pipelines, Risers, Cables & Mooring, Ice Mechanics, Modeling and Forces, Ocean Resources and Deep-Ocean Mining, Steel, Metal and Tech., Soil Properties and Improvements, Composite Materials, Smart Structures, Foundations & Pile, Fatigue & Fracture, Geotechnical Earthquake Engineering, Corrosion Fatigue & SCC, Geo-Environment, Environmental Impact and Modeling

Correspondence: ISOPE-2000 TPC, P.O. Box 189, Cupertino, California 95015-0189, USA
Fax: 1-303-420-3760 or California 1-408-980-1787
E-mail: meetings@isope.org
http://www.isope.org

4TH INTERNATIONAL CONFERENCE ON GROUND IMPROVEMENT GEOSYSTEMS
Helsinki, Finland, 7-9 June, 2000

Topics: Ground improvement for earth constructions: technology and innovations, Grouting/ground improvement practice for road and railway structures, Grouting practice for water constructions (canals, reservoirs,..), Grouting and stabilisation for environmental protection (liners, leakage barriers,....), Durability aspects (ageing, creep, chemical resistance,…), Material properties (testing, quality assurance, non destructive testing, standardisation), New materials, composites, degradable components, Soil reinforcement practice, Geosynthetics for ground improvement, Case histories and work performance (quality assurance, protection), Legal aspects and environmental issues

Correspondence: H. Rathmayer, secretary General 4th ICGIGS 2000 VTT-Technical Research Centre, Communities and Infrastructure, Box 1901, FIN-02044 VTT, Finland
Tel: +3589 4561, Fax: +3589 456 7077
Email: Hans.Rathmayer@vtt.fi
http:// www.sgy.fi

1ST INTERNATIONAL CONFERENCE ON GEOTECHNICAL ENGINEERING EDUCATION & TRAINING
Sinaia, Romania, 12-14 June, 2000

Organised by: The Romanian Geotechnical Society and The Technical University of Civil Engineering Bucharest, Romania under the auspices of The International Society for Soil Mechanics and Geotechnical Engineering TC 31 on Geotechnical Engineering Education

Topics: Geotechnical engineering in civil and environmental engineering curricula at undergraduate and postgraduate level around the world, Syllabuses (content) of geotechnical engineering courses at undergraduate and postgraduate levels, Laboratory and field works in geotechnical engineering education Teaching, learning and assessment in geotechnical engineering education, including the use of communication and information technology, Innovation and case studies in geotechnical engineering education, Continuous professional development in geotechnical engineering, Relevant practice of in-house training of geotechnical engineers, International co-operation in geotechnical engineering education

Correspondence: Iacint Manaliu
Chairman for GEET Conference, Technical University of Civil Engineering Bucharest, Bul. Lacul Tei, Nr. 124, Bucharest, 72302, Romania
Tel: +40.1.2421161 or +40.1.24208 / ext. 139, 134
Fax: +40.1.2420866 or +40.1.2420781

Email: manoliu@hidro.utcb.ro
http:// www.euceet.utcb.ro/firstconf1.htm

8TH INTERNATIONAL SYMPOSIUM ON LANDSLIDES
Cardiff, UK, June 26-30, 2000

Correspondence: The Secretary British Geotechnical Society, The Institution of Civil Engineers, 1 Great George Street, London SW1 P 3AA, UK, Tel: 44 171 839 9829, Fax: 44 171 799 1325

19TH ISPRS CONGRESS: GEOINFORMATION FOR ALL
Amsterdam, the Netherlands, 16-23 July 2000

Organised by ISPRS (International Society for Photogrammetry and Remote Sensing)

Topics: Geographic Information Systems Data and Applications, Digital Elevation Models, Photogrammetry, Remote Sensing, Hazardous Waste and Environmental Pollution, Coastal Zone Monitoring

Milestones: September 1999 - deadline for abstracts, March 2000 - deadline for manuscripts.

Correspondence: Prof. Dr. Klaas-Jan Beek or Dr. Freek D. van der Meer, ITC, Hengelosestraat 99, P.O. Box 6 7500 AA Enschede, the Netherlands
Fax: +31 53 487 4335
E-mail: isprs@itc.nl
http://www.geod.ethz.ch/isprs

21ST INTERNATIONAL GEOLOGICAL CONGRESS
Rio de Janeiro, Brazil, 6-17-August, 2000

Theme: Geology and Sustainable Development: Challenges for the Third Millennium including Colloquia, Special Symposia, General Symposia, Short Courses, Workshops, and Field Trips.

Topics: Stratigraphy, Metamorphic Petrology, Seismogeology, Paleontology and Historical Geology, Geology of Mineral Deposits, Quaternary Geology, Sedimentology, Geology of Fossil Fuels, Hydrogeology, Marine Geology and Paleoceanography, Mineral Economics, Engineering Geology, Structural Geology and Geomechanics, Geochemistry, Environmental Geology, Igneous Petrology, Remote Sensing, Mathematical Geology, Experimental Petrology, Exploration Geophysics, Comparative Planetology, Mineralogy, Geotectonics, Plate Motions and Regional Geophysics, Geological Education, Precambrian Geology, Geochronology and Isotope Geology History of Geosciences

Correspondence: Executive Office for the 31st International Geological Congress
Av. Pasteur, 404 – Anexo 31IGC – Urca, Rio de Janeiro – RJ – CEP 22.290-240
Tel: 55 21 295 5847 – Fax: 55 21 295 8094
E-mail: 31igc@31igc.org

GEODENVER
Denver, Colorado, USA, 3-8 August, 2000

Organised by: Denver Technical Center Marriott, sponsored by the Geo-Institute of ASCE

Topics: geophysical exploration, soil/rock property determination and site characterization, construction practices, geoarcheology, unsaturated soils, environmental geotechnics, deep foundations, slope stability, risk assessment, earthquake engineering, pavements and pavement subgrades, geosynthetics, visualization and image processing, rock mechanics, issues on education in geotechnical engineering, and research and funding.

Correspondence: ASCE - World Headquarters
1801 Alexander Bell Drive, Reston, Virginia 20191-4400
Tel: (800) 548-2723 or (703) 295-6300
Fax: (703) 295-6144

SECOND INTERNATIONAL CONFERENCE ON DEBRIS-FLOW HAZARDS MITIGATION: MECHANICS, PREDICTION, AND ASSESSMENT
Taipei, Taiwan, R.O.C, 16-18 August, 2000

Sponsored by: American Geophysical Union, American Society of Civil Engineers, (WRE Division and GEO Institute), Association of Engineering Geologist, Federal Emergency Management Agency, USA, Geological Society of America, International Association for Hydraulic Research, International Erosion Control Association, National Science Foundation, U.S. Geological Survey

Topics: Geomorphic and land-forming processes by debris flows, Debris-flow occurrence as related to hydrologic and geologic settings, Debris-flow initiation and termination mechanisms, Rheological properties and modeling of debris flows, Mechanics of debris flows, Unsteady debris flows, Free-surface instability (roll waves) in debris flow, Erosion and deposition processes in debris flow, Debris-flow routing methods, Numerical modeling of debris flows, Debris-flow experiments, Debris-flow monitoring and sampling network, Forecast of debris-flow occurrence, Field observations and measurements of debris flows, Assessment of debris-flow hazards, Debris-flow hazard frequency estimates and risk analysis, Debris-flow hazard delineation and mapping techniques, Real-time debris-flow hazard alert systems, Structural and non-structural debris-flow countermeasures

Correspondence: Dr. Gerald F. Wieczorek
U.S. Geological Survey
National Center, MS-955, 12201 Sunrise Valley Drive, Reston, VA 20192, U.S.A.
Tel: (703)648-6788, Fax: (703)648-6032
E-mail:gwieczor@usgs.gov

STRESS WAVE'2000
THE SIXTH INTERNATIONAL CONFERENCE ON THE APPLICATION OF STRESS-WAVE THEORY TO PILES QUALITY ASSURANCE ON LAND AND OFFSHORE PILING
São Paulo, BRAZIL, 11-13 September, 2000

Organized by: the Brazilian Society for Soil Mechanics and Geotechnical Engineering - ABMS

Topics: Wave mechanics and application to pile driving analysis, Stress Wave Analysis, High Strain Dynamic Testing of driven piles and cast in situ piles, Low strain dynamic testing of piles and shaft integrity, Dynamic pile-soil interaction, Dynamic properties of soils, Dynamic testing of foundations and earthquake engineering, Dynamic methods and environmental aspects, Vibratory pile driving, Statnamic and other similar techniques, Prediction reliability, Case histories and correlations

Correspondence: conference secretariat ACQUA Consultoria
Av. Brigadeiro Luiz Antonio, 317 cj 33
CEP 01317-901 - São Paulo - SP
Tel: +55-11- 3104 6412, Fax: +55-11-3104 3406
E-mail: stress@acquacon.com.br
http://eu.ansp.br/~abms/stress/sw2000.htm

INTERNATIONAL SYMPOSIUM ON COASTAL GEOTECHNICAL ENGINEERING IN PRACTICE (IS-YOKOHAMA 2000)
Yokohama, Japan, 20-22 September, 2000

Topics: Coastal geotechnical engineering: Exploration of soft soil and determination of design parameters, Prediction and performance of earth structures on soft clay - case histories, Soil improvement, New geotechnical materials

Correspondence: Dr Takashi Tsuchida
Port and Harbour Research Institute, Ministry of Transport, 3-1-1, Nagase, Yokosuka, 239-0826, Japan
Tel: +81 468 44 5021, Fax: +81 468 44 4577
E-mail: is-yokohama@ipc.phri.go.jp
http:// www.phri.go.jp/division/ge/news/

INTERNATIONAL EARTH SCIENCES COLLOQUIUM ON THE AEGEAN REGION
Izmir, Turkey, 25-29 September, 2000

Organised by IESCA and Dokuz Eylul University, Department of Geological Engineering.

Topics: Environmental and Engineering Geology, Mineral and Energy Resources, Remote Sensing, Geophysics and marine Geology, Geoarcheology, Hydrogeology, Geochemistry, Geothermal Energy, Ceramic Raw Materials, Metamorphism and Metamorphic Belts, Magmatism, Sedimentology, Stratigraphy and Paleontology, Tectonics, Neotectonics.

Correspondence: Dr. Ismet Ozgenc, organising secretary, IESCA-2000, Department of Geological Engineering, Dokuz Eylul University, P.O. Box 37 (E.U.Ptt) 35100 Bornova, Izmir, Turkey, Tel: +90 232 388 29 19, Fax: +90 232 388 78 65
E-mail: iesc2000@izmir.eng.deu.edu.tr
http://www.deu.edu.tr

INTERNATIONAL WORKSHOP ON ENGINEERING GEOLOGY AND ENVIRONMENTAL PLANNING
Hannover, Germany, October 10-12, 2000

Organised by the National Group of IAEG in co-operation with BGR.

Topics: Waste Disposal, Mitigation of Natural Hazards, Water and Mineral Resources Development, Ethics of Geoengineering.

Milestones: March 31, 2000 - deadline for receipt of abstracts.

Correspondence: Dr. M. Wallner c/o Federal Institute for Geosciences and Natural Resources,

Post-box 51 01 53, D- 30 631 Hannover, Germany, Tel: (49) 511 643 2422, Fax: (49) 511 643 3694,
E-mail: manfred.wallner@bgr.de
http://www.bgr.de/iaeg2000

INTERNATIONAL SYMPOSIUM ON SCOUR OF FOUNDATIONS
Melbourne, Australia, 19 November, 2000

Topics: The scour problem, Predicting scour depths, Scour counter measures, Case histories

Correspondence: Professor Jean-Louis Briaud
Department of Civil Engineering, Texas A&M University, College Station, Texas 778433136, USA
Tel: +1 409 845 3795, Fax: +1 409 845 6554
Email: briaud@tamu.edu

GeoEng 2000, INTERNATIONAL CONFERENCE ON GEOLOGICAL AND GEOTECHNICAL ENGINEERING
Melbourne, Australia, 19 - 24 November, 2000

Organised by the International Society for Soil Mechanics and Foundation Engineering (ISSMFE), the International Association for Rock Mechanics (ISRM) and the International Association of Engineering Geology (IAEG). Supported the International Geosynthetics Society, the International Tunnelling Association and the International Association of Hydrogeologists.

Topics: The conference will provide a forum for all interested parties to meet and discuss both formally and informally issues relevant to the current states-of-practice as well as future directions. The conference will combine five themes of common interest, with a number of invited lectures from eminent practitioners, researchers and recent achievers on issues that are relevant to our various disciplines. The themes being developed are in the areas of Geotechnical Earthquake Engineering, Underground Works, Stability of Natural and Excavated Slopes, Environmental Geotechnics, Ground Improvement and Ground Support.

Milestones: Call for Abstracts: February, 1999, Abstract Deadline: May 1, 1999, Notification of Abstract Submission: July 1, 1999, Paper Deadline: November 1, 1999, Return of Papers: March 1, 2000, Final version of Papers to be received by the Secretariat: July 1, 2000

Correspondence: Mr. Max Ervin, Chairman GeoEng2000 Organising Committee, c/o Golder Associates Pty Ltd, 25 Burwood Road, Hawthorn, Victoria 3105, Australia.
Fax: 61 3 9818 7990
E-mail: geoeng2000@icms.com.au
http://www.icms.com.au/geoeng2000/

IS-SHIZUOKA 2001
INTERNATIONAL SYMPOSIUM ON SUCTION, SWELLING, PERMEABILITY AND STRUCTURE OF CLAYS (IN RELATION TO SOIL CONTAMINATION AND WASTE DISPOSAL)
Shizuoka, Japan, 11-13 January, 2001

Correspondence: Dr. Masaharu Fukue,
E-mail: fukue@scc.u-tokai.ac.jp

FOURTH INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN GEOTECHNICAL EARTHQUAKE ENGINEERING AND SOIL DYNAMICS
San Diego, California, 26-31 March, 2001

Organised by: the University of Missouri-Rolla in co-operation with ISSMGE, IAEE, ASCE

Topics: Dynamic properties for soils, wave propagation, engineering seismology, soil amplification, stability and displacement performance of slopes, soil-structure interaction under dynamic loading, seismic analysis and design of retaining marine structures, seismic analysis and retrofit of foundations of bridges and other sub-structures, model and full-scale tests of geotechnical structures, case histories of geotechnical earthquake engineering, seismic zonation, earthquake risk assessment.

Correspondence: Shamsher Prakash
Conference chairman
308 Civil Engineering, University of Missouri-Rolla, Rolla, MO 65409-0030, USA
Tel: 1-573-341-4489, Fax: 1-573-341-6553/4729
E-mail: prakash@novell.civil.umr.edu
http://www.umr.edu/~conted/conf8767.html

EngGeolCity – 2001, INTERNATIONAL SYMPOSIUM ON ENGINEERING GEOLOGICAL PROBLEMS OF URBAN AREAS
Ekaterinburg, Russia, 30 July – 2 August, 2001

Organised by the International Association for Engineering Geology and the Environment (IAEG), the National Group of Engineering Geologists of Russia, and the Association of Economical

Interaction Between Areas and Republics of the Ural Region.

Topics: Engineering geology and rational use of urban areas, Engineering geological and engineering environmental site investigations on urban areas, Natural hazards and stability of urban areas, Technogenous changes in urban geoenvironment, Use of urban underground space, Protection of historical, architectural and cultural sights, Geoinformation systems of urban geoenvironment

Milestones: More information will be provided in Bulletin No 1,2.

Correspondence: Secretariat of EngGeolCity – 2001, UralTISIZ 79, Bazhov str., Ekaterinburg, Russia, 620075, Tel: (3432) 559 772, Fax: (3432) 550 043, E-mail: UralTIS@etel.ru

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AGGREGATE 2001 CONFERENCE, ENVIRONMENT AND ECONOMY
Helsinki, Finland, August 6-10, 2001

Organised by the Finish National Group of IAEG and the Aggregate Commission of IAEG.

Topics: Geological grounds for aggregate production, Classification of aggregate and available production techniques, Prospecting and testing raw materials for aggregate production, Mineralogical studies and long term durability of aggregate, Environmental influences of quarrying and processing aggregate, Importance of aggregate industry for national economies.

Milestones: November 1999 – Bulletin 2, conference registration form, April 30, 2000 – submission of abstracts, December 30, 2000 – submission of full papers.

Correspondence: AGGREGATE 2001, Tampere University of Technology, Laboratory of Engineering Geology, P.O. Box 600 FIN-33101, Tampere, Finland, Fax: (358) 3 365 2884,
E-mail: kuulavai@cc.tut.fi, or
pekka.ihalainen@luvy.fi

15TH INTERNATIONAL CONFERENCE ON SOIL MECHANICS AND GEOTECHNICAL ENGINEERING (XV ICSMGE)
Istanbul, Turkey, 27-31 August, 2001

Correspondence: Prof. Ergün Togrol, Chairman Organising Committee, Faculty of Civil Engineering, Istanbul Technical University, 80626 Ayazaga, Istanbul, Turkey.
Tel: +90 212 285 3747 Fax: +90 212 285 6587

4TH INTERNATIONAL CONGRESS ON ENVIRONMENTAL GEOTECHNICS (4TH ICEG)
Rio de Janeiro, Brazil, September 2002

Correspondence: Luiz Guilherme de Mello,
4 ICEG-Rio 2002 c/o Dr Maria Claudia Barbosa, Programa de Engenharia Civil, COPPE-UFRJ, Cidade Universitaria û Ilha do Fundao, PO Box 68506, Rio de Janeiro 21945-970, RJ, Brazil
Fax: +55 21 280 9545
Email: 4iceg@pec.coppe.ufrj.br / lgdmello@usp.br

THIRD INTERNATIONAL CONFERENCE ON UNSATURATED SOILS
Recife, Brazil, 2002

Organised by: Brazilian Society for Soil Mechanics and Geotechnical Engineering (ABMS), Federal University of Pernambuco (UFPE), and International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE)

Topics: development of modern unsaturated soil mechanics, theoretical and practical aspects of unsaturated soils, earth dams, landfills, foundations on expansive and collapsible soils

Correspondence: unsat@npd.ufpe.br

9TH INTERNATIONAL CONGRESS OF THE INTERNATIONAL ASSOCIATION OF ENGINEERING GEOLOGY AND ENVIRONMENT
Durban, South Africa, September 16-20, 2002

Organised by SAIG, the South African Council for Geoscience and the International Association of Engineering Geology and Environment (IAEG).

Topics: Engineering Geology for Developing Countries (Appropriate Technology), Waste Management, Engineering Geology Mapping and Site Investigations, Engineering Geology and the Environment, Groundwater, Construction Materials, Information Technology Applied to Engineering Geology, Gondwana Rocks and Engineering Geology, Groundwater.

Milestones: More up to date information will be available on the Internet early in 1999.

Correspondence: The technical committee, 9th IAEG Congress, P.O. Box 1283, Westville 3630 South Africa

The Netherlands Students Award for Engineering Geology

The Ingeokring, the Netherlands National Group of the International Association for Engineering Geology and the Environment (IAEG), has established a prize for the best ir., drs. or MSc thesis in the field of Engineering Geology submitted to a Netherlands institute of higher education. The prize consists of a sum of NLG 1,000 and a certificate, to be handed out at the annual meeting of the Ingeokring in the spring of 2000. The thesis must be a contribution to the application of earth scientific knowledge to the solution of problems in civil engineering, mining engineering or environmental engineering.

We invite the submission of theses produced in the academic year September 1998 - August 1999

Individuals can send in their own thesis or the thesis of others. Membership of the Ingenieursgeologische Kring is not required. Three complete copies of the thesis (including figures, photographs, annexes) have to be submitted by January 1, 2000 to the secretary of the Ingeokring. The committee which will select the best thesis is composed as follows:

* Dr. H.R.G.K. Hack (chairman, Ingeokring)
* Ir. C.M. Breukink (IWACO)
* Ir. A.H. Nooy van der Kolff (Boskalis Westminster BV)
* Dr. J. Rupke (University of Amsterdam, Dept. of Physical Geography)
* Dr. P.N.W. Verhoef (TU Delft, Dept. of Applied Earth Sciences)

Criteria used for the selection will be:

* Relevance for earth sciences and engineering
* Scientific quality
* Originality of approach
* Quality of presentation

The Award is sponsored by:

* Ingenieursgeologische Kring
* Boskalis Westminster BV
* Fugro Engineers BV
* Ballast Nedam Engineers BV
* IWACO
* Rijks Geologische Dienst
* Geocom Consultants