news ingeo letter

nl-iaeg ingeo kring

No. 10 Summer 2002

From the chairman of the Ingeokring	**2**
Off-shore Funderingstechnieken "Suction Foundations" *ir J. W. Bierman*	**3**
Section Engineering Geology at TU-Delft dismantled *drs. Richard H.B. Rijkers*	**5**
Is there a future for Engineering Geology at Delft University of Technology ? *Dr. Peter N.W. Verhoef*	**7**
High Speed Railway Construction in Spain: **Excursion to construction site at Lilla (Montblanc, Tarragona)** *Compilation of reports written by the 2002 fieldwork students of the Engineering Geology Group Delft*	**9**
Turkije reisverslag *Jeroen Dijkstra en Liesbeth Meerwaldt*	**16**
Thesis abstracts	**20**
Geplande Activiteiten, Internet en Nieuws	**26**

Editorial

Dear readers, Beste Lezers,

Wij willen ons graag voorstellen als de nieuwe redactie van de Ingeokring Newsletter. Het stokje wordt overgenomen van Senol Ozmutlu, die vele jaren de moeilijke taak heeft gehad om de Newsletter in de lucht te houden. Senol wordt dan ook hartelijk bedankt voor zijn inspanningen en de hulp die hij geboden heeft bij het tot stand komen van dit nummer.

Centraal thema in dit nummer zijn de perikelen bij Sectie Ingenieursgeologie. Op de Technische Universiteit Delft is een reorganisatie aan de gang waarvan de Sectie Ingenieursgeologie het slachtoffer van dreigt te worden, zo dit al niet het geval is. Het bestuur heeft de leden eerder dit jaar al op de hoogte gesteld. In dit nummer wordt hierop door Richard Rijkers nog een toelichting gegeven. Daarnaast heeft Peter verhoef, als medewerker van de sectie, een stuk over de laatste ontwikkelingen geschreven. Dat het werkveld Ingenieursgeologie echter springlevend is, wordt in dit nummer aangetoond door het lezingverslag, het excursieverslag van de studenten Ingenieursgeologie en de studiereis van de DIG naar Turkije. Tevens wordt een voorschot gegeven op de activiteiten van de Ingeokring in de rest van dit jaar.

Een nieuwe redactie brengt natuurlijk ook nieuwe ideeën met zich mee. Wij willen graag dat de Newsletter een belangrijk medium voor professionals is waarin nieuwe ontwikkelingen of ervaringen met mede geïnteresseerden gedeeld kunnen worden. Zeker met de recente ontwikkelingen op de TU Delft zien we een belangrijke rol weggelegd voor de Newsletter als binding voor alle Ingenieursgeologen in Nederland. De redactie wil de drempel voor bijdragen aan de Newsletter laag houden, zodat de Newsletter bovenal een (verenigings)blad is en blijft voor de professionele Ingenieursgeoloog. Een aanpassing die daarop wellicht een positief effect zal hebben is dat bijdragen in het Engels als in het Nederlands welkom zijn. Iedere bijdrage is van harte welkom voor publicatie in de Newsletter en wij rekenen op de inzet van de leden.

Tenslotte willen wij het DIG, met name Bart Fellinga en Vera van Beek, bedanken voor hun inzet bij het tot stand komen en de verspreiding van de Newsletter. Veel leesplezier!

Xander van Beusekom, Jacco Haasnoot en Erik Schoute

From the chairman of the Ingeokring

Dear Members,

It is with honour that I can present to you this first issue of the new Ingeokring Newsletter. Recently, it was emphasized strongly by the board of the Ingeokring to rejuvenate the Newsletter into a platform for professionals, students and anybody else involved in engineering geology. Consequently, the opportunity was accepted promptly when three members of the Ingeokring were enthusiastic on the idea to the Newsletter. And here it is!!! I want to congratulate the Newsletter Committee for this achievement.

The Newsletter is planned now to be issued twice a year and has also the ambition to be the most necessary SOURCE for INFORMATION on activities and excursions, new books, university, educational curriculum affairs, fieldwork developments, projects, Delft Cluster, technical discussions, www.iaeg.com, graduations, theses, Phd's, (inter-) national congress, photo's, investigation techniques, interesting people, laboratory work, tunnels, www.ingeokring.nl, companies, job-opportunities, www.geonet.nl, subsurface data, software, underground building, etc. There are too many subjects to make a complete list.

I want to emphasize here as well that the Newsletter is the perfect platform to DISCUSS and publish your professional OPINION on any engineering geological subject. Please be invited. It is also strongly advised to publish your research results in (inter-) national research magazines such as 'Geotechniek', 'Engineering Geology' or to present these in one of our societies evening lectures. You are also very much invited to contact the board of the Ingeokring when you want to 'take the floor'.

I have informed you in February already on the disastrous decision of the College van Bestuur of the TU-Delft to close the Section Engineering Geology at Technische Aardwetenschappen in Delft. The board have already taken determined action and have a strong belief that education and research in Engineering Geology must be continued. On the short and long term a solution most be found to ensure a solid education in Engineering Geology in the Netherlands. In autumn 2002 a symposium "Engineering the Geology" - Perspectieven voor Ingenieursgeologie in Nederland will be organized by the Ingeokring were the need for engineering geological knowledge will emphasized by speakers from industry, government and research institutes. Please attend this meeting!

On this opportunity I also want to focus your attention on the First IAEG Regional European IAEG conference EurEnGeo 2004 to be organised in Liège, Belgium 2004. This congress is organised by the Belgium, German and Dutch engineering geological societies. This most interesting event is gratefully hosted by the Liège university Sar-Tilman and is projected to be the hotest place to be from 2-6 May 2004. Official announcements are being prepared today and you will be informed. Be there!

I wish you great pleasure with reading this Newsletter !

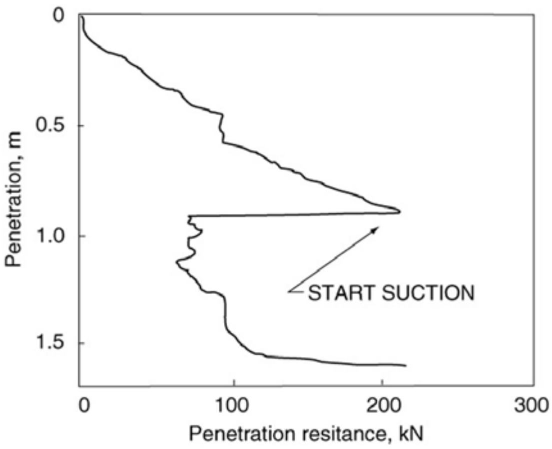
drs Richard Rijkers
President INGEOKRING

Off-shore Funderingstechnieken "Suction Foundations"

ir J. W. Bierman, secretaris Ingeokring
Fugro Engineers, Leidschendam, Nederland

Op woensdag 27 februari organiseerde de Ingeokring een lezing over "Suction Foundations". Onder het genot van een broodje en koffie verzamelden zich rond kwart over zeven ongeveer 30 geïnteresseerden Zij konden luisteren naar twee interessante presentaties, gegeven door ir Harry Kolk van Fugro Engineers BV (FEBV) en ir Rob van den Heuvel van Suction Pile Technology (SPT). Het onderwerp van de presentaties was "Suction Foundations". Suction foundations zijn de afgelopen 10 jaar in toenemende mate toegepast in de offshore industrie. Dit type ondiepe funderingsconstructie dankt zijn naam aan de installatie methode. Deze bestaat uit het wegpompen van water uit een van boven gesloten cylindervormige fundering waardoor een zuigkracht ontstaat die deze de grond in drijft. De constructies worden toegepast voor zowel tijdelijke verankeringen in de zeebodem ("suction anchors") als voor permanente platform funderingen ("suction cans").

De presentatie van Harry Kolk gaf een algemene inleiding over suction foundations en een overzicht van de geotechnische aspecten die bij het ontwerp van deze funderingen een rol spelen. Aan de hand hiervan werden de mogelijkheden en beperkingen van deze funderingsvorm toegelicht. Een en ander werd geïllustreerd aan de hand van enige recente toepassingen.

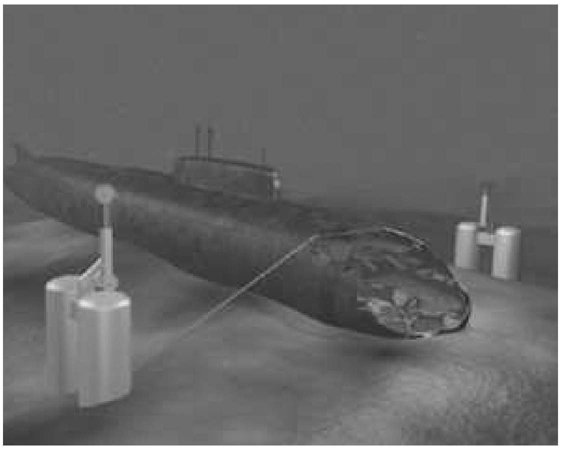


Figuur 1: Reductie van de verticale weerstand door verlaging van de effective verticale gronddruk onder invloed van pompen.

Aandachtspunten van de presentatie waren:
- Introductie over suction foundations;
- Installatie- en verwijderingsaspecten, waaronder installatie in verschillende grondsoorten en effectieve gronddruk reductie door pompen;
- Haalbaarheid van installatie;
- Funderingsanalyse van suction foundations, waaronder statische en cyclische sterkte van grond, optredende bezwijkvormen van de ondergrond en eindige elementen analyses;
- Platform funderings experimenten.

De presentatie van Rob van den Heuvel van SPT ging over drie verschillende toepassingen van zuigpalen:

Lichting Kursk, Barentszzee, Rusland
De beschadigde neus van de Kursk is verwijdert door de desbetreffende sectie van de Kursk van boven naar beneden door te zagen met een zaagketting verbonden aan zuigankers aan weerszijden van de Kursk. Door steeds dieper inzuigen van de ankers werd de zaagketting steeds verder naar beneden getrokken. Een stuk gebruikte zaagketting alsmede een nieuw, ongebruikt stuk zaagketting konden bezichtigd worden. De zeebodem ter plekke bestond voornamelijk uit zachte tot redelijk vaste klei, de zuigpalen bestonden uit 2 cylinders van 4.2 m diameter bij een hoogte van ongeveer 12 m.



Figuur 2: Om de beschadigde neus van de Kursk te verwijderen is gebruik gemaakt van een zaagketting, bevestigd aan zgn. zuigankers ('suction cans').

Ceiba Field Development, offshore Equatoriaal Guinea, West Afrika
Voor de fundering van onderwater manifolds en SDUs in diep water was gekozen voor een 3-paals clusterconcept i.v.m. met de stringente eis dat de fundering maximaal 1 graad uit het lood mocht staan. Door de inzuigdruk per paal te variëren kon tijdens zuigpaalinstallatie de hellingshoek gecontroleerd worden en was het mogelijk om aan de strenge eis te voldoen. De zeebodem bestond uit zeer zachte tot zachte klei.

Millom-West SIP-II platform, Ierse Zee, UK
Het SIP-II concept bestaat uit een 4-pootsplatform met als fundering één zuigpaal per poot. Het platform wordt in zijn geheel naar de locatie gesleept, waarna de zuigpalen worden ingezogen. De waterdiepte ter plekke was ongeveer 40m, de zeebodem bestond uit een 3m dikke toplaag van los tot zeer losgepakt zand met daaronder dicht tot zeer dichtgepakt zand. In verscheidene grondmonsters werden in de dichtgepakte zandlaag kleilaagjes aangetroffen met een maximale dikte van ongeveer 20mm. Dit had een grote invloed op de zuigpaalinstallatie doordat het de verticale permeabiliteit van de grond sterk verlaagde.

Ter afsluiting was er nog een druk bezochte en gezellige borrel. Rond half elf gingen de laatsten naar huis.

(advertentie)

AGG
Adviesbureau voor Geofysica & Geologie

Section Engineering Geology at TU-Delft dismantled

drs. Richard H.B. Rijkers
President INGEOKRING / Netherlands section of the IAEG

When the status report 'Engineering Geology in the Netherlands' was compiled in May 1996 it was not foreseen that 6 years later this a unique research group of scientists in the Netherlands would have be dismantled at the TU-Delft. Also from conversations with prof. Keith Turner it seemed that decisions that have been taken were irreversible.

The portfolio committee of the Faculty Civil Engineering and Geosciences (CiTG) was critical on the research program of the Section and did not felt optimistic on the future plans already during last year. The number of students that finished successfully the curriculum Engineering Geology was of no importance. Current financial problems of the TUD, due to decreasing numbers of TUD registrations of students, and the implementation of a long term strategic research 'vision' turned out to be main arguments for the decisions taken. Accordingly to my information the final decision on dismantling the Section Engineering Geology was taken in March. This meant that the TU-Delft shall stop financing the chair in Engineering Geology and that the new curriculum Engineering Geology shall be redefined by Technische Aardwetenschappen and the ITC to offer an educational program in Engineering Geology for the next academic year. In my opinion the new curriculum Engineering Geology should be redefined with a broad vision on a multi-disciplinary concept together with research groups in geotechnics, geohydrology, civil engineering, architecture and management planning disciplines, ……..… and not just compiling the curriculum comfortable and suitable for the short term.

This is truly a disaster for continuation and development of Engineering Geology in the Netherlands! I was shocked because I felt during the last five years that Engineering Geology was truly filling the gap between geologists and engineers in the field of planning and building infrastructural works in the Netherlands. Also from members working in international operating firms I have only heard alarming stories.

Consequently, the Ingeokring sent their severe concerns to ir. G.J. van Luijk (chair of the Board of the TU-Delft) and prof. dr. ir. J.T. Fokkema (rector magnificus TU-Delft). The main concerns have been described in this letter as follows:

1. continuation of the academic curriculum in Engineering Geology on the short term
2. continuation of the academic curriculum in Engineering Geology based on an integrated vision on multi-disciplinary research and projects
3. continuation of the educational program on delivering Engineering Geologists for industrial companies and research institutes
4. lack of conception (at the TUD) that Engineering Geology is based on combining disciplines in geology and engineering sciences

The Ingeokring has offered the TU-Delft to help with redefining and rehabilitation of Engineering Geology to ensure a firm and long term basis for academic multi-disciplinary research in engineering the geology. The Ingeokring has developed a clear vision in 1997 on the importance and benefit of Engineering Geology in a special status report that was made by more than 70 Ingeokring members. This report will be reviewed and sent to the College van Bestuur of the TU-Delft in June 2002.

Definition of Engineering Geology

'Engineering Geology' is the study of the interaction between 'ground' and any possible use of 'ground' for engineering purposes, either during the design, construction or maintenance phase of an engineering work. 'Ground' consists of any material that is found at the earth's surface or within its subsurface and includes rock, soil or a combination of both materials.

The understanding of the interaction between ground, water and engineering construction is based on combining <u>various disciplines in geology and engineering sciences</u>. Geological disciplines include, but are not limited to, structural geology, sedimentology, mineralogy, geomorphology and geophysics. Engineering sciences incorporate soil and rock mechanics, foundation and construction engineering, and geohydrology. <u>However, geology should always be considered as the core discipline in the multi-disciplinary approach of engineering geology)</u>.

The board of the Ingeokring is willing to put full pressure on universities to ensure an educational program that meets with the current needs and standards of the state-of-the-art Engineering Geology. To empower this strong belief the Ingeokring shall organise the symposium in Autumn 2002:

'Engineering the Geology' - Perspectieven voor Ingenieursgeologie in Nederland

Speakers invited on this symposium will emphasise the need for academic education and research from the industry, government and research institutes. We will keep you informed and invite you to attend this symposium in Autumn.

(advertentie)

Is there a future for Engineering Geology at Delft University of Technology ?

Dr. Peter N.W. Verhoef
Department of Applied Earth Sciences, Faculty of Civil Engineering and Geosciences, Delft University of Technology.

'Delft University of Technology wants to be at the forefront of research and aims to belong to the 'top five' of its kind in the world.'

One year ago I never thought that this mission statement formulated by the University Board would affect the Section of Engineering Geology so badly as it did in the end. Yes, we had troubles in getting our new research plans funded. But the new research direction chosen early 1998 is beginning to bear fruit. Not so strange just four years after implementation of the programs on improved subsurface modelling methods and geotechnical behaviour of clays. Besides research we maintain a flourishing educational program of high standard. We are attracting quite a number of highly motivated students (20-30% of the Department of Earth Sciences). We just started the new international master course in Engineering Geology in 2001. The performance of our graduates in practice is excellent. Most of them work in the field of geotechnical engineering and most still do after a career period of 10 years or more.

In May 2001 the 'portfolio commission' of the Faculty of Civil Engineering and Geosciences submitted their report on the quality of the research at the Faculty. The assignment of the portfolio committee was to critically review the research programmes and to indicate which programs should be discontinued. About 25% of the programmes should be abandoned, to be able to concentrate fully on the stronger programs. The committee concluded on Engineering Geology that it was a discipline of importance for the Faculty. But the research group was too small to be likely to be successful. It was noted that Engineering Geology should play a greater role in teaching at the Department of Civil Engineering, considering the importance of the subject. Much closer cooperation of the Sections of Geotechnical Engineering and Engineering Geology was recommended. Research of Engineering Geology should be part of the theme 'Ground' with other groups studying the shallow subsurface, such as Geotechnical Engineering, Underground Construction and Road Engineering. It was advised that the Section of Engineering Geology would reformulate and focus their research program to fit the new theme. In August 2001 we started an intense effort to redefine our research aims together with the geophysicist Dr. Evert Slob who joint the Section to set up a program incorporating shallow depth geophysics. A brainstorm session with experts from the field of site investigation was held in November. We came up with the theme 'Ground Response', that aimed at improving the accuracy and resolution of subsurface geotechnical models. Sixteen projects were formulated. The other research area of high importance that was indicated at the brainstorm meeting, 'ground improvement', was kept for the future. This program would be implemented once we had the 'ground response' projects going.

Much to our dismay, the management team deciding on the portfolio projects finally notified us early January 2002 that our program was considered not viable. Technically, they said, it was fine, but financially they saw problems. This meant that the Section Engineering Geology would be terminated, since the University Board had decided that groups or staff with disapproved research programs were not allowed to teach! However, the Faculty management team wanted the education program of Engineering Geology to continue.

At the time of writing (May 2002) it is uncertain where the staff of the section will be based. It is expected that before summer more clarity on this subject can be given, but not now. The teaching programs (TU ir. program, the new MSc program and the international MSc program) should proceed. At present there are about 45 students enrolled in Engineering Geology and one international student. We expect more international students in September 2002. Due to the change towards the new Bachelor-Master program that starts in September, some breath is available to cope with the shock, since TU students will choose their MSc specialisation after three years instead of two. Also the staff of Engineering Geology from ITC will still be involved in the teaching, due to the recent events even more so than in the past. Professor Salle Kroonenberg, Chair of the Section of Earth Sciences, has taken the responsibility for the education program. This program should continue along the old lines until a better solution is found. The old engineering geology staff from TU and ITC will supervise students working on thesis subjects. Also staff from other sections (with an approved research program) will be involved in supervising new MSc studies in Engineering Geology. The situation is grave, however. Prof. Turner is leaving in August, completing his three-year part-time position. He is possibly the last professor of Engineering Geology at the TU Delft.

And what can we expect in the near future?

The management of the Faculty has decided to organise a Symposium on research of the shallow subsurface. In this Symposium, which is to be held in September 2002, the interest of Government organisations and industry in innovative research into the shallow subsurface is probed. All groups involved in the theme 'Ground' are interested in the result of this symposium, because it is hard to find sponsorship for truly innovative and fundamental PhD studies on this subject.

If positive, the symposium may result in funding of projects and that can lead to revival of Engineering Geology research that can support the education program. If no boosting of subsurface ground modelling research is possible, than I personally foresee a dead end for the education program as well.

If you would ask the staff of the section its opinion, you would find that they all agree that the obvious future for Engineering Geology is with Geotechnical Engineering. The logic stems from the common field we operate in. The GeoEng 2000 conference, which was held in November 2000 in Melbourne, Australia, was dedicated to the state of the art of the field of Geotechnical Engineering. The lectures delivered were all keynotes that were very well prepared. The speakers were all great names and they were invited five years in advance to prepare their papers. One of the most important conclusions of this conference was that if geotechnical engineering wanted to improve its record, much closer cooperation between the geotechnical and engineering geology specialists is needed. Most uncertainty still lies in the modelling of the groundmass and this can only improve by paying more attention to the geology and have geological and geotechnical specialists work closely together to design the best models. Prof. Morgenstern came with the example from Hong Kong, where the Geotechnical Office developed improved systems of slope stability appraisal. Graphs of the number of slope failures per annum show clearly that after the implementation of combined input of engineering geologists and geotechnical engineers using specified site investigation procedures the number of failed slopes in Hong Kong dramatically decreased.

Geotechnical engineers, engineering geologists and rock mechanics specialists still live in separate worlds. They have separate professional societies, separate journals, separate university education programs. In all countries around the world this seems to be the case. If the record of geotechnical engineering is to improve, this situation should change.

Delft University is (or was?) a unique place. One of the advantages in Delft is that the student can receive excellent education in mathematics and basic engineering sciences next to the applied earth sciences and civil engineering. In this way the mix of knowledge needed for a good engineering geologist could be put on the menu of the TU. It was clear for me that our program neatly fitted the ideal that was drawn at the workshop on education at the GeoEng 2000 conference. Traditionally Geotechnical Engineering at Delft had a very strong focus on the mechanics part of geotechnical engineering. The site investigation aspects and the ground modelling part were less addressed. The education program of Engineering Geology focussed on site investigation and material and mass properties. The programs were therefore complementary. It is obvious that by close cooperation in joint projects great improvement of the state of the art of geotechnical engineering may be made at Delft.

This is the reason that the Engineering Geology staff has the view that close association of the Engineering Geology education programme with the Section of Geotechnical Engineering of the Civil Engineering Department is essential. We also see great benefits coming from joint research projects.

This report on the state of Engineering Geology at the TU Delft cannot be else but a glimpse of the sequence of events that has taken place since August last year. Many of us know how much time and effort has been going into the building of a sound education and research program of Engineering Geology. The aim of the profession is to ensure safe and economical constructions in the earth. In order to do this in-depth knowledge of Earth Sciences and Engineering Sciences is needed. This knowledge certainly is needed for the challenging infrastructure projects that are carried out right now and lay ahead in the future. Engineering Geology requires a sound education on academic level. It has taken about 25 years to come this far at the TU Delft and it is sheer waste if the present reorganisation process would lead to abandonment of Engineering Geology. Let us hope wisdom will win in the end and an experienced professional may fill the vacancy for the Chair of Engineering Geology in the near future.

High Speed Railway Construction in Spain: Excursion to construction site at Lilla (Montblanc, Tarragona)

Compilation of reports written by the 2002 fieldwork students of the Engineering Geology Group Delft:
Group 1: Sara Eeman, Johan Haan (TU Delft); Carolina Sigarán (ITC, Costa Rica)
Group 2: Bat Bold (ITC, Mongolia); Bregje Hegtermans, Agnes van Uitert (TU Delft)
Group 3: Dionisio Pedro de Amurane (ITC, Mozambique); Alyssa Kohlman (TU Delft, Colorado School of Mines, USA); Geert de Jong (TU Delft)
Group 4: Yufei Dong (TU Delft, China); Noëlle Fierloos, Armando Swart (TU Delft)
Group 5: Jeroen van Nes (TU Delft); Rajesh Pandit (ITC, Nepal)

Staff: Michiel Maurenbrecher (TU Delft), Siefko Slob (ITC), Peter Verhoef (TU Delft)

Guides: Alfredo Alba, Luis Fernando San Dimas (Inocsa Ingeniería, S.L.); Jose Luis Amibilia, José Espejo (FCC Construcción S.A.)

Introduction

On Thursday, May 16, 2002, the ITC and TU Delft fieldwork group visited a construction site near the village of Lilla, in the Tarragona province of Spain. The purpose of the project is to construct a passageway for the high-speed railway line from Madrid to the French border. The project we visited is “subsection 4B” of the Lleida – Martonell leg of the Madrid – Barcelona section. The site itself is located near national highway N240 between Valls and Montblanc.

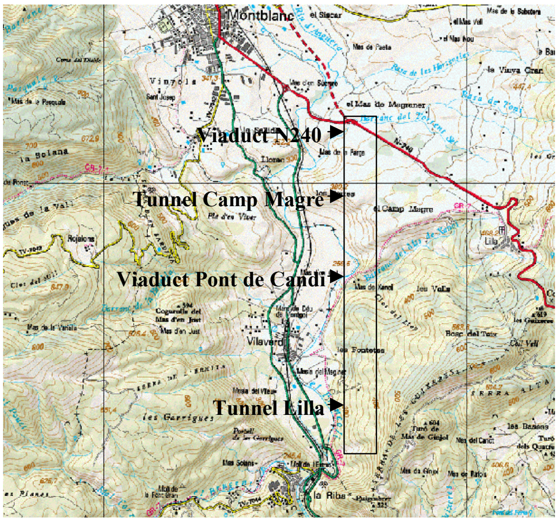


Figure 1. Site location

The Spanish Ministry of Public Works funds the project. A consortium of contractors and consultants handles the work. The main contractor is FCC Construcción S.A., one of the main contractors in Spain. The project is approximately five kilometres long, and includes two tunnels (totalling 3 km in length), five open cut excavations and two bridges. One bridge is over the national road running from Lleida to Tarragona, and the other crosses a valley near the town of Villaverd. The decision to build tunnels at the selected locations was based on a combination of factors, including environmental and ecologic concerns, geotechnical issues, and economics. The budget for the project is 63 million euros.

Characteristics of the project

The section of the high-speed railway under construction (“IV-B, Lleida-Martorell”) has a north-south orientation with a total length of 5260 m and a width of 14 m. There are lateral concrete ditches in some sectors. It consists of four sections: two tunnels and two bridges (Tables 1 and 2). It starts south-east of Montblanc with the first bridge (no.1, Table 2) and finishes with the Tunnel de Lilla, to the east of La Riba. The bridges have a maximum slope of 1.8%, and the tunnels 2.5%. The tunnels are 10 m high and 14 m wide.

Tunnel	Length (m)	Radius (m)	Section (m^2)	Excavation (m^3)
De Camp Magre	993.8	7.26	110	138000
De Lilla	2102.2	6.46	90	245000

Table 1: General characteristics of the tunnels

Bridge	Location	Length (m)	Maximum height
1	Highway N-240	116	16
2	Pont Candi valley	413	56

Table 2: General characteristics of the bridges

The owner of the project is GIF (Gestor de Infraestructuras Ferroviarias, the Spanish Railways Owner). Funding is by European government (75%) and the French and Spanish governments (25%). The construction started in February 24th of 2001 and is expected to be finished in June 2003. At the moment progress is ahead of schedule, so one estimates to be finished a few months earlier. The project is in its advanced construction stage. The excavation of the tunnels was finished a few weeks ago and the final lining is now being put in place. Both bridges are under construction at the moment.

Geological setting

The site is in the Tertiary of the Ebro River basin, in Lower and Middle Eocene rocks. In this area the bedding is generally horizontal. Valleys formed by the Francoli River dominate the geomorphology. There are essentially two horizontal to sub-horizontal units of Tertiary deposits, the Formación Roja (Red Formation) and the Lagunar de Techo Formation (Lake roof formation).

The Formación Roja is the lower unit and includes clays, siltstones, argillites, and shales. These are strongly cemented by mainly gypsum and also calcium carbonate, which occur both in the rock material and as infill of the discontinuities. The gypsum cementation gives the Red Formation claystones a high strength and gives the rock a massive appearance.

The upper "Lake roof formation" consists of interstratified layers of limestone and marl, but can be divided into two units: one of dominantly limestone and another of dominantly marls. The units are generally jointed and occasionally faulted. The thickness of the layers is generally on the order of decimetres. Thicker layers occur; most are less than 1.5 - 2 meters thick. In this formation a few erodable clayey layers occur.

Site investigation

Inocsa Ingenieria S.L performed the site investigation. Several vertical and inclined boreholes were drilled along the alignment of the tunnels and at proposed pillar locations. Seismic methods were also employed to look for fault features. No major faults were encountered, only some minor faults with small displacements. In-situ testing included penetrometer and permeability tests. UCS and abrasion tests were also carried out. The rock material strengths found are between 20 to 50 MPa for the Red Formation, and between 80 and 90 MPa for the limestones of the Lagunar de Techo Formation. Rock mass characterisation was done using Bieniawski's Rock Mass Rating (RMR) system. It was concluded that for tunnelling, the rock mass quality is "fair" when the depth is greater than 50 meters. Above that the rock was weathered and of poor quality. When the contractors started working they made between 10 and 15 extra boreholes to improve the geologic engineering model.

Tunnels

The Camp Magre tunnel cuts both geological formations; approximately 350 m was excavated in the Lagunar de Techo Formation and the rest in the Red Formation. The Lilla tunnel only cuts the Red Formation. The highest overburden in the Camp Magre tunnel is 80 m, and in the Lilla tunnel 110 m.

Excavation methods

The tunnels are horse-shoe shaped with a final dimension of 10 m height and 14 m width. During the first phase of the tunnel excavation, only the upper part of the tunnel was excavated. The floor was lowered during the second phase. The predominant methods of excavation used were drilling and blasting and mechanical excavation. The method of excavation applied was mainly determined by the geology of the site. Weaker rock mass was excavated using hydraulic hammer and excavator. The use of a TBM in this project was not feasible due to the strength variations of the rock mass and the short length of the tunnels.

The daily excavation advance was between 8 and 12 m. Generally it was done in two steps, first the upper half section was drilled and blasted, then the blasted material was extracted, followed by emplacement of the support. After that the lower section was drilled, blasted, excavated and supported. The drilling pattern and blasting sequence used in the stronger rock was designed to create a smooth wall. For this purpose the explosives in the centre of the face were ignited a few milliseconds before the explosives on the side.

HSL Lilla Bridge

HSL Lilla tunnel portal

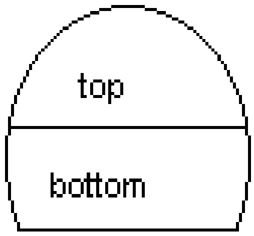


Figure 2: Tunnel cross section

Temporal support

The design of the temporal support was based on the NATM (New Austrian Tunnelling Method), using the RMR (Rock Mass Rating) classification system in the design stage. The temporal support design was chosen before the excavation based on the characteristics of the rock mass. Tunnel support depends on the geotechnical conditions. To monitor the deformation of the rock around the excavation, convergence measurements and extensometers were used. For hydraulic monitoring pressure cells were used, although there have been no reports of engineering problems due to water. Triangular convergence monitoring was found to be one of the best monitoring methods, and these stations are checked daily.

The minimum support used was shotcrete. The shotcrete used in both tunnels is Silex, a sulphate resistant type, to ensure that sulphate coming from the gypsum in the rock cannot damage the shotcrete. Ordinary rock bolts and Swellex bolts were also used as support and in the worst conditions steel arcs were applied.

HSL Lilla Bridge

Approximately the first 100 to 150 m of both tunnels (the portals) needed a stronger support due to the weathering degree of the rock mass (especially in the case of the Red Formation) and the low overburden height. This extra support consisted of steel arches (HEB-160) every 1 m, mesh, systematic bolting, and 25 cm of steel-fibre reinforced shotcrete. The bolts employed in these sections of the tunnels are of the super-swellex type, placed at the same spacing as the arches, with a density of 21 bolts for every 4 m of tunnel length. They are 4 m long, have a force of 25 tons, and were placed only in the walls, not in the roof.

The rest of the tunnels have as support mainly 10 to 15 cm thickness of fibre reinforced shotcrete, systematic bolts in the walls of the tunnel in some areas of poor quality rock mass. Steel arches (HEB-160) are placed every 1.5 m with mesh in some sections of very poor quality in the argillites. The bolts are Swellex type, 4 m long, giving a force of 12 tons.

In many cases shotcrete was applied to support the face immediately after excavation. This was done to prevent decompression and excessive deformation of the argillites of the Red Formation in the tunnel face. The “probing ahead” technique was also used before the next excavation round. Wherever gypsum rich material was found, a curved floor was introduced to the shape of the tunnel and reinforced concrete was used.

Final lining

The tunnel will be finished with a layer of geotextile to provide drainage, then a layer of PVC to keep the water away from the concrete and lead it to drains in the tunnel floor. The smooth concrete wall will be cast in place to increase aerodynamics; this is a requirement for the high speed trains in tunnels.

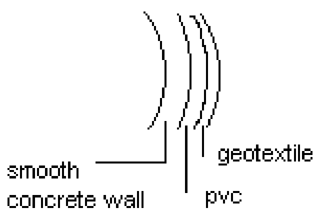


Figure 3: Tunnel lining

Problems during excavation

In general there was no water present during the excavation, and if so only low rates of water inflow occurred. The local aquifers are related to the upper layers of the Lagunar de Techo Formation, located above the excavation. There are apparently no important geological structures (faults, shearing zones) through which water could flow into the tunnel. A normal ventilation system inside the tunnel was used to extract the local air contamination due to blasting and the machinery employed; there was no presence or risk of any hazardous gas.

In a few areas of the tunnel an extra support ring of reinforced concrete was needed in the floor due to brief changes in convergence. The highest convergence registered at the moment has been 4 cm in the argillites of the Red Formation. There were some problems with overbreak related to the argillites. The maximum overbreak that occurred was 2 to 3 m. The Lagunar de Techo Formation also had this problem along the erodable clay layers, giving a flat geometry on the roof of the tunnel.

Bridges

The project also includes construction of two bridges: one 116 meters long and another 413 meters long. The bridge design allows for the maximum speed of 350 km/h of the high-speed

Bridge over N240

The first bridge, with a length of 116 m (Table 2), has a maximum span of 53 meters. Its maximum height above the road is 16 m. The large span was needed for two reasons: the angle between the highway and the bridge is smaller then 90 degrees, thus increasing the minimum distance, and space needed to be left for doubling of the highway in the future. The bridge consists of two large elements. Each cast in situ in a steel casing. The bridge is very stiff to prevent vibration when trains are passing at top speed. The abutments are also extra stiffened to make sure a train can make an emergency stop on the bridge. The bridge is founded on piles on the Middle Eocene limestones. Stronger and weaker limestone layers alternate, but because the formation is horizontal it is sufficient to found on one of the stronger layers.

Pont de Candi

This bridge spans 413 m and reaches a maximum height of 56 m. The bridge has ten sections, each 43 meters long. All pillars are founded on eight or nine concrete piles, cast in situ. The piles are founded on a siltstone layer of the Lower Eocene. The piles under the middle pillars are 22 m long and bear mainly on their ends. The side pillars are 42 m deep and bear mainly through sleeve friction with the surrounding red claystone. One side of the bridge is founded in the claystone layer, to take up the high dynamic loads in case of an emergency stop. The other side is loose to prevent the bridge from breaking.

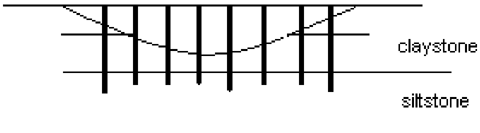


Figure 4: Pile foundation

railway trains. Both bridges were designed to resist the forces of a high-speed train suddenly braking. This required that special care be taken with the foundation design to resist horizontal strains. In the case of the longer bridge, only one abutment is fixed. The shorter bridge is designed to resist the forces of two high-speed trains travelling in the same direction braking simultaneously, and also the forces of two high-speed trains travelling in opposite directions braking at the same time, which would induce a torque.

The material for the concrete of which the bridges are built comes from a nearby quarry in the “Muschelkalk” Formation. Water and other materials are added on a concrete plant on the site. The strength of the concrete used is 45 MPa.

The concrete deck elements are cast on the north side of the bridge and then pushed forward on hydraulic jacks. The platforms are built in sections, which are linked with steel cable. The whole unit is subsequently pushed with a system of hydraulic jacks as a new section of the platform is added. When a section is dry, it is fastened with steel strips to the previous section and pushed forward with jacks. The jacks have an extension of 25 cm, and the pushing takes place two or three times a week. To improve the sliding, there is a special system between the pillars and the bridge. This consists of a steel reinforced concrete casing (2 half hollow blocks), with a round block inside, consisting of Neoprene on the upward side, and Teflon on the downward side. Since Neoprene has a very rough surface, and Teflon very smooth, the bridge slides over the Teflon layer and grips on the neoprene layer.

Each element needs to be pre-stressed twice. The first is at the casting site, but this is not yet enough. The second phase of pre-stressing will be through special holes in the bridge, after each element is in place. There are also tubes in the bridge to finally fix the bridge to the pillars using grout and cables. At the front of the bridge a steel appendix is connected to keep the vertical stress on the bridge low when the front is in the middle of two pillars. Small jacks are on the front to lift it when the next pillar is reached. This is needed since there is always some bending downward when crossing a section between two pillars.

This technology has been on line for the past ten years or so and has proven to be very effective from an economical and technical point of view. It also has a high factor of safety for working conditions.

Excavations

One of the open cuts made for the railway showed instability. After heavy rainfall previous to the visit, a small (20 meters long by 9 meters high) slide occurred at the contact between the Lower Eocene Red clays and the pervious colluvial material on top. The slope has been left to rest since then. When the project is nearly completed, the unstable material will be shovelled away and large stones will replace the slide material to stabilize the slope.

Conclusion

Apparently the building of both bridges and tunnels is going quite smoothly. The only real problem has been overbreak occurring in the tunnel. It is apparently possible construct a tunnel in a claystone formation containing a lot of gypsum. The engineers stressed, however, that in this case the surrounding ground is quite dry. This rock type would probably give serious problems in a humid country, due to excessive deformation in the tunnels through water-weakening of the claystones.

Our hosts at the project site were Alfredo Alba, the director of the project; José Luis Amibilia, the construction manager; José Espejo, the structural engineer; and Fernando Sandimas, the project geologist. They were gracious hosts and later treated us to a traditional Spanish lunch (paella!) and local Francoli wine at El Moli de Mallol (= windmill) in Montblanc.

Lilla Slip

De blauwe moskee in Istanbul


Een groepsfoto voor de bibliotheek in ephesus

Turkije reisverslag

Jeroen Dijkstra en Liesbeth Meerwaldt
Studenten Ingenieursgeologie, Technische Universiteit Delft

Op zaterdag 30 maart was het zover, een groep ingenieursgeologie studenten vertrok naar de andere kant van Europa. Turkije was de bestemming.

De reis begon op Delft centraal station alwaar de reisleiding (wij dus) ons veel te vroeg liet verzamelen om nog drie kwartier op de rest te wachten op schiphol. In deze tijd werd gebruik gemaakt van alle faciliteiten die schiphol rijk is, onder andere koffie en thee, die het leuk doen op een Tommy Hilfiger broek. Nadat iedereen gearriveerd was, werd het tijd voor de incheckbalie. Het was voor deze balie dat wij voor het eerst in aanraking kwamen met de camera van Michiel…..(die we tijdens de reis nog heel vaak zouden zien). Na een voorspoedige reis werden we op Istanbul international airport opgewacht door onze gids, steun en toeverlaat Cenk Kocak. Hij begeleidde ons naar de Campus dormitories, alwaar wij de eerste drie nachten van ons Turkse avontuur doorbrachten. De eerste avond begon al gelijk goed, een diner bij kaarslicht gelokaliseerd op een van de mooiste plaatsjes van Istanbul samen met enkele Turkse studenten. Onze gastheer trakteerde ons op alle lekkernijen die de Turkse keuken rijk is. Na een magnifique diner gingen we met een nu wel werkende bus terug naar de dormitories. Een goede nachtrust was de basis voor een rondleiding over de campus, een bezoek aan de campus dam en een middagje Istanbul. In Istanbul hebben we alle culturele bezienswaardigheden bekeken en geconstateerd dat Nederlandse meisjes en een hoofddoekje niet de beste combinatie zijn (of toch wel?). Moe maar voldaan werden we bij onze avondattractie afgeleverd….Een echte partyboot op de Bosporus!!

Metro van Istanbul

Maandag werd dan toch begonnen met het technische gedeelte van de reis. Allereerst stond een bezoek aan de oude en nieuwe metro van Istanbul op het programma. We werden bekend gemaakt met de NATM methode en verbaasden ons over de dunne trappetjes. Na alle beschermende laarzen zonder stalen neuzen weer te hebben ingeleverd stond het middagprogramma al weer te wachten. Maar dit kon niet beginnen zonder de beide docenten tevreden te maken met een bezoek aan het café waar de koning van de geotechniek, Terzaghi, wel eens een Turkse chai dronk. Na een theetje had iedereen het weer gezien en was het tijd om de Turkse fast-food ketens eens aan een onderzoek te onderwerpen alvorens we drie earthfill dammen zouden gaan bezoeken. Bij de derde dam was het animo om uit de bus te komen erg laag, want het was zo guur en koud dat zelf een ijsbeer liever in de bus zat. Met een goede kebab maaltijd en een avondje gezellig borrelen op de faculteit was het de volgende dag tijd om Istanbul in te ruilen voor ons grote avontuur….alleen op pad met een Turks sprekende buschauffeur. Met in de middag een stop op het slagveld van ataturk uit de eerste wereld oorlog, Gallipoli, werd de oversteek naar een ander continent gewaagd voor onze slaapplek. Onze buschauffeur, in de veronderstelling dat wij als Nederlanders alleen maar fast-food eten, leidde ons meteen naar de locale hamburger tent, maar met de nodige handgebaren maakten wij hem duidelijk dat wij ook de plaatselijke specialiteit konden waarderen. Met een zeer vroeg vertrek en voor het eerst van de reis een zonnetje was het tijd voor het toeristische Troje. Na onze eerste kennismaking met de Griekse oudheid was het tijd voor weer een lange busrit naar Bergama. Onderweg werden de locale specialiteiten vriendelijk geweigerd toen de ingrediënten ons ter ore kwamen.

Open pit

De volgende dag werd voor ons een les in Turkse gewoonten door een afgesproken tijd met een korrel zout te moeten nemen. Allereerst stond een goudmijn op het programma waar we een rondleiding kregen door een Australische mijngeoloog. Met een bezoek aan de openpit en het showen van de modellen en boorkernen was het tijd voor een voor sommige te stevige lunch. Met een goed gevoel werd de reis ondernomen naar een dam constructie. Deze dam zal in de toekomst een oud grieks thermencomplex overspoelen. Op dit moment zijn door de vondst van deze site de werkzaamheden gestopt en konden wij rustig de ruines bezoeken. Na een bezoek aan de dam was het weer tijd stenen en zuiltjes te kijken in Pergamon. Met verwoede versierpogingen op de Turkse dames en een huwelijksaanzoek werd deze dag afgesloten. Op vrijdag was het tijd voor een kort ingelast bezoek aan een gekkenhuis uit de oudheid en een zeer indrukwekend bezoek aan een steenkolen open-pit mijn. Deze gigantische mijn bestond uit 7 gigantische open-pits. De chauffeur was na al die regenachtige dagen in combinatie met baggerende mijnbouwers het poetsen zat en regelde een bus van het mijnbedrijf waarmee we de hele mijn doorgingen.


De overblijfselen van een volcanische tuf op de weg naar Ankara.


De verticale offset van de breuk.

Geothermaal Izmir

Op de weg naar Izmir stopten we voor een snel bezoekje bij de ouders van een van onze gidsen. We kregen een warm onthaal en werden gelijk voorzien van hapjes en drankjes. De schoenen die we bij de deur uit hadden getrokken stonden met de neus naar de deur weer op ons te wachten toen we weggingen, dat bedenk je hier in Nederland toch ook niet! In Izmir bezochten we een geothermal plant voor stadsverwarming. Alvorens we ons tot grote hoogten lieten voeren voor een picknick. Het boeiende nachtleven maakte dat de meeste van ons de volgende dag met een wat minder scherp beeld de mooiste Griekse opgraving van de tour zagen: Ephese. Op de terugweg werden in Sirince de nu ook in Delft bekende wijnen geproefd en alleen, hoe kan het ook anders, door een persoon met een baard en een camera gekocht.

Een overzicht van een van de zeven open pits van de kolenmijn

Met een lange rit naar Pamukkale voor de boeg, vertrokken we de volgende ochtend uit Izmir, om onderweg nog even te stoppen bij een thermale energieplant. Hier werden we rondgeleid door een minimaal Engelssprekend klein kaal dwergachtig mannetje. En toen, na een kort tripje naar de witte travertijnen (Pamukkale)…was het zwembad tijd. Badmuts op, ogen dicht en gaan! ‘s Avond werd, helaas zonder getuigen, het buikdansen beoefend door een van de stafleden, terwijl de rest van de groep zichzelf gaar liet stomen in het rode, licht radioactieve thermale water van 45 graden. Geheel herboren gingen we de volgende dag via de rode travertijnen en een zoutmeer op naar het volgende thermale resort. Ditmaal een met wat meer sterretjes! Hier maakte iedereen zich door middel van massages, gezichtsbehandelingen en Turkse stoombaden op voor het laatste gedeelte van deze o zo zware studiereis.

Met spijt namen wij de volgende dag afscheid van deze hemelse locatie en brachten onze dag door met een afwijkend programma. We vielen met onze neus in de tuff, grote punten van tuff…..oftewel een geologische bezienswaardigheid. Waarna sommige heren scènes uit cliffhanger imiteerden op een veel te steil trappetje op een uitgehakte kerk.

Ankara

‘s Avonds laat kwamen we aan in Ankara, hoofdstad van Turkije en de laatste rustplaats van Ataturk. De twee dagen die we in Ankara doorbrachten werden gevuld met culturele en ingenieursgeologische dingen als het *directorate of disaster affairs*. Na twee dagen waren er alleen nog jongens met een stijve nek, vanwege het nakijken van al die mooie vrouwen, en een lege portemonnee, vanwege de dure smaak van onze Turkse vrienden, binnen onze groep te vinden. Ons bezoek aan Ankara werd afgesloten met een traditioneel Turks diner, waar we de verleiding niet konden weerstaan de traditionele Turkse kledij te showen. Door een van de docenten werden zijn vrouwelijke kanten ontdekt….

Bursa

Na een vroeg vertrek kwamen we 500 km verder tegen lunchtijd aan bij de constructiesite van Bursa. Hier wordt een snelweg aangelegd van Istanbul naar Izmir. Hier werden we heel gastvrij ontvangen en rondgeleid. Dit alles werd afgesloten met een, hoe kan het ook anders, Kebab BBQ. Na een nacht op de constructie site begon een indrukwekkende dag, we bezochten het aardbevingsgebied rond Izmir waar nog steeds de gevolgen van de ’99 aardbeving zeer goed te zien zijn. Land werd zee, tuinen werden bergtuintjes, gebouwen werden lege plekken in de stad. De tranen in de ogen van onze Turkse vrienden gaven weer wat allen van ons voelden. Met deze waardige afsluiting van de studiereis werd op 15 april de terugreis aanvaard.

Teruggekomen in dit westerse landje was het voor iedereen tijd om met veel plezier terug te kijken op een mooi Aziatisch avontuur. Wij zijn blij dat deze reis een succes was en willen iedereen die mee is geweest bedanken voor de gezelligheid.

ADVERTISING IN THE NEWSLETTER

The Newsletter is a journal on engineering geology and related fields. It is distributed twice a year to the 200 members of the Ingeokring and several companies and institutes, active in the field of applied earth sciences.

The Newsletter gives the possibility to advertise and bring your company to readers' notice. Advertisements will be in black and white either half a page or a whole page large.

- A4 format Euro 200 (for two issues)
- ½ A4 format Euro 125 (for two issues)

Camera-ready advertisements should be sent to:

Dispuut Ingenieursgeologie
Delft University of Technology,
Faculty of Applied Earth Sciences, Section Engineering Geology
PO Box. 5028, 2600 GA, DELFT
phone : 015-2786026
fax : 015-2784103

Payment should be made to:
DIG
giro nr: 5780457
Mijnbouwstraat 120
2628 RX, DELFT

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.

Weathering processes in the Upper Muschelkalk of the Tarragona Province (Spain) in relation with material composition

Guru Prasad Adhikari (Nepal)
International Institute for Aerospace Survey and Earth Sciences, Section Engineering geology
April, 2002

Material composition of a rock has an important role to the processes of weathering. It determines the dominant weathering process in a particular area and climatic condition. It has been decided to establish a relation between the material composition of the rock and the processes of weathering. The Upper Muschelkalk (tg 23) rocks, from Taragona province, Spain, have been reported in this formation. Samples have been collected during the field work in this area in June 2001, considering the difference in material composition, at least in clay content and carbonate content, has been taken in to account.

All samples used in this study come from the same slope. The samples have been classified according to BS 5930: 1999 and modified Price (1993) methods. Then, various tests haven been carried out in the laboratory to obtain the data. Data thus obtained were plotted against material weathering rating of the samples as well as against the other engineering properties of the rocks to show a relation. In this way, all the results, and findings, were used to make an interpretation. It has found that, due to change in sedimentary depositional environment (transgressive and regressive cycles), alternating layers of clay and carbonate were deposited, at the time of deposition. After they were exposed to atmosphere, due to the climatic condition of the slope,they were subjected to the physical process of weathering. Chemical process of weathering has almost no or small effect. Wetting and drying is the dominant weathering process in the slope, under the action of which clay rich layers are more affected, resulting the samples in present different weathering grade. As a consequence some changes in engineering properties have been observed within the sample.

Rock mass classification, Rock mass degradation and slope stability in the Middle Muschelkalk, in Tarragona Province (Spain)

Eddy Hernandez Hernandez (Cuba)
International Institute for Aerospace Survey and Earth Sciences, Section Engineering geology
Februari, 2002

The middle Muschelkalk (Tg22) formation in the province of Tarragona, Catalonia, Spain consists of red clays, claystones and gypsum. The amount of gypsum varies considerably. In many outcrops a thinly laminated combination of the claystones and gypsum is encountered.

In the man-made slopes in which this particular unit is present the stability depends mainly on the erodability of the rock mass. The dissolution of the gypsum plays a secondary roll. The main slope failure mechanism is the surface erosion and washing out of the material from the slope face dealing to a reduction of the slope angle, undercutting of the hillsides above the cuts and increasing in road maintenance costs.

The aim of the research would not only be to quantify the rock material degradation, but also to establish the degradation in time and come up with a classification system to describe and predict the stability problems in this particular unit.

A series of laboratory tests were carried out. The results of the slake durability tests following the ASTM standard procedure combined with the non-standardized methylene blue absorption test, X-ray diffraction and fluorescence and description of the samples following the British Standard procedure are presented in order to quantify the rock degradation of this unit and establish the factors that affect it. These factors are the amount of gypsum, the strength, the spacing of the discontinuities and the grain size in the samples. In

addition, the slake durability index values are compared with other results for other types of weak rocks around the world.

The data collected from 12 years of fieldwork consists of outcrop or slope location, slope dip, dip direction and height, discontinuities and their characteristics in the rock mass, degree of weathering at given moment, rock mass description, slope instability problems description, sketches and pictures. In the data gathering and processing other parameters were estimated such as the date the slope was cut and the percentage of gypsum mineral in the rock mass. A stability category scheme with descriptions for this unit is suggested.

The results on small scale indicate that the degree of slaking or degradation of the samples is related to the amount of gypsum and clay mineral and the strength values. There are other factors that are likely to have influence also, such as the grain size, the presence and spacing of the discontinuities and mineral hardness. On large scale, the relationship between the slope dip, slope height, the estimated percentage of gypsum in the rock mass and the stability category reached by the slope in a given time was established and a classification system is presented.

The discussion is illustrated with graphs and tables. The conclusions are drawn about the limitation of the results and the necessity of carrying out more research in order to increase the reliability of the results.

North Sea Geotechnical Database

Le Minh Son
International Institute for Aerospace Survey and Earth Sciences, Section Engineering geology
May, 2002

Geotechnical data of the Dutch sector, North Sea collected by TNO-NITG for many years has still been stored in the raw format. However, data can be explored much more effectively if it is organised in an appropriate database. In addition, if data is stored in a digital database then this database can interconnect to Geological Electronic Information Exchange System (GEIXS) on a Web server and facilitate the interchanging data among organizations through the network according to EUMARSIN program.

Quadrant K and L of the Dutch sector, North Sea is selected as a pilot area for the North Sea geotechnical database. All geotechnical properties of soil samples within these two quadrants are entered into the database. However the North Sea geotechnical database has not included CPT data and seismic data yet.

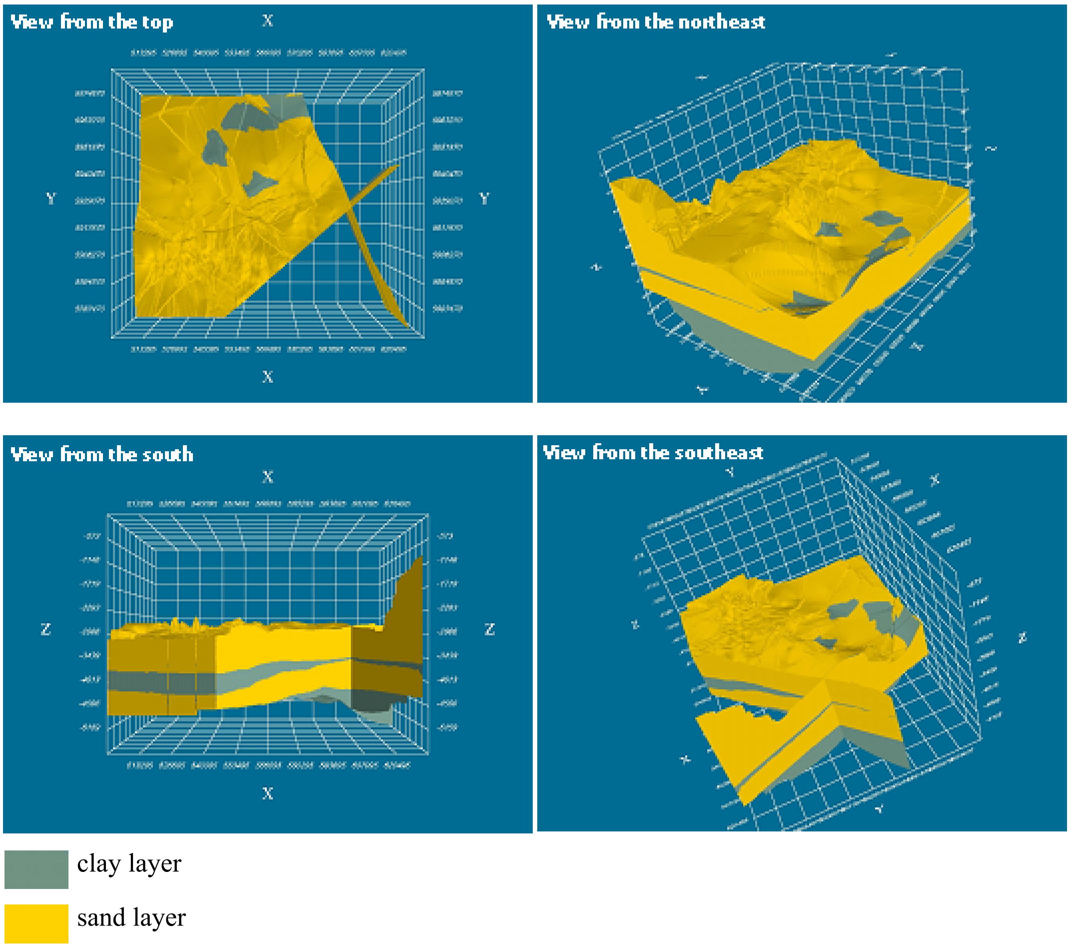
The field names in the North Sea geotechnical database follow the DINO structure as far as possible. After defining the structure of the database, the conceptual design can be implemented into a relational database software such as Microsoft Access.

From the designate database, two applications are carried out as illustrations:

1. Statistical characteristics of sand deposits in Quadrant K & L, the Dutch sector, North Sea are explored. In addition, the uncertainty of estimation in terms of the confidence intervals and relationship between effective friction angle and other properties are also examined.
2. Seabed surface map and boundary maps of each geotechnical unit are established using the ordinary Kriging method. These maps are visualised in the three-dimensional view using Geospatial Explorer package from Cyze & Associated Ltd. company and Geo3DJViewer package from TNO-NITG (see Figure). Besides the estimated maps, error maps are also included to quantify the uncertainty of the interpolation.

The conclusions of the thesis are:

1. Data can be explored much more effectively if it is organised in an appropriate database instead in a raw format.
2. If the geotechnical database is designed properly, the temporal/spatial distribution of a geotechnical property can be extracted through SQL statements, which are available in all relational database management systems.
3. The major structures of the seabed surface from the Kriging interpolation and from bathymetry measurements are almost identical. The bathymetry seabed surface map is certainly more detailed than the Kriging seabed surface map due to the regular distribution and the huge amount of data points.
4. Kriging method can be used to obtain a spatial distribution of a geotechnical property, especially in case the data points distribute sparsely.



Thesis Le Minh Son: 3D view of Quadrant K & L using Geo3DJ Viewer

---

Semi-automatic Cone Penetration Test data interpretation

Jos Maccabiani
Delft University of Technology,
Faculty of Applied Earth Sciences,
Section Engineering Geology
2002

The construction of a subsurface model is a common but important step in many geotechnical projects and investigations. The construction of these models requires a lot of expert knowledge, yet very often different experts will construct different models based on the same hard data. It is increasingly recognized by the geotechnical community that quantitative techniques might assist in producing more objective and robust subsurface models and, more importantly, that computing power has increased to a level that these techniques can be applied to data sets of practical size.

In this light, this research deals with the semi-automatic interpretation of Cone Penetration Test (CPT) data. Every year, about 30,000 CPTs are performed in the Netherlands while only about 5,000 boreholes are made. Consequently, many Dutch institutions and companies have an extensive database of CPT results. Due to the time involved in analysing these data, a lot of the information contained in the CPT data of a given project area is often left unused. A more reliable image of the subsurface can result from a refined interpretation of these CPT data. The aim of this thesis research is to explore the possibilities of the use of certain soft computing techniques in the construction of subsurface models using Cone Penetration Test data.

Before any new method is developed, the benefits and limitations of the existing methods should be known. Three existing automated techniques were applied to the data. These techniques are 'direct visualization', in which a colormap is applied to the values of one of the parameters, 'data binning', in which the values of one of the parameters are divided into several pre-defined categories, and 'Olsen classification', in which the bivariate data are color coded based on the soil classification chart by Douglas and Olsen. The results that provided the most information about the subsurface were obtained by the 'direct visualization' technique. By applying a colormap to the CPT data for either one of the measured parameters, it may be possible to obtain a general idea of the subsurface structures. The best results are obtained when there is a high contrast between the parameter values of the occurring soil types; when there are gradual changes the results are much more difficult, if not impossible, to interpret reliably.

The new method is based on an approach that more resembles an expert's approach at CPT data interpretation. The techniques to be developed are roughly defined as follows. First, the CPT logs should be segmented, i.e. subdivided into regions which are significantly different from the surrounding regions. These regions should signify a distinct sedimentological period or situation. Second, these segments should be correlated spatially with other segments. Finally the geotechnical meaning of these groups of segments should be determined.

The dynamic programming algorithm proposed by Huijzer (1992) is presented for semi-automatic segmentation of CPT data. This algorithm is able to segment a CPT into geotechnically meaningful segments by minimizing the pooled within-group dispersion matrix. In 1992 the computational load of this algorithm prevented use on practical data sets, but this is now no longer a major problem. The algorithm does not automatically determine the optimum number of segments in a CPT trace. In this research the optimum number of segments is based on the average number of segments per meter CPT length, determined by a human expert. This yields a 90% match with the separately performed manual segmentation by an expert.

The next step after segmentation of the CPTs is spatial correlation of the segments. In order to be able to perform quantitative spatial correlation to the segments, they need to be parameterized. Seven different parameters, developed by Coerts (1996), were researched; two central tendency parameters and five parameters describing the shape of the CPT trace (e.g. convexity, number of peaks etc.). Because there are two traces, for qc and Rf, this makes a total of 14 parameters. It was shown that these parameters can be transformed automatically to univariate normality using the Box-Cox power transformation. Univariate normality is necessary for most statistical procedures among which the cluster analysis techniques used.

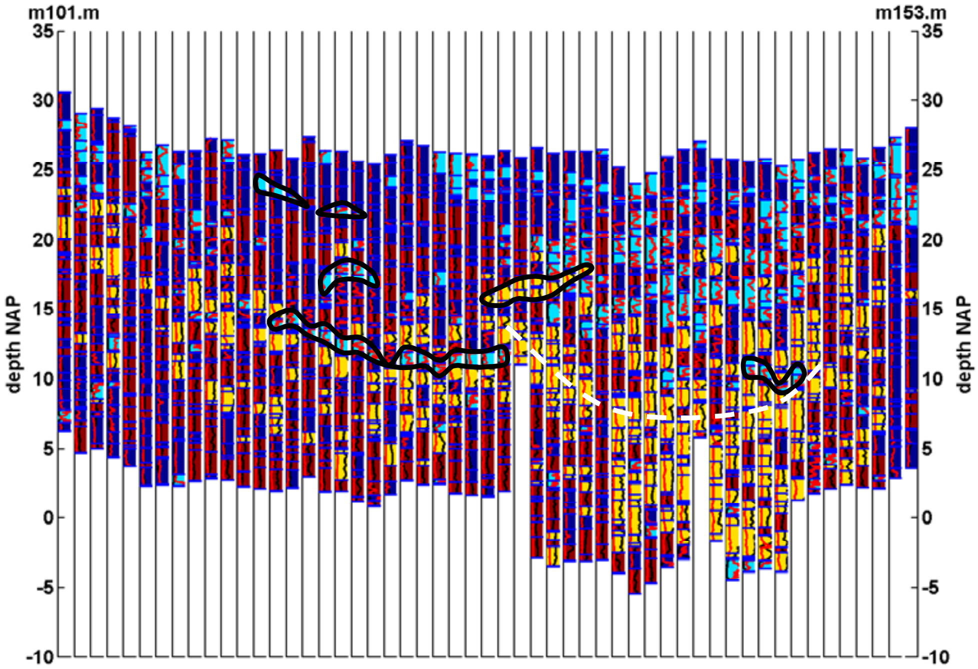
When the CPT segments are described using these 14 parameters, cluster analysis can be applied to correlate the segments. There are many different clustering algorithms and in this research the focus was on fuzzy cluster analysis techniques. The problem with the more conventional fuzzy clustering algorithms is, that the number of clusters present in the data set is an input parameter. The cluster validity measures known from literature are not able to predict the number of clusters present in the data. The E-FCM algorithm, a new fuzzy clustering algorithm developed by Kaymak et al. (2000) that features volume prototypes and similarity-based cluster merging, is able to automatically determine the optimum number of clusters. For the research data, the best clustering results are obtained when the segment means of the cone resistance and friction ratio and the relative interquartile range are used as parameters. They have to be normalized by the Box-Cox method and the scaled principal components of these normalized parameters have to be clustered. Then four clusters are retrieved, as shown in figure 1. The manual interpretation by a geologist also resulted in four, very similar, lithologies that were mappable on this regional scale.

In conclusion, these techniques show great promise. Especially the speed of the techniques enables the processing of large amounts of data so that the experts can use their time more efficiently. In this research the clustering is mainly based on the central tendency parameters. Since these parameters can fluctuate heavily within a 'layer' in the lateral direction, further research should focus on improving the quantitative characterization of CPT segments to improve this.

Assessment of In situ Block Size Distributions and Block Shapes for Discontinuous Rock Masses

Bas Vos
Delft University of Technology,
Faculty of Applied Earth Sciences,
Section Engineering Geology
May 2002

The geometry of rock mass discontinuities is universally recognised as a very important parameter for rock engineering purposes. Discontinuity geometry determines block sizes and shapes occurring in the rock mass. Another relevant parameter is the statistical homogeneity of the rock mass. The research has been focussed on finding an easy and versatile method to determine statistically block size and shape in a rock mass. This has been done with the help of In situ Block Size Distributions (IBSD). The main hypothesis behind the performed study is that IBSD analysis may reveal homogeneity characteristics of rock masses.



Thesis Maccabiani: Result of E-FCM algorithm applied to the Principal Components of Box-Cox normalized central tendency parameters m_{qc}, $I_{,riqc}$ and $I_{,riRf}$ for the southern line of CPTs. The horizontal distance of the cross-section is 25,7 km. Indicated with lines are several characteristic features.

In situ Block Size Distributions represent the different block sizes occurring within a discontinuous rock mass, much like a sieve curve used for soil descriptions. These distributions could be useful for many rock engineering applications, such as excavability or slope stability assessments, and are often used in the quarrying industry. The sophisticated rock mass modelling software that currently exists is expensive, often aimed at hydrogeological applications, and may be difficult to use.

For the prediction of In Situ Block Size Distributions, two methods have been applied (developed by Wang/Latham, 1991): the Dissection Method and the Equation Method. The dissection method builds a 3-D geometrical model of the rock mass using input data from scanlines, and calculates a block size distribution from this model. The equation method relies on several empirical relationships between discontinuity data (orientations, spacings) and the final block size distribution. The equation method was implemented into a Matlab script and extended with kernel density estimates (histogram-type analysis) and block shape estimates.

In order to collect data, a 4-week fieldwork has been carried out in Spain. Here, 7 scanline surveys (systematically collecting of rock mass data) were performed on outcrops of two different geotechnical rock formations. Scanline surveying is a very time-consuming process. Therefore, for the equation method the use of quick scanlines is proposed, where the number of discontinuity sets is assessed by eye and a number of spacing values and orientations (~30 each) is directly measured for each discontinuity set. Additional data on the geotechnical rock formations in the investigated area were available from the Falset database, which contains basic geotechnical data (from the same area as where the scanline surveys were performed). In addition, a small fieldwork was carried out in a quarry in Warstein, Germany.

The conclusions of the research are that it is possible to estimate average block shapes in a formation, and analysis of the variance of the logV50-IBSD data may provide information on the variability or homogeneity of the investigated rock mass. The produced Matlab script can handle very sparse data and can process a large number of locations in a short time span (200 locations ~ 10 sec.). However, careful selection of the data is important and the establishing of spacing distribution types remains difficult. The introduced block shape graph can give a quick visual impression of dominant block shapes in a formation, in addition to the block shape percentages calculated by the script. The shape assessments are based on the ratios of the mean spacings of the main discontinuity sets.

IBSD and block shape data can be used for many engineering projects involving rock excavation. One of the possible applications lies in rock dredging. Information on rock block sizes can be of major importance for dredging plant selection or assessment of blasting requirements, and block size will also influence the dominating excavation process. Applications outside rock dredging can be in rock quarrying, mining excavation, rock trenching or highway and tunnelling excavations.

Recommendations are the inclusion of block-size transition models for blasting predictions, implementation of Lu and Latham's impersistency factors and Grey Correlation Analysis, performing further research on the accuracy of the block shape assessment method, and performing more research on the proposed method for quantifying the variability of a formation. It is further recommended to make the estimation of discontinuity spacing distributions part of any rock site investigation.

Constitutive Models for very weak rocks: An Assessment using FEM

Garcia Garcia W.(Cuba)
International Institute for Aerospace Survey and Earth Sciences, Section Engineering geology
February, 2002

The Keuper formation in the fieldwork area in the Spanish province of Tarragona has the special feature that the material that composes it can be considered as a hard soil or a very weak rock.

In order to know and assess which constitutive model(s) is suitable to assess the stability of the slopes in materials that behave as that one in the Keuper formation in the Tarragona area, a specific road cut made in this formation which shows slight stability problems for the near future, has been selected as study slope.

Due to the lack of available geotechnical parameters of the Keuper formation from previous fieldwork in the Tarragona area, a bibliography review was made in order to find out appropriate data related to this type of material, which allow making the analysis.

The material described in the slope face is composed of very hard clays. Considering this as a continuous and isotropic medium, the Finite Element Method (FEM) has been selected as the analysis method for the calculation. Two software packages that use this analysis method were used for this work (PLAXIS and FLAC). The constitutive models used by these programs were assessed in order to determine which would be applicable to the study slope. The assessment of the different material models was based on the type of material to be analyzed and the application field. Three material models were selected suitable for the analysis.

Finally, the study slope modelled using measurements from previous fieldwork was analyzed following the construction sequence; and the suitability of the material models selected was assessed based on the displacements, following the excavation process, and the factor of safety obtained according to the range of the material properties. Conclusions and recommendations were drawn based on the discussion of the results.

(advertentie)

Gemeentewerken
Gemeente Rotterdam

Geplande Activiteiten, Internet en Nieuws

Ingeokring Activiteiten

De volgende Ingeokring activiteiten zijn gepland onder voorbehoud

20 juni 2002:
Jaarvergadering en lezing om 18:00 uur op TU Delft, faculteit Technische Aardwetenschappen;

Begin september (zaterdag) 2002:
Mergelgrotten excursie in Maastricht en omgeving onder leiding van Dr. R. Bekendam;

Eind September / begin Oktober 2002:
Seminar: "Perspectieven voor Ingenieursgeologie";

Oktober 2002:
Lezing "Gecontroleerde Duindoorbraak", Zuid Holland;

22/23 november 2002: Lezing/rondleiding ITC Enschede + excursie op zaterdag naar Iben Buren in Duitsland;

Internet

De Ingeokring is ook te vinden op het Internet, www.Ingeokring.nl. Hier is onder andere de onderstaande lijst te vinden van bedrijven met websites, waar de meeste Ingenieursgeologen werkzaam zijn.

Bedrijf	**Internet adres**
Adviesbureau Geofysica & Geologie	www.agg.nl
Ballast HAM Baggeren	www.ballastham.com
Ballast Nedam Engineers	www.ballast-nedam.nl
Boskalis Westminster BV	www.boskalis.com
CMG	www.cmg.nl
CUR	www.cur.nl
DHV	www.dhv.nl
EARS	www.ears.nl
Elsevier Science	www.elsevier.nl
TU Delft Faculteit TA	www.ta.tudelft.nl
Fugro Engineers B.V.	www.fugro.nl
Geocom	www.geocom.nl
GeoDelft	www.geodelft.nl
HAM Dredging	www.ballastham.com
Ingenieursbureau Gemeentewerken Rotterdam	www.gw.rotterdam.nl
ISRIC - NBV	www.isric.org
ITC	www.itc.nl
Haskoning Ingenieurs- en Architectenbureau BV	www.royalhaskoning.com
MTI Holland B.V.	www.ihcholland.com
Netherlands Pavement Consultants	www.npc.nl
NITG-TNO	www.nitg.tno.nl
Outokumpu	www.outokumpu.fi
Petroplus Contracting BV	www.petroplusengineering.com
Philips Research Laboratories	www.philips.com
Provincie Zuid-Holland	www.pzh.nl
SIEP BV	www.shell.com
Staatstoezicht op de Mijnen	www.sodm.nl
Thales Geosolutions	www.thales-geosolutions.com
TU Delft	www.citg.tudelft.nl
URS	www.urscorp.com
Witteveen en Bos	www.witteveenbos.nl
WL	www.wldelft.nl

Nieuws

OSCUR Trofee voor het team GEOKOEPELS

Persbericht Ingenieursbureau Amsterdam:

Met het “Geokoepelconcept” heeft het projectteam ‘Ingenieursbureau Amsterdam’ op 23 mei jl. de prestigieuze Morgen de Ruimte Prijs gewonnen. De overige 4 genomineerden waren DHV, WL/Delft Hydraulics, Blue Architects en Next Architects. Het team is er in geslaagd om de jury te overtuigen van het idee dat geokoepels over 25 jaar een oplossing kunnen zijn voor het toenemend ruimtetekort in Nederland.

Geokoepels

Het Geokoepelconcept is gebaseerd op de gedachte dat over 25 jaar de oplossing voor het toenemend ruimtetekort in Nederland gevonden moet worden in de ondergrond. In de Nederlandse bodem kunnen namelijk op 100 tot 500 meter diepte open ruimtes gecreëerd worden: geokoepels. Daarin kunnen zaken worden ondergebracht die op maaiveldniveau te veel ruimte in beslag nemen. Zo kan een geokoepel als opslag- of archiefruimte fungeren. Maar ook voor de industrie liggen er mogelijkheden. Je kunt zelfs denken aan Disney onder de Dam in Amsterdam of aan een compleet kassencomplex in een netwerk van koepels in de Betuwse ondergrond.

De Morgen de Ruimte Prijs

De Oscur Trofee is voor het Geokoepelteam de kroon op een jaar werken. Na de nominatie in mei 2001 kreeg het team van de jubilerende opdrachtgever CUR.NET een jaar de tijd en 70.000 EURO om de drievoudige opgave van de MORGEN DE RUIMTE prijs in te vullen: werken aan een netwerk, aan een innovatief idee en een presentatie waarmee het idee naar een breed publiek gecommuniceerd kan worden. Het winnende team staat onder leiding van drs. Frans

Taselaar van Ingenieursbureau Amsterdam en bestaat uit 27 jonge professionals, afkomstig uit 11 verschillende bedrijven en maatschappelijke organisaties.

Uit handen van juryvoorzitter Dick Tommel ontvangt drs. Frans Taselaar de OSCUR Trofee.

Het Geokoepels netwerk

De bedrijven en organisaties die participeren in het geokoepel-netwerk zijn:

- Ingenieursbureau Amsterdam
- Milieudienst Amsterdam
- Dienst Ruimtelijke Ordening van Gemeente Amsterdam
- Heijmans Beton- en Waterbouw
- Imtech Projects
- GeoDelft
- TNO-NITG
- Rijksplanologische Dienst
- 2B-Insite
- Men in Color
- Oxus

De jury

De jury onder leiding van Dick Tommel bestond uit een aantal prominente vertegenwoordigers uit de bouw- en architectuurwereld en enkele jonge politici.

Hoe verder?

Aangemoedigd door de erkenning van de jury wil het team nu aan de slag om draagvlak en fondsen te verwerven. Als het team daarin slaagt liggen de mogelijkheden voor verder onderzoek en daarna het bouwen van een pilot-koepel wellicht in het verschiet.

Voor meer informatie:

Ingenieursbureau Amsterdam
drs. F. Taselaar, projectleider
Tel. : 020 6501.674
e-mail: ftaselaar@iba.nl

TNO-NITG
drs. R. Rijkers
Tel. 015-2697222
e-mail: r.rijkers@nitg.tno.nl