BULLETIN

PLAXIS

Nº 7 - JANUARY 1999

Editorial

Some people fear the next millennium. We on the other hand look forward to an exhilarating 1999 and thriving future beyond the year 2000. The first International Plaxis Symposium has a similar title: "Beyond 2000 in Computational Geotechnics". In this bulletin you will find the program and registration form. The symposium is preceded by the "International course for Experienced Plaxis Users". Both events have been scheduled successively to give your trip extra merit. Other events are listed in the calendar on the back of this bulletin, or on our web-site at http://www.plaxis.nl.

In 1998 about 250 people signed up for one of the courses, workshops or users meeting that were organised in Amsterdam (2), Boston, Delft, Karlsruhe, Paris, Singapore, Stuttgart and Trondheim. Most events are in English, except for the courses in Stuttgart and Paris and the users meeting in Trondheim which were in the national languages.

Participants and lecturers in French course (Paris).

In September another memorable event took place. On this day, the Dutch Public Works and the Indonesia Public Works (PU) signed a Memorandum of Understanding (MOU). This MOU describes a close cooperation on the subject of Soft Soil Engineering. Directly after signing the MOU Mr. Hendro Moeljono (PU Director General) accepted the first of ten Plaxis licenses for the Indonesian Public Works. Besides the delivery of software, an extensive training program is planned in the framework of the cooperation.

Last October Plaxis BV celebrated their fifth year of existence. Since it's establishment the company has grown substantially and is now looking for further expansion (see also vacancies).

In November Version 7.1 was released on CD and sent to all registered Version 7.0 users. The past year has been very successful as a result of the release of the new Windows Version. This can also be seen from the users group which has increased to well over 1000 people. For the next year and beyond 2000 new developments are scheduled as described in an outline by Ronald Brinkgreve.

Other plans for the near future include moving to a new office. Around summer time Plaxis BV will move to the city of Delft, the Dutch knowledge centre of civil engineering and numerical analysis. Of course we will keep you informed on further details. We hope you will enjoy reading this extra thick issue of the Plaxis bulletin and look forward to see you during the Plaxis Symposium or one of the other events.

Bulletin of the PLAXIS Users Association (NL)

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The Netherlands
E-mail:
bulletin@plaxis.nl

IN THIS ISSUE:

Column Vermeer

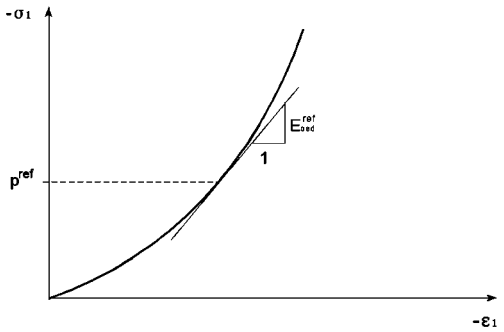
On re-reading my previous column on creep in oedometer tests, I am struck by the fact that geotechnical engineers have so many different soil parameters. It would seem that there are two entirely different reasons for this. The first is that we are dealing with a complex cohesive, frictional material and that the formulation of its mechanical behaviour simply requires several different (model) parameters. The second reason is that different countries have different geotechnical traditions, including different soil parameters. Especially in the field of one-dimensional compression, we see different traditions and different definitions of soil compressibility parameters. In the following I will review some of them.

For primary oedometer consolidation, the USA provides us with the well-know compression index C_C, as used in a 10-log compression law. From critical-state soil mechanics, as developed in the UK, we have an e-ln compression law, and consequently a slightly different index called λ. For the Soft Soil Creep model, the compression law involves strain rather than void ratio, and so we introduced the modified compression index λ^*. The conversion rules may be simple, but there is still a considerable risk of confusion. The essentials are:

C_C	=	compression index
λ	=	C_C / 2.3
λ^*	=	λ / (1+e)
E_{oed}^{ref}	=	p^{ref} / λ^*

The logarithmic law for oedometric compression can be differentiated and one obtains for the tangent stiffness $E_{oed} = \underline{\sigma} / \lambda^*$. Hence stiffness moduli are proportional to the applied vertical stress. In geotechnical literature different symbols are used for E_{oed}, e.g. M or E_s as used in German literature.

In Plaxis 7, both E_{oed}^{ref} and λ^* are used as model parameters for oedometer compressibility. The Soft Soil Creep model uses * and the Hardening Soil model uses E_{oed}^{ref}. For the sake of clarity, it would have been much nicer to use the same input parameters for both models, but old traditions die hard.



Definition of E_{oed}^{ref} in oedometer test results.

No doubt, the use of compression indices, such as C_C, λ or λ^* relates to the use of a logarithmic compression law. It dates back to pioneering work of Terzaghi 1925, and it is thus deeply rooted in soil mechanics. Ten year later, however, the general applicability was already refuted by Ohde. The latter was the first to propose a more general power law of the form $E_{oed} = \alpha\ \sigma^m$. During the second World War Ohde's German writings were more or less lost, but the power law was re- discovered by Janbu. The beauty of the power law is that it is accurate for all different types of soil. Test data on sands, for example, tend to fit well when using $m \approx 0.5$, whereas soft soils require the exponent $m \approx 1$. For $m = 1$, it can also be shown that the power law reduces to the logarithmic law.

Of course, the power law is much more general than the logarithmic law. Using $m = 1$, and E_{oed}^{ref}/ λ^*, it reduces completely to the logarithmic law. This does not mean that the entire Hardening Soil model will become identical to the Soft Soil (creep) model. In fact, agreement will only be obtained for oedometer-type loading paths. To properly compare and assess various soil models, it is necessary to consider model responses in drained and undrained triaxial testing as well. And this could well be an interesting topic for another bulletin.

P.A. Vermeer, Stuttgart University

Engineering Practice

On October 15 the Dutch Plaxis users association held it's annual workshop. The main purpose of these meetings is to upgrade users' modelling abilities and knowledge. This year the workshop's theme was: "Soil tests, parameters and constitutive models" and attracted over 40 enthusiastic users. Questions related to the theme were:

- Which in-situ and laboratory tests are currently available ?
- Which material parameters can be determined from the available tests ?
- Which constitutive models are most appropriate ?

In practice these questions will not appear in the above sequence. Usually we start off with the nature of the geotechnical problem: loading, retaining structure, excavation, etc. The key to a successful analysis is not a matter of finding the right buttons, but to my opinion to model the situation correctly.

Let me explain. Modelling a situation means recognition of the essential geotechnical phenomena and including these in a numerical analysis. This requires theoretical insight from the user:

- How does (real) soil behave under different types of loads ?
- What types of stress-paths are significant in my project ?
- Which constitutive model is capable of capturing the soil behaviour for the dominant stress-paths in my project ?

Only after being able to answer the above questions we can make an appropriate decision as to which material parameters are needed and wich soil tests should be performed. Therefor, the order of themes of the workshop should have been: "Constitutive models, parameters and soil tests".
Unfortunately the above ideal situation is not common practice. For standard engineering projects, site investigation is usually limited. However, when dealing with projects that include a considerable risk for failure or damage to the surrounding area, engineers need to take their responsibility. This responsibility includes , the creation of extra budget for thorough soil investigation and analysis !

The workshop proved that continuous attention is needed on the subject: "models, parameters and soil tests", not only for the user, but also for the Plaxis developers. What is the point of investing in more advanced constitutive law's if the user cannot benefit from these developments. From this perspective the organizers of the Experienced Users Course (15-17 March 1999) will focus the attention on practical usage of advanced models. To this end I would recommend people to participate in this course !

Eric Sluimer, chairman PLAXIS Users Association (NL)

PLAXIS Practice

THE VAASA TRIAL EMBANKMENT

Geometry, instrumentation and construction:

In [1] a trail embankment in Vaasa (Finland) was presented. The main purpose of the construction was the testing and development of the calculation methods for the planning of road embankments. The trial embankment has a rectangular shape (fig. 1). The height of the embankment is 2 metres and the gradient of slopes is 1:1.5. The width of the embankment is 15 m. and the length 25 m. The instrumentation of the trial embankment is also presented in fig. 1.

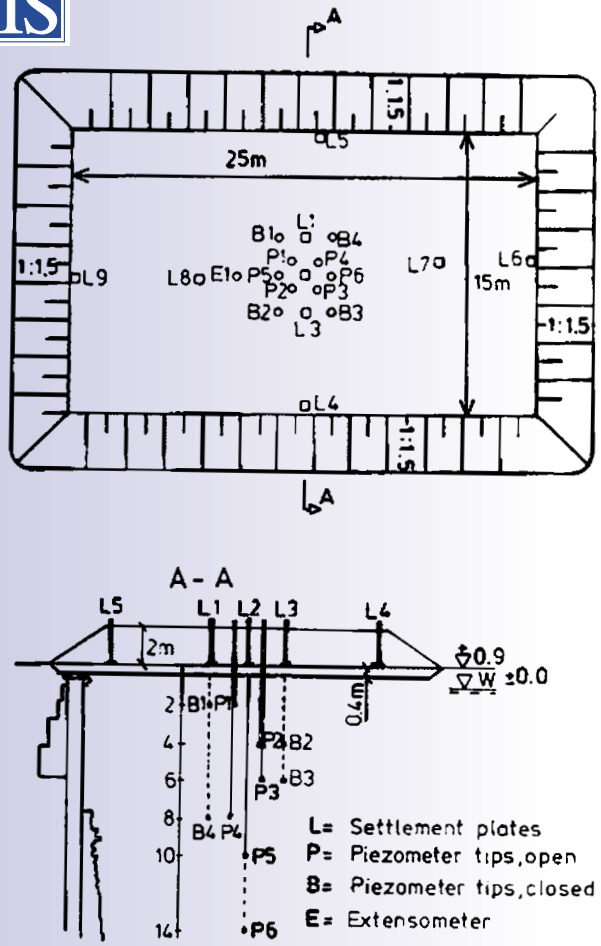


Figure 1 Geometry and instrumentation of Vasaa trial embankment.

Settlements at the base level of the embankment are measured with settlements plates, and deeper in the ground with magnetic extensometer. The pore pressures are measured using open and closed piezometer tips installed at different depths. The construction of the embankment took 3 days. Furthermore, extensive laboratory soil tests using the triaxial apparatus and the oedometer have been done in order to determine the soil parameters.

Table 1 Model parameters.

Layer	k_x; k_y [m/d]	ϕ [°]	c [kPa]	v [-]	e_0 [-]	κ^* [-]	λ^* [-]	μ^* [-]
1	1.167e-05	26.0	6.0	0.08	2.0	0.0390	0.390	0.016
2	6.000e-06	26.0	6.0	0.08	2.0	0.0293	0.330	0.014
3	1.333e-05	26.0	6.0	0.07	2.0	0.0293	0.325	0.007
4	2.633e-05	25.0	6.0	0.15	2.0	0.0293	0.325	0.012
5	8.700e-05	30.0	6.0	0.22	2.0	0.0223	0.293	0.009
6	8.700e-04	30.0	6.0	0.22	2.0	0.0650	0.065	0.007

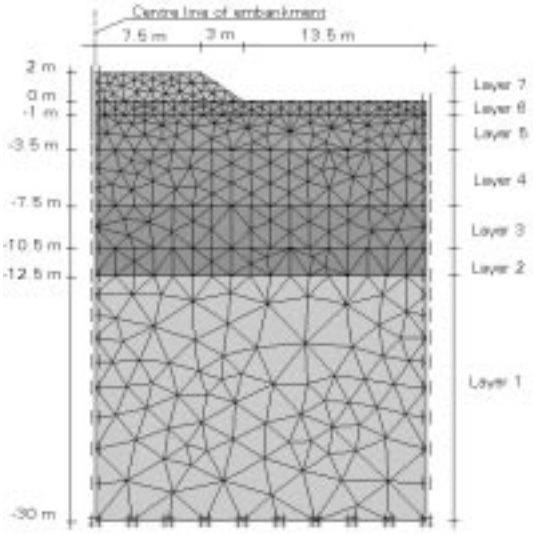


Figure 2 FEM mesh.

Ground conditions:

The subsoil consists of more than 40 m. thick layer of soft silty clay with high organic content and sulphur. The clay layer is homogeneous and most of the laboratory investigations are concentrated only to 15 m. depth. The ground water level is 0.5 m below the original surface. The parameters used for the calculations are obtained from the results of oedometer tests. They are presented in table 1 and table 2.

Calculations:

For the calculations with the FEM code Plaxis the Soft Soil Creep model has been used.

The Vaasa embankment and the subsoil have been schematised using the mesh presented in figure 2. The mesh consists of 6-node triangular elements. In [1] three node elements were used.

The calculations have been done in plane strain conditions. The staged construction option in the Plaxis code has been used. At first the stress distribution due to the body weight of the sub-soil is calculated (drained). In the following calculation step the load due to the weight of the embankment has been applied in an undrained state, followed by consolidation and creep.

In the Soft Soil Creep model computations the input parameters listed in table 1 have been

used. The determination of the parameters was done by extensive laboratory testing in Finland. The same set of parameters has been used in the Cam Clay computations [1]. The overconsolidation ratio OCR in the Plaxis calculations is 1.45.

The results are presented in two different types of figures. The time vs. settlements curve (figure 3):

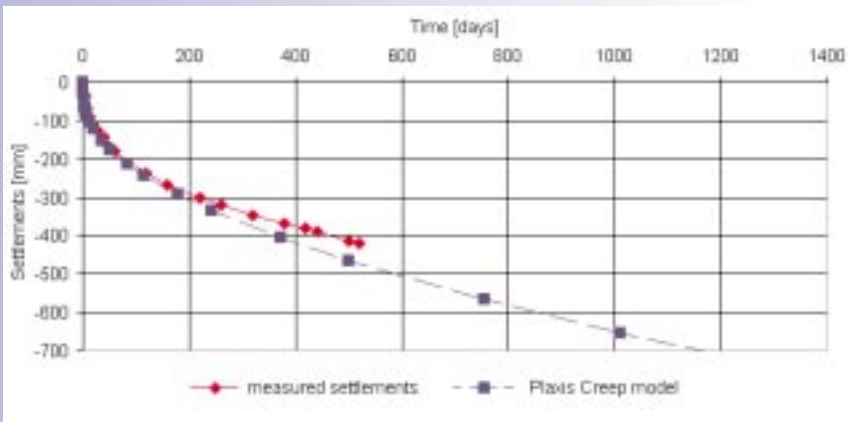


Figure 3 Time-Settlement curve.

The calculated initial settlement is 120 mm (that means after the construction of the embankment), the measured one is 100 mm. Figure 3 shows that the calculated settlement is quite the same as the measured one (11 % overrating)

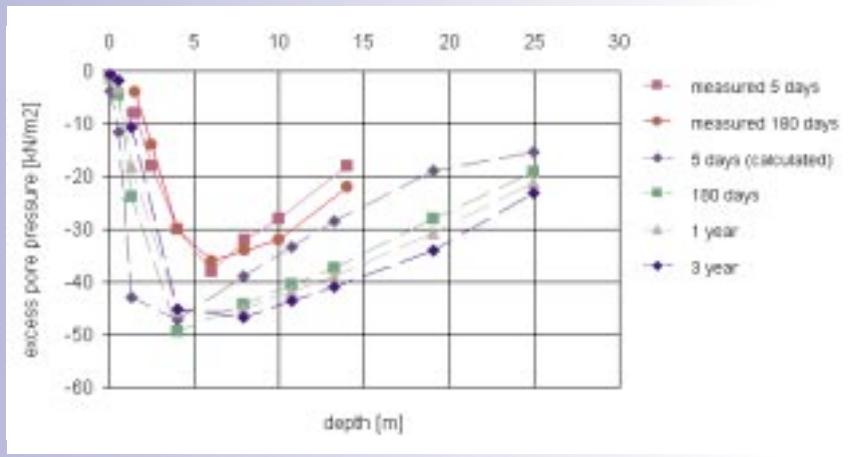


Figure 4 Developement of excess pore pressure.

Conclusions:

Considering the settlements, it can be concluded that the initial stress distribution has a large influence on the results. The measured settlements can be simulated accurately with the Soft Soil Creep model. Considering the excess pore pressures at the centre of the embankment the calculated excess pore pressures correspond very well with the measured ones (12% accuracy). Notice that the excess pore pressures in the top layers are decreasing while the excess pore pressures in the deeper layers are still increasing (see also figure 4).

References:

[1] Vepsälainen,P., Arkima O., Lojander M., Näätänen A. The trial embankments in Vaasa and Paimio, Finland. Proc. of the tenth European conference on soil mechanics and foundation engineering Florence, Vol II, pg. 633-640, AA. Balkema

Peter The, Dutch Ministry of Public Works

PLAXIS Symposium

"BEYOND 2000 IN COMPUTATIONAL GEOTECHNICS"

The first International PLAXIS Symposium will be held on 18-20 March, 1999, in Amsterdam, The Netherlands. The purpose of this Symposium is to bring together PLAXIS users, developers and others who are interested, in order to exchange geotechnical knowledge and experiences with computational methods. The programmma is centred around "Ten Years of PLAXIS International". In a special celebration session invited speakers will look at the past, presence and future of PLAXIS.

There will be poster presentations and theme sessions. A number of papers have been selected for oral presentation. All papers will be published in the Symposium proceeding. The registration fee is ƒ 1175,- (incl. the proceedings).

Wednesday 17 March (evening)

Registration and welcome party

Thursday 18 March

Opening

Session 1: General Geotechnical Aspects
Chair: Dr. Harvey Burd (UK)
Keynote speaker: Prof. Antonio Gens (ES)

Session 2: Ten Years of PLAXIS International
Chair: Mrs. Margriet Jansz (NL)
Speakers: Dr. Harvey Burd (UK), Prof. Steinar Nordal (N), Prof. Pieter Vermeer (D)

Boat tour and banquet

Friday 19 March

Session 3: Dams and Embankments
Chair: Prof. Antonio Gens (ES)
Keynote speaker: Mr. Ruud Termaat (NL)
Session 4: Tunnelling and Deep Excavations
Chair: Prof. Helmut Schweiger (A)
Keynote speaker: Mr. Klaas Jan Bakker (NL)

Session 5: Suburban and Infrastructural Works
Chair: Dr. Cino Viggiani (I)
Keynote speaker: Prof. François Schlosser (F)

Session 6: Education and Research
Chair: Dr. Tom Schanz (D)
Keynote Speaker: Prof. Pieter Vermeer (D)

Saturday 20 March
Excursion to IJmuiden sluice complex (Optional)

Further information on the PLAXIS Symposium can be found on the internet site:
http://www.stw.nl/stw/plaxis/index.html

Registration:
In order to register for the Symposium, please use the Registration Form in this bulletin or contact Mrs. Cora Passchier of the Technology Foundation at fax number: +31 30 601 44 08.

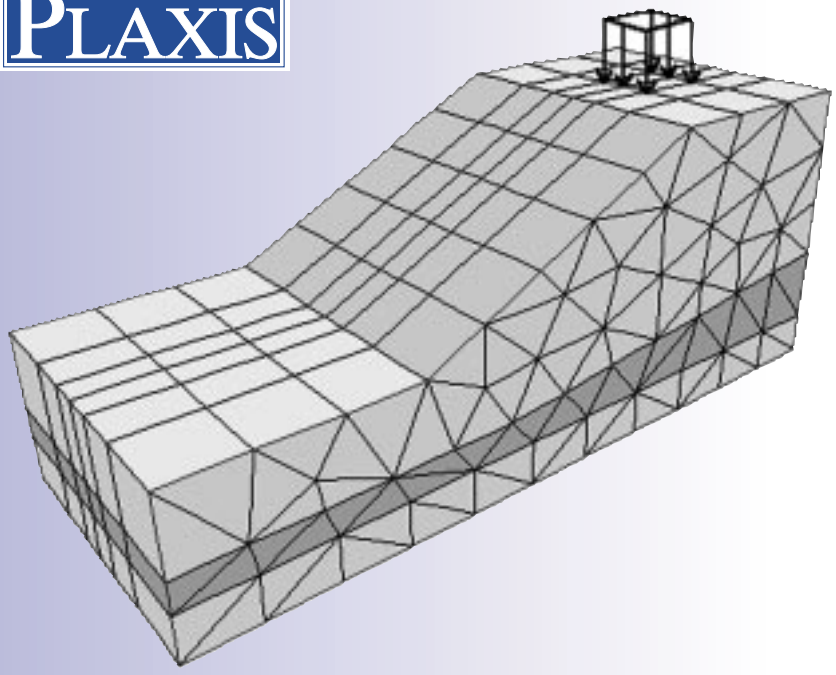
New Developments

At the end of this year the third two-year PLAXIS development project will be finished. Results of this project will be robustly implemented and operationalised in the PLAXIS Windows version, which will result in the next version in the year 2000. Meanwhile, the fourth research project has been formulated and announced for the coming two years and many companies have already granted financial support for this project. The new project involves, a.o., research and developments in the following areas:

a. 3D modelling
b. Transient and unsaturated groundwater flow
c. Constitutive modelling
d. Other calculation options

As usual, the developments are controlled by an international scientific CUR1 committee consisting of people with a high reputation in geotechnical engineering and numerical methods. This committee checks the quality of the results and makes sure that money is effectively spent. Underneath, the proposed developments are described in more detail.

Ad. a. The 3D calculation module, as described in the previous bulletin, will be extended to allow for a more flexible modelling of geometries. In addition, special elements for the modelling of piles and pile groups will be added to this module and connections between structural elements and interfaces will be considered in more detail.



3D mesh based on Version 7 plane strain mesh.

Ad. b. In addition to what has been done on transient groundwater flow in a previous project, we will consider a more detailed relationship between pore pressure and permeability. This should also improve the robustness and stability of the calculation process. Moreover, special features like sources, wells and infiltration will be implemented in the groundwater flow module to make the module more practically applicable.

Ad. c. In order to make PLAXIS more applicable for scientific applications at centers of research, we will implement the possibility for user-defined soil models. For practical applications, we will further validate and improve the Hardening Soil model and the Soft Soil Creep model . Extensions will be made to account for small strain effects, lost-memory behaviour and cyclic loading.

Ad. d. In the current version some calculation options are impossible to combine, like consolidation with staged construction or updated Lagrange calculations. These inconsistencies will be investigated solved in future versions. In addition, we will focus on extended possibilities for structural elements like detailed modelling of special beam (plate) connections (for example in tunnel linings) and on plasticity and time dependent behaviour in structural elements.

Besides these research-like activities, we will put a lot of effort in the development of the user-interface to make all options available within a userfriendly environment. Apart from improvements of the convenience of the input program, emphasis will be focused on the output of graphs and tables. In this respect we will work on an efficient report generator in the output program which should simplify the collection of relevant output data for the user.

Companies that financially support this research project have a more direct vote in the PLAXIS developments and they benefit from the knowledge that is generated in the project. For their financial support companies obtain all resulting PLAXIS versions (including intermediates and beta versions) at an early stage and free of charge. If your company is interested in such an extended relationship with PLAXIS, please contact me at PLAXIS BV, tel. +31 10 50 30298, fax. +31 10 50 18041, e-mail R.Brinkgreve@plaxis.nl.

Ronald Brinkgreve, PLAXIS BV

PLAXIS BV searches for new staff members

PLAXIS BV is a growing high-tech company in computational geomechanics, mainly developing, marketing and supporting the PLAXIS finite element program for soil and rock analyses. Our future developments require new specialists to enter the Research & Development team. At the moment, PLAXIS is situated in Rhoon, near Rotterdam, but we will soon move to a new location in Delft, the Dutch knowledge centre of civil engineering and numerical analysis. Being market leader in Europe we plan to become world leader in the

modelling of soil and rock problems. The company searches for two new talented staff who are eager to help us reaching this challenging goal. Working at PLAXIS BV means interesting teamworking on high-tech software products in a stimulating environment.

VACANCY 1: Specialist on computational geomechanics

Job description:
This job mainly involves the scientific development of PLAXIS modules. The work is concentrated around numerical procedures for 2D and 3D finite element analyses, with *robustness* and *reliability* as major keywords. Besides in-house research work the job involves cooperation with colaborating research centers and high-level user support on complex engineering projects.

Requirements:
- Research experience (PhD) in the field of computational geomechanics
- Thorough programming experience in FORTRAN (90)
- High level of accuracy and efficiency
- Good communication skills in English
- Team spirit

VACANCY 2: Programmer with experience with visual programming tools

Job description:
This job involves the creative development of a new Windows user-interface for three-dimensional finite element models. Most of the work is concentrated around 3D modelling and visualisation, with *convenience* and *userfriendliness* as major keywords. Besides programming, the job involves contacts with users to discover the needs for further developments.

Requirements:
- Completed professional education in a technical direction; affinity with civil engineering
- Thorough experience with a visual programming tool (preferably Delphi)
- High level of accuracy and efficiency
- Good communication skills in English
- Team spirit

APPLICATION:
Inhabitants of the EC can apply freely for a job in The Netherlands. Applicants outside the EC are subjected to formal governmental procedures. To apply for one of the above positions at PLAXIS BV, please send your letter of application including Resume (CV) to:

PLAXIS BV
Attn: Dr. Ronald Brinkgreve
P.O. Box 851
NL-3160 AB RHOON
The Netherlands
Fax: +31 10 50 18041
E-mail: R.Brinkgreve@plaxis.nl

Users Forum

When modeling thick massive walls a more realistic behaviour is obtained when using volume elements. Beam elements work well for relatively thin walls like sheet-piles. However, volume elements have no direct output of bending moments, axial and shear forces. An experienced Plaxis user proposed the following solution:

- Model the wall by means of continuum elements.
- Include a beam element in the middle of the continuum elements.
- Apply real stiffness properties of the wall to the continuum elements (use an elastic model)
- Apply reduced stiffness properties to the beam elements. (e.g. factor $10E^{-8}$ compared to the real properties of the wall.
- Although the beam does not carry any load, the deflections are real.
- Apply the inverse factor ($10E^{8}$) to the results of the beam (bending moments, axial forces etc.)

International course for Experienced users

This international course provides both the knowledge and hands-on experience on the use of the advanced soil models. Invited lecturers concentrate on various aspects beyond the scope of the standard courses on the subjects: deep excavations, dams and tunneling.

Finite Elemente Anwendungen in der Grundbaupraxis

This standard course on Computational Geotechnics is lectured in the German language. Local specialists have been invited to give special attention to the application of finite elements analysis in the German situation.

Registration form

I, the undersigned, register for the course:

International Course for Experienced PLAXIS users
15-17 March, 1999, The Netherlands

Last Name: _____ (m/f)

Title and initials: _____

Business / organisation: _____

Full Office Address: _____

Country: _____

Telephone: _____

Fax: _____

E-mail: _____

❑ I will bring my own Pentium computer (Windows 95/NT, 32 MB RAM, screen resolution 800 x 600 and 100 MB free disk space; applicable for Hfl. 150,- discount)

❑ I have subscribed for the PLAXIS Symposium and like to make use of the free transportation to the Victoria Hotel on 17 March 1999

Date _____

Signature _____

Return to the course organiser, fax: +31 15 278 4619

Anmeldungsformular

Ich, der Unterschreibende melde mich für den Kurs:

Finite Elemente Anwendungen in der Grundbaupraxis (24303)
22. - 24. März 1999

Name,Vorname: _____

Titel: _____

Beruf/Firma: _____

Adresse: _____

Land: _____

Telefon: _____

Fax: _____

E-mail: _____

❑ Ich nehme an den empfohlenen Mahlzeiten teil

❑ Ich übernachte im nahegelegenen Filderhotel

Datum: _____

Unterschrift: _____

An den Kursveranstalter zurücksenden, Fax: (0711)-34008-27

Place stamp here

PAO Civil Engineering
c/o Delft University of Technology
P.O. Box 5048
NL-2600 GA DELFT
The Netherlands

Bitte frei-machen

Technische Akademie Esslingen
Weiterbildungszentrum
Anmeldung
Postfach 1265
D 73748 Ostfildern
Deutschland

Registration Form

Beyond 2000 in Computational Geotechnics

18-20 March, 1999, Amsterdam, The Netherlands

Family Name: _____

First Name: _____

Title and Initials: _____

Business / Organisation: _____

Full Address: _____

_____

Country: _____

Telephone: _____

Fax: _____

E-mail: _____

❑ I will be present at the Welcome Party on 17 March, 1999 (free)

❑ I will be present at the Banquet on 18 March, 1999 (no extra charge)

Special diet: _____

❑ I want to register for the Excursion (Dfl. 100)

❑ I am interested in the Experienced User Course and like to receive further information on this.

Total fee:

Symposium (Dfl 975 when registering and paying before 1/1/99, otherwise Dfl. 1175): Dfl.. _____

Excursion: Dfl. _____

_____ +

Total: Dfl. _____

Method of payment:

❑ By bank transfer in Dfl. to ABN-AMRO Bank, Utrecht, The Netherlands, Account no. 55.57.85.556, Switfcode ABN.NL.2A, Branchno. 716108 The Netherlands

❑ Bank draft:
I enclose a cheque in Dfl. made out to STW to be drawn on a bank in The Netherlands

Date: _____ Signature: _____

Send or fax the completed form to:

Technology Foundation STW
- Plaxis Symposium -
P.O. Box 3021
NL-3502 GA UTRECHT
The Netherlands

Fax: +31 30 601 44 08

ACTIVITIES:

9-11 DECEMBER, 1998

Short course on Computational Geotechnics (French),
'Pratique des éléments finis en Géotechnique'
Paris, France

18-20 JANUARY, 1999

Standard course on Computational Geotechnics (English),
Noordwijkerhout, the Netherlands

15-17 MARCH, 1999

International course for experienced Plaxis users (English),
Noordwijkerhout, the Netherlands (see also next activity)

18-19 MARCH, 1999

"Beyond 2000 in Computational Geotechnics"
Symposium to celebrate 10 years Plaxis international (English)
Amsterdam, the Netherlands (see also previous activity) web-site:
http://www.stw.nl/stw/plaxis/symposium.html

22-24 MARCH, 1999

Short course on Computational Geotechnics (German),
'Finite Elemente Anwendungen in der Grundbaupraxis',
Stuttgart, Germany

APRIL, 1999

Annual meeting of Dutch Users Association (Dutch),
Utrecht, the Netherlands

1-12 MAY, 1999

Short course on Computational Geotechnics (English),
Cairo, Egypt

7-10 JUNE, 1999

XII European Conference SMGE
Amsterdam, the Netherlands (see also next activity)

11-12 JUNE, 1999

Short course on Computational Geotechnics (English),
Amsterdam, the Netherlands (see also previous activity)

AUGUST, 1999

Short course on Computational Geotechnics (English),
Bandung, Indonesia

1-3 SEPTEMBER, 1999

NUMOG VII, Technical University Graz, Austria
web-site: http://www.cis.tu-graz.ac.at/geotechnical_group/numog.html
E-mail: schweiger@ibg.tu-graz.ac.at

OCTOBER, 1999

Workshop of Dutch Plaxis Users Association,
Delft, the Netherlands

NOVEMBER, 1999

6st European Users meeting (English),
Karlsruhe, Germany

NOVEMBER, 1999

3rd Norwegian Users meeting (Norwegian),
Oslo, Norway

JANUARY, 2000

Standard course on Computational Geotechnics (English),
Noordwijkerhout, the Netherlands

For more information on these activities please contact:

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the Netherlands
Tel: +31 1050 30290
Fax: +31 1050 18041
E-mail: info@plaxis.nl