

Edito

While 2010 was marked by a slight decrease of our activity due to the sudden cancellation of a number of major projects for socio-political reasons, 2011 is a year of strong increase.

Notable examples include the East-European High-Speed Line (or "LGV"; the construction of the Saverne tunnel has already begun), the "Bretagne - Pays de Loire LGV" (soil investigations are underway), but also building renovation projects that re-use existing foundations with extra reinforcement (the depots on Boulevard Mac Donald and the Jussieu Faculty in Paris). We could also mention the geotechnical services we provide to support the projects of companies operating in the "oil and gas" sector in various regions of the world, from Australia to Russia or Latin America.

We will present the progress of these projects in future issues. This issue of the **TERRASOL** newsletter illustrates some of our projects that have marked our first semester 2011, and the variety of our missions: project types, regions of the world, type of services.

This year will also be important for our software department: the development of AMRetain, on request from ArcelorMittal, was finished in may 2011. And major updates of Foxta and K-Rea will be released in autumn 2011. It should be pointed out that both AMRetain and the new K-Rea version are in compliance with the NF P 94-282 standard (French standard for the application of Eurocode 7 to retaining structures).

The National ASIRI Project, in which Bruno Simon has performed admirably as technical manager, will also be completed in 2011 with the publication of recommendations offering clear conclusions to more than four years of research.

TERRASOL thus proceeds with its development and focuses on the answers to bring to the increasingly varied requests of our customers. We are more than ever willing to anticipate the strategic, technological and regulatory changes affecting geotechnical engineering, and to participate through our engineers to the geotechnical scientific community.

A. GUILLOUX
Président Directeur Général

The Petit Rhône earth dikes

In 2009, SYMADREM ("SYndicat Mixte interregional d'Aménagement du Delta du Rhône et de la Mer") entrusted the **TERRASOL / Hydratec** group with a contract for carrying out the outline studies and preliminary design for reinforcement and partial geometrical modification of 18 km of dikes along the left bank of the Petit Rhône (downstream from Arles). SYMADREM is an inter-regional association created by SIDRHEMER, itself founded in 1996 following the never-to-be-forgotten flooding that took place in the Camargue area.

These dikes reinforcement studies and works fall within the scope of the flooding section of the "Rhône Plan" which aims to achieve the following:

- Reduce flooding by acting on causes,
- Reduce vulnerability by acting on stakes,
- Adapt to living with the risk by developing an understanding and appreciation of the risks involved.

To this end, the contract awarded to the **TERRASOL / Hydratec** group consists in carrying out preliminary studies aiming to geographically define the failure risks and quantify these risks, and to determine the reinforcements needed and measures to be taken in areas where there is clear evidence of danger.

The specificity of this type of mission lies in the way it is broken up into multiple phases, each of them subject to validation by a committee of experts:

- Phase 1: historic background and visual inspection, GIS,
- Phases 2 and 3: systematic survey of dikes and areas identified for geometrical modification,
- Phase 4: detailed investigations,
- Phase 5: definition of failure risks,
- Phase 6: preliminary report,
- Phase 7: preliminary design of reinforcement works,
- Phase 8: preliminary design report.

When compared with other work sections awarded to hydraulic engineers, the particularity developed by the Terrasol / Hydratec group was to have the group managed by the geotechnical team.

This type of "packaging" was unanimously welcomed by experts as a way of ensuring quality and a technical appreciation of the ways in which dikes are expected to fail.

The proximity of Terrasol and Hydratec within the Setec Group buildings in Lyon ensured that work was carried out rapidly in a manner fully adapted to the various phases.

Preliminary studies are now in their final phase and preliminary design studies will begin this summer.

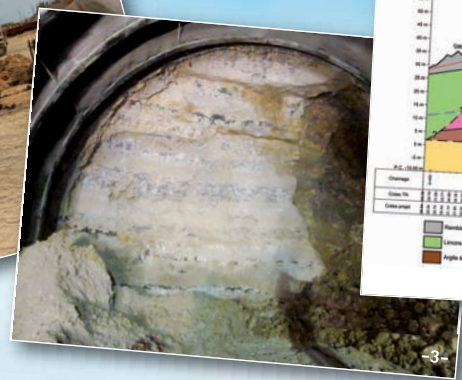
J. Drivet



The Petit Rhône



- 1- A89
- 2- Gabes
- 3- Jenner tunnel, tunnel face
- 4- Jenner tunnel, geotechnical profile
- 5- Majunga building
- 6- Sheraton Park project



Loire

A89 Balbigny/Violay

Works on the A89 motorway section between Balbigny and the Violay tunnel have been going on since 2009. Within the scope of constructing these 14.5 kilometres of motorway that include three viaducts and 15 standard civil engineering structures, TERRASOL, having carried out the geotechnical part of the preliminary and detailed designs, and contractor bid studies, is now providing geotechnical assistance during the site works phase to Setec TPI, project manager for earthworks and standard civil engineering structures and owner assistant for the viaducts with a "design and build" contract.

Currently, and despite bad winter weather, the earthworks and standard engineering structures are almost completed and five out of the six viaduct slabs have been cast.

The geological context, essentially highly tectonised volcanic rock, required a few minor adaptations during the works phase to take into account large variations of substratum alteration and fracturing over very short distances.

For example, it was necessary to rebuild the slope under a structure abutment as it presented an erratic alteration that endangered the structure stability.

These adaptations were carried out very rapidly, and in coordination with the group of contractors and the project manager, in order to avoid perturbing the works schedule. Terrasol's reactivity contributed to maintaining the schedule.

A-L. Fauroux
J. Drivet

Gabes, Tunisia

Storage depot

Within the scope of the construction of a new liquid hydrocarbon storage depot in Gabes (Tunisia), TERRASOL, working with TERRASOL TUNISIA, was chosen by ENTREPOSE CONTRACTING to carry out the construction design for six storage spheres, each with a 4,000 m3 capacity and, in particular, the foundations design. The spheres are protected by a sand-filled reinforced concrete shell. Each sphere, weighing around 10,500 tons, is seated on a general annular raft with a 24 m external diameter. These rafts are subject to very strict admissible settlement constraints (maximum absolute settlement: 15 mm).

Geotechnical surveys revealed a succession of sandy and then clayey levels, with three reference layers: loose fine sand (almost subject to liquefaction) between 5 and 10 m deep, very compact fine sand from 10 to 22 m, and stiff clay with gypsum nodules below 24 m. Boreholes identified a large number of decompressed levels and compressible layers within this clay, corresponding to gypsum dissolution pockets.

This major concern as well as the sensitivity of the structure to settlement led us to focus on the foundation principle to be adopted. We finally chose a piled raft foundation solution with a raft and short piles anchored into the compact fine sand. As a result, each sphere will rest on foundations comprising 150 piles, each with a diameter of 0.6 m and a length of 13 m.

The chosen execution technique is the CFA (Continuous Flight Auger) technique, equivalent to a type II hollow auger, and locally available.

The foundation works, supervised on site by TERRASOL TUNISIA, began in March 2011 at an average construction rate of 10 to 12 piles a day.

M. Reboul
H. Le Bissonnais



Central Seine

TERRASOL, moved on June 27th to new offices in Paris and thus joined the other Paris offices of the Setec group. Please take note of our new coordinates:

TERRASOL
Immeuble Central Seine
42-52 quai de la Râpée
75583 Paris Cedex 12 - France

Tel.: +33 (0)1 82 51 52 00
Fax: +33 (0)1 82 51 52 99
Email: info@terrasol.com



Le Havre

Jenner tunnel

The Jenner tunnel is a 535 m long two-track underground structure for the first tramway to be built in Le Havre, linking the lower part of the city to Place Jenner located in the upper part. It is constructed in parallel with and fairly close to the existing road tunnel.

The overburden varies in depth from 35 m to 6 m for an excavated section of around 60 m².

The tunnel is excavated with the "traditional method" using a cutter machine equipped with a milling head weighing several tons: excavation began end-January 2011 and is scheduled for completion for end-2011.

Spie Batignolles commissioned **TERRASOL** to carry out an additional geological survey and geologically monitor the tunnel excavation.

The main concern about the excavation phase was the installation of heavy supports (steel ribs, sprayed concrete, umbrella arch and face bolts, as well as local counter ribs on raft) to compensate for unfavourable geological conditions (karstic or weathered areas) anticipated over most of the route while it may be assumed that the facies being crossed is largely compact chalk considered as a rock.

The tunnel is located next to a plateau dug out from Cenomanian chalk, covered over a decametric thickness by flint clay and, locally, plateau loam. The beginning of the excavation confirmed the presence of largely sound chalk, although with the presence of small karsts requiring "forepolling" type pre-support.

L. Casasola

La Défense

Majunga high-rise building

Construction of the Majunga high-rise building in the "La Défense" business district has begun and, on what is probably the last free plot remaining among the existing high-rise buildings and skyscrapers, the Eiffage Construction and Botte Fondations teams have started work: jet-grouting, injections, soldier piles and "Parisian" piles, etc.

Over the four years that **TERRASOL** has been following the project with Setec tpi, a wide range of problems have been resolved. The engineering studies have had to deal with issues as varied as the former Calcaire Grossier quarries located under the plot, the retaining structure around the excavation, the raft foundation and the impact of the works on neighbouring buildings.

In particular, **TERRASOL** chose to use Tasplaq software to estimate the settlement caused by the building. This has been estimated as approximately 9 cm below the core after 50 years of operation. The "G3" level study, carried out by Fugro using Plaxis 3D software, shows the successful matching of these two approaches when considering settlements.

TERRASOL is now responsible for the geotechnical supervision of works ("G4" mission) as well as the external inspection of the construction design documents ("visa").

For the time being, everything is still taking place below groundlevel, and earthworks have not yet begun. We will keep you informed about Majunga building in a later issue of this Letter!

C. Lefèvre

Doha, Qatar

Sheraton Park project

Within the scope of constructing an underground car park (2,000 parking spaces) and a 73,000 m² landscaped park positioned in front of the Sheraton Hotel in Doha, the VINCI CONSTRUCTION GRANDS PROJETS Structural Design Department entrusted **TERRASOL** with a mission to study a solution using a micropile anchored raft-type foundation. More specifically, the study, based on numerical modelling (PLAXIS 2D), aimed to establish the forces in the micropiles required to absorb the hydrostatic pressure (tension piles) while taking into consideration the shrinkage of the concrete raft.

The car park raft is positioned in compact limestone formations located approximately 20 m below groundlevel and 15 m below the water table.

Modelling using several 2D profiles led to the feasibility of the micropile solution being validated. The modelling also better defined the installation conditions for this type of solution insofar as the following points were concerned:

- Adaptation of the micropile grid to match the specific positioning of the piles,
- Minimal steel section used for the micropiles,
- Raft – micropile connection system.

K. V. Nguyen
P. Chalivat

Software Department

64bit compatibility

Talren 4, K-Rea and Straticad are now available for 64bit operating systems (Windows® XP/ Vista / 7).

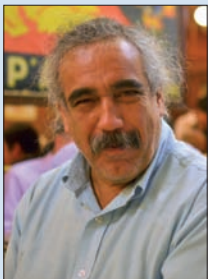
Note: standalone hardlocks need to be exchanged for new ones in order to be compatible with 64 bit OS. Please contact us for more information.

AMRetain software

TERRASOL developed for ArcelorMittal the AMRetain program, enabling for the checking of ArcelorMittal sheet pile walls (single ou double walls, cantilever or anchored walls). This software also includes various checks according to the French standard NF P 94-282 (application of EC7 for retaining walls calculations): checking of passive earth pressures, balance of vertical forces, Kranz check (equilibrium of anchoring block).

AMRetain was just finished and we will now make the same features available in our commercial software K-Rea.

Agents – Focus on Mexico



GEO INGENIERIA ALFVEN (Mr Alfonso A. MANILLA) has been our agent in Mexico for several years now. His territory has been progressively extended to most countries of South America.

He has recently spent a few days at TERRASOL and we are presently preparing together a training session about TERRASOL software (Foxta, Talren, K-Rea, etc) to be held in Mexico in 2012.

International Events



- Geogrup, our agent in Turkey, organized a Talren training session in Istanbul in April 2011 with about 15 participants.
- TERRASOL had an exhibition stand during the International Symposium GEORAIL in May 2011, and represented both Terrasol and Plaxis software.
- TERRASOL TUNISIA will have a stand representing both Terrasol and Plaxis software during the next African Regional Conference in Maputo, July 2011.
- And we will have a stand during the next European Conference on Soil Mechanics and Geotechnical Engineering in Athens, September 2011.

Up-to-date versions



Talren 4 v2.0.4



Straticad v1.2



Foxta v2.0.2



K-Rea v2.4.0



Plaxis 2D 2010.01



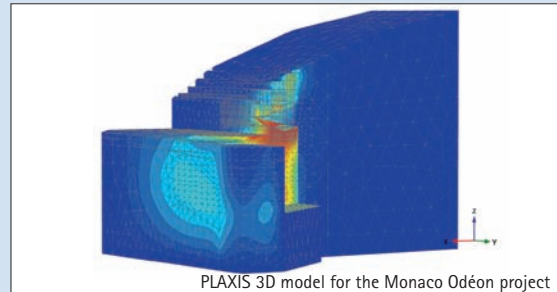
Tunren v1.05



Plaxis 3D 2010.02

Plaxis 3D

TERRASOL recently achieved 2 major studies using PLAXIS 3D: modeling of a very high and complex excavation in Monaco (Tour Odéon, please refer to Plaxis bulletin) and modeling of Toulon Tunnel excavation (PhD jointly with INSA de Lyon).



PLAXIS 3D model for the Monaco Odéon project

Recent publications

- Gestion de l'aléa karstique sur les ouvrages en terre de la ligne ferroviaire Gauthrain en Afrique du Sud (A. Guilloux et A. Bergère) – Symposium International Georail 2011 – Paris, Mai 2011
- Déformations excessives d'une plateforme ferroviaire suite à une saturation du corps de remblai (A. Guilloux et A. Bergère) – Symposium International Georail 2011 – Paris, Mai 2011
- Optimisation des plateformes de tramway à partir d'une modélisation tridimensionnelle en éléments finis (H. Le Bissonnais et M. Reboul) – Symposium International Georail 2011 – Paris, Mai 2011
- Retour d'expérience sur les études et le creusement du tunnel de Chavane – Terrassement et excavation dans les marnes gonflantes (P. Legrand, C. Lefèvre et S. Curtil) – Symposium International Georail 2011 – Paris, Mai 2011
- South Toulon Tunnel: Analysis of an instrumented section (JP. Janin, D. Diasl, R. Kastner, F. Emeriault, A. Guilloux et H. Le Bissonnais) – Symposium TC28 IS Roma – Rome, Mai 2011
- Settlement monitoring and tunneling process adaptation – case of South Toulon Tunnel (JP. Janin, D. Dias, R. Kastner, F. Emeriault, A. Guilloux et H. Le Bissonnais) – Symposium TC28 IS Roma – Rome, Mai 2011



Immeuble Central Seine
42-52 quai de la Râpée
75583 Paris Cedex 12 – France

Tel.: +33 (0)1 82 51 52 00
Fax: +33 (0)1 82 51 52 99
Email: info@terrasol.com



Immeuble L'Orient
10, place Charles Béraudier
69428 Lyon Cedex 03 – France

Tel.: + 33 (0)4 27 85 49 35
Fax: + 33 (0)4 27 85 49 36
Email: lyon@terrasol.com



2, rue Mustapha Abdessalem
El Menzeh
2037 Tunis – Tunisie

Tel.: + 276 71 23 63 14
Fax: + 276 71 75 32 88
Email: info@terrasol.com.tn