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## Editorial

In 2012, in spite of the postponement or slowing down of certain projects, we have succeeded in maintaining our activity and continued to develop our market shares in France in various segments, some of which are presented in this letter :

- projects of rehabilitation of old structures (particularly buildings) and maintenance of existing infrastructures (motorways or railways), markets which are developing rapidly in France and in countries which are already well equipped. Rehabilitation presents new challenges for geotechnical engineers; our geotechnical knowhow and our combined expertise in soil testing, soil reinforcement and modelling techniques make us particularly capable of meeting these challenges;
- as always, major infrastructure projects: in addition to the BPL and CNM High-Speed Lines, on which we are continuing our integrated engineering interventions in close collaboration with the Setec teams, the SEA HSL is an opportunity to participate in some highly interesting studies, including viaducts in karstic sites and a large embankment on rigid inclusions in a site of near-legendary status for geotechnical engineers, the Dordogne Valley at Saint André de Cubzac. Nor should we forget the extension of the Eole line between Saint-Lazare and La Défense, which has entered an active phase, pending the Greater Paris studies;
- and major constructions, including in particular the Tribunal de Grande Instance de Paris, which we will discuss again shortly, together with the works on the Odéon Tower in Monaco which are continuing with the start of the construction in "top-down" mode and the excavation which is nearing the planned final depth of 70 metres.

However, as 2012 draws to a close, the national (and European) economic situation is generating a lot of uncertainty concerning activity in the construction sector in the years to come, particularly in France, and is leading us to continue in parallel our international development:

- oil & gas projects (the Browse methane tanker terminal in Australia) and projects in the energy sector (several power plants in Ivory Coast with Cegelec and in the Middle East and Vietnam with Alstom);
- infrastructure and building projects: Third Bosphorus Bridge, missions for ADM in Morocco, various projects in progress in Algeria, intervention on behalf of our Lebanese partner on the Crystal Towers in Beirut, etc.

This is not to mention the many sometimes less spectacular but equally exciting projects which occupy our teams of nearly 50 engineers, who are permanently at your disposal to assist you in your geotechnical engineering projects.

A. Guilloux

setec

# Geotechnical engineering and rehabilitation of structures

Rehabilitation projects for constructions, buildings or civil engineering structures include а geotechnical engineering component which must simultaneously seek to meet imperative technical requirements and provide an optimum answer Sustainable Development to needs. This means aiming to make maximum re-use of existing foundations to limit demolition and reconstruction work and minimise consumption of new materials.



TERRASOL is currently committed to these goals:

- both in a research project entitled Rufex (Re-Use of EXisting Foundations) as part of the competitive cluster Advancity, aiming to develop the use of Soil Mixing with a retractable tool (Solétanche-Bachy process) for reinforcement of railway platforms without removal of the track, and of existing foundations of buildings;
- and in various building renovation projects in the Paris region: the former Calberson warehouses on Boulevard MacDonald (for conversion into offices and flats), the East sector of Jussieu university campus, and a former postal sorting centre in Pantin redeveloped as a Data Center.

In such contexts, the geotechnical problems are different from those encountered in new projects and lead to the development of very different study methodologies:

- to re-use existing foundations, it is necessary to know them well and therefore, because the «as-built» drawings are not always available, to implement means of investigation and inspection of the geometry of the existing foundations, the quality of the concrete, etc;
- in cases when the renovation leads to an increase in loads, it is necessary either to reinforce the existing foundations or to create new ones, which raises load redistribution questions involving all phases of the construction work, from demolition through to reconstruction. The modelling is often complex and must take into account this whole loading history;
- furthermore, even when there is no significant change in the loads, the application of existing

regulations could lead paradoxically to the reinforcement of foundations which have served their purpose very well for decades, on the grounds that they are no longer in line with regulations;

 lastly, whether it is necessary to reinforce the existing foundations or to create new ones, the often restricted spaces oblige us to choose unusual and innovative construction techniques, all of this being done while minimising the demolition of existing structures.

We applied this methodology particularly to the renovation of the Calberson warehouses, the structure of which was originally designed to withstand higher loads than those of the future construction. However, the foundations were designed to the "bare minimum", and the discovery of an anomalous layer under the base of the piles led to reinforcement of the existing foundations by Jet Grouting at the tip of the piles, thus enabling them to work at an optimum level. The creation of new foundations on micropiles was then the second significant step in the project. At this stage, a study of the interaction between these new "flexible" foundations and the stiffer existing piles was conducted to evaluate the load transfers as accurately as possible. Lastly, in order to check the correct behaviour of the construction, which combined new and old structures, it was decided to monitor the behaviour of the building over time in accordance with the principles of the observational method.

Renovation projects thus involve a desire to incorporate an element of the past in the buildings of the future. And such projects oblige us to review and rethink our engineering know-how.

A. Guilloux & T. Perini

## **Vridi Energy Production Plant – CIPREL IV**

#### Abidjan, Ivory Coast

The thermal power plant operated by the Compagnie lvoirienne de Production d'Electricité (CIPREL) is located to the south-east of Abidjan, in the region of the Vridi Canal which links Ebrié Lagoon to the Atlantic Ocean. CEGELEC was chosen by CIPREL for the turnkey construction of a fourthunit extension of the existing plant, enabling the production capacity to be increased by an additional 111 MW.

At the request of SETEC ENERGY SOLUTIONS, which provides CEGELEC with technical assistance for aspects related to civil engineering, TERRASOL was called upon for the (G2) project geotechnical studies. TERRASOL intervened first of all with the definition of the geotechnical campaign and a mission to follow-up this campaign in June and August 2012. The soil-testing campaign was marked by the setting up of Cross-Hole tests, the conducting of which was a major first in Ivory Coast. Analysis of the tests enabled the risk of liquefaction due to the turbine vibration phenomenon to be ruled out.

In a second phase, TERRASOL designed the foundations of the various structures (turbine, steel structure, chimney, buildings, etc) adapting the techniques used on a case-by-case basis in accordance with the loading levels and strict differential settlement criteria (shallow raft foundations, micropiles, raft foundation combined with shells executed by cutting, etc).

C. Bernuy



## South Europe Atlantic High Speed Railway Line

#### **Tours - Bordeaux**

The Tours-Bordeaux South Europe Atlantic (SEA) HSL is the first High-Speed Line project based on the Public-Private Partnership (PPP) model in France. It will involve 340 km of new line, including 302 km of highspeed line and around 40 km for connection to the existing line. With the aim of commissioning in 2017 for a concession period of 50 years, various preparatory works and studies necessary for the first construction operations have been underway since 2010. TERRASOL has been taking part in this project since the summer of 2011 on several geotechnical construction missions (G3) to assist various teams in the design and construction sub-group COSEA:

- Standard (52) and specific (4) civil engineering structures of section B (work sections 3 & 4);
- Viaducts (4) with prefabricated segments crossing the Auxance, the Indre and the Claix rivers (with taking
  into account of the karstic context);
- Hydraulic retention tank in Ambarès-et-Lagrave;
- · Soil reinforcement under the Dordogne Valley embankments.



## **Dordogne Valley embankments**

The SEA line passes through the Dordogne Valley near Saint André-de-Cubzac, a location known to geotechnical engineers for the experimental embankments built on soft organic clay, which have been the subject of numerous publications by the LCPC since the 1970s. The detailed soil-testing campaigns for the SEA project showed that it was also necessary to take into account the presence of a metre-thick peat layer for at least two of the three embankments to be built. The option chosen is to build these embankments on driven prefabricated rigid inclusions combined either with small concrete caps or with geogrids. At BALINEAU's request, TERRASOL carried out the pre-design of these various solutions with the aim of installing experimental plots equipped with instruments to compare the performances obtained and validate the design methods.

## **South Alpine Arc Phase II**

#### **St-Marcel lès Valence - Moirans**

The railway lines linking the conurbations of Valence, Grenoble and Chambéry constitute what is commonly called the "South Alpine Arc". Phase II of the project consists of electrification of the lines between St-Marcel lès Valence and Moirans, connection of the line to the HSL (South operation) and electrification of the lines between Gières and Montmélian (North operation).

The consortium (ALSTOM – Representative, SPIE BTP, COLAS RAIL, NOUVETRA and SETEC) is working on the South operation in the frame of a design and construction contract.

The 80-kilometre line runs along the terraces of the lsère Valley and cuts through a few rocky outcrops, which justified the drilling of three tunnels (Têche, Poliénas and Rochefort). For this project, TERRASOL dealt with the following project studies:

B. Simon

K.V. Nguyen

- Replacement of five standard civil engineering structures; Gauge adjustment of the three tunnels on the line; the Tèche
- tunnel is the sensitive structure of the project, for which an extensive sensitivity analysis on various parameters was conducted by means of finite element calculations; Noise barriers studies.

The design phase has now been completed. Approval of the construction drawings is in progress and the construction follow-up (integrated Project Management) should start at the beginning of January.



Credit: SETEC TPI

C. De la Salle & N. Kottaki

## Moroccan motorways – Geotechnical expertises

#### Morocco

In mid-2011, AUTOROUTES DU MAROC (ADM) entrusted TERRASOL with a standing offer agreement over a period of several years for geotechnical expertises on the Moroccan motorway network. The agreement also includes structural and hydraulic expertises, entrusted to MAROC SETEC.

We thus carried out more than ten missions, mainly on sections which are in service, concerning aspects as varied as:

- Embankments which have been unstable for around ten years, or showing worsening cracking after only a few months of operation;
- Rocky cutting slopes with problems of protection against falling blocks or wider instabilities;

- Cutting slopes in loose soils, often evolving clays and marls, on heights up to one hundred metres;
- Problems on underpasses or viaduct abutments;
- Pavement cracking.

These operations cover the whole national motorway network, from North to South (Tangiers, Rabat -Fès - Oujda, Marrakech - Agadir, etc) and provide an opportunity to apply our know-how on the various aspects of motorways infrastructure damage and repair works.

A. Guilloux



## Raymond Barre Bridge

Marking the South entrance of the city of Lyon, the Raymond Barre Bridge across the Rhone was designed in harmony with the entrance of the Confluences Museum, with a modern architecture featuring two outward-leaning arches. Working alongside the Project Manager, TERRASOL was entrusted with the study of the foundations of this structure, which is part of the project to extend tram line T1.

The 3-span bridge has a pier in the river (P1) and a pier on the edge of the bank (P2). Both piers will be founded on piles. The geotechnical context does not present any particular problems; the soil is composed of river alluvia becoming compact at depth before encountering the bedrock consisting of granite sand associated with the facies of the Jardin des Plantes.

The problems of the project essentially concern:

- the complex load distribution of the structure, due in part to the asymmetry of the deck which is embedded on the piers, inducing considerable transverse forces for the foundations;
- compliance with river traffic, which requires the area covered by the foundations to be restricted;
- difficulties related to construction in a river with a water depth of approximately 12 metres at pier P1.



Credit: Alain Spielmann Architecte

The calculations for the deep foundations of the piers were performed using the FOXTA software, its various modules making it possible to account for the behaviour of a pile group subjected simultaneously to transverse and axial loading.

The construction works were entrusted to the BOUYGUES TP/MATIÈRE/ZWALHEN & MAYR consortium. The first stone was laid on the 24th of November 2011. SETEC ALS, with TERRASOL's assistance, carries out the works and studies Project Management for the civil engineering. The works began in April 2012 with the construction of the cofferdam for pier P2 and of the piles for abutment C3. The large cofferdam of pier P1 has now been completed and is awaiting the construction of the sixteen 1600 mm piles necessary to support this pier on which the steel structure will be embedded.

T. Rossi & B. Aksoy

## "Crystal Towers" project

### Beirut, Lebanon

TERRASOL is assisting its local partner STS CONSULTANTS in the design of the foundation system for two towers (30 and 20 storeys) near Antelias Bridge in Beirut (Lebanon).

The geotechnical context of the site is marked by the highly variable top level of the bedrock (from 20 to 50 metres deep) and the presence of a loose silty sand horizon at the surface with furthermore a risk of seismic liquefaction. These conditions justified the choice of a piled-raft foundation system with reinforced concrete piles 1.2 metres in diameter anchored to a depth of 3 to 5 metres in the bedrock. This system is combined with prior reinforcement against liquefaction by stone columns over a depth of 20 metres. The FOXTA v3 software was used for estimation of the foundations displacements and stiffnesses under static and seismic conditions, taking into account the group effect.

F. Cuira



Credit: SAYFCO

## **Software Department**

#### **International Events**

- TERRASOL, together with our agent AIMIL, attended the Indian Geotechnical Conference 2012. IGC 2012 in New Delhi (3 papers and a booth).
- TERRASOL was also represented by GEOGRUP during the Turkish National Congress of Soil Mechanics and Geotechnical Engineering in Isparta and the Dam safety symposium in Eskisehir (Turkey).
- TERRASOL is a Partner sponsor and we will get a stand during the next International Conference on Soil Mechanics and Geotechnical Engineering in Paris (France) in September 2013. Join us there ! www.paris2013-icsmge.org

## **Training sessions**

TERRASOL provided several software training sessions at the end of 2012:

- In Beirut (Lebanon) together with our agent STS CONSULTANTS
- In Algiers (Algeria) together with our agent AMEDIC
- In Denpasar (Indonesia) for the team of our new agent PT WAHANA KRIDA KONSULINDO.

We will of course go on providing training sessions about our software next year. Check the agenda on our website for sessions close to your offices !

## **Geotechnical CAD module: Straticad**

Straticad is now available in English ! This time-saving CAD tool allows for the semi-automatic processing of geotechnical data within CAD drawings. It tool provides high-quality customized CAD display of geotechnical data.



Straticad application example



#### Agents for Russia and Indonesia

Let us introduce to you our new software agents:

- Russia: ALCOMP EUROPE recently became our agent for Russia. They
  could have Talren 4 approved by Russian authorities and started
  promoting the software.
- Indonesia: PT WAHANA KRIDA KONSULINDO became our agent for Indonesia in October. We had the opportunity to visit them for a training session and the start our cooperation.

You may view their full coordinates on our website. Welcome to them among the Terrasol software agents team !





Indonesia: our agent team

Mr Timur KUDAKAEV (Alcomp Europe)

(PT Wahana Krida Konsulindo)

**Terrasol software newsletter** Visit our website and subscribe to our newsletter: you will regularly get information about our training sessions, our new software releases, etc. http://www.terrasol.com/en/newsletter-subscription

F. David

## **Recent publications and presentations**

- Mise en place de la méthode observationnelle pour la construction d'une tête de tunnel (LGV Est lot 47) (0. Bril, E. Ducoin, R. Bourget and S. Perrot-Minot) JNGG2012 – Bordeaux, July 2012
- Meet'ing 2012 (Paris, October 25th 2012) Table ronde « L'espace souterrain urbain : une alternative et des opportunités ». Presentation by B. Simon on geotechnical challenges and geothermal opportunities
- Computation of local dynamic impedances for an embedded structure (N.Kottaki) European Plaxis Users Meeting Karlsruhe, November 2012
- Information day Cimbéton FFB/UNESI SMABTP (Bordeaux, November 20 th 2012). Presentation by B. Simon with L. Carpinteiro (Socotec) « La géotechnique pour la conception et la réalisation des dallages »
- Millau Viaduct: geotechnical studies and foundations (F. Schlosser, C. Servant, A. Guilloux and A. Bergère) Indian Geotechnical Conference New-Delhi, December 2012
- Settlement monitoring and tunneling process adaptation case of South Toulon Tunnel (JP. Janin, D. Dias; R. Kastner, F. Emeriault, and H. Le Bissonnais) Indian Geotechnical Conference - New-Delhi, December 2012
- Yield design applied to earth retaining structures (B. Simon) Indian Geotechnical Conference New-Delhi, December 2012





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