TERRASOL

La Lettre
June 2010 - n°16

Edito

After 2009, a year during which we were hardly impacted by the crisis, 2010 has, for **TERRASOL**, a level of activity similar to previous years, in spite of some major infrastructure investments postponed due to the economic slump.

This issue of our **TERRASOL** Newsletter presents projects which vary from one another at many levels: geographical areas, clients, geotechnical fields, types and volumes of work, project progress... illustrating well how **TERRASOL** was able to diversify its work and offer answers meeting the specific requirements of its different clients.

This issue summarizes our interventions for:

- the Croix Rousse tunnel in Lyon, in a very delicate urban context: the famous Lyon rock shelters are well-known to geotechnicians due to the geological accidents they have incurred in the past;
- the preparatory works for the EPR nuclear power plant in Flamanville, deep rocky excavations under sea level, are now complete;
- studies to optimize tramway platforms by means of numerical modeling;
- in the environmental field: the Taparura project in Sfax, Tunisia, managed by our subsidiary **TERRASOL Tunisia**, and project management of the rehabilitation works of spoil deposits in the Ouche mine;
- various "Tunnel" Technical Committees.

Also, this 'new layout' issue uses the graphics standards of our new Web site (www.terrasol.com) which we hope reflects **TERRASOL**'s image.

Finally, our commitment to Sustainable Development continues, with the publication of our carbon inventory for year 2008, a vital step as it provides us with a reference: we will now be able to assess the effectiveness of environmental care measures we take in our daily operations.

Alain Guilloux
Cheif Executive Officer

Lyon: Croix Rousse tunnel

The Croix Rousse tunnel, a single tube 1753m long, is an urban infrastructure connecting the Saône side to the Rhône side of the Croix Rousse hill (Lyon). Traffic through this structure exceeds 25,000 vehicles/day in both directions.
Its condition and the resulting safety issues have led the Communauté Urbaine de Lyon (the structure's manager), to launch a 'heavy renovation' operation which when completed (by February 2014) will lead to:

- Renovating the existing tube so that it meets safety standards (ventilation, niches, etc)
- Constructing a second parallel tube dedicated to soft modes (bus, cycles and pedestrians) which may be used as a rescue tube if required (intertubes)
- Implementing a new information system common to all tunnels in the Greater Lyon area.

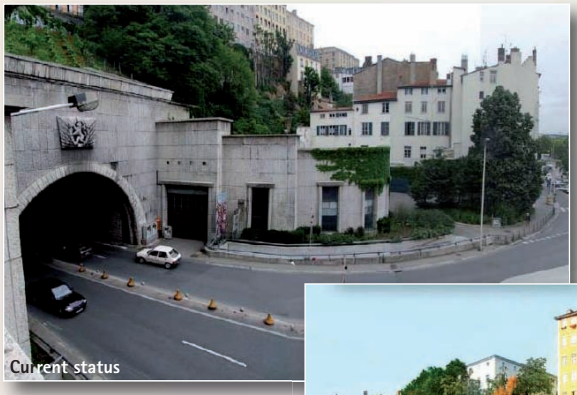
Early 2009, the pool of companies including CAMPENON BERNARD (Civil Engineering), CEGELEC (Equipment), SETEC (Design), STRATES (Architect) was selected for the design / construction of this major project.

Within this operation, **TERRASOL** handles the geotechnical part of the entire project through Package 3: Design which, with package 4: Architecture, constitutes the integrated Project management cell. The tasks assigned to the integrated project Management consist in:

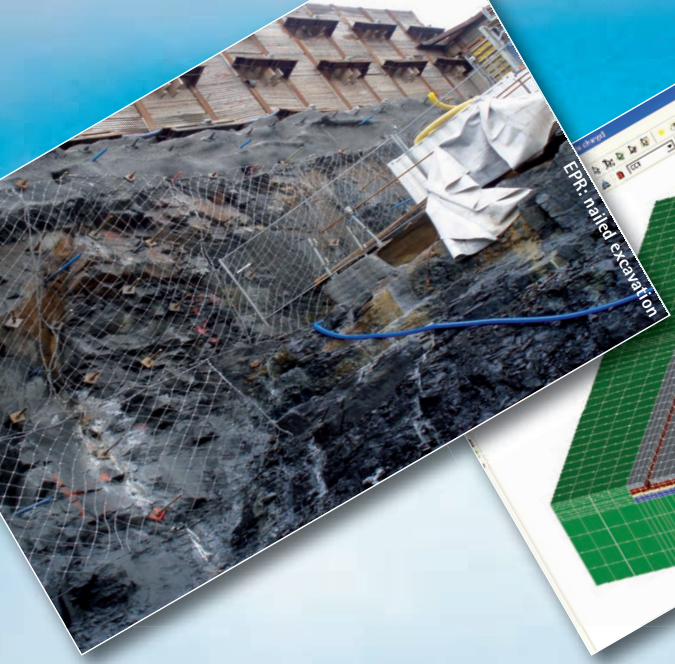
- Producing pre-design studies during the call for tender phase
- Producing detailed design studies
- Ensure external checking of execution studies produced by Civil Engineering. One of the specifics of the Croix Rousse tunnel is the complexity of its portals, implanted in slopes at limit of stability and, moreover, urbanized (Lyon Balmes).

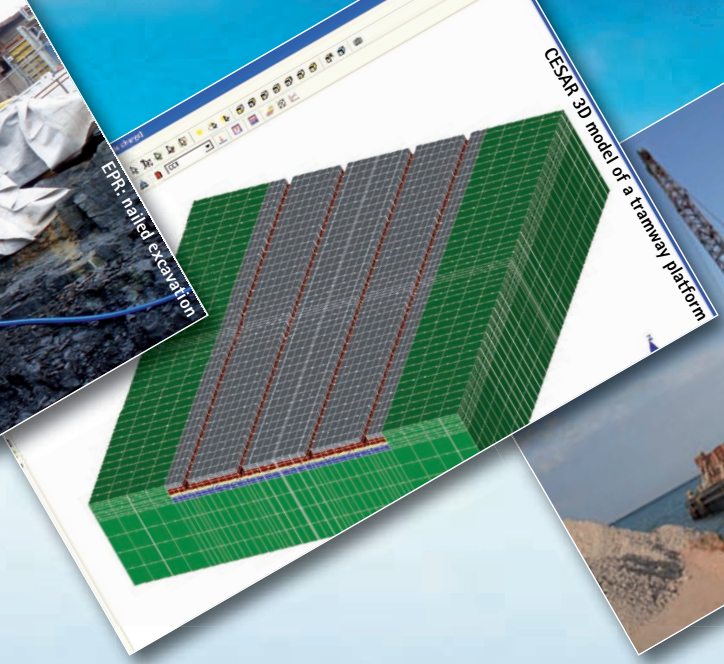
The construction of these structures requires major earthworks taking into consideration drastic limitations of displacements, both during the design and execution phases, to guarantee this work will have no impact on existing constructions. Another specific point is the presence, on the Rhône side, of a large network of existing underground galleries ('fishbone'), with an impact on planned structures which had to be taken into account. The works, initiated in March 2010, should continue until February 2013.

J.Drivet


Current status


Project


EPR: nailed excavation


CESAR 3D model of a tramway platform


Sfax: mech

Rock excavations

EPR Flamanville (France - 50)

In 2006, EDF initiated the construction of the EPR nuclear power plant in Flamanville, France (50). **TERRASOL** intervened within the framework of a G3 mission on earthworks and retaining structures preparation works.
This included more particularly:

- nailed/bolted slopes in a highly fractured, sometimes altered, rocky context
- sheet-pile gabions
- anchored soldier-pile walls
- traditional retaining walls

Parts of these structures are located under sea level. In terms of geology, the project is located at the periphery of the Flamanville granite batholith and overlaps hornfels, highly metamorphised terrains, characterized by a very high abrasivity. Geological monitoring during earthworks enabled to optimize embankment reinforcements and drainage systems according to the fracturation observed, but also to adapt the techniques.

Certain sensitive structures were subject to reinforced monitoring, with definition of deformation thresholds and interpretation of inspection results.

P. Chalivat

Tramway platforms

3D calculations

Within the framework of several projects of new tramway lines, whether in France (Angers tramway, Tram-Train in La Réunion) or abroad (Rabat – Salé tramway in Morocco, Lusail tramway in Qatar), **TERRASOL** was called upon to validate and optimize the design of the platforms foundations (pavement, bearing soil...).

Usually, the study consists in producing a 3D Finite Elements model (CESAR software) which takes into account the bearing soil, the different elements making up the tramway platform (foundation layer, blocking concrete, supporting blocks, rails), the load on the pavement from each bogie wheel, and the various behaviors between pavement elements (adherent or sliding contact).

The calculated stresses obtained in the various pavement structures are then compared with allowable stresses, estimated according to the recommendations of SETRA for road pavement structures made of cement concrete, taking into account fatigue phenomena.

These calculations enable to optimize layers thicknesses with a one centimeter accuracy, leading to major savings.

H. Le Bissonnais

Pollution clean-up

Sfax beach (Tunisia)

The promise made to clean up the pollution on the coast north to the town of Sfax has finally been kept. After four decades of heavy pollution and the closure of the NPK phosphoric acid plant, the coast has inherited a stock of phosphogypsum spread over the beach and at sea. The project to clean up and rehabilitate the coast, coming up to 140.5 million dinars (72.5 million Euros), was initiated mid-2006 and completed mid-2009 (i.e. about 28 months). It included:

- underwater excavation of 445,000 m3 polluted soils (thickness varying from 0.2m to less than 1m) by mechanical shovels carried on barges, with a bucket controlled by an automatic positioning system
- excavation and transport of the phosphogypsum plate of 1247000 m3, remodeling and covering the initial deposit of phosphogypsum: 787166 m3
- dredging and laying of 6.75 million m3 hydraulic sand. Leading to an area of land gained over the sea of about 420 ha.

The isolation system of the final deposit is made of 2636 ml of impervious screen (bentonite–cement) anchored about 10 m deep, and equipped with a sheet of Agrulock type PHD.

TERRASOL Tunisia performed two missions in the frame of this project:

- acting as national geotechnical expert in the supervision team (mission allocated to ROYAL HASKONING and IDC).
- advice for the study on geotechnical ability of terrains in order to adjust the development plan according to the foundation types: prescription and monitoring of a geotechnical survey, definition of the number of levels above and below groundlevel.

K. Zaghouani

Underground structures

Technical committees

Frequently, for major underground structures projects, those involved in the works implement technical committees or expert committees in charge of monitoring work performance, with an outside view. These committees are implemented, either by one of the parties, project owner, project managers or construction companies, or jointly by several of these parties.

This is how I participated in several of these committees over the last few years:

- Toulouse metro line B - France
- Lioran and Bois de Peu road tunnels - France
- Hallandsas rail tunnel – Sweden
- La Praz – LTF raise - France
- North tunnel, Croix Rousse in Lyon - France
- Oullins subriver tunnel on metro line B in Lyon - France
- La Bussière and Chalosset tunnels on the A 89 motorway - France
- Cairo metro - Egypt

These committees help site managers in choosing major options in terms of methods and design, as well as in facing any difficulties encountered during the works. And this detached from daily constraints of the project, offering higher vision, and by engineers who have handled many projects in various contexts, therefore able to offer broad feedback.

A role which seems to offer real added value, as these committees tend to multiply.

A. Guilloux

Ouche mines

Securing mines in Massiac (France -15)

The antimony mine in Ouche, near Massiac, has been operated quite irregularly since the early 19th century, before stopping its activity in 1967. It has become an abandoned polluted site with failing management, with ore processing residue making up a potential source of arsenic and antimony pollution. Embankment instability is also a risk on the site.

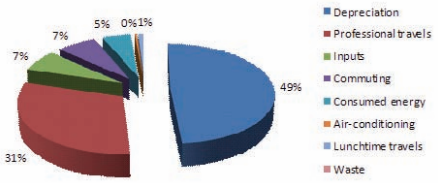
Facing this issue, ADEME called upon **TERRASOL** to perform the project management of design and works guaranteeing long-term stabilization of arsenic residue storage slopes in the washing area. The goal is to eliminate risks for the environment and public safety, particularly due to erosion and spreading of polluted deposits by lixiviation.
Analyses of water flow conditions from upstream the site, as well as the risk of regressive erosion of the embankments by the Bussac river, have allowed to define the principles for earthworks and protection against erosion.

The works will be engaged on site in 2010. Temporary hydraulic developments will prevent pollution flows, and will be associated with strict monitoring of the quality of river waters along the site, thus enabling to control the impact of the works on the environment.

C. Lefèvre / S. Curtil

CARBON FOOTPRINT ®

Late 2009, the SETEC group established a first reference Carbon Footprint® for all its companies, for the year 2008. The one produced for **TERRASOL** has shown the emission of 79 Carbon equivalent tonnes, with the following distribution:



The most important points are:

- depreciation (offices buildings, computers, etc): due to our engineering activity, each employee has a dedicated working space, and we need many computer stations (although we do apply systematic recycling).
- professional travels: when travelling in France, **TERRASOL** staff uses the train most often, but we also work abroad, and emissions due to travels by plane represent 72 % of this item.

The conclusions drawn from this first inventory should allow us to reduce our emissions in the future, through the following first measures: optimization of our office spaces, optimization of the lifecycles of our computers and intensification of recycling, installation of a visioconference room to limit long distance travels.

V. Bernhardt / H. Le Bissonnais

Software Department

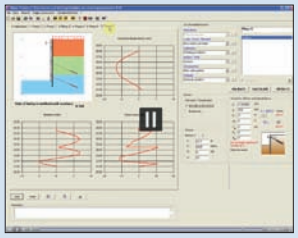
Call for references

You worked on exceptional, unusual, or complex geotechnical designs, using our **TERRASOL** software, and would like to advertise that.

Send us (software@terrasol.com) some screenshots, datafiles or printouts of your models, together with some pictures of the site during or after construction of the works and your contact information, and we will publish these elements in the next issues of La Lettre **TERRASOL** !

UP-TO-DATE VERSIONS

- Talren 4 v2.0.3
- Foxta v2.0.2
- K-Rea v2.4.0
- Tunren v1.05
- Straticad v1.13b



K-Rea video

A video demo is now available from our website (K-Rea page), either to be viewed online, or to be downloaded.

Agents

We are happy to announce that we recently appointed a new agent for India : ATES, a division of AIMIL Ltd. Your contact with Aimil is Mr Khullar. He's located in New Delhi (full coordinates on our website www.terrasol.com).

We had the opportunity to visit Aimil offices and to participate in a workshop in India (mid-may 2010), and thus also to meet some Indian engineers. We trust this will be the start of a fruitful cooperation.

New website

After renovating its premises in Montreuil in 2009, **TERRASOL** posted in early 2010 a new version of its website: www.terrasol.com !
Come and visit it !

Recent publications

- Les études géotechniques et les fondations (F. Schlosser, **A. Guilloux**) – Revue Travaux 868, N° spécial Viaduc de Millau, Janvier 2010
- Full-scale experiments of pile-supported earth platform under a concrete floor slab and an embankment (**B. Simon** et L. Briançon) – Symposium on New Techniques for Design and Construction on Soft Clays - Brésil, Mai 2010
- Traitement de grands déblais et déblais sur la section Larbatache – Lakhdaria de l'autoroute Est-Ouest (Algérie) (L. Zhuo, J. Yuan, M. Zermani, P. Brossier, **M. Yahia-Aissa** et **N. Li**) – Revue Travaux 872, Juin 2010
- Pile-supported earth platforms: two approaches with physical models (**B. Simon**, L. Thorel, JC. Dupla, G. Rault, J. Canou, G. Baudouin et AQ Dinh) – 7th International Conference on Physical Modelling in Geotechnics – Zurich, Juin et Juillet 2010
- Une méthode simplifiée pour la calcul des semelles sur sol renforcé par inclusions rigides (**B. Simon**) - JNGG'10 – Grenoble, Juillet 2010
- Dimensionnement de fondations mixtes sur pieux battus pour une centrale électrique à gaz en Tunisie (**A-L. Fauroux** et **J. Drivet**) - JNGG'10 – Grenoble, Juillet 2010

TERRASOL

Immeuble Hélios
72, avenue Pasteur
93108 Montreuil Cedex - France

Tél. : + 33 (0)1 49 88 24 42
Fax : + 33 (0)1 49 88 06 66
Email : info@terrasol.com

TERRASOL Rhône-Alpes

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

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

TERRASOL Tunisie

2, rue Mustapha Abdessalem
El Menzeh
2037 Tunis - Tunisie

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