La Lettre

n° 20 June 2012

TERRASOL

Bretagne - Pays de Loire
High Speed Railway Line

Editorial

As I mentioned at the end of last year, 2011 was marked by a pickup in the pace of activity for TERRASOL. With a growth of over 15%, the company resumes the almost continuous progress seen since 2000.

Over the last few months, our teams have been particularly called on to participate in wide range of actions and works. A few strong constants which stand out are illustrated in this edition of our newsletter :

- Large linear infrastructure projects: high speed railway lines such as the LGV Bretagne Pays de Loire or, more recently, the Nîmes Montpellier bypass, as well as urban transport through the major Paris projects on which we are already highly involved.

- An international activity which is developing in the industrial sector, particularly energy production and transportation (pipeline in Yemen, methane terminal in Australia, thermal power plants, etc), and in the field of transport infrastructures (expert reports on Moroccan motorways, assistance to contractors for railway projects in Algeria, viaducts in Ivory Coast, etc).

- Accompanying technical and scientific developments in the geotechnical sector with, in particular, the finalisation of the ASIRI National Research Project on rigid inclusions with Bruno Simon as scientific manager. And at the same time the launch of our Foxta v3 software developed to enable the design of foundations according to the recommendations resulting from this project. Terrasol is also maintaining its high involvement with the Organising Committee of the International Conference on Soil Mechanics and Geotechnical Engineering «Paris 2013».

Moreover, I would particularly like to underline the recent arrival of Philippe Reiffsteck who, after 15 years with IFSTTAR (former LCPC), has considerably reinforced our geotechnical expertise potential.
We are now a largely renewed team with over 55 employees at your disposal to provide assistance for your geotechnical projects all over the world.

A. Guilloux

The Brittany – Pays de la Loire High Speed Railway Line project extends the existing Atlantique Paris – Le Mans HSR line inaugurated in 1989. Its objective is to significantly improve the service to Brittany and the Pays de la Loire and increase their accessibility. It is anticipated that the travel time between Paris and Rennes will be reduced by 37 minutes (to less than 1h30).

The PPP (Public-Private Partnership) contract was signed between RFF and the EIFFAGE group in the first quarter of 2011. The EIFFAGE group is responsible for the implementation of all aspects of the project, followed by line maintenance and renewal over a 25 year period. The main key figures are: 214 km of new line (82 km of high speed line and 32 km of connection lines), around 200 civil engineering structures including about ten viaducts, and an estimated cost of 3.4 € billion. As the schedule is particularly tight, preliminary design surveys began in May 2011 and the studies will be completed by July 2012. The beginning of the preparatory works is programmed for July 2012.

Within the special project management group, comprising SETEC FERROVIAIRE (contract leader), SETEC INTERNATIONAL and SETEC TPI, TERRASOL was responsible for the management of the geotechnical surveys during the preliminary design phase as well as for the geotechnical studies for the civil engineering structures over a distance of approximately 120 km including 11 viaducts and 149 standard structures.

The survey campaign began in April 2011 and was completed in January 2012. An additional two month survey was subsequently launched in March 2012.

Geotechnical studies began in October 2011, before all soil testing results were available. To comply with the preliminary design completion dates, TERRASOL mobilised a team of over ten engineers. By the end of January 2012, we had almost completed the geotechnical studies for all the works, with a rate rising up to 20 structures / week. The review phase then took place between January and mid-May. This allowed for the incorporation of new data (laboratory results, additional surveys), of the various external control remarks made by Mr. Guilloux and Mr. Simon, and of the exterior control comments. A strong mobilisation of Terrasol engineers was maintained up to 15.05.2012, date of the official preliminary design release.

This new experience in large infrastructures was acquired within a new contractual context given that we designed the project as well as participated in its construction. Our constant aim is to seek the best technical solutions while simultaneously optimising the project in terms of quantities, costs and schedule.

This experience will be particularly useful for the other high speed railway line PPP projects on which we are currently working such as the LGV SEA (between Tours and Bordeaux) where TERRASOL is carrying out the geotechnical works studies on several sections for VINCI, and the LGV CNM (between Nîmes and Montpellier) where the SETEC group forms part of the project management team alongside BOUYGUES.

N. Li

Montets tunnel

Rhône-Alpes, France

Among its other civil engineering structures, the Mont-Blanc Express tourist railway line includes the Montets tunnel (2 km) linking the Chamonix and Vallorcine valleys.
Built in the early 20th century, this high altitude railway tunnel can also be used as a road tunnel should there be a risk of avalanche on the Col des Montets road.

Over the years, the condition of the support (granitic masonry) has continued to deteriorate. The main factors responsible for this degradation are the large number of water infiltration points in the tunnel, and the severe climatic conditions.

Following a number of rockfalls, design & build modernisation works were carried out.

These were intended to:

- create, repair and ensure the long working life of the drainage and waterproofing systems,
- improve the safety of the tunnel for road use,
- maintain the level of the train operation function.

TERRASOL, within the framework of a technical project management assistance, is intervening on behalf of SETEC ORGANISATION, Deputy Contracting Authority for RFF.
TERRASOL participated in the studies, in the preparation of the contractors consultation file, and in the choice of the design & build contractor (SPIE BATIGNOLLES). The assignment also includes supervising the engineering studies (Bonnard et Gardel) and monitoring the works which are programmed for completion in December 2013.

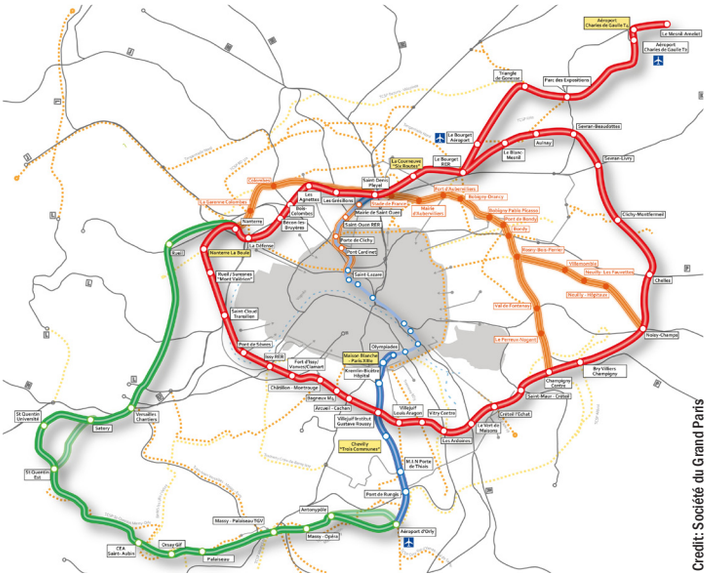
J. Senemaud

The «Grand Paris» and parisian transport projects

Paris, France

Essentially linked to the need to provide new public transport infrastructures (tramway, metro, regional express railway, train), a particularly large number of underground works projects are currently being studied in the Paris region. TERRASOL, thanks to its historic presence in Paris, its considerable knowledge of the region's geology and geotechnics, and its expertise in underground constructions, is particularly involved in a large number of projects. These are either exclusively geotechnical assignments or project management missions in association with various companies of the SETEC group.

Concerning metro lines, these projects include the extension to line 4 (2nd phase, from the Montrouge town hall to Bagneux) with a "second geotechnical evaluation" mission for RATP during the studies and works phases. A similar mission is currently being carried out during the detailed design (PRO) phase for the extension of line 12 up to the Aubervilliers town hall (2nd phase). TERRASOL is also involved in the extension to line 14, considered a priority project for RATP to reduce the passenger load on line 13 between Saint Lazare main line station and the Saint Ouen town hall station.



Credit: Société du Grand Paris

Concerning the RER (regional express railway) lines, the major project in the near future will be the extension of Eole (automatic metro) to La Défense with, in particular, a new station under the CNIT building. The management team for this project design and works will be chosen shortly. It is also worth mentioning the doubling up of the tunnel for lines B and D between Châtelet and the Gare du Nord main line station, for which a feasibility study is presently being carried out.

Finally, the project that will call for a vast amount of energy in terms of studies and then works over the next few years is, of course, the Réseau de Transport Public du Grand Paris (Greater Paris public transport network). TERRASOL, working with SETEC TPI and XELIS, is currently finalising the preliminary studies for the Villejuif – Saint Cloud section (south-west arc – the "red" line) and is involved in the feasibility study concerning the orange line between Noisy and Saint-Denis. There are a considerable number of geotechnical challenges facing the "red" line, including a major problem related to the presence of underground quarries.

H. Le Bissonnais

Protection of a gas pipeline from erosion

Yemen

Transporting gas from the Marib' deposits in the middle of the country to Bahlaf on the coast of the Gulf of Aden, a YEMEN LNG "pipe" runs across almost 320 kilometres of sandy, stony and occasionally very mountainous deserts.

A 5 km section, permitting the passage from a high plateau reaching up to an altitude of 1,700 m to a plain lying 800 m below, is subject to hard geotechnical conditions: surrounded by high dolomitic cliffs that occasionally see massive rockfalls and located in a barely stable slope, this section also crosses over a series of oueds that, during the monsoon season, erode everything lying in their path.

Following an expertise assignment carried out in 2010 concerning the damages linked to this torrential erosion, TERRASOL was once again called on by TOTAL in March 2012, this time to send a TERRASOL engineer on site for a one month period. The works concerned:

- Supervision of works on a gabion and rockfill hydraulic structure,
- An expert assessment of all the redevelopment works carried out to date.

A. Beaussier

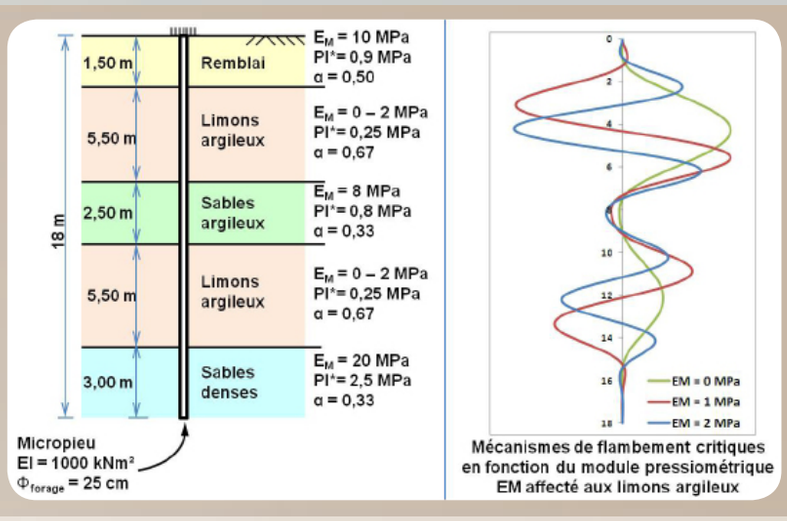
Buckling calculations

Foxta v3 software

A "direct" buckling calculation has been integrated into the Piecoef+ module of the Foxta v3 software. It has already proven itself efficient in the design of a large number of projects including foundations on flexible inclusions and vertical or inclined micropiles, for which the buckling needed to be taken into consideration.

The method used is based on the matrix formulation employed in Piecoef+ and overcomes the limits of standard analytical approaches by providing a direct estimation of the critical buckling load for complex configurations. It also makes it possible to evaluate second order effects in the case of a defect in shape or of a lateral load concomitant to an axial load.

F. Cuira



Mécanismes de flambement critiques en fonction du module pressiométrique EM affecté aux limons argileux

Riviera Marcory viaduct

Abidjan, Ivory Coast

For Ivory Coast, the construction of the third bridge in Abidjan will be one of the most symbolic projects of the 21st century.

This 1,500 m long viaduct with 30 piers will cross over the large Ebrié lagoon and, as such, form part of the global project linking the Marcory and Riviera districts. The project is being carried out by BOUYGUES TRAVAUX PUBLICS and will be operated by the SOCOPRIM concession-holding company within the framework of a construction/concession contract whose central component will be the viaduct.

On request from BOUYGUES, TERRASOL became involved early on in the project for the definition of the geotechnical surveys and an assignment to monitor the soil investigations carried out on site in November 2011. These works are followed by the definition and analysis of static pile loading tests as well as by the preliminary and detailed design.

Given the depth of the boreholes that exceeded 80 m and the difficulties inherent in a lagoon environment, the soil testing campaign proved to be particularly complex. As a result, it was necessary to modify the initial programme which provided for at least one piezocone sounding per support and replace them with destructive and pressuremeter testing.

The viaduct will be founded on 2 m diameter piles bored using hollow augers. These piles will be more than 80 m deep in the central part of the lagoon in order to be embedded into a layer of compact sand laying under a considerable thickness of muddy clay deposits. This compact layer also includes a layer of deep clay with a lesser bearing capacity that required a precise definition of its stratigraphy, a definition made difficult by the erratic sedimentation conditions and the problems encountered during the investigations. To date, the major challenge remains the validation of the calculation assumptions, including the evaluation of the piles bearing capacity.

One or more pile tests using an Osterberg cell shall be carried out to confirm the proposed assumptions, particularly insofar as the pile tip bearing capacity is concerned. This highly depends on an execution methodology that includes pile tip injections to recompress the soil.

T. Perini

Chooz laboratory

Ardennes, France

Within the scope of the "Double Chooz" scientific experiment aiming to study the behaviour of neutrinos, the GUINTOLI - SOLETANCHE BACHY TUNNELS group of contractors is currently building an underground laboratory on the site of the Chooz nuclear power plant in the Ardennes region of France on behalf of CEA and CNRS, with project management by EDF. The detailed design was awarded to the TERRASOL (contract leader) – SETEC TPI group.

TERRASOL carried out the design of supporting structures for the laboratory access (trench – 90 m long, and access tunnel – 20 m² section, 145 m long), for the underground cavern (95 m² section, 30 m length) and for its vertical shaft required for the experiment (13 m excavation depth, 9.5 m diameter). The studies for the works, excavated in shale/sandstone materials, combined a structural approach (analysis of the stability of blocks cut out by bedrock fracturation) and finite element calculations in an equivalent elasto-plastic environment (estimation of deformations and stresses using 2D and 3D modelling).

J. Marlinge

Software Department

PLAXIS software

- 2D: The latest version **PLAXIS 2D 2011.02** is available. Among other features, it improves the 64bit calculation, and allows for the direct input of bending moments.
- 3D: The latest version **PLAXIS 3D 2011.1** includes permanent groundwater flow calculation, and a wizard for circular shapes generation (tunnels). **PLAXIS 3D 2012** is planned for this summer. PLAXIS 3D will include within a few more months transient groundwater flow (Plaxflow) as an option.
- The dynamic module for 2D and 3D is available as an option. Plaxis and Terrasol jointly organized the 1st «PLAXIS Dynamic workshop» in Paris in May 2012. Terrasol presently uses **PLAXIS Dynamics 2D and 3D** for consultancy on several projects.

Talren 4 v2.0.4 | Straticad v1.23
Foxta v3.0.13
K-rea v3.0.2 | Plaxis 2D 2011.02
Tunren v1.05 | Plaxis 3D 2011.01

Agents – Focus on Turkey

Geogrup has been our successful software agent for Turkey for several years.
After the success of our 2nd training session about TALREN 4 in April 2011, it's now time to plan the third one !

We will organize it jointly with Geogrup, as usual, and are considering dates during next winter.

If you are interested in this course, please contact Geogrup !
(info@geogrup.com.tr)

Muge Inanir and Sinem Soytürk (Geogrup)

International Events

- TERRASOL had an exhibition stand during the International Symposium on Ground Improvement in May 2012 (Brussels), and represented both TERRASOL and PLAXIS software.
- TERRASOL was represented by Geogrup during the New Developments In Soil Mechanics and Geotechnical Engineering Conference in North Cyprus on June 28th and 29th 2012.
- TERRASOL will be represented by Geo Ingenieria Alfven during the International Conference of Civil Engineering in Colombia in August 2012.
- TERRASOL is a Partner sponsor of the next International Conference on Soil Mechanics and Geotechnical Engineering in Paris (France) in September 2013. Join us on our stand in Paris !

Training

TERRASOL is organizing several training sessions around the world with the support of our agents. Training sessions in United-Kingdom, Algeria, Lebanon, Turkey, and Colombia have been organized recently or will be organized soon.

Please contact your local agent or TERRASOL to get information about upcoming courses.

International Symposium IS-GI - May 2012 in Brussels

F. David

Recent publications

- Performance of pile-supported embankment over soft soil : full scale experiment (**B. Simon** and L. Briançon) – Journal of Geotechnical Engineering – ASCE, April 2012
- Tunnels en milieu urbain : Prévisions des tassements avec prise en compte des effets des pré-soutènements - PhD **J.P Janin**, May 2012.
- General report S5 Rigid Inclusions and Stone Columns (**B. Simon**) - TC 211 International Symposium on Ground Improvement IS-GI - Brussels, May / June 2012
- Spread foundations on rigid inclusions subjected to complex loading: Comparison of 3D numerical and simplified analytical modeling ISSMGE (D.Dias, **B. Simon**), TC 211 International Symposium on Ground Improvement IS-GI Brussels, May / June 2012
- Short course on Rigid inclusions : Enseignements du projet national ASIRI et Conception des semelles sur inclusiosn rigides (**B. Simon**) - TC 211 IS-GI Brussels May / June 2012
- Micropieux d'ancrages pour haubans d'éoliennes en Ethiopie (**B. Madinier**, **H. Le Bissonnais**, Romain Pellissier), TRAVAUX N°889 – « Sols & Fondations », June 2012
- Une approche simple pour l'étude du flambement d'un pieu souple dans un sol multicouche (**F. Cuira**) – JNGG 2012 - Bordeaux, July 2012
- Fondations renforcées par sol-mixing : modélisation physique et numérique (M. Dhaybi, A. Grzyb, F. Pellet, **F. Cuira**, F. Emeriault and M. Masapolo) – JNGG 2012 Bordeaux, July 2012
- Tunnel Sud de Toulon : rétro-analyses numériques sur les mesures in situ (**JP. Janin**, **H. Le Bissonnais**, D. Dias, F. Emeriault and R. Kastner) – JNGG 2012 - Bordeaux, July 2012

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