

## Edito

For **TERRASOL**, the end of the first decade of the XXIst century is a symbolic milestone, 10 years after François Schlosser, its founder, left and the integration into the **SETEC** group.

Having more than doubled both staff and revenue over the last 10 years, **TERRASOL** has consolidated its leadership in the French geotechnical engineering market. The contribution from the **SETEC** group has been significant: it provided us with access to geotechnical project management (from design to completion) of major projects, such as the Rhin Rhone High Speed Railway, the A41 motorway, the Millau viaduct, the design of the Louis Vuitton Foundation or Toulon South tunnel.

We also tightened our relations with leading construction companies and owners, who have entrusted us with various assignments on major projects, including: the East-West motorway in Algeria, the Gautrain project in South Africa, the Qatar-Bahrein Causeway, the logistic platforms in Montoir de Bretagne, and many power plants in France and throughout the world.

This development was supported by our permanent commitment to research and innovation: our activity in geotechnical software shows this clearly, as do our proactive participation in research programmes (such as ASIRI on rigid inclusions), or our action in the field of sustainable development (specific paper on the inside page).

Finally, **TERRASOL** maintains strong cooperation with the scientific community. For example, I am particularly proud to have served, as Chairman of the French Committee on Soil Mechanics, the team who was awarded the organisation of the XVIIIth International Conference on Soil Mechanics and Geotechnique to be held in Paris in 2013. This commitment will continue within the future Organisation Committee.

All this was made possible thanks to the synergy between our clients, partners, peers, and staff. I am most grateful for this to all of you.

**Alain GUILLOUX**  
Chief Executive Officer

## Algeria: progress on the East-West Motorway

Extending our actions in Algeria and the Maghreb region over the recent years, 2009 was marked for us by the phased delivery of the seven sections in the centre lot of the East-West Algerian motorway.

In this project, **TERRASOL** acted as representative for the **SETEC** group, and was entrusted with the management of technical assistance and external check by the Chinese contractor CRCC.

The Project Owner is the Direction des Projets Neufs de l'Agence Nationale des Autoroutes (DPN/ANA).

One more key section, crossing the mountains South East of Algiers, is to be delivered in 2010. Delayed land availability resulted in postponing soil testing campaigns and initial design, thus explaining that difficulties were uncovered only during works, and that delivery time had to be extended.

More generally, major geotechnical issues were expected or presumed for several sections. They were indeed encountered, and **TERRASOL**'s teams worked with the Chinese contractor and design offices in an unusual context: although geotechnical issues are often met in this kind of project in the Algerian mountains, among which serious instability of slopes and embankments, one of the main specificities of this project was the very prompt decision-making required to continue the project.

Meeting deadlines required deciding fast on technical options, whether during design or works.

In this unusual contractual context, with the combination of cultures and techniques from the various participants complicating relations, the quickness of the decision-making and consecutive actions was a true challenge which seemed initially difficult to raise.

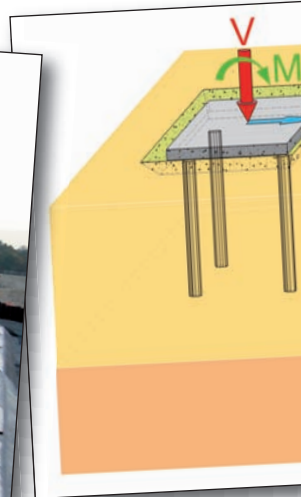
This project was an opportunity for CRCC to demonstrate its ability in handling very large public works projects. There is no doubt that Chinese companies, among which CRCC, offer a capacity for action different from that usually encountered in companies working in Algeria in these major infrastructure works.

For **TERRASOL**, this project was an opportunity, within a technically and financially challenging mission, to manage a multidisciplinary team with several colleagues from **SETEC**, specialised in routes, engineering structures, hydraulics, equipment and safety, etc.

**P. BROSSIER**



Wall and viaduct: lot M5 - Djebel Guantès



## Morocco

### Bouregreg viaduct

For the last few years, ADM (Autoroutes du Maroc) has wished to build a cable-stayed bridge for the Kingdom of Morocco.

After a first project studied on the Sebou Oued near Fes and led in 2005 up to the APD stage (detailed preliminary study) by a team composed of SETEC TPI, the architect Hervé Vadon (Strates) and TERRASOL for the geotechnical part, a second opportunity arose with the Rabat bypass motorway, as an alternative solution to a more classical viaduct composed of concrete segments. The same team presented an ambitious project with exceptional dimensions: a total length of 800 m with a central span of 375 m, a 100m high deck, and two 200m-high central pillars with an architecture inspired by the Arts of Islam.

The geological and geotechnical context is marked by the presence of metamorphic soils (Silesian shales) covered in unconformities by sedimentary formations (limestones, calcarenites, mudstones). The quality of the soils below the main pillars led to choose and design shallow foundations, though with impressive dimensions (25x30 m, i.e. similar to a tennis court).

The project is currently in the bid for tender stage.

H. Le Bissonnais

## DEA 93

### Water storage and routing

Since 2007, the Direction de l'Eau et de l'Assainissement of the Seine-Saint-Denis département (93) has entrusted TERRASOL with all the geotechnical studies relating with its various projects.

Six missions are currently in progress. Most structures involved are reservoirs, semi-buried basins, as well as various associated facilities (main drains, wells, etc.). However, TERRASOL also designed a permanent open basin, included within a more general landscaping project.

These missions are to be carried out throughout all design and work phases, and concern:

- existing structures showing disorders or that are to be converted (diagnostic),
- structures being built (assistance to project owner during works),
- new structures at various stages of their design, from initial bibliographic research to detailed design and writing of documents to be included in the bids for tenders.

The geotechnical issues encountered are varied and strongly marked by the area geology, with the dissolutions of anteludian gypsum, and the presence of captive water tables, which frequently interfere with deep structures. Therefore, the design of the structures (dimensions and depth) strongly depends on the local geological and hydrogeological contexts.

C. Lefèvre

## Strip foundations on rigid inclusions

### A simplified method

When designing a reinforcement by rigid inclusions under an extended foundation, such as a raft foundation or a slab, one should consider in the current section only the effects of a vertical load. The Taspie+ module in the Foxta software package is a simple and particularly adapted tool covering such situations. These projects increasingly include also strip foundations, laying on a smaller number of inclusions, subjected to horizontal loads and moments: these inclusions are then impacted transversally, and must withstand flexion loads.

It is to meet this issue, also encountered for foundations on reinforced soil subjected to seismic loads, that an important validation work was carried out by TERRASOL, in order to determine how to estimate displacements and flexion loads of the inclusions using a combination of Taspie+ and Piecoef+ modules. This work resulted from a benchmark exercise performed by the working group set up within AFPS (French Association for Earthquake Engineering), to define recommendations on the use of soil improvement techniques in seismic conditions.

This exercise covered the case of a strip foundation laying on four inclusions, with an intermediate granular distribution layer subjected to an equivalent pseudo-static load. The procedure combining both Taspie+ and Piecoef+ modules was successful in estimating solicitations in inclusions, whether they were axial or transversal: the magnitudes obtained are close to those found in other answers based on 3D finite element calculations.

This new procedure will be described in the documentation of the future version of Foxta V3, a software package which will include both these latest modules.

B. Simon





Taspie+ and Piecoef+

Givors: structure during the shifting process

## Givors

### Structure shifting under close surveillance

Within the development of the area around the Givors train station, BEC frères SA was awarded the construction of an underground passage under the railway track. The structure planned is a prefabricated frame. As the stoppage time imposed by SNCF was 72 hours to excavate, install the structure and refill, the construction company suggested an installation of the structure by shifting.

This shifting work was subcontracted to Freyssinet who recommended, in order to comply with the deadline, and with safety and cost requirements, to use a shifting technique with air cushions and skidways.

This consists in implementing hydraulic jacks outside the frame, under concrete 'tabs' designed specifically by the structural design office (OSC in Aix les Bains), to lift the structure. Under these jacks, a distribution plate allows them to slide on metallic skidways by means of an air cushion (pressurised nitrogen).

The total weight of the structure is 1,080 tons, and the load per jack 108 tons. Skidways are metallic composites. Their rigidity, although high, remains low with respect to the external loads.

The mission entrusted by BEC to TERRASOL covered several aspects:

- analysis of the results of additional investigations and confirmation of the feasibility of the air cushion solution,
- calculation of deformations and loads in the skidways and, if applicable, recommendation of additional measures.

The analysis of the results of additional investigations showed two weak zones likely to jeopardise the feasibility of air cushion sliding. The first, on the structure prefabrication zone, could possibly lead to major deflections in the skidways from the very beginning of the shifting. Therefore, TERRASOL recommended (as substitution was not feasible in this location) to preload the soil below the skidways using the lifting jacks. The purpose of this solution was to consolidate the soil below the skidways before starting the shifting. A second area was considered as hazardous, and a substitution recommended.

These checks were carried out with Plaxis 2D, in short and long term conditions, by applying a phasing of the loads modelling the construction progress.

The shifting operations were performed successfully on 29 August 2009.

J. Drivet



Wind generator plant

## Sustainable development and Terrasol

TERRASOL is particularly committed to sustainable development, which is materialised under various forms.

First in the field of renewable energies: we led a general study for one of the only French wind generator builders, the Vergnet group, the inventor of dual blade light wind generators, which are lowered in case of weather turbulence. As these wind generators are stabilised by cables anchored by micropiles, TERRASOL developed a method taking cyclic loads into consideration when designing the micropiles. TERRASOL will also take in charge the follow-up of soil testing campaigns and the design of foundations for the installation of a field of 120 wind generators (1MW each) in Ethiopia. Similarly, a study of the different solutions for building foundations of photovoltaic panel anchors in full field plants is under way.

On the other hand, TERRASOL, with various companies, universities and Project Owners (Solétanche, SNCF, LCPC, INSA-Lyon, CERMES) started on the French RUFEX research project (certified by the Advancity Competitiveness Pole), dedicated to reusing existing foundations of buildings, engineering structures and rail platforms when rehabilitating infrastructures. And as sustainable development as a concept is a concern for all of us, the first calculation of Terrasol carbon footprint is currently in progress.

H. Le Bissonnais

# Software Department



Alexandria, 06/10/2009  
(room for Terrasol presentations)

## Recent events

**TERRASOL** had a booth at the International Conference ICSMGE in Alexandria (October 2009). This conference was also the opportunity to present **TERRASOL** geotechnical services and software to some of you.

**TERRASOL** also had a booth together with WILDE FEA (our agent for the United Kingdom and Ireland) at the Slope Engineering 09 Conference in London (November 2009).

Finally, **TERRASOL** was also represented in local conferences by its agents (like with Basis Soft in Singapore for example).

## Tasplaq

The English version of Tasplaq has been available since September 2009. It works with a Microsoft Excel® user-friendly interface (and will later be included in the Foxta v3 software).

This easy and powerful program may be used worldwide for the design of slab and raft foundations, including: simple rafts, rafts with joints, multiple rafts, rafts with external loads, rafts lying on stiff supports, etc.

The calculation output includes settlements and moments (shadings, cross-sections or tables).

### Up-to-date versions



Talren 4 v2.0.3



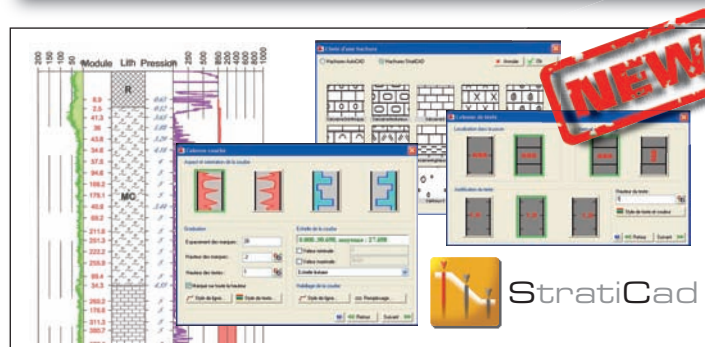
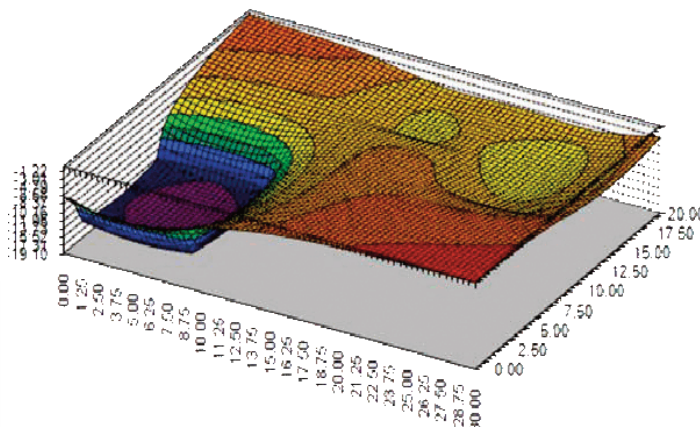
Foxta v2.0.2



K-Rea v2.4.0



Tunren v1.05



## Straticad

**TERRASOL** will shortly release (first in french language) a new tool dedicated to CAD drawing of geotechnical data. Straticad includes 2 types of tools: one for boreholes location, and one for boring logs.

Straticad will first be compatible with Autocad and Autocad LT environments (before later extensions), and enables to import boreholes data provided in following formats: Microsoft Excel®, Microsoft Access®, OpenOffice spreadsheet

From our own experience, Straticad is useful for small sites as well as for major infrastructure projects: it provides high quality and user-defined drawings in a very short time.

## Publications of 2009 second semester

- Yield design calculation of earth retaining structures (B. Simon) - Revue Ground Engineering, Septembre 2009
- Pont de Radès La Goulette (Tunisie) : consolidation des remblais d'accès (K. Zaghouani, A. Chouikha, A. Guilloux, F. Schlosser et P. Berthelot) 17th International Conference on Soils Mechanics and Geotechnical Engineering - Alexandrie, Octobre 2009
- Les fondations du Pont de Radès La Goulette (Tunisie) : reconnaissances, conception et essais de pieux (A. Guilloux, P. Berthelot, K. Zaghouani et F. Schlosser) 17th International Conference on Soils Mechanics and Geotechnical Engineering - Alexandrie, Octobre 2009
- Deux outils simples pour traiter des interactions complexes d'un massif renforcé par inclusions rigides (F. Cuira et B. Simon) 17th International Conference on Soils Mechanics and Geotechnical Engineering - Alexandrie, Octobre 2009
- Cyclic design of the micropiles foundation of a wind turbine (M. Reboul) 17th International Conference on Soils Mechanics and Geotechnical Engineering - Alexandrie, Octobre 2009
- Geotechnical investigation challenges and solutions for Gautrain (R.B. Storry, R. Tosen, TEB. Vorster et A. Bergère) ISRM Regional Symposium Eurock 2009 - Dubrovnik, Octobre 2009
- Deux outils simples pour des systèmes de fondation complexes (F. Cuira et B. Simon) Colloque sur le développement de la Géotechnique au Maghreb - Casablanca, Novembre 2009
- Les fondations du viaduc de Millau : application de la méthode observationnelle pour un ouvrage exceptionnel (A. Guilloux et F. Schlosser) Colloque sur le développement de la Géotechnique au Maghreb - Casablanca, Novembre 2009
- Large scale dynamic compaction for Gautrain rapid rail link, South Africa (R.B. Storry, R. Tosen, A. Guilloux et K. Diemont) International Symposium on Ground Improvement Technologies on Case Histories (ISGI09), Décembre 2009



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