

The future EOLE station at La Défense (Paris region)

Edito

After nearly 35 years working at TERRASOL, first under the leadership of François Schlosser, then for the last thirteen years as CEO, it seemed to me that I could step back somewhat while ensuring a gradual transition to the TERRASOL of tomorrow.

I have therefore decided to begin what I hope is a well-deserved retirement, while maintaining a part-time activity: I remain Chairman of the Board, and am continuing my work as an expert within TERRASOL, as well as providing support for the whole team: geotechnical support for passing on what I have learned from my experience to the younger employees, and managerial support for the new company management.

It is naturally with much emotion that I partly turn this page, but also with a certain pride in having participated from the start in the grand adventure of TERRASOL's development and in observing what it has now become. And I declare all my gratitude to those who have contributed, at one time or another, to the great company that TERRASOL is today: my colleagues of course, at TERRASOL and in the SETEC group, my 'companions' in the French and international geotechnical community, and also of course all our customers who trust us.

We must now look to the future: after a very busy 2013, our order book is already well filled for the coming year and beyond. And this future is more than ever open to attractive prospects for development, particularly in terms of diversification of our competencies and of still greater opening up to the international market, always with the same requirement of quality and thoroughness which is at the base of the 'TERRASOL culture'.

This future is from now on in the hands of Valérie BERNHARDT, who is taking over as Managing Director, backed by the whole of our Management Committee: Hervé LE BISSENNAIS (Deputy Managing Director), Bruno SIMON (Scientific Director), as well as Jean DRIVET and Philippe REIFFSTECK. I fully rely on them and am sure that they will successfully pursue this journey begun 35 years ago with the same passion and the same enthusiasm that have motivated me.

A. Guilloux

As part of the extension of the RER E (Eole) line to the west of Paris, the project management design studies for which are being carried out by the SETEC - EGIS - Jean-Marie DUTHILLEUL consortium, a new station has to be built in the La Défense district, under the CNIT building. It will comprise a main part built under existing structures, extended by two underground connecting tunnels. Anchored at a greater depth than the existing structures in the sector, this station is located in a particular geological context raising demanding technical challenges, characterized by stratified layers at vault level and a limestone slab remnant (coarse limestone formation) overlying loose sands with a confined groundwater level at foundation level. Moreover, as the CNIT building is sensitive to deformation and vibration, the construction methods to be considered must limit the displacements and nuisances generated. From the basic design phase, in the framework of an overall risk management process, substantial soil survey works have therefore been undertaken from the building's deepest basement level, with the aim of characterizing the geological formations concerned by the project and assessing the feasibility and the impact of the planned construction methods.

TERRASOL, which is conducting for this Eole project the geotechnical analyses of the structures in the La Défense sector for SETEC, defined the soil testing programme and followed-up its implementation. The challenge consisted in defining methods for geomechanical and hydrogeological characterization of all the formations impacted by the project: from loose soils (Ypresian sandy clay formations, located below the structure foundation levels) to soft rocks (very heterogeneous stratified marls, screes and coarse limestone formations that will be cut into by the excavations). The proposed methods had to take account of the highly-restricted context (underground car park with low height clearance).

The approach adopted consisted in full-scale tests supplemented by more conventional tests.

A dedicated exploratory shaft with a diameter of 4 m was excavated by conventional means to a depth



of 25 m in the formations intended to constitute the foundation for the structures.

It enabled the rocks to be viewed at full scale and plate loading tests (horizontal and vertical loadings) and vibration tests to be performed at several levels. The programme is supplemented by conventional geotechnical surveys, including core drilling (used for a number of logging measurements), in situ geotechnical tests (SPT, pressuremeter, dilatometer and cross-hole tests) and laboratory tests. Full-scale permeability tests were performed in the two impacted aquifers (selective pumping tests).

The works, started in June 2013, required substantial preliminary excavations to obtain the height clearance needed for machinery and equipment (slab sawing, clearing of the base of the present foundations, etc). They are now approaching completion. All the data obtained will be used to establish an exhaustive geological, geotechnical and hydrogeological analysis adapted to the context and to the complexity of the project, to define the calculation parameters for the detailed design phase, and to propose appropriate construction methods for the construction phase.

J. Marlinge, H. Le Bissonnais

LNG plant at Browse

Australia

The project consists of the construction of a natural gas liquefaction plant on the Dampier peninsula in the region of Kimberley (Western Australia). TERRASOL provided geotechnical assistance for SAIPEM which was producing a competitive FEED (Front End Engineering Design) for WOODSIDE.

In the maritime zone, 3 geophysical testing campaigns and 5 geotechnical testing campaigns were conducted between 2010 and 2012, comprising a hundred or so boreholes and more than a thousand laboratory tests. TERRASOL's geotechnical analysis enabled to identify several geotechnical profiles, define the geotechnical calculation parameters and assess the risk of liquefaction of the site's soils.

Because of the presence of loose sands on the sea bed, particular attention was paid to the analysis of pore pressures in these sands under the caisson-type main breakwater. Time-dependent dynamic finite element calculations were performed using the PLAXIS 2D software to examine the behaviour of the main dike under thousand-year return seismic and swell loads.

The earthquakes were modelled by application of the accelerograms at the base of the model; the values of the swell loads of the thousand-year return storm applied to the caissons were derived from a physical model in a basin. The sandy soils were modelled initially using a "standard" soil behaviour law (HSM) and then, once the cyclic shear tests were available, by an advanced behaviour law (UBC Sand) capable of simulating the accumulation of pore pressures and cyclic plastic deformations in the loose sands. The results of these studies confirmed the need for specific tests and studies to analyze the cyclic behaviour of the soils.

K.V. Nguyen, A. Bergère, A. Guilloux

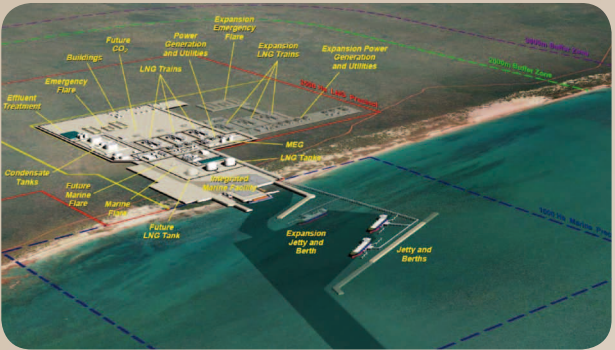


Photo credit : Woodside

South-Europe Atlantic HSL

Dordogne valley embankments

In "La Lettre TERRASOL" no. 21 (December 2012), we reported on the preliminary design by TERRASOL of an experimental embankment intended to validate the reinforcement to be used under the embankments of the SEA (South Europe Atlantic) HSL (High-Speed railway Line) in the Dordogne valley, near Saint André-de-Cubzac. The experimental embankment was constructed between January and March 2013, and was instrumented to compare reinforcement by geogrids and inclusions with three different mesh sizes (1.6 m, 1.7 m and 1.8 m) with reinforcement test plot without geogrids but with pavers and inclusions (with a 1.6 m mesh).

The observations, gathered during more than 6 months already under an embankment height including the effect of railway overload, confirmed that the project criteria (including settlement criteria) could be satisfied by each of the configurations tested. The test plots enabled optimization of the project in a difficult geotechnical environment. On this base, TERRASOL continued with the geotechnical detailed design of the reinforcement by inclusions and geogrids for all the embankments on the left bank (total length 1400 m) and for the various technical blocks located either side of the civil engineering structures.



Photo credit : Balineau

The preliminary design calculations carried out prior to the construction of the experimental embankment provided values for settlement and loads on the inclusion heads in good agreement with the measurements; this also validated the mode for taking into account geogrids above a network of inclusions, as introduced into the calculations performed using the Foxta software (Taspie+ module).

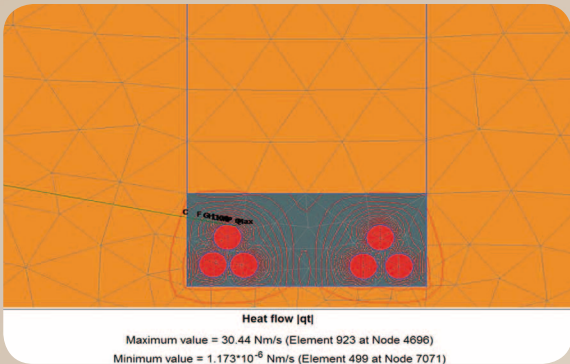
B. Simon

Thermal classification of soils

France

Taking the thermal properties of soils into account in projects for geothermal heat exchangers, burial of electrical cables, or roadways and hydrocarbon pipelines subjected to freeze/thaw cycles, is a major issue. TERRASOL, in partnership with BRGM (French Geological Survey) and the University of Paris VI, has conducted a study for RTE (French Transmission System Operator) aiming to develop a practical method for determination of the thermal conductivity of soils, based on the "GTR" classification from the French Road Earthworks Guide (French standard NF P11-300).

This method takes account of the saturation state of the soil using the determination of the particle-size distribution curves of the various categories starting from the single points defined in the GTR. In a second step, the relationship between the particle-size distribution and the characteristic water content of the soils is defined by a simple empirical model. Lastly, the thermal conductivity is estimated according to various models in the literature. The predictions obtained by these different thermal conductivity determination methods have been compared successfully with several data sets covering all soil categories. This tool has been used in combination with the Thermo-Hydro-Mechanical module recently introduced in PLAXIS 2D to study heat flows around some reference structures (an example is shown here, around a high-voltage cable burial trench).



P. Reiffsteck

Tabellout dam

Texenna, Algeria

The Algerian National Dams and Transfers Agency (ANBT) has awarded to the GEIE/RAZEL/CMC/RAVENA consortium the contract for the Tabellout dam project construction near the city of Texenna, about 70 km south of the Jijel wilaya (district), in Algeria.

The project as a whole comprises the construction of a roller-compacted concrete (RCC) dam 366 m long and 112 m high (reservoir capacity 294 hm³) and a transfer tunnel 4.3 m in diameter (finished diameter 3.5 m) 13 km long, for which a tunnel boring machine (TBM) is being used.

From the start of the work, in March 2010, a number of geotechnical problems have been identified, in particular a landslide on the left bank of the dam, but also extensive degradation of the tunnel lining segments with the development of a collapse, and blocking of the TBM for more than 6 months.

At the request of the consortium, in July 2012 TERRASOL carried out an expert assessment of the landslide of the left bank of the dam, with a full review of the risks of embankment and earthworks instability for the whole of the site.

Given the complexity of the geological context and the insufficiency of geotechnical data, TERRASOL is also providing technical assistance and consultancy services to the consortium on the various geotechnical aspects, including for prediction of the behaviour of the massif during the tunnel excavation, and in particular the behaviour of the Numidian clays and the zones of toppling suspected of being the source of the problems encountered.

M. Yahia-Aissa, A. Guilloux



RD1091 deviation at “Séchilienne Ruins”

Isère

The RD1091 road deviation project at the well-known “Séchilienne Ruins” place consists in shifting the alignment of the road to the opposite hillside in order to protect it from a predicted 3 million m³ landslide (this scenario is assumed to be the most probable in the short and medium terms by the experts).

This deviation, about 1000 m long and costing a total of €30M, includes a large excavation in the Montfalcon micaschists: maximum height 40 m with an excavated volume of 200,000 m³ and an exposed surface of 15,000 m².

The height of the cutting and the poor quality of the soil mass (micaschists globally highly fractured, presence of bands of coal-bearing formations and high water circulation) require reinforcement by dense soil nailing: more than 45 km of nails combined with shotcrete facing on 4/5ths of the surface.

TERRASOL was involved in the main phases of the project as geotechnical assistant to the Project Manager (Conseil Général de l’Isère): design and tender documents in collaboration with SITE ETUDES, VISA approval of the detailed design, and geotechnical follow-up of the works started in spring 2013 and carried out by the GUINTOLI/Bianco/NGE/GTS consortium.

A. Bachelier



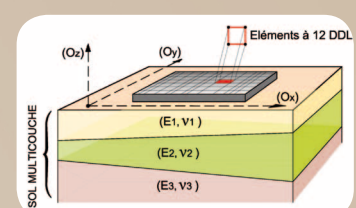
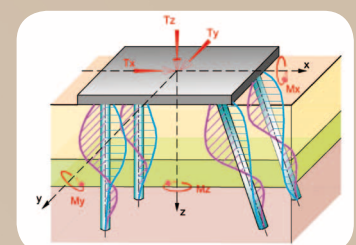
Scientific developments

2013 has been marked for TERRASOL by sustained scientific activity which has resulted in notable upgrades of the calculation engines of several of our software products, in particular Foxta:

- The Groupie+ program now has a new mathematical formulation processing the 3D equilibrium of the combination “foundation + piles + surrounding soil” simultaneously and in a single system: the formulation directly integrates the non-linearities related to the soil behaviour, thus avoiding the complexity of the present procedure which requires back and forth transfers between the three modules Taspie+, Piecoef+ and Groupie.
- The Taspie++ program generalizes the elementary cell model by integrating the shear likely to develop at the cell periphery: this enables processing of the cases with a finite number of inclusions, a line of inclusions, and more generally the edge effects on the periphery of the reinforced area (the method developed was the subject of an oral communication at the 2013 Paris Conference).
- Recasting of the initial formulation of the Tasplaq program now makes it possible to take into account a non-horizontal multilayer with a dip defined by layer and by direction.

These developments, already made available to our engineers in-house, will be incorporated into the next commercial version of Foxta.

F. Cuira



Software Department

Talren v5



The English version of Talren v5 is now ready! Talren v5 is the brand new version of our historical software for slope stability analysis.

Of course, this new version includes all previous calculation features of Talren: calculation of complex geometries, accounting for various types of reinforcements, advanced calculation methods such as the yield design method. But this new version also provides you with a fully new, powerful, robust and user friendly user-interface: it will enable you to save a lot of time and perform efficient checks of your projects stability!

Focus on our agent for the United Kingdom and Ireland



Wilde Analysis has been our agent in the UK and Ireland for 6 years. They advise and support our users there on a daily basis and we have organized several events together in London and Manchester. Some of our British customers are very long-time users of Talren!

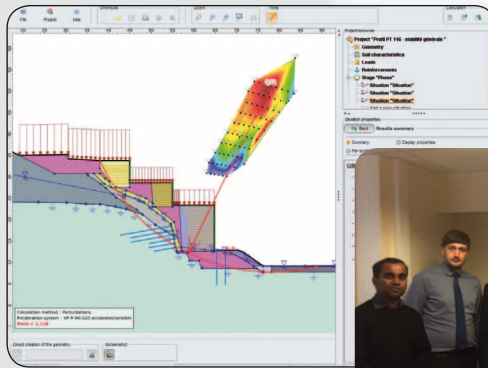
Wilde recently pushed us to deliver the English version of Talren v5 as quickly as possible in response to their customers' interest and helped test the beta version.

They also helped us to provide in Talren v5 the partial safety factor sets issued from the British application documents of Eurocode 7.

We are planning a training session for Talren v5 in the UK during early 2014.

Feel free to contact them for information or for a demo:
info@wildeanalysis.co.uk !

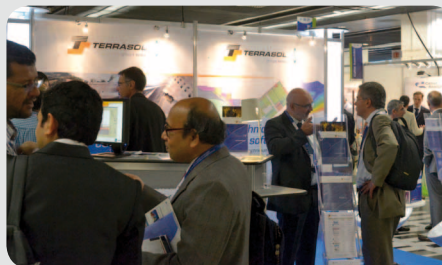
F. David



Talren v5



The team in charge of Terrasol software at Wilde



18th International Conference on Soil Mechanics and Geotechnical Engineering
Paris, September 2013



3rd Maghrebi Conference on Geotechnical Engineering
Algiers, November 2013

Recent publications and presentations

Proceedings of the 18th International Conference on Soil Mechanics and Geotechnical Engineering - Paris, September 2013

- « Prise en compte des effets de bord dans un massif renforcé par inclusions rigides » (**F. Cuira** and **B. Simon**)
- « Innovations Françaises en Géotechnique : les Projets Nationaux de Recherche » (**F. Schlosser**, **C. Plumelle**, **R. Frank**, **A. Puech**, **H. Gonin**, **F. Rocher-Lacoste**, **B. Simon** and **C. Bernardini**)
- « La réutilisation des fondations existantes dans les projets de réhabilitation de constructions anciennes » (**A. Guilloux**, **H. Le Bissonnais**, **L. Saussac** and **T. Perini**)
- « Conception, modélisation et auscultation d'une très grande excavation à Monaco » (**A. Guilloux**, **M. Porquet**, **P. De Lavernée**, **P. Lyonnet** and **P. Roman**)
- « General report - Parallel session : ISP6 Pressuremeter test last innovations » (**S. Burlon** and **P. Reiffsteck**)
- « Application et validation d'abaque pour la classification des sols à partir des résultats pressiométriques » (**P. Reiffsteck**, **A. Martin** and **T. Perini**)
- « Modélisation numérique du comportement d'une colonne de soil-mixing et confrontation à un essai de chargement en vraie grandeur » (**F. Cuira**, **S. Costa d'Aguiar**, **A. Grzyb**, **F. Pellet**, **JF. Mosser**, **A. Guimond-Barrett** and **A. Le Kouby**)
- « Comptes rendus du volume V relatifs aux Short Course du TC 211 - Inclusions Rigides et Sols renforcés » (**F. Cuira** and **J. Verstraelen**)

3rd Maghrebi Conference on Geotechnical Engineering - Algiers, November 2013

- « Confortement du glissement de la route de Stora dans la Wilaya de Skikda » (**M. Yahia-Aissa**, **F. Binet**, **P. Brossier** and **O. Naimi**)
- « Effet Marston au droit d'un ouvrage rigide mis en place à la base d'un remblai de grande hauteur » (**M. Yahia-Aissa** and **P. Brossier**)

Geotechnics for Sustainable Development - Geotec Hanoi 2013

- « Keynote lecture: Management of settlements for an urban tunnel, Toulon, France » (**A. Guilloux** and **H. Le Bissonnais**)



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