

terrasol opens an office in Aix-en-Provence

After Lyon in 2005 and Bordeaux more recently, we opened our new branch in the south-east of France at the beginning of March 2024, located in the heart of the Aix-Marseille-Provence metropolitan area, on the Arbois plateau, close to the Aix-en-Provence TGV train station. We will be joining one of the setec group's main offices in a dynamic region with a complex geological history.



As always, our aim is to develop our geotechnical expertise and engineering activities for our clients in the south-east of France (project owners, builders, manufacturers, etc.), and to provide geotechnical support for infrastructure projects undertaken locally by companies within the **setec** group.

We are already involved in a number of different operations in the region:

- urban transport infrastructure (in Marseille: Schlœsing slip road, Saint-Pierre engineering structure, in Nice: PEM Saint-Augustin);
- port facilities on the Rhône and in the Mediterranean (in particular the overhaul of the Milhaud 4 wharf in Toulon harbour);
- the Fishermen's Esplanade in Monaco ;
- the evacuation gallery at the Vicat quarry at La Courbaisse, ...

Aix-en-Provence branch

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We are also involved in the large-scale railway project for the underground crossing of Marseilles (TSM) as part of the new Provence Côte d'Azur line, as part of the Setec project management consortium. This very comprehensive project in terms of underground construction techniques and methods in a densely built-up environment will present us with a number of challenges in terms of qualifying the behaviour of the stampian formations and studying the soil-structure interaction of the different planned structures (tunnels using tunnel boring machines and traditional methods, large-scale prefunded excavations, foundations for engineering structures and buildings).



Don't hesitate to contact us to find out more about our references and activities in the region, or to discuss your projects: our team will be delighted to meet with you and share their expertise.

M. Hocdé & C. Bernuy

Editorial

After 23 years with terrasol, of which 10 as General Manager, I am now handing over to Fahd Cuirra, who will succeed me as General Manager of terrasol, continuing as Deputy General Director alongside Hervé Le Bissonnais.

This is a perfect opportunity to look back and see how far we've come.

Terrasol is first and foremost a team of passionate geotechnical engineers, which has grown steadily in size (there are now around one hundred of us, based in Paris, Lyon, Bordeaux and Aix-en-Provence), but also in experience and skills, thanks to a solid team of experienced managers. We work on behalf of our clients, including project owners, contractors and industrial companies, both in France and abroad. We have also consolidated our position within the setec group, regularly supporting our colleagues on their projects.

We have also broadened our scope to include soil-structure interaction, soil dynamics and thermal geostructures, and we are now developing our activities in the fields of low-carbon construction, the resilience of structures, offshore wind power and the digital transition (with the marketing of our **Orbow** geotechnical web platform, for example).

Most importantly, we have preserved our model, a guarantee of our technical standards, which combines geotechnical expertise, scientific developments and software, as well as high-quality supervision, an ambitious ongoing training programme and a valuable team spirit.

Our fundamentals are solid and our outlook particularly dynamic, boosted in particular by the sectors of urban transport, railways, nuclear power and ports.

Terrasol is therefore fully equipped to assist its clients with all major transitions taking place in today's world.

I would like to thank Fahd and Hervé for accepting the task of taking on this new role together: it's a strong commitment to all our clients and employees at **terrasol**.

As for me, I will be joining the Group's holding company, as Director in charge of structuring the Group.

The transition is taking place in a spirit of continuity: the new management team is just as committed to the terrasol model as the previous generations.

I would like to thank all our clients for the trust they have placed in us over the years, and the entire terrasol team for the years we have spent working together to contribute to the development of geotechnical engineering.

I wish you every success as you embark on this new chapter.



Valérie BERNHARDT

Geotechnical expertise in the nuclear sector

EPR2 at Penly and Gravelines, France

Terrasol is responding to a growing number of requests in the nuclear sector, reflecting the sector's growing importance following the French President's announcements and the confidence gained from layers in the field: **EDF, Edvance, CEA, Orano, Framatome**, etc. Our teams in Paris and Lyon are heavily involved in the EPR2 project on the Gravelines and Penly sites.

We are currently involved in feasibility studies for the foundation systems of the future EPR2 at Gravelines. The construction of an EPR2 on this site is a challenge due to the presence of very thick loose soil, with substantial and differential settlements expected. In order to ensure the reliability of the design of such a structure and to limit settlement to levels already experienced at existing facilities, the use of a soil reinforcement system is being considered. In addition to the problems of static interaction, several questions relating to the response of reinforcement systems under seismic conditions are currently being analysed by the **terrasol** teams.

At the same time, our teams are also involved in detailed civil engineering studies for the Penly EPR2 nuclear island, assigned to the ENSPIR3 consortium of which the setec group is a member. Several topics concerning the static and dynamic ISS are being studied, including studies of the prestressing chamber, which benefit from the experience gained by **terrasol** in the UK EPR projects (Hinkley Point C and Sizewell C).

J. Pérez Herreros & F. Cuira



Photo credit: © EDF/Santer Van Hoof Architecture

Restoration works on Notre-Dame Cathedral in Paris

France



Photo credit: © terrasol

As part of the restoration works following the fire of the 15th April 2019, **terrasol** has carried out different geotechnical studies on behalf of the Etablissement Public de Conservation et de Restauration de la Cathédrale Notre-Dame de Paris.

An initial G2 PRO assignment was completed in early 2021 in relation to the redevelopment of the site facilities. **Terrasol** then performed assignments G1, G2 PRO and G4 until the end of 2022 as part of the design of the foundations for the 100 m high scaffolding required to rebuild the spire. One of the challenges was to take into account the presence of archaeological remains under the existing paving, avoiding any destructive solutions and verifying the impact of their presence on the stability of the foundation system chosen.

From late 2022 to early 2024, assignments G1, G2 PRO and G4 were undertaken for the installation of a mobile crane and the construction of an underground technical gallery along the south facade.

M. Targosz, S. Delattre & O. Payant

Toulouse Metro - Underground section of Line 3

France

Since January 2022, **terrasol**, in collaboration with **setec tpi**, has been assisting the **Eiffage Génie-Civil - NGE consortium** commissioned by **TISSEO INGENIERIE** for the construction of the underground structures of lots 1 and 2 of the third metro line in the Toulouse agglomeration. After providing technical assistance during the consultation phase, **terrasol** has been performing the geotechnical execution studies for the project since January 2023. These cover 9 underground stations, 12 service structures, 1 branch structure, 12 km of tunnel boring and 800 m of tunnel using conventional methods.

They include :

- Preparation of geotechnical and hydrogeological reports;
- Dimensioning of water management systems during the construction phase (discharge drains) and during the final phase (draining inverts);
- The external control of the dimensions of the retaining screens carried out by the internal design offices of the companies in the consortium;
- Estimating the strain on the surrounding area.

Earthworks are currently under way at the stations, in preparation for the arrival of the tunnel boring machines.

At the same time, **terrasol** is acting as external controller of the geotechnical aspects of the execution studies for lot 3, on behalf of the winning consortium led by Demathieu & Bard.



Photo credit: © MR Communication

J. Marlinge & M. Blanchet

Orbow

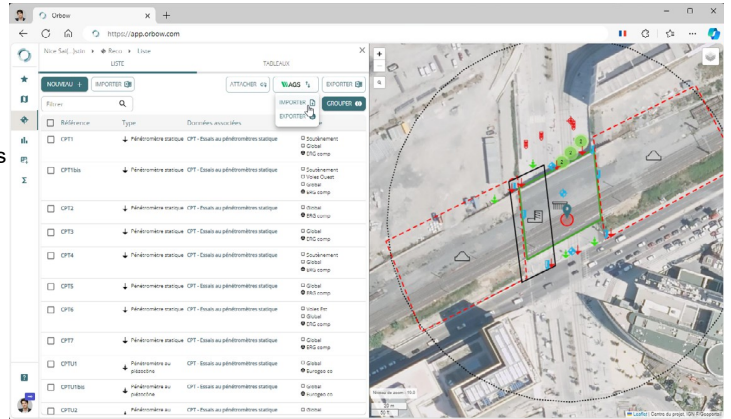
A growing selection of new functions



Launched last year, our platform is constantly undergoing improvements. These improvements are guided by feedback from users, and in particular from all of the **terrasol** engineers who now use it as a everyday tool. In addition to the **Ecow** tool described below, and the traditional improvements to the site's stability and performance, our main focus has been on:

- improved ergonomics for importing soil data via wizards and forms;
- the addition of new modules (pressure test analysis, calculations, etc.);
- automatic generation of reports;
- file archiving...

For a more complete list, follow our [LinkedIn account](#). To test the application or for more information, write to us at orbow@terrasol.com.



G. Chapron

Ecow

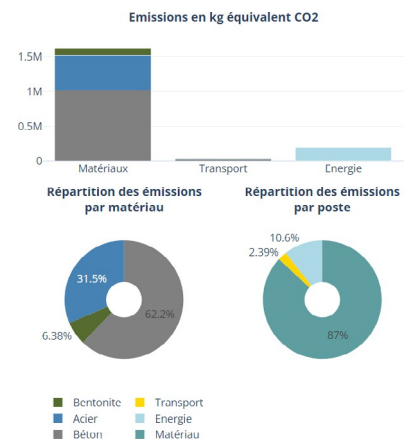
Carbon footprint assessment and comparison for geotechnical structures

Geotechnical engineers have an important role to play in decarbonisation, because geotechnical solutions they propose have a significant impact on the construction methods used and the quantities of materials used. In order to reduce the environmental footprint of geotechnical structures, it is essential to gain a better understanding of the greenhouse gas (GHG) emissions generated by the various solutions they design. This requires the development of decision-support tools for estimating the GHG emissions of the various possible alternatives.

Terrasol undertook R&D work to create **Ecow**, a pioneering tool that is easy to use and tailored to designers' needs. The interface has been developed to correspond more closely to the level of expertise of an engineer working in the design phase, i.e. with a limited understanding of the equipment and machinery that will actually be used on site to carry out geotechnical work. The right balance was sought between the number of parameters to be entered and the accuracy of the results.

Ecow is based on a database that can be expanded (capitalisation) as projects are processed, and covers all activities involving interaction with all types of soil (earthworks, foundations of all types, underpinning, soil reinforcement, etc.). It enables a quick comparative analysis of different variants of a project, based on a standardised carbon footprint approach.

The carbon footprint calculation module is integrated into the library of calculation modules of the **Orbow** collaborative platform developed by **terrasol**.



C. Bernuy & J. Targhaoui

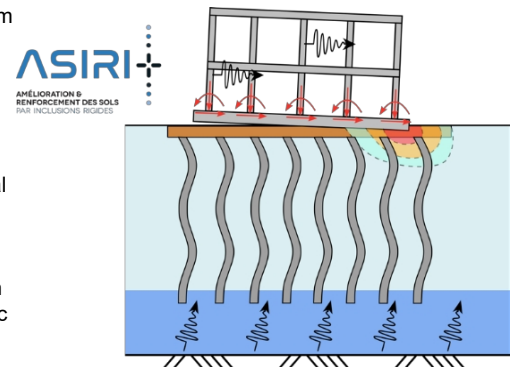
Seismic behaviour of foundations on rigid inclusions

PhD thesis as part of the national ASIRI+ project

Terrasol continues to play an active role in the national ASIRI+ project, which was launched in 2019 and aims to extend the technique of reinforcement by rigid inclusions to structures subject to complex stresses. In particular, **terrasol's** contribution to the seismic component has taken the form of a PhD thesis project co-supervised by the **Institut Polytechnique of Paris** (J.F. Semblat) and **terrasol's** Dynamics Division (J. Pérez). The presentation of Y. Shen's thesis was presented to a panel of national and international experts on the 18th of December 2023, who praised the innovative nature of the work and underlined its interest for the profession.

In addition to significantly improving our understanding of the mechanisms of interaction of inertial and kinematic origin controlling the seismic response of a mass reinforced with rigid inclusions, this work also provided an opportunity to propose a new approach for determining the static and seismic bearing capacity of this type of foundation using a rigorous theoretical framework based on the kinematic method of calculation at breaking point. A new multi- criteria approach, based on the method developed historically in the **Talren** software, was designed and adapted to the specific characteristics of reinforcement using rigid inclusions.

These developments served as ingredients for a new macro-element designed to reproduce, simply and reliably, the non-linear dynamic response of a foundation on soil reinforced with inclusions. This macro-element is now integrated into the **Fondsis** software package developed by **terrasol**.



Y. Shen & J. Pérez Herreros

Software section

Talren v6

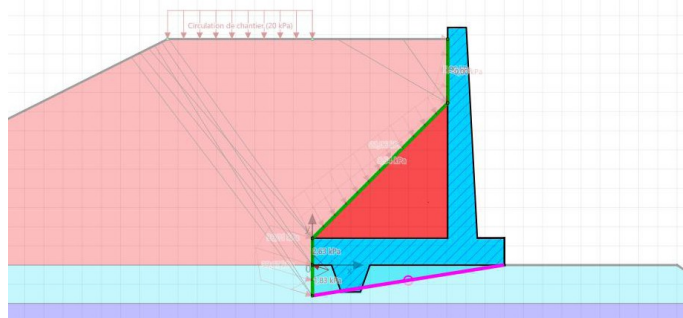
Wall Module

The current version of **Talren v6** offers an additional module dedicated to the analysis of problems relating to the general and local external stability of weight walls, 'L' or 'T' walls, with or without spades, in compliance with standard NF P 94-281. The key features of this module are:

- Analysis of the global and local external stability of one or more walls in the same **Talren** project;
- Automated calculation of thrust and abutment forces (calculation at failure) with cohesion taken into account for complex configurations (variable natural terrain, multiple loading, etc.);
- Automatic generation of load combinations (NF P 94-281 and Eurocode 0).

The following example shows the case of a T-shaped wall with a spade and a bearing at the bottom for which the following have been calculated: an inclined thrust plane, an inclined base of the wall, the presence of a localised surcharge, and a variable vertical datum. Such a configuration can be processed immediately using **Talren v6**.

Y. Abboud & M. Huerta



K-Réa v5

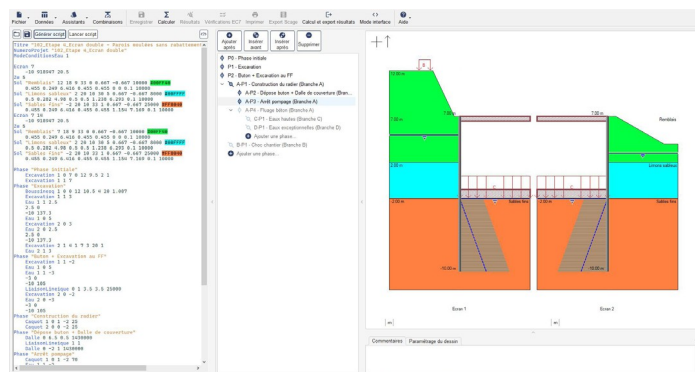
Script mode and phasing tree structure

This new version of **K-Réa** brings an updated graphical interface and two major, much-awaited features:

- Script mode allows to edit and configure a **K-Réa** project entirely from a series of commands, making it much easier to modify and implement parametric analyses;
- The phasing tree structure makes it possible to manage several branches or scenarios in parallel within a single project. For example, this makes it easy to find the optimum position for the supports of a screen to minimise the deflection and/or internal forces in the screen.

This new version also includes a direct gateway to **Talren** (import of thrust/wall diagrams for complex situations such as non-horizontal multi-layers, complex hydraulic conditions, etc.) and **Scage** (structural verification of a retaining wall, whether cast or in secant piles).

C. Grisselin & M. Huerta



Training

2023 was a record year for training, with more than 80 days of training organised by **terrasol**. 2024 will see a number of inter-company training sessions. Below is a list of those scheduled before the summer.

14 May	Introduction using Python with Plaxis	
15th to 17th May	Introduction to Plaxis 2D - Digital modelling of geotechnical structures	
14 / 21 / 28 May	Eurocode 7 and National Application Standards - Justification of geotechnical structures	
13 June	Workshop Talren/K-Réa - Hydraulic checks on retaining structures	
17 June	Workshop K-Réa v5 - Dimensioning complex retaining walls	
18 June	Workshop Foxta v4 - Dimensioning rigid inclusions	
20 June	Workshop Talren v6 - Retaining wall design	



Don't hesitate to contact us to organise in-company training courses to suit your needs:

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M. Blanchet & M. Huerta

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