SOLETANCHE FREYSSINET

resonance

—THE MAGAZINE OF THE SOLETANCHE FREYSSINET GROUP

Number 04
December 2012

CONTENTS
— December 2012

SOLETANCHE FREYSSINET

resonance The magazine of the Soletanche Freyssinet Group. Communications department: 133 boulevard National, 92500 Rueil Malmaison, France.
Publisher: Jérôme Stubler.
Editor in chief: Marine d'Anterroches.
Contributors: Jean-Marc Brujaille, Delphine Goater, William Mengebier.
Editorial committee: Guillaume Billaroch, Stéphane Cognon, Isabelle Mennesson, Stéphane Monleau, Jennie Osborne.
Design and production: Idé Édition.
Translation: Alto International.
Photoengraving: Arto.
Printed by Sira.
Photo credits: Luc Benevello, Chasing-moments/Fotolia, Cyrille Dupont, Cédric Helsly, Idé, Annuar Martinez, Bob Peters, François Roig, Francis Vigouroux, the photo libraries of Soletanche Bachy, Freyssinet, Menard, Nuvia and Terre Armée, all rights reserved.

01 Project engineering: another Soletanche Freyssinet skill Page 2
02 Radiation protection for EDF's Dampierre en Burly facility Page 24
03 Odeon Tower: exceptional foundations for Monaco's flagship tower Page 28


01


02


03

EDITORIAL
— JÉRÔME STUBLER

Chief Executive Officer
of Soletanche Freyssinet

> Whether in ground technologies, structures or nuclear, we deploy an integrated model that includes design and engineering capability, machines and materials developed by our design offices, and the capacity to implement all of that on our sites. To continue to grow, this is the model we have to cultivate and strengthen.

With revenue expected to increase by over 10% to reach close to €2.6 billion, our 2012 performance is set to confirm that Soletanche Freyssinet is a dynamic group which is currently in a vigorous growth momentum. All three of our major segments – structures, ground technologies and nuclear – are concerned. In each segment, our expertise is a benchmark across markets driven by increasing demand for construction or renovation of urban, transport and energy infrastructure. Operating in some 100 countries, we are able to combine our expertise with the strong local roots of our businesses to generate solutions tailored to the needs and challenges of each individual customer.

Our goal is to amplify this expansion and fully exploit our potential. To achieve this, we are stepping up our international expansion by bringing new companies on board: in ground technologies, Zetas in Turkey, Bermingham in Canada, Roger Bullivant in the United Kingdom, March in New Zealand and US Wick Drain in the United States; for Freyssinet, Mndeni Structural Services in South Africa and Freyssinet CS in the Czech Republic; and in nuclear, Envinet in the Czech Republic and Slovakia. These companies will benefit from the strength and momentum of our networks while enabling us to offer our services in more countries.

Our goal is also to improve our ways of "working together" through our Resonance programme. This approach has resulted in several examples of technical progress, as in the recent first time use of Freyssinet anchor ties in Soletanche Bachy projects, and the new contract to strengthen PTR tanks through which Nuvia and Soletanche Bachy are contributing to an improvement in the safety of nuclear power plants in France.

Our teams are constantly developing new products, processes and equipment, such as the polymer mud used as a drilling fluid that won a VINCI 2011 Innovation Award. This ability enables us to systematically offer our customers the best possible solutions. To encourage this capacity to innovate, we have launched the second Soletanche Freyssinet Innovation Awards, which will give prizes in five categories (safety, engineering, techniques and processes, business development, site know-how) for each of our business sectors. There will also be two cross-company awards for "resonance" and sustainable development. The suggestions coming from each of our employees, reflecting the diversity of our expertise, are the crucible of ideas that will be implemented in the future.

Whether in ground technologies, structures or nuclear, we deploy an integrated model that includes design and engineering capability, machines and materials developed by our design offices, and the capacity to implement all of that on our sites. This integration of our different skills enables us to offer clients a tailored, economic and efficient solution. To continue to grow, this is the model we have to cultivate and strengthen.

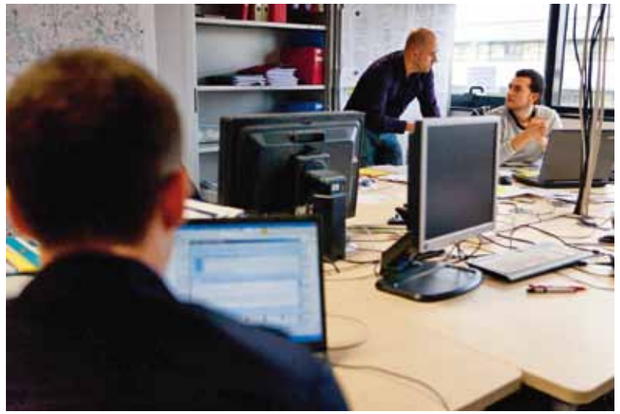
Strategy

Project engineering: another Soletanche Freyssinet skill

_Soletanche Freyssinet is known for its core specialities in ground technologies and structures, and the founding inventions that changed the course of specialist civil engineering, such as prestressing, pressuremeter tests for ground consolidation, the Hydrofraise and Reinforced Earth®. Possibly best known of all are the processes, products and techniques showcased by the projects, Soletanche Freyssinet is involved in and regularly honoured with prizes for innovation.

01


02


03

01-03 Soletanche Freyssinet's design offices employ some 800 people who provide support for the Group's projects and are a key component of the solutions it offers.

This essentially technology-based vision shouldn't overshadow another speciality: project engineering, an area in which each of the Soletanche Freyssinet companies has developed its own model over time. "In the specialist foundations business," explains Christian Gilbert, director of engineering at Soletanche Bachy, "project engineering refers to everything that touches on the surveys and designs for a project; more specifically, it includes the methods, which are a determining factor when sizing a structure." At Soletanche Bachy's two original entities, project engineering was linked to works development from the outset. This area became very important during the 1990s, when clients in France were opening up to alternative solutions. This really motivated the company to come up with solutions that were more cost-effective, which in turn enabled it to emerge as a global leader in its field.

A key asset for comprehensive solutions

Jérôme Racinais, head of the design office at Menard, confirms the importance of project engineering within each agency. He describes the aim as "closing the gap between the technical and the commercial sides so that we stay one step ahead of our competitors."

"At Freyssinet, our project engineering teams are focused on developing alternative solutions, working from a toolbox of all the company's products and processes – things like prestressing, stay cables, specialist construction methods and composite reinforcement materials – that allow our clients to optimise their construction process in terms of costs and lead times," says Erik Mellier, technical director at Freyssinet. "Working from technical centres in different continents, this forms a strategic component of the vertically integrated model that is one of the factors that sets us apart." This structural expertise (notably in engineering structures), whose origins lie in Freyssinet's original prestressing business, is proving more and more valuable today for works to existing structures, particularly structural repairs and reinforcement. In a field like this, where working conditions are often highly restrictive, the ability of Freyssinet's technical department to offer project engineering studies that deal with structures and methods alike, from diagnosis to completion of works, is a key advantage that enables the company to offer its clients performance guarantees for its design-build services.

Controlling risks

More generally, the desire to progress higher up the value chain has become a strategic priority in recent years. This has led Soletanche Freyssinet to expand and increase specialisation of its engineering assets *(see opposite)*, in order to improve its responses to risk management challenges faced in the construction and operating phases of structures. This is especially true for the nuclear sector, the third Group's core business lines, run by Nuvia, which was founded in 2008 through mergers and acquisitions. In the United Kingdom, 55% of Nuvia Ltd's revenue comes from engineering services. In France, the six companies that make up Nuvia France – Essor, Mecatiss, Millennium, Nuvia Travaux Spéciaux (NTS), Salvarem and Vraco – supply expansive range of services: upkeep, maintenance, logistics, radiation protection, decommissioning, passive fire protection and safety studies. Three of them, NTS (nuclear civil engineering), Essor (radiation protection) and Salvarem (clean-up and decommissioning), started out as specialists on the works side, but in recent years have increased their engineering capacities to keep pace with the demands of their business.

> Project engineering has become a strategic priority for Soletanche Freyssinet, in order to improve its responses to risk management challenges faced in the construction and operating phases of structures.

A key component of the solutions on offer

"In recent years, it has become more and more common for design studies, or even feasibility and execution plans, to be part of our projects. This has led us to significantly expand our in-house engineering capacity," says Hervé Ridoux, NTS's director. Rafael Teruel, southern regional director at Salvarem, explains that "for Salvarem, the project engineering era really began just after 2000, with the start of decommissioning at Marcoule, then La Hague. Today, our design offices employ close to a hundred engineers and technicians, who examine the scenarios for our interventions and design the extremely specialised tools that we need to carry them out." These engineering teams, with their differing resources and organisational methods, account for some 800 engineers within the Soletanche Freyssinet Group as a whole. In their role of providing support for the Group's projects, they are a key component of the solutions it offers.

Soletanche Freyssinet's specialist engineering subsidiaries

SOLDATA

Speciality: prevention of construction and operating risks for structures and industrial installations
Profile and services: an international company with two specialist acoustic and geophysics subsidiaries; measurement systems design (including Cyclops®, Centaure®, EAR-Box® and Cylindre Électrique®); acoustic and vibration engineering; expertise in applied geophysics, installation and maintenance of on-site systems; data acquisition and management (Geoscope® software); interpretation, diagnosis survey and recommendations.
"Soldata" is a combination of the words Solution and Data:
- data, because real-time detection and monitoring are the main tools used to assess and manage risk with optimised costs;
- solution, because measurements are usually backed by a detailed study, analysis and recommendations to support the decision-making process.
Clients: infrastructure managers, manufacturers, local governments, towns and cities, general contractors, etc.

"The all-in-one tools and solutions that we design increase the value component of our solutions. Today, these solutions also answer the increasingly widespread need for risk management, whether structural, geotechnical or environmental."
Jean-Ghislain La Fonta, director, Soldata

ADVITAM

Speciality: continuous infrastructure inspection and surveillance; design and integration of structure monitoring and maintenance tools
Services and tools: development and implementation of infrastructure monitoring and management tools (ScanPrint® software); continuous surveillance, monitoring, alarm management (EverSense® software); ad hoc measurement (on-site tools for measuring tension in cables, prestress bars and concrete; tools to check for corrosion faults in prestressing cables and ducts).
Clients: infrastructure managers

"Initially, all our engineering effort went into creating our tools. Today the focus is on adapting our solutions to fit the projects."
Gilles Hovhanessian, CEO, Advitam

MILLENNIUM

Speciality: safety studies, scientific calculation, design
Field: nuclear
Clients: nuclear operators

"Our clients are the key players in the nuclear sector. We mainly provide them with the safety studies required by the regulators before issuing permits to build, alter or decommission nuclear installations."
Eric Lejeune, director, Millennium

NECS

Speciality: computer simulation and structural calculation
Expertise: seismic, structural stability
Clients: infrastructure managers, manufacturers, local governments, general contractors, etc.

"Our expertise is in using modelling and complex non-linear calculations to evaluate structures, assessing for example the earthquake or explosion resistance of existing or planned structures."
Shahrokh Ghavamian, director, NECS

Training

Freyssinet reaches out to young engineers from around the world

Within the framework of Soletanche Freyssinet's policy in favour of bi-cultural training for engineers, combining their own culture with French culture, Freyssinet took the decision to call on the n+i network. The network offers a comprehensive range of services, including cultural and linguistic immersion, accommodation, insurance, air travel, top-up health insurance, registration fees and contacts with overseas students.

n+i is a non-profit organisation set up in 2000, and since then it has welcomed over 1,800 engineers from overseas, representing 64 different nationalities. The network's members include over 70 leading French higher education establishments (Ensam, Insa, Mines de Nancy, ESTP, EIVP, HEI, and others) and close to 100 overseas partner universities. For example, in September 2011, a young Mexican student joined the second year of the engineering course at the ESTP engineering school.

At the same time, Freyssinet also paid the fees for two young Russian engineers at the Siberian State University of Communication. These two 18-year-olds have a good level of scientific knowledge and are bilingual in Russian and English. They will be able to follow the complete syllabus at this prestigious institution, with Freyssinet paying for the five years of their university education.

Safety

Nuvia France makes two new QHSE commitments

As part of the continuous improvements to its safety policy, in 2011 Nuvia France decided to extend the scope of its commitments on safety (for installations) and radiation protection (for people). Two new banner slogans were designed, and targets were set: zero significant event (safety and radiation protection), zero deviation from the applicable requirements (safety), and individual exposure to be below 14 mSv (radiation protection). These targets take quality, H&S and environmental commitments one step further, and are the subject of monthly reports.

Expertise

New edition of the Soletanche Bachy Technical Guide

The new edition of the *Soletanche Bachy Technical Guide* is available now in French, Spanish and English versions. Drafted by company experts, the guide presents the state-of-the-art equipment, materials, processes and techniques developed by Soletanche Bachy, and includes the changes that have been adopted in various fields in recent years. The guide is based on Soletanche Bachy's well-known expertise in its field and provides an invaluable working and research tool. It testifies to the company's steadfast commitment to R&D and innovation in its quest for heightened performance and sustainability at its worksites for the greater benefit of its clients. This is a reference book for all project owners, project managers and design offices.

Event

Trophée Eugène Freyssinet award ceremony

On 16 September 2011, the Eugène Freyssinet association and the Freyssinet company held an awards ceremony for the Trophée Eugène Freyssinet in the Halle Freyssinet in Paris. The awards are presented to young engineers who achieve progress in materials optimisation, as did Eugène Freyssinet when he invented prestressing. The organisers of the Trophée Eugène Freyssinet are keen to reward innovation and encourage young people to enter the construction engineering industry. They also seek to raise the profile of Eugène Freyssinet's achievements and to celebrate the global reach that prestressing has given the French civil engineering sector.

The winners

- **First prize:** Nicolas Roussel, Guillaume Habert, Mickael Thiery and Patrick Belin from the IFSTTAR, for their work on the sequestration of CO_2 in demolition concrete *(photo above)*.
- **Second prize:** François Olard from Eiffage Travaux Publics, for his work on the optimisation of bituminous concrete.
- **Grands prix:** Michel Placidi and René Walther.

The next edition of the Trophée Eugène Freyssinet will be held in 2013.

For more information, please visit www.efreyssinet-association.com

Acquisition
Turkey
Soletanche Freyssinet has agreed to take a majority stake in Zetas, a leading name in the Turkish market. The company, with revenue of around €45 million, offers a range of geotechnical and foundation skills. Zetas has offices in the Middle East (UAE, Saudi Arabia, Lebanon and Qatar) and central Asia (Azerbaijan, Turkmenistan and Kazakhstan).

Mexico 2012

A convention for exploring synergies



A mixture of a plenary session and working groups enabled Soletanche Freyssinet companies to share their expertise in key markets.

Synergies continued to be explored during the Soletanche Freyssinet Group convention held in Mexico City in April. This was the second convention, after the first in Paris in 2009 when the Group was created, and the three-day event was attended by almost 300 managers from the five Soletanche Freyssinet companies around the world.

The choice of Mexico City as the venue for the convention was a powerful statement of the Group's international reach. The Mexican capital is in a region experiencing sustained growth – Latin America and Mexico in particular – and in a country where a range of promising synergies are being explored by the two local subsidiaries: Freyssinet de Mexico and Cimesa (Soletanche Bachy). One example is the Ameca motorway bridge repair project *(see* Resonance *no. 3)*.

The Mexico City convention was a key phase in Soletanche Freyssinet's strategy to pool the advancements made by the Resonance programme. Resonance aims to foster synergies across business lines in a range of fields: technical, geographical, knowledge sharing and developing combined offers.

The Group's strength and originality are anchored in the wealth and breadth of its expertise. A policy of encouraging different companies to collaborate and exchange information on a broad range of issues is an essential plank in its development.

Faced with the ever-growing complexity of projects, our solutions rooted in these synergies provide clients with a response that stands out. These solutions are the bedrock of the Group's ambitions for the years ahead.

New projects

Areva's La Hague site – France
Salvarem: WRC operations well under way
The freeing of the silo slab in the south high-activity oxide (HAO) building at Areva's La Hague site was a key stage in the waste recovery and conditioning (WRC) project. Under way since June 2011, decommissioning work on the casemate and the hydraulic transfer of the HAO building's activities continued in line with a demanding timetable agreed with Areva.
Every day, about 20 staff from **Salvarem** were at work on the project, cleaning, dismantling and managing waste. Almost 400 tonnes of waste had been removed by mid-2012 in order to allow the WRC silo operations to commence.

B202 national road – Germany
Menard Vacuum™ comes to the aid of Germany's roads
The Landesbetrieb Straßenbau und Verkehr Schleswig-Holstein (the Schleswig-Holstein road department) has awarded BVT DYNIV, a local Menard subsidiary, the contract for consolidation work on the B202 national road using the **Menard** Vacuum™ technique. This 27,000 m^2 section of road is in very poor condition, with a 40 km/h speed restriction. The vacuum plant (for atmospheric consolidation) will be installed as several units in order not to interrupt traffic flow. Work started in March.

Penly -- France
Contract awarded to NTS and Essor
Nuvia has been awarded the seven-year Global Site Support Services contract for the Penly site. **NTS**, as leader of the joint venture, will manage and coordinate **Essor**'s activities, as well as scaffolding, heat insulation and cleaning.
As of 1 January 2012, 50 members of staff are on site at this power plant, rising to 120 in a year when the reactor will be shut down to allow equipment to be maintained and the reactor refuelled. The full range of Essor's services will be provided: logistics coordination and fulfilment, waste management, stores, radiation protection, setting up controlled zones, management and oversight of hazardous goods transport, radiological monitoring and testing.

In pictures
World record cable-stayed span: 1,104 m

On 25 March 2012, at around 3 p.m. Paris time, the teams from Freyssinet Vladivostok installed the final stay cables on the Russky bridge. The longest cables (581 m) were positioned opposite their symmetrical counterparts, put in place two weeks earlier. Only some eight months from when work started in late July 2011, 3,200 t of stay cables had been fitted, in conditions that Freyssinet had never previously encountered: working 24/7 in temperatures with wind chill of up to -40 °C. The bridge opened to traffic in early July 2012.

Seminar
Soletanche Bachy Designers Meeting

The fifth Soletanche Bachy Designers Meeting was held in December 2011 under the auspices of Soletanche Bachy's engineering division, 18 months after the previous edition in Paris.

This major event was held in Budapest, and was attended by all parent company and subsidiary design offices, adding up to a total of over 100 participants. The company's international growth was evident in the presence of representatives from new companies that joined Soletanche Bachy in 2011: Zetas (Turkey), Roger Bullivant (UK) and Bermingham (Canada). The event was also attended by the technical directors of Freyssinet and Menard as part of the push for further synergies within Soletanche Freyssinet.

The aim of the two-day technical seminar was to present the year's emblematic projects, developments in expertise in various fields and to listen to feedback on techniques, methods and processes. Sharing best practices, knowledge and insights is the key to the company's development.

The technical seminar enriches and strengthens the ties between the company's network of designers, a hub for future innovations.

Safety
Menard's first international HSE seminar

Menard Group's first ever health and safety seminar was held in Dubai, in the UAE, on 27 and 28 February 2012. The event, held at the instigation of senior management, was staged by the company's HSE coordinator David Maltman and attended by around 20 delegates. The goal of the meeting was to enhance networking and a collaborative approach among managers, sharing ideas and best practices. Working groups were set up to look at the key issues facing the company: working conditions, safety culture, training and recognition, responsibilities, staff skills and lifting equipment. Discussions were also held concerning the application of the Soletanche Freyssinet Group's health and safety rules and the value of using the Internet reporting tool. In the end, participants were able to collectively decide on HSE targets for Menard and its companies.

Acquisition
Canada
Soletanche Freyssinet has acquired a majority interest in Bermingham, Canada's longest established foundation and offshore contractor. With a track record of working on major infrastructure projects in over 40 countries, Bermingham is also involved in the mining, transport and energy fields, as well as manufacturing specialist equipment and providing engineering consultancy services.

Innovation
Decommissioning: synergies around Clementine

The ability to successfully develop a new special purpose machine in just a few months showcases how valuable the Freyssinet Product Company's expertise in industrialisation is to the Group.

Designed by Nuvia Travaux Spéciaux's Lyon agency, which specialises in decommissioning, the WCS 5000 – known as Clementine – will be used to cut up the four sodium expansion vessels in the secondary loops[1] at the Superphénix nuclear power plant. It is designed to meet extremely demanding specifications, as the operation has to be performed using diamond cutting wire, and must never generate temperatures in excess of 300 °C.

Creating Clementine required exacting mechanical welding and precision machining of very large parts, as well as careful assembly of the electromechanical elements (motors, sensors, automated systems and hydraulics), with a greater degree of complexity than FPC or NTS were used to.

After successful testing at NTS's premises, Clementine was transferred to the site in Creys Malville, where it started work in mid-February.

(1) The entire heat exchanger circuit between the primary circuit and the steam generators, which NTS is decommissioning.

Synergies
Menard Vibro emerges in the Middle East

Another successful merger between Menard and Soletanche Bachy has resulted in the emergence of Menard Vibro, a wholly owned company headquartered in Dubai, UAE. This merger has created a new regional leader in ground technologies and soil improvement techniques. It is also an illustration of the joint approach that forms the bedrock for the company's future growth. Menard Vibro will be increasing its palette of soil improvement techniques, notably by adding to its capacities the ability to deal with sites that require ground consolidation. With a 120-strong staff, Menard Vibro will reap the benefits of its new workforce's extensive experience. Two high profile projects under way: Das Island Development Phase III, in Abu Dhabi, and Yerp (Yanbu Export Refinery), in Saudi Arabia.

New projects

Port of Lomé – Togo
Third quay for the container terminal
Bolloré Africa Logistics has missioned **Soletanche Bachy**, as the representative of a JV including two other VINCI companies (Sogea-Satom and EMCC), to carry out the design and construction of a third container facility at the port. Work on the €42.5 million contract began in May 2012 and is scheduled to last 18 months. One of the 450 m quay walls will be of mixed curtain construction, requiring 190,000 m^3 of material to be dredged. The project will enable fitting of quayside equipment, track for the cranes and container handlers.

Chooz casemates contract – France
Dismantlement continues with Nuvia France
After the contract to dismantle the reactor vessel at the Chooz nuclear power plant, the first time a PWR reactor (305 MW) has been dismantled in France, the **Nuvia Travaux Spéciaux (NTS)-Salvarem** consortium won the four-and-a-half year contract for the casemates. As the site is constructed underground, the casemates are located in the HK cavern, which was used to stock the contaminated waste generated by operating the reactor. This project is a first for EDF, as the five casemates are all in the red zone, which people cannot enter. The Nuvia consortium is capitalising on its expertise in the design and operation of robotic equipment, allowing work to proceed without risk to the operators. A robotic arm which can be fitted with an impressive range of tools will be installed on a beam that will give access to all the necessary components.

Dammam bridge – Saudi Arabia
New contract for Freyssinet
On 30 April 2012, Freyssinet signed a contract for the construction of a bridge on King Faisal Road in Dammam. Built using a supporting launching beam in the span-by-span technique, the bridge will have a total length of 2,300 m and will comprise 714 segments and 48 spans. Prefabrication of the segments is planned to commence in December 2012 with the spans put in place in March 2013. Freyssinet's work should be completed during April 2014.

Acquisition
South Africa
Freyssinet has acquired structural repair specialist Mndeni, a company operating in South Africa, Mozambique and Botswana.

Innovation

Polymer mud, a breakthrough in drilling fluids

During the last two years, Soletanche Bachy has been studying the use of polymer mud instead of bentonite mud. Over a hundred tests and dozens of experiments resulted in the identification of a suitable family of polymers. Easily available around the world, they meet the demands of both site and materials (mud excavation and treatment) for foundation works. They offer multiple advantages: environmental (easily eliminated on site), financial (50% to 75% cut in volumes to use and remove) and logistical (reduced installation time and site footprint).

Lastly, and most importantly, they make it possible to undertake operations that would be difficult to achieve using bentonite mud. This solution, which won a Grand Prix at the VINCI 2011 Innovation Awards Competition, will probably be seen at 20% to 60% of sites over the next five to ten years.

Diary

30 May to 1 June 2012
Brussels (TC 211)
International Ground Improvement Works Symposium
Soletanche Freyssinet partnered the event through three ground technology specialist companies: Soletanche Bachy and Menard (Platinum Sponsors), and Terre Armée (Gold Sponsor).

19 to 21 September 2012
Seoul
IABSE Congress
Freyssinet was a Gold Sponsor at the International Association for Bridges and Structural Engineering congress.

New projects

Port of Montevideo – Uruguay
Construction of a new quay
Soletanche Bachy, in a joint venture with Uruguayan contractor SACEEM and Dredging International, has signed a contract with the Uruguayan port authorities for the construction of a new quay, Muelle C. The contract covers the design and construction of a 330 m platform supported on 7,000 linear metres of bored piles, upgrading and surfacing a 5 ha container terminal and dredging the access channel.

El Teniente mine – Chile
Two tunnels for the largest underground copper mine in the world
VINCI Construction Grands Projets (60%), **Soletanche Bachy Chile** (20%) and **Soletanche Bachy International** (20%) have been awarded a $400 million contract by Codelco, the national copper company, for the design and construction of two tunnels.
The works will include blasting twin 9 km tunnels with an average cross-section of 65 m², as well as two 6 km intermediate access galleries, making 24 km of tunnels in total. The works, which started in October 2011, will last 40 months.

Dunkerque LNG terminal – France
A dock and a tunnel for the port
Two Soletanche Freyssinet companies are hard at work in Dunkerque, France. **Menard** is building a dock for LNG tankers at the terminal.
A 15 m submarine embankment will be built, its stability ensured by treating the ground to mitigate the risks of liquefaction. Two rigs will work from the water and two on dry land, both operating together. **Soletanche Bachy** will be constructing the Sea Water Tunnel, as part of a joint venture with CSM Bessac and Razel, on behalf of Dunkerque LNG (a subsidiary of EDF, in association with Fluxys and Total). The tunnel, 5 km long and 3 m in diameter, will be used to transport warm cooling water from the Gravelines nuclear power plant to the LNG regasification station at the Dunkerque terminal. The project involves a shaft with
a 16 m diameter diaphragm wall,
a 29 m diameter diaphragm wall for the pumping station and a concrete raft. Work started this summer and will last three years.

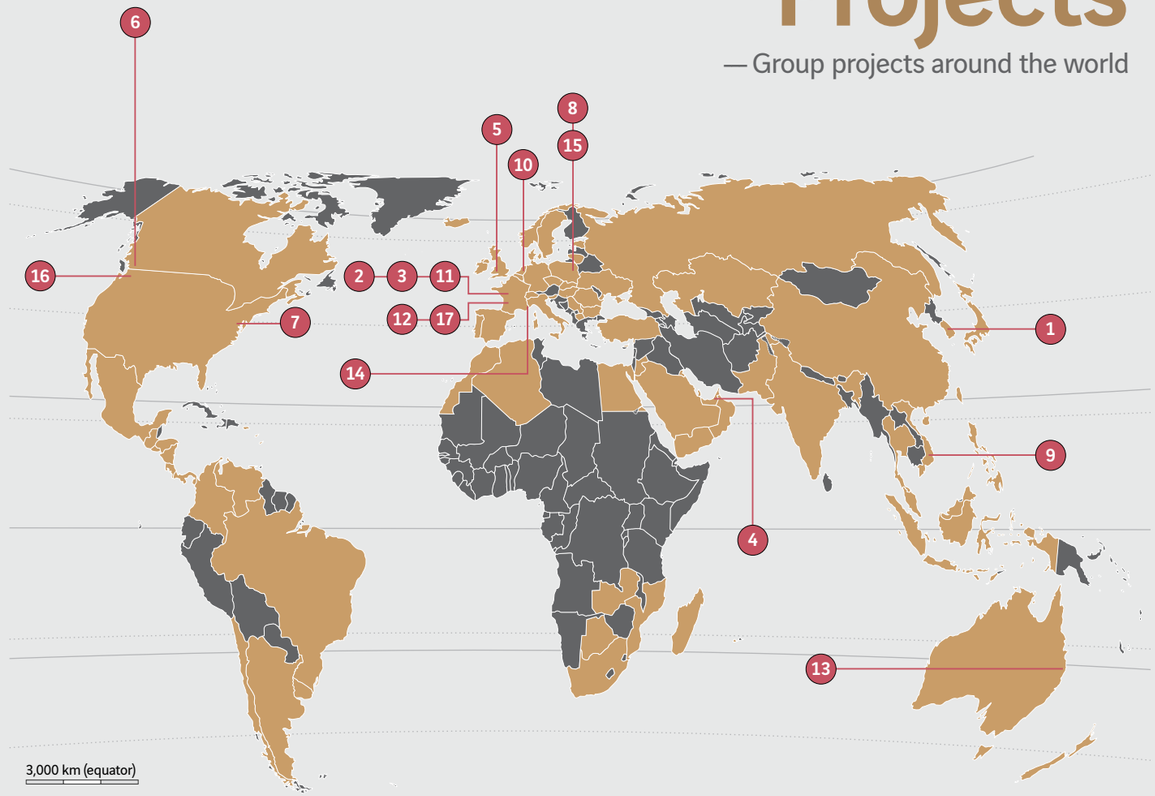
Bucharest metro – Romania
Soldata awarded a monitoring contract
Operating company Metrorex has awarded **Soldata** a 63-month monitoring contract during the construction of the first section of Line 5, comprising a 6.5 km twin-bore tunnel and 10 underground stations. The contract includes automatic instrumentation, manual inclinometric and levelling readings, satellite readings and environmental measurements.

Port of Noumea –New Caledonia
Pier 8 construction
A consortium comprising Interoute, **Balineau**, ETB and Infratech won the contract for the construction of pier 8, an extension to the main quay at Noumea. Balineau will create a combi-wall (sheet-piling and caissons), a back wall, two ranks of passive ground anchors and the crown beam, a 250 m long and 56 m wide structure. Works started during Q3 of 2012 and will last two years.

Mixed development zone, left bank, Paris – France
Development of a new plot
Public development company SEMAPA missioned a joint venture including **Soletanche Bachy** to construct rafts to cover the rail lines on plot T7. Some of rail operator SNCF's installations for the Tolbiac sector will then be located on these rafts, in addition to a 12-storey building and a number of public open areas. Reinforcement cages have to be brought in at night, while rail services are temporarily suspended.

Projects

— Group projects around the world



Countries where Soletanche Freyssinet companies are located

The 17 projects showcased in this edition

1
South Korea
2nd Geo Geum bridge

2
France
Toulon tunnels

3
France
EDF basic preventive maintenance procedures

4
Abu Dhabi
Al Ain development

5
United Kingdom
Lee Tunnel

6
Canada
Store in earthquake risk zone, Richmond

7
USA
Tunnel beneath the Capitol, Washington

8
Poland
Motorway bypass, Gdansk

9
Vietnam
Vietcombank tower, Ho Chi Minh City

10
The Netherlands
Scheveningen Boulevard

11
France
EDF power plant, Dampierre-en-Burly

12
France
Bruckhof residence, Strasbourg

13
Australia
Dinmore–Goodna motorway

14
Monaco
Odeon Tower

15
Poland
Wroclaw bridge

16
USA
Seattle Light Rail

17
France
Cabled roof for Gallo-Roman stadium, Puy du Fou

FREYSSINET

_ Second Geo Geum bridge/ South Korea

A bridge of sunbeams

The second Geo Geum (pronounced "gokeum") bridge is not to be confused with the Geoga[1] cable-stayed bridge opened in the Busan region in the eastern part of South Korea at the end of 2010. This second bridge is located in the south-western part of the peninsula, where islands abound – as do cable bridges, six of which were built by Freyssinet. It completes a project that started with the construction some years ago of the first Geo Geum bridge to link the city of Noktong on the mainland to Sorok Island. That first bridge was opened to traffic in March 2009. The second structure, designed to link with Geo Geum Island itself, consists firstly of a 1,116 m cable-stayed bridge with a central span of 480 m supported by two 170 m high towers, and secondly of a 912 m access viaduct. The lower part of the deck is 6 m high and includes a traffic lane for pedestrians, cyclists and emergency services vehicles.

Aesthetics is the order of the day

"The main constraint was to keep clear a navigation lane 210 m wide and 38.5 m high," says Freyssinet's technical department.
The client's only other real requirement was that the bridge should be attractive. So what makes it stand out – and it's a first worldwide – are its 12 bundles of seven stay cables, with two groups of three flaring out from each tower, all housed in a yellow HDPE sheath so that they look like sunbeams piercing a cloudy sky.
Freyssinet supplied and installed the stay cables and 84 dampers. The client's requirement for an aesthetically pleasing structure had a strong impact on the design and construction methods selected. "Because the stay cables were arranged in bundles, we were able to build the deck by assembling large, 72 m sections of mixed (steel and concrete) composite truss girder, each section being supported by a cable bundle," explains the site's technical manager.
The sections, also yellow, were prefabricated (assembly, welding, painting, concreting and transverse prestressing of the upper slab) in the Port of Gwangyang. Weighing 1,600 to 2,500 t, each section was transported to the site by barge and raised into place by a huge 3,000 t floating crane mounted on support barges specially designed for the project. The installation of the deck components was carried out simultaneously on either side of the tower, as were the installation and adjustment of the two associated stay cable bundles. "We had to install 14 stay cables within 10 days. Thanks to our organisation and highly qualified team members – all of whom had been trained in a specific task for the Geoga project, we managed to keep to the schedule while paying particularly close attention to quality and safety," says the works director of the Freyssinet consortium.
Construction of the main deck started in June 2010 and ended in April. The structure was opened to traffic at the end of 2011.

(1) Freyssinet also participated in this project, supplying and installing the stay cables and dampers.


01


02


03


04

Participants

Client: Iksan Regional Construction Management Office
Project manager: Soosung Engineering
General contractor: Hyundai Engineering & Construction
Specialist contractor: Freyssinet International-Freyssinet Korea consortium

Key figures

Number of stay cables: 84 (1,140 t)
Stay cable length: from 58 to 250 m
Composition: 55, 61 and 75 strands (stay cables in a given bundle are of the same type)
Dampers: 56 IHD (Internal Hydraulic Damper) and 28 IRD (Internal Radial Damper) for the longest stay cables

01 The second Geo Geum bridge facilitates access to the southern islands, a holiday spot much enjoyed by South Koreans.
02 The prefabricated deck components, each weighing between 1,600 t and 2,500 t, were installed by a 3,000 t floating crane.
03-04 Each bundle of seven stay cables supports a 72 m section of deck.

SOLETANCHE BACHY
_ Toulon tunnels/France

A big challenge in a difficult geological environment

For people working on a tunnel, no matter who they are, breakthrough is always a special moment. And it was no different on 3 March 2011 in Toulon, when the East and West face teams of the South tunnel met up. It marked the end of months of continuous effort and, more generally, the end of a project that, for the first structure, started in 1993 and ran into major difficulties. "In the beginning, all we had to do was build two tunnels," says Patrick Rolandetti, chairman of Soletanche Bachy Tunnels, joint contractor of the works consortium in charge of the South tunnel. "They were to have two one-way lanes less than 3 km long and run under a densely populated part of Toulon to provide a link between the A50 motorway towards Marseille and the A57 towards Nice. However, as soon as we started the works, this medium-scale project became problematical due to the complexity of the subsurface. It was made up of clayey materials of a mediocre quality and highly variable nature. As a result of a thrust nappe phenomenon, the materials presented a large number of anomalies." Special methods were therefore selected for building the two structures: conventional boring, along with forepoling and supports of different types and adequately dimensioned for strong reinforcement.

Warding off subsidence risks

In 1996, the measures put in place by other companies working on the North tube were not enough to prevent subsidence at the face when nearing the Marchand area and work had to be suspended for a long time. The South tube, which runs parallel to the North tube at an average of 50 m closer to the sea, also had to go through this area. And, just to make things more interesting, it had to go under a more densely built-up area. As a result, the contracting authority looked very carefully at all the feedback from the first project, particularly with regards to structure of the support profiles and the need to survey buildings. To ward off difficulties, it was decided to sink a shaft (with diaphragm walls) near the sensitive area with a view to creating two additional faces – off the critical path – and apply a suitable solution to this portion of the tunnel. But even this safety approach was not enough because the ground analysis carried out in great detail over the entire tunnel route by Soldata, the Soletanche Bachy subsidiary specialising in instrumentation, revealed the extreme sensitivity of the ground and buildings in the area. A combination of reinforcement and compensation grouting was therefore necessary[1]. Consortium member Soletanche Bachy executed the approach perfectly and solved the problem.


01

Working in absolute safety

The consortium decided to use special GTA-type machines at two faces – Castigneau in the West and Bir Hakeim in the East – for boring and supports. Each machine, weighing 70 t, was suspended from guide rails attached to the tunnel crown, thereby freeing up precious space that had to be shared by tunnel boring machines and spoil removal equipment (excavator, loaders and trucks). "Thanks to their remote-controlled articulated arms, these rigs were able to carry out all the very tricky operations at the face in absolute safety," says Patrick Rolandetti. "Moreover," he adds, "there has been no serious accident to date on the site, which is a remarkable performance in itself."

An 18-month extension was required to perform the works in the South tube. Following completion of the civil engineering in December 2011, it will take a further year to fit out the tunnels, which are scheduled to open to traffic in mid 2013.

(1) See Resonance *no. 3, p. 24*

Participants

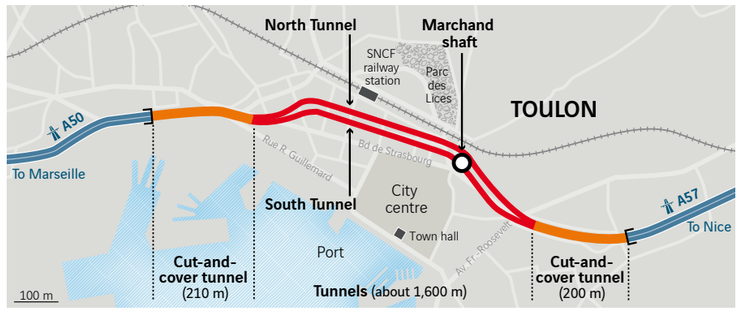
Contracting authority: DREAL PACA (regional department for the environment, planning and housing)
Project manager: Setec TPI (leader) and Terrasol
Consortium: Bouygues TP (leader), Soletanche Bachy, Soletanche Bachy Tunnels, Colas, Screg
Specialist contractor: Soldata


02

01 The complexity of the sub-surface was a constant challenge for site teams.
02 Compensation grouting was necessary at the surface to enable tunnelling in a critical zone beneath buildings.
03 Hung up from guide rails attached to the tunnel crown, GTA-type machines with their remote-controlled arms made operations at the face safer.


03

Tunnel routes



NTS and Advitam inspectors survey structures inside and outside, recording any anomalies observed directly in their PC tablet equipped with ScanPrint™ software.

3

NUVIA
__ EDF Basic Preventive Maintenance Programme/France

NTS (Nuvia) and Advitam join forces to inspect structures

NTS (Nuvia Travaux Spéciaux), which specialises in the maintenance and repair of structures in nuclear facilities, has been carrying out a new assignment in association with Advitam[1] at five EDF power plants since the spring of 2010. Nicolas Box, manager of the NTS Greater Paris area agency, tells *Resonance* more about the nature and content of this assignment.

What does this new NTS business activity entail?

Nicolas Box – NTS and Advitam won a seven-year inspection contract in April 2010 covering the power plants at Flamanville, Saint Alban, Chooz, Civaux and Paluel (12 reactors in total). The inspections are part of EDF's basic preventive maintenance programme (BPMP). It's an important assignment because maintenance is a key component of EDF's effort to prolong its facilities' life cycle. Our partnership with Advitam makes very good sense in that it brings together NTS's expertise in inspection and special works in the nuclear sector with Advitam's experience and methodology in terms of monitoring structures. It also falls neatly into line with Soletanche Freyssinet's strategy to create and exploit synergies between Group companies.

Who carries out this assignment and what does it consist of?

N.B. – We have 12 inspectors working on the contract. They are skilled civil engineering technicians, trained through mentoring and varied work experience under the French *compagnonnage* system, and they have all the requisite certifications. The idea is to form mixed NTS-Advitam teams in order to maximise the complementarity of skill sets. The inspectors are tasked with surveying structures classified as important for the facilities' safety, identifying and characterising any pathologies found. The contract covers all on-site structures: reactor buildings, fuel buildings, auxiliary buildings, peripheral buildings, cooling towers, etc. The inspections are visual and carried out to EDF's procedures and timetable, which vary according to the structure concerned and nuclear safety requirements. NTS and Advitam have set up an IT-based inspection process. The inspectors record signs of deterioration – cracks, spalling, traces of humidity or corrosion – directly in their PC tablet through ScanPrint™ *(see box)*. This enables rapid and reliable processing of inspection data and boosts the efficiency of the NTS/Advitam consortium's defect management and visit reports.

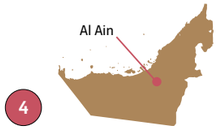
What does this activity bring the consortium? And how do you think the first year went?

N.B. – For NTS, whose core business is to deal with nuclear operators' technical problems at their facilities, this work is a logical extension of our civil engineering assessment activities and it is giving us more in-depth knowledge of structures. For Advitam, this contract is a new opportunity to demonstrate the efficiency of its ScanPrint™ inspection software.
This first year went very well. The inspectors are working completely autonomously in the power plants and have provided EDF with the essential information it needs for managing the maintenance of its facilities.

(1) Advitam is a Soletanche Freyssinet subsidiary that specialises in monitoring and managing structures.

ScanPrint™: from surveying structures to processing data

Since 2000, Advitam has been developing an exclusive range of surveillance and monitoring processes and systems to help structure owners and managers anticipate their maintenance and repair needs. One example is ScanPrint™, a software and services suite for the management, inspection and maintenance of assets. The field module, ScanPrint Inspection™, enables inspectors to record information about anomalies directly in their PC tablet. The inspection data is held in a database, to which photographic evidence can be added if necessary. The data is then processed (gap analysis, comparison with base values, comparison of identical structures, etc.) with a view to drafting a report and proposing solutions. ScanPrint™ makes inspections on the ground consistent, maximises reliability and can produce a time saving of up to 80% on data analysis, report printing and data exchange between users.



4

SOLETANCHE BACHY
__ Al Ain housing development/ Abu Dhabi

Record geophysical survey for a 4,000,000 m² housing development project

Since 1994, Européenne de Géophysique (EDG)[1] has been providing clients with a range of solutions enabling them, among other things, to locate structures (concession company networks) in land to be developed and avoid drilling costly exploratory boreholes to locate underground cavities. EDG's services have caught the attention of people in the Middle East, particularly the United Arab Emirates, where huge urban development and construction projects are planned or under way. EDG arrived in the region in 2008 and carried out two assignments in a joint venture with Soldata. Then, at the beginning of 2011, the company was awarded an exceptionally valuable contract at the Jebel Hafeet site in Al Ain, about 150 km to the east of the city of Abu Dhabi and near the border with Oman. "The 1.3 million m² site is for a housing development project," explains François Roig, project manager, "but the Al Ain municipality stipulated that no work could start before a geophysical survey had been done to locate any underground cavities. The technique and scope of the survey were therefore set by the client – and that's a special feature of this project."

Measuring soil resistivity

The method used was the "electric panel" method. This consists of measuring the soil resistivity and then analysing the graphic representation of the data collected. Any contrasting areas may indicate cavities. Exploratory boreholes are drilled in such areas to check anomalies. In practice, the method requires planting a line of electrodes (brass rods) in the ground at a set interval – every 2.50 m over a distance of about 1,500 m in the case of Jebel Hafeet. A current is then injected into the ground according to a given protocol and the data on the panel is recorded. After that, the line of electrodes is shifted sideways 5 m to measure the resistivity there. Over the 130 ha of its survey area, EDG used about 40 people to do some 270 km of panels between February and April 2011. And that figure takes on a very different meaning when compared with EDG's average number of panels a year in France: 50 km!
This exceptional contract is more than just a flash in the pan. The company is working on other projects in the region and already reaping the benefits of high visibility. Immediately after submitting its Jebel Hafeet survey report, the EDG team returned to Abu Dhabi to start up another project for the Abu Dhabi Airports Company (ADAC) as part of the airport extension. On this contract, worth several million euros, the team will use the Multi Channel Analysis of Surface Waves (MASW) method. But that's not all. EDG is also working in Qatar and Saudi Arabia and cooperating with Menard in Turkmenistan, where its processes are being used after the fact to check ground improvement operations.

(1) A Soletanche Bachy subsidiary specialising in instrumentation (see Resonance *no. 1, p. 38).*

01

02

01 The "electric panel" method requires a lot of manpower.
02 Resistivity is measured by injecting a current into the ground through electrodes planted at regular intervals.

Participants

Client: Tourism Development & Investment Company (TDIC)
Project manager: PAL Technologies
Specialist contractors: Soldata-Européenne de Géophysique (EDG) joint venture

5

SOLETANCHE BACHY

_ Lee Tunnel/United Kingdom

Four diaphragm wall shafts of monumental dimensions

To the east of London, about 10 km from the City, the Lee Tunnel project is being carried out. It is a huge project by virtue both of its dimensions and its environmental importance. Located on the banks of the Thames, the tunnel will reduce the volume of untreated wastewater and stormwater discarded into the river each year by 16 million m³ from 2015. It is the first part of the very ambitious Thames Tideway Improvement Programme, which includes later construction of another structure of about 30 km to link 25 to 30 shafts along the Thames.

The biggest shafts ever built in the United Kingdom

"Lee Tunnel consists of four monumental diaphragm wall shafts – the biggest ever built in the UK – connected by a network of tunnels bored at a depth of 55 m to 75 m," says Julian Gatward, project director at Bachy Soletanche Ltd. "In the north, it connects to a large combined sewer overflow (CSO) via a first shaft, Abbey Mills Station, and about 6.5 km further south to three other shafts at the Beckton Sewage Treatment Works on the banks of the Thames. In the event of heavy rain, these structures will be able to stock 350,000 m³ of stormwater and wastewater from the CSO before it is pumped, transferred and treated in the plant, which is currently being extended."

The project started at Beckton with the Beckton Overflow Shaft works in October. Located near the Thames, this structure will be connected by a culvert that, as its name suggests, is designed to evacuate any excess water. It was also the starting point for the 8.88 m diameter slurry closed face tunnel boring machine, which set out at the beginning of 2012. The overflow shaft will be connected by this tunnel to a second shaft, the Beckton Connection Shaft, 750 m away, from which two tunnels leave. The first of these is 6.5 km long and will be bored by the TBM in the direction of Abbey Mills Station, where breakthrough is scheduled in two years' time. The second is much smaller (only 30 m long and 2.8 m in diameter) and will be constructed using conventional methods. It will connect to the Tideway Pumping Shaft, the biggest of the shafts, where pumping equipment will be installed to lift and transfer the water for treatment at the new plant.

A closely monitored site

The construction of the three Beckton shafts had to overcome several geological difficulties. These included the presence of a layer of chalk that, when mixed in the slurry, complicates the bentonite treatment, flint that could block the wheels of the Hydrofraise, and clay in the upper layers. Because of this, a conventional hydraulic excavator had to be used for the surface layers, followed by the Hydrofraise. "The specifications called for 1 in 300 verticality, which is a severe constraint when working at depths of almost 100 m. To meet that requirement, we had to use a Koden ultrasonic drilling monitor to check the verticality of the panels using 3D images," says Julian Gatward.

Excavation of the three Beckton shafts was completed at the end of August 2011 and the earthworks commenced. At the same time, preparatory work was launched for the excavation at Abbey Mills Station, which is right in the heart of a residential area, making noise management an additional challenge for the teams. "Before starting the work, we measured the 'normal' noise level," explains Julian Gatward, "and we will continue to measure it throughout the project to ensure we keep within the limits set by Thames Water, taking corrective steps if and when necessary."

01 Inspecting excavation works in the overflow shaft.
02 The connection shaft (foreground) and pumping shaft (background) during excavation.
03 Installing the diaphragm wall for the pumping shaft.

01

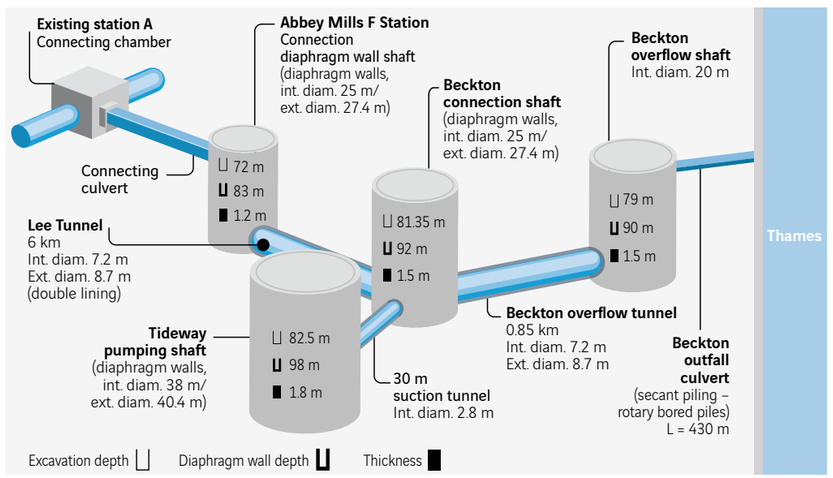
02

03

Participants

Client: Thames Water
Project manager and works:
MVB consortium (Morgan Sindall, VINCI Construction Grands Projets, Bachy Soletanche Ltd)

The four Lee Tunnel shafts and their tunnel network



Q&A

Julian Gatward

Project director
Bachy Soletanche Ltd

How significant is this project for Bachy Soletanche Ltd?
The company had already built diaphragm walls 1.80 m thick or 100 m deep, but never 1.80 m thick AND 100 m deep. Because of the exceptional dimensions of this project and the importance of its success, we drew on the Group's expertise, particularly for international teams, to help us organise the site and its management.

Lee Tunnel is a design-build project that is being executed in a consortium. What does that mean in operations terms?
One of the great things about this project, which is being executed by Morgan Sindall, VINCI Construction Grands Projets and Bachy Soletanche Ltd, is that we're all working together as if we're from one and the same company. Except for the specialist tasks, all the teams are mixed. This encourages a spirit of challenge that is well suited to the project. The pain/gain clause in the contract has a similar effect by involving the client: if the cost of the works is different from the estimate we put in, the savings or additional costs will be shared between the client and the consortium.

> For this operation, mixing the teams encourages a spirit of challenge that is well suited to the project.

MENARD/AGRA FOUNDATIONS
_ New Ikea store in Richmond/Canada

Ground improvement: skills combined to protect against seismic risk

To the south of Vancouver in British Columbia, the Fraser river delta is a vast alluvial zone, in which the ground, comprising recent saturated deposits, is highly likely to liquefy in the event of an earthquake. Ikea was obliged to take this risk into account in the design of a new store, comprising a two-storey building with a car park at Richmond. It sits in a zone where the subsoil comprises clayey silt for 2 m, underlain by alluvial sands for 25 m over a deep layer of marine silt. As the upper levels of the ground were not capable of supporting the high loads from the building, the specification called for a Franki piling foundation system 7.50 m deep, set out under all the structural elements. However, the use of the piles alone was insufficient to meet the requirements of the Canadian national building code, as they were still exposed to a risk of punching failure if the soil were to liquefy in the layer of alluvial sands. It was therefore necessary to densify the soil to control the movement induced by ground liquefaction in the event of an earthquake and maintain the load-bearing capacity under the piles, together with their lateral support. Geopac, Menard's Canadian subsidiary, and Agra Foundations, a piling specialist that joined Soletanche Freyssinet in summer 2010, joined forces to propose a solution, which was finally accepted, that combines an improvement of the ground using stone columns (wet top-feed method) to a depth of 15 m, with pile foundations. The works were carried out in two phases. At the end of November 2010, Geopac mobilised two stone column rigs fitted with V-23 vibroflots (from Vibro Services). Two weeks before the programmed date, work was handed over to three Agra Foundations rigs, which completed the execution of the piles by mid-March 2011, as scheduled.

Participants
Client: Pivotal Projects Inc., Ikea Properties Ltd
Geotechnical consultant: Levelton Consultants Ltd
General contractor: Ledcor Group of Companies
Specialist contractors: Geopac Inc., Agra Foundations Ltd

The ground treatment was carried out on a regular grid of stone columns 0.90 m in diameter, into which the piles were inserted.

Q&A

Nelson Beaton
Vice-president
Geopac West Ltd

How can ground improvement prevent the effects of earthquakes?
In the event of an earthquake, with granular soils such as sands and loose, saturated loamy sands, the water in the ground is pressurised under the effect of the shear forces and of insufficient drainage, such that the grains may no longer be in contact. This is the phenomenon of liquefaction. The ground may temporarily lose its load-bearing capacity until sufficient drainage is restored to allow the structure of the ground to be reconstituted. Under such conditions, the ground literally becomes liquid and buildings may fall over or collapse. This phenomenon can be prevented by densifying the ground, in other words by reorganising its structure. There are several possible techniques. The most common is using stone columns (known as vibro-replacement in North America). It consists of adding stone to the ground, using a vibrating jet. These columns of compacted material act as land drains, compact the soil around them and increase its relative density, which prevents the pressure increasing in the water and eliminates the risk of liquefaction in the event of an earthquake. If the ground comprises clean sand, it will only be necessary to use vibro compaction. These two techniques allow ground to be treated down to a depth of 35 m. Dynamic compaction is also suitable for treatment at shallower depths, between 5 and 12 m. If need be, the two technologies can be combined, as was the case for a recent project in the port of Vancouver.

FREYSSINET
_ Tunnel repairs under the US Capitol, Washington/United States

Highly technical work in a sensitive environment

Containing the chambers of the Senate and of the House of Representatives, the Capitol, in Washington DC, has been one of the most symbolic monuments of the United States since the 18th century. Constructed at the heart of a 110 ha park, the building is connected by several tunnels to other government buildings and to associated offices located in nearby districts. An underground crawl space approximately 3 km long, used exclusively for technical services, also connects the monument and other government buildings to a central boiler room and contains the steam pipes necessary for the heating and air conditioning of the Capitol and for various other services, such as water and electricity.

Upgrading to comply with standards
Constructed in the 1910s, this crawl space, together with certain structures for access and their installations (lighting, ventilation, electrical supply, etc.), needed to be modernised and brought into compliance with standards. These works were preceded by the repair, carried out in several phases, of the concrete structure of the crawl space damaged to a depth of 10 to 18 cm over an area of more than 2,300 m², due to the 38 °C temperature conditions and the high level of humidity (caused by steam leakage).
As the extent of the works to be carried out made it impossible to do the making good by hand, Freyssinet Inc. proposed a solution using sprayed concrete and galvanic protection, the cost of which and the time it would take convinced the general contractor. "This work was still a challenge," admits the project engineer at Freyssinet Inc. "The tiny amount of space and the crowded installations inside it made it difficult to clear away the damaged concrete and remove it from site and did not allow enough room to set up sprayed concrete mixing equipment. In addition, the temperature had to be brought down to a level in which the operatives could work and which was suitable for the application of the sprayed concrete. Lastly, the location of the construction in a sensitive zone subject to various jurisdictions required security and coordination of a very high level to meet the requirements of the Capitol police, the Supreme court police, the District of Columbia police department, representatives of the Washington public transit authority, the local energy suppliers, and so forth."


01


02

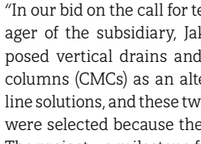
03

01 Located in the middle of a park, the US Capitol is built over an extensive network of crawl spaces and tunnels. The Foreva® repair solutions developed by Freyssinet were used for these works.
02 Sprayed concrete carried out by Foreva's® teams.
03 Foreva® repair products and solutions.

Participants
Client: Federal Government
Project manager: Architect of the Capitol
General contractor: The Lane Construction
Specialist contractor: Freyssinet Inc.

Extreme organisation requirements
On a logistics level, the solution proposed by Freyssinet Inc. included the air conditioning of critical sections of the construction, providing operatives with full breathing masks and protective overalls, and the implementation of a works organisation in shifts, in order to reduce as much as possible the number of operatives working in the crawl space at the same time. As it was out of the question to store equipment in the tunnel and not always possible to store it next to the surface entrances, the site logistics (removal of spoil, arrival of supplies) had, for a time, to be organised on a just-in-time basis. Temporary installations were set up on the surface to allow for access control and also provide site accommodation for the operatives. In the end, all these constraints and the exceptional location of the site made a contribution to promoting the company's brand image and its repair skills.
Once this project was complete, at the end of September 2011 after 11 months, Freyssinet Inc. suffered no dead time – work started on a new contract for the repair of 11 bridges in Virginia. And work on two more phases of the tunnel repairs was under negotiation.

01



8

MENARD
_ Motorway bypass, Gdansk/Poland

A key project for developing soil improvement

Since it joined the European Union in 2004, Poland has undertaken a large number of infrastructure upgrade projects. One of these, which was commissioned in the spring of 2012 as the 14th European *UEFA* football championships got under way, is the construction of a bypass to take the motorway around the cities of Gdansk, Sopot and Gdynia, all three situated on the Baltic Sea in the north of the country. The 18 km long four-lane motorway connects in a southerly direction with the Gdansk-Katowice A1 motorway and runs through wetlands in which the layer of peat and clay is 6 to 25 m deep in places. The project got under way in November 2009 with a major soil improvement campaign, which general contractor Bilfinger Berger awarded to Menard Polska. "In our bid on the call for tender," says the manager of the subsidiary, Jakub Saloni, "we proposed vertical drains and controlled modulus columns (CMCs) as an alternative to the baseline solutions, and these two Menard techniques were selected because they were competitive." The project – a milestone for the subsidiary *(see opposite)* – involved about 60 people, 50 of them on the worksite. They installed 677,700 linear metres of CMCs over a 280,000 m² area (using up to five rigs) and 3,175,201 linear metres of vertical drains over 400,000 m² (using up to four rigs).

01-02 To improve the compressible areas of the bypass, Menard installed 3,175,200 linear metres of vertical drains over 400,000 m².
03 Installation of controlled modulus columns (CMC).

Participants

Client: GDDKiA (Gdansk) general management
Project manager: ZBM-Inwestor Zastępczy
General contractor: Bilfinger Berger Budownictwo SA Wakoz SP. zoo
Specialist contractor: Menard Polska Sp. zoo

02

03

Q&A

Jakub Saloni

Director
Menard Polska

What impact did the Gdansk bypass have on Menard Polska's volume of business?
This project represented a very large share of our 2010 revenue and it coincided with a strong increase in our business. Its relative share was smaller in 2011 because we worked on a larger number of projects for about a dozen general contractors, mainly involving roadworks: the Ełk and Jarosław bypasses, the Jarosław-Radymno A4 and Strykow-Konotopa A2 motorway sections, etc.
We are using Menard's full range of soil improvement techniques: dynamic replacement, dynamic compaction, controlled modulus columns, stone columns, vertical drains and deep soil mixing (DSM).

The joint Menard-Soletanche Bachy agency in Poland was set up in early January 2011. What prospects does this move open up?
It will have a very positive effect on our business activity since our techniques complement each other in works involving soil improvement under fill, and our teams will be able to help each other out with geotechnical problems. We have already worked together on the construction of the Castorama store in Wroclaw. In terms of marketing, the joint banner will also help give us greater visibility with customers and should boost our expansion.

01

02

9

SOLETANCHE BACHY
_ Vincom Block A,
Ho Chi Minh City/Vietnam

A city centre technical showcase

Bachy Soletanche Vietnam is taking an active part in the development of the Eden Area business district in the heart of Ho Chi Minh City. Having worked on the first phase (Vincom Block B) of a luxury complex comprising a shopping centre, hotel and a six-level underground car park in 2008, the company returned to take on a new works phase (Vincom Block A) in late 2010 and early 2011.
"The client, Vincom, one of Vietnam's leading private-sector investors, made an urgent request in December 2010 for preliminary retaining wall and foundation work," says Minh Quang Le Nguyen, CEO of Bachy Soletanche Vietnam. Six days of intensive technical design studies and contract negotiations resulted in an agreement providing for replacement of the drilled piles with a more innovative solution based on shaft grouted barrettes *(see opposite)* and design support.
Work on the 15,806 m^2 diaphragm walls and 72 barrettes got under way just 12 days later, on 18 December. Three sets of grabs and 140 employees were mobilised to meet the 22-week completion schedule.
"Time was not our only challenge," says Minh Quang Le Nguyen. "This is a very high profile project – the worksite is located just opposite City Hall – and we wanted to make a point of conducting it as an exemplary operation in terms of cleanliness, safety and environmental protection."
The project lived up to all these objectives and the structures were handed over 17 days ahead of schedule on 17 May 2011. During the five months of works, no serious accident occurred and there were no complaints of disruption. Lastly, the company's excellent relationship with the client holds out prospects of further works involving other techniques that are new to Vietnam and that make the most of the company's expertise.

Participants

Client: Vincom Joint Stock Company
Project manager: Premier Construction Management (PCM)
Works contractor: Bachy Soletanche Vietnam Co. Ltd

Q&A

Minh Quang Le Nguyen

CEO
Bachy Soletanche Vietnam

Could you describe the advantages of the alternative solution proposed?
Shaft grouted barrettes are not as deep as piles. The solution therefore reduces the amount of steel and concrete consumed and the amount of time needed to complete the works. Because this technique had not previously been used in Vietnam, we performed static loading of the first barrette to confirm the choice of technique for Vincom B in 2008.

Does this project open up further prospects for the company?
Vincom Block A is a major operation for us, accounting for nearly 50% of the work done by the company in 2011. It is also a major learning experience. The very short deadline for placing our bid confirms our methods, especially the close working relationship between our operational and commercial teams. We are now applying the same model to other projects, in Da Nang and Hanoi, and together with our range of expertise it gives us a competitive edge.

01 For this city centre project, Soletanche Bachy paid particular attention to keeping down all pollution and nuisance, such as noise and dust.
02 The use of shaft grouted barrettes reduced materials consumption and the time needed to carry out the works.

10

TERRE ARMÉE
_Scheveningen Boulevard,
The Hague/Netherlands

A safer, more attractive dike

Scheveningen Boulevard in The Hague runs along a 2 km dike that protects low-lying inland areas from flooding. When it was included in the Dutch government's plan to reinforce coastal areas, municipal leaders decided that they wanted to integrate the 2 m increase of height dike properly into the landscape and invited Spanish landscape architect Manuel de Solà-Morales to work on the project.
His design included 1,100 panels forming the dike's seaward wall, capped with elliptical handrails. To design and install the 1.2 m wide concrete panels on uneven ground along the winding boulevard, while complying with strict safety standards, the city turned to Terre Armée for solutions.

One of Terre Armée's most complex projects

First up: casting the panels. Then, there was the weight problem created by the need for each vertical panel to appear to be monolithic. Safety regulations specified that no individual piece of the structure could weigh more than 700 kg in order to protect the underlying dike from damage – in the unlikely event that a catastrophic storm should ever destroy the wall. It turned out that panels high enough to reach the top of the wall would exceed the weight limit.
Terre Armée's innovative solution was to construct each vertical panel in three pieces, with extremely narrow horizontal joints in order to maintain the perception that each panel was a single piece. To precisely position the cement panels and meet stringent alignment tolerances, the team created special columns behind each vertical joint to which the panels could be affixed.
Wim Meiborg, director of Terre Armée B.V., says that the aesthetic requirements made it one of Terre Armée's most complicated projects *(see opposite)*. Challenges met, since spring 2012 residents of The Hague can enjoy their brand new, beautiful Scheveningen Boulevard – from atop their very safe, strengthened dike.

Participants

Client: City of The Hague, Netherlands
Contractor: Zeefont bv
Specialist contractors: Terre Armée, Hurks Beton bv

From panel design to installation, Terre Armée met every technical challenge to turn the architectural proposal selected by the City of The Hague into a reality.

Q&A

Wim Meiborg

Director, Terre Armée B.V.
Terre Armée Pays-Bas

What was Terre Armée's role in this project?
From the start of the process in 2008, the client, the municipality of The Hague, asked us to advise on transforming the ideas of the architect, Mr De Solà-Morales, into actual structures. The specifications required us to be very creative. Terre Armée enabled Mr Morales' ideas to be realised and executed to an extremely high standard. Our job also included managing the quite complicated design, providing the materials, which required finding a new supplier, and providing technical advice on the installation.

What made this project different?
The technical specifications, driven by a combination of safety and æsthetics, created some unusual situations. For example, the 700 kg weight restriction on individual components meant that our subcontractor had to design joints that would break apart under sufficient pressure. In our world, we're not used to designing things to break – normally, it's just the opposite. Our supplier even asked us to put in writing that this breakability was required!

How was the weight restriction for the panels determined?
The limitation actually reflects multiple levels of safety. The dike itself is built to withstand any storm, up to a catastrophic level, which is estimated to occur about once every 10,000 years. Storms below that level, however, are capable of damaging or destroying structures close to the dike, such as the boulevard. Safety testing has shown the dike is capable of withstanding the impact of a 700 kg object, so that is where the limit is set.

11

NUVIA

_ EDF power plant at Dampierre-en-Burly/France

Radiation protection, the added value of Essor's logistics services

At the EDF power plant at Dampierre-en-Burly, in the Loiret department, reactor No. 1 was turned off for 12 weeks in spring 2011 for its "10-year inspection". As with the other partial shutdowns that occur regularly every year in this type of facility, this demanded a great deal of work for Essor, which tripled its staff for the inspection from 50 to 150 people. "This increase is spectacular and typical for this type of service," says the project manager, "but it's not the most important aspect of the services provided." Essor was appointed in 2009 for the multi-year site logistics contract, which involves site assistance, handling and waste management – tasks for which EDF has, for a long time, relied on partner companies. Essor has now also been appointed by the operator for large radiation protection projects, mainly carried out by its radiation protection technicians and its DI 82 operatives (from the name of EDF's internal directive 82). At the time of the partial shutdowns, when the reactor buildings are opened up for fuel recharging, maintenance or repair operations, 10 or so Essor radiation protection technicians are sent to the site to take radiation survey meter measurements, specify steps to be taken for the protection of workers against the risks of radiation and contamination, and to check that those steps are being complied with.
Permanently on site, but in greater numbers during partial shutdowns, the DI 82 operatives are responsible for preventing contamination of the environment by checking the outgoing flows of equipment and materials and waste in the buffer zones (between the controlled zone and the outside).

02

01-03 Checking radiation in nuclear facilities.
02 The team at Dampierre in the controlled zone.
04 Checking contamination on the floor.

"Although they are totally complementary at an operational level, logistics and radiation protection services have, for a long time, been provided by different companies", says the project manager, "as they require different skills." Their combination at Essor results from the history of the company, which was created at the beginning of this century from the merger of two specialist companies – one a services specialist, the other a radiation protection specialist – and a strategy aimed at providing a full service. From the outset, the company used this unique positioning to differentiate itself from the competition; in 2008 it won its first significant contract of this type for the Cruas power plant in southern France.
Then, in 2009, Essor was awarded the Dampierre contract, which was a boost to its growth strategy and encouraged it to extend its skills *(see opposite)*.

01

03

04

Q&A

Sébastien Couque
Deputy Director
Essor

Essor has recently extended the skills it offers. Could you tell us about them?
The first is the measurement of radon in underground structures (car parks, tunnels, etc.). This will allow employers to comply with their obligation, set out in article R. 4457-6 of the French Labour Code, in certain French *regions*, to detect this radioactive gas, which increases the risk of lung cancer. The second is the characterisation of types of radiation. This is an activity that requires official approvals and will complement the measurement work we are already carrying out at Dampierre and Cruas on known radioactive elements.

> The characterisation of types of radiation will complement the measurement work we are already carrying out on known radioactive elements.

During the works, the instrumentation installed confirmed the absence of site problems.

12

MENARD
__ Bruckhof residential development, Strasbourg/France

New business in eastern France

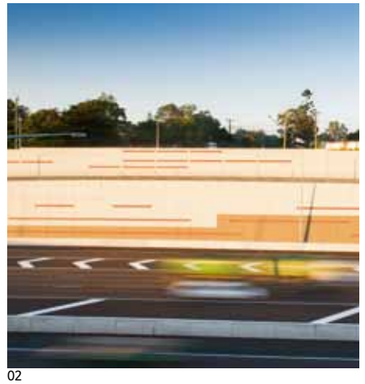
In the district of Neudorf in Strasbourg, an eco-district is currently being created on the former bus station site of CTS, the Strasbourg transport operator. Eiffage Immobilier is developing the Bruckhof residential complex there and Menard carried out two phases of work, in 2010 and then at the start of 2011, to improve the load-bearing capacity of the ground over a total area of 12,375 m². "The technique used, vibroflotation, was that specified," points out Hubert Scache, the head of the Menard office in Lille, which was responsible for the work. "Initially, we looked for possible alternatives and considered dynamic compaction, which would have saved the client the cost of removing the polluted earth from the site and disposing of it, but we rejected this idea once the existence of sensitive main services (gas, light railway fibre optics) within the area of the site became apparent."

Reversal of the situation

Even though not of an exceptional volume or technical difficulty, this project was nevertheless of great value to Hubert Scache. "Since Menard joined the Group in 2001," he explains, "the company had only rarely worked in eastern France, where competition is extremely fierce. But we have now opened an office there, evidence that things have changed and a real reason for satisfaction."
In 10 years, Menard has come a long way, tripling its overall revenue and improving its positions in France through the competitiveness of its techniques, such as CMC (controlled modulus columns), which are increasingly accepted by technical offices.
New business in eastern France began in spring 2010, when Menard won the contract and improved ground conditions over an area of 10,000 m² for the new Liebherr factory in Colmar. Since then, there has been no shortage of business, with one or two machines in permanent use and frequent toing and froing between northern and eastern France. In 2010, the company completed some 15 contracts, in particular for wastewater treatment plants in the Ardennes, Bas-Rhin and Moselle. And, since the opening of the eastern France office in October 2011, 27 contracts have been won.

Participants
Client: Eiffage Immobilier
Project manager: Merat Workshop
General contractor: Eiffage
Specialist contractor: Menard (Lille office)

01



02

03

01-02-03 The architectural patterns applied to the 41 Reinforced Earth® walls supplied by RECo.

13

TERRE ARMÉE
__ Dinmore-Goodna motorway upgrade/Australia

Technical innovation for an upgrade project

Main Roads QLD, the Queensland Department of Transport and Main Roads, initiated an upgrade project on an 8 km section of the Ipswich M2 motorway between Dinmore and Goodna, south of Greater Brisbane in 2009. The department set up a consortium, named Origin Alliance, to carry out the project.
Since the section comprises a variety of retaining structures (bridge abutments and section and access road backfill), Origin Alliance placed an order with Reinforced Earth Company (RECo) for 41 Reinforced Earth® walls with TerraPlus® facing panels with a combined surface area of 20,168 m², as well as 11 temporary wire mesh walls (3,762 m²).
"This project is unusual in several respects," says the RECo project manager. "For example, this is the first time we have been called on to design and supply a system that includes the posts and capping beams of the structures. It is also the first time that one of the temporary walls, which in this case was made of fully galvanised wire mesh, has been completely 'embedded' in the backfill of the final structure."
The retaining structures along this section are also aesthetically distinctive. As the section runs through an urban area, Origin Alliance's landscape architect called for the facings to be given architectural treatment. RECo put forward four patterns – in the form of leaves, waves and rocks and a mineral composition – for the facing panel finishing.

Extreme weather conditions

To ensure that the works did not disrupt traffic – this objective being included in the specifications – RECo proposed that they be organised in two stages and put in place two-weekly site inspections. Despite this phasing and an expansion of the RECo organisation to better control the project's logistics (elements manufactured by several subcontractors had to be delivered to four different work zones), the project suffered disruption and delays due to the heavy rainfall in the region in early January 2011 that resulted in catastrophic flooding, with 26,000 homes flooded. "Our structures were not in any way affected, and our client, represented by Peter Andrews, expressed satisfaction with the service we were providing and described the panel finishing as 'perfect'. We were able to complete as planned in early 2012."

Participants
Client: Main Roads QLD
Project manager: Florent Sygall
General contractor: The Origin Alliance
Specialist contractor: Reinforced Earth Pty Ltd (Australia)

14

SOLETANCHE BACHY

_ Odeon Tower/Monaco

Exceptional foundations for Monaco's flagship tower

Before imposing its 160 m high, characteristic "two petals" silhouette on the Monaco skyline, the Odeon Tower will already have been the subject of spectacular support and foundation works. "When we arrived on the site in November 2009," recalls Emmanuel Robert, managing director of Soletanche Sam, the Monaco subsidiary of Soletanche Bachy, "we found ourselves looking at a hill slope with a few villas dotted around. The difference in level between the highest and the lowest sections was around 30 m. So our first job was to provide temporary supports (micropile retaining walls and Berlin-type retaining walls) to create the platform needed for the construction of the diaphragm walls, the deep foundations and the transition slab. This would then make it possible, at the beginning of 2012, to start simultaneously on the construction of the above-ground works and of the 10 levels of underground car parks, together with their earthworks."

55 m deep diaphragm walls

Just like on a small project up in the mountains, the upper sections of this flagship project began with the technique of micropile retaining walls *(see box)* and passes of excavation limited to 2.12 m; 50 m farther down the slope, in June 2010, as soon as the platform was capable of taking a larger piling rig, the supports were installed at a faster rate, using a Berlin-type retaining wall. At that time it was also possible to start the demolition works and the construction of the diaphragm walling for the below-ground levels. Work began along Boulevard du Tenao, the sole point of access and deliveries to the site, using a Hydrofraise drilling machine to build diaphragm walling down to a depth of 55 m.

The work revealed a few surprises. In January 2011, karstic voids were encountered on the lower slope, which stopped the construction of the diaphragm walling in this section in order to strengthen the ground by compaction grouting, which took from February to May. In another "adventure", the presence of a layer of weathered marl on the upper slope made it necessary to stabilise the ground using carbon-fibre nails. "These unforeseen events interfered with the regular progress of the works, as the various rigs (anchors, earthworks, deep foundations, diaphragm walls) had to work at the same time within an area which, at its longest, was no more than 70 m. Even so, every step was taken to meet the schedule," says Emmanuel Robert. But these types of problems are typical on sites in Monaco. Constraints in connection with the environment, which is almost exclusively residential (although in this case with a school in term time on an adjacent site), and problems due to a lack of accessibility were nothing new for Soletanche Sam's teams.

Key figures

Site area: 2,820 m²
Exposed area of retaining walls:
- micropile retaining walls 1,000 m²
- Berlin-type piled retaining walls 1,500 m²

Area of diaphragm walls and barrettes: 25,000 m²
Thickness of the diaphragm walls and barrettes: from 800 to 1,000 mm
Maximum depth: 55 m
Total number of temporary anchor ties in all retaining walls: 501
Length of the ties: 35 to 40 m
Volume of spoil prior to the construction of the transition slab: 64,000 m³
Volume of tunneled earthworks spoil 75,000 m³

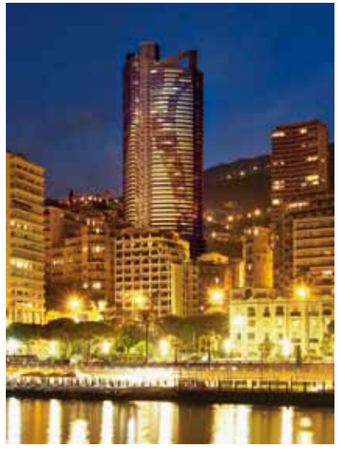
Participants

Client: Marzocco Group
Project manager: Cabinet Giraldi, Coyne et Bellier
Works joint venture: VINCI Construction France's Monaco branch (leader), GTM TP Grand Sud, GTM TP Côte d'Azur, Triverio, Soletanche Sam, SGTM.

Once the retaining walls and the foundations have been constructed, the next major stage of the works is the casting of the ground floor slab. Subsequently, the works can continue simultaneously downwards (construction of the basement levels) and upwards (above-ground works).

Micropile and Berlin-style retaining walls

Micropiling and Berlin-style are two systems for the construction of retaining walls that are based on the same principle, but vary in scale. The principle comprises a foundation system (steel section, micropile or large-diameter pile) forming a rigid vertical structure, and shoring units (sprayed or cast-in-situ concrete) supported by the vertical structures and holding back the ground. As the excavation work proceeds, the stability of the retaining walls is ensured by a system of high-strength (up to 180 t) anchors of great length (up to 42 m).



Q&A

Joseph Lavisse

Expert consultant
Soletanche Bachy

What best defines this project, in your opinion?
Its very unusual aspect, I would say. This is linked to the size of the tower. A building with almost 50 storeys weighs a great deal and its location in a seismic zone requires careful management of the forces below ground level. The layout of the site is also remarkable due to its considerable slope, which means that retaining walls 70 m high are needed, which I have never seen before in 36 years in the job.

What are the characteristics of the ground?
Monaco is located in a volatile tectonic zone, characterised by the presence of faults and very variable ground conditions. From the surface downwards there are, successively, scree and limestone marl of very varying composition and compactness. Last, at great depth, you find extremely hard Jurassic limestone. Very particular attention was paid to the soil investigations for this project: 15 investigations were carried out for the tender documents, with 31 additional core samples or pressiometric tests, and then a further 33 destructive tests.

How has protection against the seismic risk been dealt with in the design of the foundations?
In a geological context of this type, you cannot simply place the tower on a raft. Here, the lower part of the construction is hollowed out to form a "base" following the shape of the deep rock that covers the whole of the plot. At the level of the transition slab, the loads from the tower itself are transferred to the deep foundations, 1 m thick barrettes anchored into the limestone marl. In its final state, the construction is self-supporting and can withstand tensile forces in the event of an earthquake.

Was the structural design work for the substructure and for the superstructure coordinated?
At the present time, there is no tool that is powerful enough to incorporate the structural design work for the works below ground level and for those above ground level. Initially, we constructed a 3D finite element mode with Terrasol, to assess the behaviour of the ground and of the retaining walls. We then worked closely with VINCI Construction France's design office to carry out consistent design work. This allowed us to produce the execution plan within a short period of time and to limit subsequent modifications to variations requested by the architect.

01

15

FREYSSINET

_ Redzinski Bridge, Wroclaw/Poland

Freyssinet builds Poland's largest cable-stayed bridge

01 The unusual architecture of the Wroclaw bridge has already made it an imposing element of the Polish landscape.
02 A 90-strong team was mobilised for the construction of the bridge.

02

The Wroclaw bypass crosses the recently opened Redzinski Bridge over the Oder. Its unusual architecture has already made it an imposing element of the landscape. With its 122 m towers, this concrete cable-stayed bridge is the longest and highest construction of this type in Poland.

Two exclusive Freyssinet processes

Freyssinet Polska contributed to the design of the bridge, the erection of which required a 90-strong team. The staying works were carried out using two exclusive Freyssinet processes: the HD2000 anchoring and cable system and the Isotension® tensioning system, patented throughout the world and already used on more than 200 cable-stayed bridges. Concrete was selected for the construction of the bridge due to its remarkable vibration absorption properties, its lower noise generation and its durability.

An unusual design

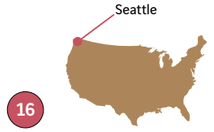
The Wroclaw construction consists of two walkways and a suspended bridge high over the river. The three lanes of the bypass, suspended separately from the top of the H-shaped towers, form two independent decks, a solution never before adopted. Faced with a very short construction period, the Wroclaw bridges authority suggested the use of incremental launching technology for the construction of the walkways, so that the towers and the deck could be built at the same time. Despite these constraints, Freyssinet's team completed the installation of the 160 stay cables in a record time of two months.

Key figures

Length: 1,742 m
Area: 70,000 m²
160 stay cables,
with a total mass of 1,500 t
Two main spans of 256 m
Two perimeter spans of 50 m

Participants

Investor: Generalna Dyrekcja Dróg Krajowych i Autostrad
Design: Mosty – Wroclaw research and design consultants
General contractor: Mostostal Warszawa, Acciona Infræstructuras
Subcontractor: Freyssinet Polska
Supervision: Egis Poland



16

SOLETANCHE BACHY

_ Seattle Light Rail/United States

First permanent diaphragm wall structure in a seismic zone

In Seattle, on the west coast of the United States, the extension of a light rail line towards the north began by the construction of an intermediate station serving the University of Washington. This was used as the starting point for two tunnel-boring machines (TBMs), one digging in the direction of the city centre and the other towards the north and the town of Everett. The construction of this station, included in the same contract as that for the first tunnel, was subcontracted to a 50-50 joint venture between Nicholson and Condon Johnson. "The construction is unusual", explains Laurent Lefebvre, executive vice president of Nicholson, "as it was the first time in the United States that a second, permanent structure has not been built inside the diaphragm walls, as the diaphragm walls will be used as a permanent construction for a transport infrastructure installation in a seismic zone." The diaphragm walls, designed by the client, were sized to allow for this (thickness, density of reinforcement). They pass through layers of hard ground (sand and gravel) and are anchored into a layer of clay at a depth of 50 m on one side and 35 m on the other.
Another particular feature of the site was its phasing. As the University of Washington station was to be used as the starting point for both TBMs, priority was given in the schedule to the TBM digging towards the city centre. The work on the station was therefore organised in two phases: the diaphragm walls and the earthworks for the pit for the first TBM and then the remainder of the earthworks and the construction of the rest of the structure, included in the same contract as the northern tunnel.
Work started in September 2010, using two Hydrofraise drilling rigs and cable buckets. The first phase of works had to be completed in the very short time of nine weeks and all of the work was completed in February 2011.

01

02

01-02 Start of the works at the location of the university stadium car park.

Participants

Client: Sound Transit Authority
Project manager: Joint Venture Jacobs Associates – KPFF and CH2M Hill
General contractor:
JV Traylor Brothers - Frontier Kemper
Subcontractor joint venture:
J V Nicholson, Condon Johnson

Q&A

Laurent Lefebvre

Executive Vice President
Nicholson

How did Nicholson become involved in this project?
Our association with Condon Johnson on this project resulted from a strategic partnership to which we committed six years ago for the development of stone columns on the West Coast. We then extended this association so as to work together on the access pit for another light rail station in Seattle (Beacon Hill).
The reason for this partnership is very simple. Nicholson is mainly based to the east of the Mississippi, thousands of miles from the West Coast, whereas Condon Johnson is present from the north to the south of the Pacific coast, from Seattle to San Diego. The three states of California, Washington and Oregon have a population of 47 million and a GDP very close to that of France, so the market is large and very specific. The attraction of the partnership is mutual. It provides us with a presence for projects in the region, with the benefit of local resources and support. Conversely, we allow Condon Johnson to develop proposals for stone columns, diaphragm walls and Geomix®.
In the spring of 2012, we were the joint winners of a large contract: the construction, as a subcontractor, of the departure and arrival pits and of the intermediate stations for the Central Subway project in San Francisco.

Les Épesses

17

FREYSSINET

__ Cabled roof for the Gallo-Roman stadium at Le Puy du Fou, Les Épesses/France

A high-tech structure for the Puy du Fou velum

By increasing its programme of events year on year, the west coast Puy du Fou park has, within 20 years, become the fourth most popular leisure park for the French. In 2011, it invited its visitors to watch the chariot races and gladiator combats organised in its Gallo-Roman circus, sheltered under an immense fabric roof (velum), just as for the Romans in the time of Titus at the Coliseum. This construction – unique in France – is supported by a structure of a similar shape to that of a bicycle wheel; it comprises an outer section (compression ring) bearing on the enclosing wall and an internal hoop (traction ring) suspended from 288 radiating cables 17 m long. Once the outer ring had been constructed using steel box beams, Freyssinet was appointed to erect the suspended structure of the internal hoop and radiating cables, including the halyards and capstans necessary for the motorised operation of the fabric roof and the 12 vertical cables anchored into the floor of the arena, to hold the roof in the event of strong winds.

Cables, hubs and rods

"In this operation", the representative of Freyssinet France's Cables and Handling agency explains, "the major constraint was the very short period of time for the work. To complete on time, it was decided to erect the structure using a minimum of tensioning equipment. This meant assembling the structure on a scaffold at a height of 14 m, not far from its final height." Initially, the four 180 m long, 52 mm diameter cables forming the grid of the inner hoop were unrolled and placed in position, using a mobile crane, on brackets at 3 m centres, before being locked together using a system of hubs and rods. Then the radial cables (14 mm diameter) were deployed. The structure was then tensioned by progressive lowering of the screw jacks supporting the scaffold. The final adjustments were made using tensioners fitted to the radial cables.

"We completed the work in six weeks, as the scaffold had to be dismantled on 1 April 2011 to allow rehearsals for the show to take place. We finished on time. The velum was deployed on 13 April 2011 for the annual opening of the park and, in July, the stadium and its velum had their moment of glory as it was there that the teams for the Tour de France cycle race were presented on the day before the start of the race."

01

04

05

02

03

Participants

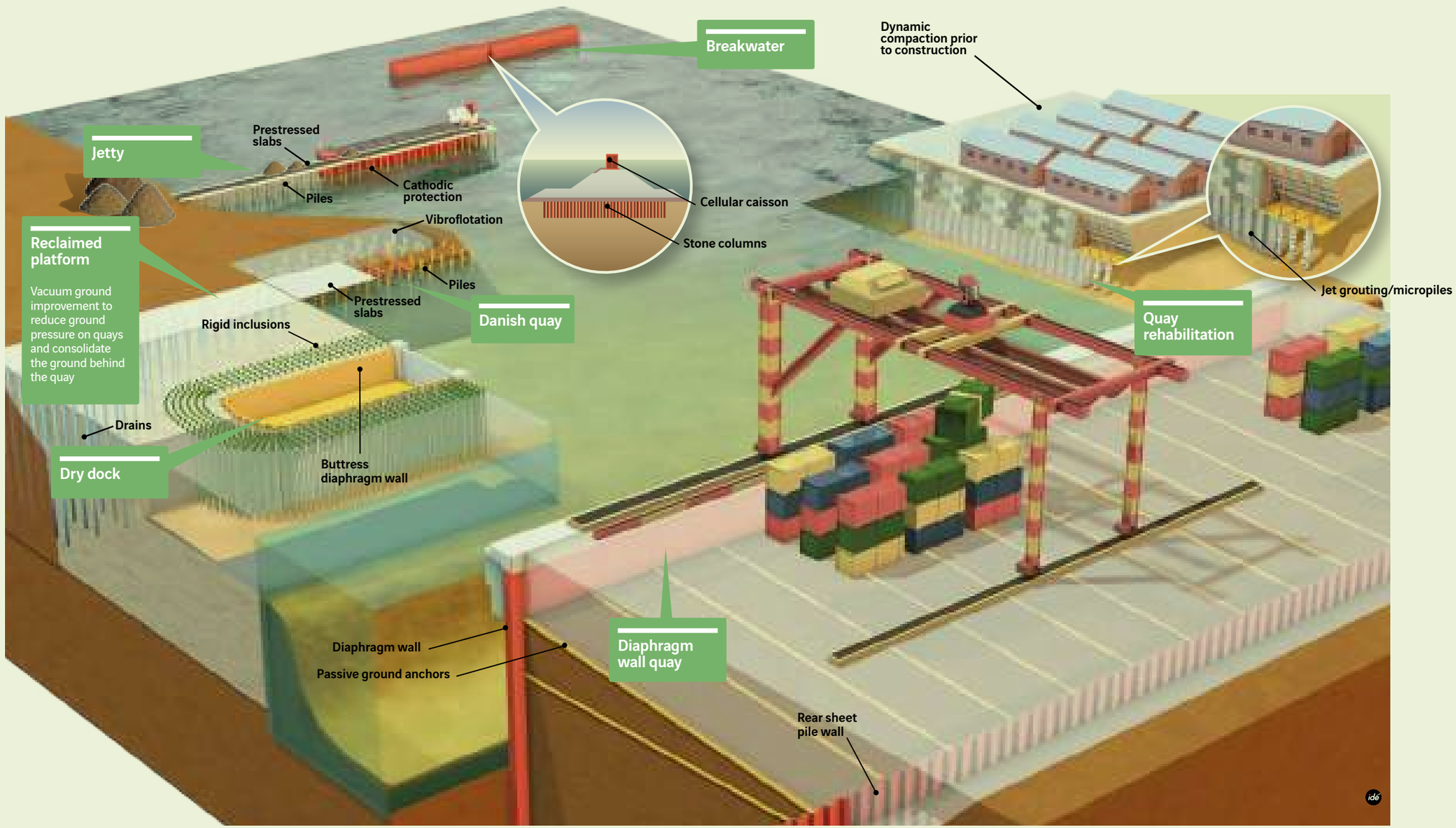
Client: Puy du Fou leisure park
Inventor: René Chambon
Project manager: SDEI Ouest (Cholet) consulting engineers
Contractor: Freyssinet France (Cables and Handling agency and Freyssinet Nantes agency)

01 Early April: final adjustments before the start of the season.
02-04 The cables for the inner hoop are installed in their final locations on the scaffold.
03 A system of hubs and rods locks together the four cables forming the inner hoop.
05 By using 36 electric winches, the 6,000 m² of the velum can be opened or closed within a minute.

Structures & know-how

Ports
Turnkey infrastructures

Soletanche Freyssinet offers dual know-how in port works. **Ground structures.** Comprehensive design-build construction of quays, dry docks, locks, wharves, and other structures. The Group can rely on its own resources to carry out such complex geotechnical works and does not need to outsource. **Special works.** Building on their comprehensive range of technologies, Soletanche Freyssinet companies deliver all types of ground and structural works as part of both new construction and repair projects.



A few examples of port projects around the world


01


02


03


04


05

01 Port Botany container terminal in Sydney, Australia.
02 Port of Cotonou extension, Benin.
03 CMIT container port construction, Vietnam.
04 Dún Laoghaire Harbour reinforced earth breakwater, Dublin, Ireland.
05 Moma Sands jetty, Mozambique.

Structures & know-how

Ports Turnkey infrastructures *(continued)*

Expert voices "Port projects with built-in environmental safeguards"

Paul Scherrer, technical and project director, Port of Le Havre, France

The French port sector has experienced contrasting trends in recent years: alongside major projects such as Port 2000 in Le Havre, a downturn in the wake of the global recession was followed by the introduction of the port reform in France. Paul Scherrer, who has first-hand experience with these changes, gives us his view of the new context in which future port projects will go forward.

What is the purpose of the reform?
The reform is designed to give French ports an organisational structure that will enable them to meet the competitiveness criteria required by our international customers and to recapture market share and traffic lost to ports in northern Europe. The reform has brought about major changes. For example, handling equipment and operators have been transferred to the private sector and port governance has been overhauled and, as I see it, made comprehensive. It now includes an executive committee, a board of trustees and a development council (which environmental protection and other NGOs are invited to join) that will make it possible to work with all the stakeholders to devise an effective development strategy. We see this in the strategic five-year Grands Ports Maritimes projects launched in 2009.

Do the plans include new infrastructure development?
Indeed they do. The purpose of the public authorities in introducing the reform was to stimulate activity. These plans pay very close attention to the environmental aspects of port design, to ensure full consistency with the principles of the Working with Nature programme developed by the world association for waterborne

transport and infrastructure (PIANC). The environmental focus is of course not new in the case of the Port of Le Havre. Soletanche Bachy will not soon forget the public debate about Port 2000, France's first such project. The upshot of that debate was that a strong environmental project aimed at initiating the rehabilitation of the Seine estuary was needed in conjunction with the port project. In future, the focus will increasingly shift from minimising the environmental impact of the works to building in environmental safeguards at the earliest possible stage of the project. This win-win approach is the very essence of sustainable development.

As a contracting authority, what will you expect of contractors?
Our requirements remain essentially technical, since a single tool can sometimes make all the difference. We therefore pay close attention to our partners' innovation policies. We consider that such "protective" processes as Soletanche Bachy's Trenchmix® and Geomix® constitute substantial technical progress. Above and beyond these processes, we also expect contractors to devise a wide range of new ways of working with us. I do not so much mean public-private partnerships and design-build projects – since we continue to have strong engineering capabilities – but rather scope for negotiation in public procurement contracts so as to give contractors an opportunity to submit innovative alternative solutions. To my mind this constitutes a radical move, and a welcome one, away from conventional tendering procedures.

What operations is the Port of Le Havre planning?
In the medium term, we will be completing the Port 2000 project – 700 m of quays remain to be built. To accommodate very large ships in the historic port, we also plan to build a connecting quay between the Americas quay and the Atlantic quay, which present difficulties due to geology and silt management respectively. In these areas, we hope prospective contractors will devise and propose efficient and effective alternative solutions when the time comes. The Emerhode project aimed at extending the Grand Canal du Havre towards the Tancarville canal, which includes construction of long embankments running along a nature reserve, is another good illustration of the new issues to be addressed. It will be vital to integrate the environment from the start and hold very broad consultations throughout the design study phases.

Expertise

— Business activities, techniques, innovations

GROUND TECHNOLOGIES

Menard A competitive alternative solution in CMC construction

In North America, where distances between worksites are commensurate with the size of the continent, the need to transport heavy machinery to carry out small projects can be a drawback. To tackle the problem, Menard came up with the idea of using a solution developed several years ago for vertical drains as an alternative to heavy drilling equipment in the construction of controlled modulus columns (CMCs). "The concept is straightforward," says Frédéric Massé. "It consists of developing a tool that can be mounted on standard excavators and transported by conventional means. This enables us to rent the heavy machine itself on the spot, which makes us more competitive." The project remained pending for some time and was re-initiated at the end of 2009 when Bermingham[1], an equipment manufacturer based in Toronto, Canada, was asked to design a prototype. Delivered in the late summer of 2010, the tool consists of a 15 t mast that is transported with its accessories (extensions, auger, connection and control systems, etc.) by conventional flatbed semi trailer. "The tool is attached to the boom of standard 45 t excavators, such as the Volvo 460 or Caterpillar 345, and then connected to the machine's hydraulic system. It is controlled from the cab by a simple joystick," says Massé. In terms of performance, the CMC mast is slightly less powerful than the Enteco drilling machine typically used to build CMCs, but the smaller diameter of its auger (28 to 30 cm instead of 32 to 45 cm) offsets the difference in torque. In 2011, the tool was employed on two worksites. One involved ground improvement on a residential project in Quebec. It achieved a daily production rate of 400 m over 10 days. The second was a project at Nasa's John Glenn Research Center (near the Cleveland airport), for which 200 CMCs to a depth of 5 m were initially ordered but 870 were ultimately built under a contract rider. In both cases, the machine performed fully satisfactorily. The CMC mast was presented at Menard's March 2012 convention in Istanbul, where it attracted considerable interest, particularly on the part of the other subsidiaries. This could result in a second model being built to cover the needs of the Group.

(1) Berminghammer (Bermingham company) joined the Soletanche Freyssinet Group in 2011.

Close-up
Main technical features
Support machine: Volvo 460 or equivalent
Drilling depth: 12.50 m; 9.45 m; 6.40 m
Torque: 10,845 Nm
Speed: 16 rpm
Bearing force on the tool: 18 t
CMC diameter: 23 to 30 cm
Control: Electrohydraulic

01

02

01 The CMC mast is attached to the arm of a standard 45 t excavator and connected to the machine's hydraulic system.
02 An extension system makes it possible to build CMCs in three different lengths.

The CMC mast won the Menard Group's innovation award in the autumn of 2011.

> The machine's small dimension could be an additional technical asset for Menard, which operates in the oil tank reinforcement segment.

Transport containers for radioactive materials must provide radiation and contamination protection even in a fire or when they fall.

NUCLEAR

A turnkey offer from Millennium (Nuvia)
Packaging design for transporting radioactive materials

The transport of radioactive materials (decommissioning and technology waste, radioactive sources, accessories and tools contaminated during scheduled unit maintenance[1]) is just as sensitive as their interim and final storage. During transport, it is necessary not only to protect the environment and personnel from radiation and dissemination of radioactive materials (contamination) but also to prevent packaging from being damaged in a road, rail or aircraft accident. Similarly, packaging design must provide protection in case of fire or criticality accidents (involving fissile materials). A wide variety of highly specific skills is required to design and qualify such products. Millennium, which specialises in nuclear engineering, has traditionally made available two such capabilities – the scientific engineering skills needed to characterise the material to be packaged and transported and management of the safety file – to designers and manufacturers as well as final customers such as France's national agency for radioactive waste management (Andra) and atomic energy commission (CEA). "Millennium has added design to these two longstanding activities, thereby acquiring the ability to position itself as an integrated provider covering all stages, from design to production," says the head of the mechanical engineering office. Above and beyond its own resources, Millennium has the support of other Soletanche Freyssinet entities, for example Nuvia Limited for impact tests and Mecatiss for fire and temperature tests.

(1) With the exception of new and spent fuel from power plants and reprocessing products, for which Areva has exclusive packaging and transport responsibility.

Close-up
Millennium resources

Design
Solidworks 2010: CAD (compatible with standard formats AutoCad, Iges, Step, etc.); finite element mechanical engineering module (pre-design).

Justification calculations
Codes for nuclear physics calculations: MCNP (radiation protection), Tripoli (radiation protection, radiolysis, criticality), Scale (criticality), Cristal (criticality).
With in-house support from NECS: Aster Code (mechanical, thermal); Ansys (mechanical, thermal); Radioss (fall and impact calculations).

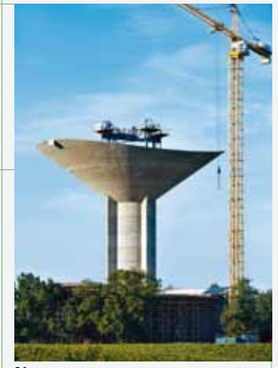
GROUND TECHNOLOGIES

Terre Armée expands its range of synthetic reinforcements

As a supplement to its traditional solutions (reinforced concrete facing panels, steel connections and reinforcement), which meet the needs of most projects, Terre Armée has focused in recent years on customised solutions designed to accommodate new project execution restrictions and customer requirements. In 2010 the company introduced EcoStrap® reinforcements to round out its fully synthetic range of GeoMega® connections that had until then used GeoStrap® reinforcements. The Reinforced Earth® process can thereby be used not only in corrosive atmospheres (marine environments, for example) but also in conjunction with fill derived from recovered and recycled materials and lower-grade materials treated with binder or lime. "EcoStrap® reinforcements can be used across a very wide range of applications, boosting the competitiveness of the system; and we have further extended it by adding a high adhesion version: HA EcoStrap® *(pictured)*, which has serrated edges to improve interaction with the fill, especially sands and fine graded materials," says Terre Armée International research and development director Nicolas Freitag. Terre Armée has also developed the GeoTrel® system, which extends the applications of GeoStrap® and EcoStrap® reinforcement to solutions using welded wire mesh, for solutions with mineral or planted facings, which are currently in high demand. The system has been offered since 2010.

Facing panels equipped with GeoMega® connections and EcoStrap® reinforcements.

02



01

03

01 Freyssinet lifted the tank of the Duret water tower in Eauze (south-western France).
02-03 The structure, weighing about 1,050 t, was lifted into position at a height of 42 m by means of eight jacks, each with 140 t capacity and a 300 mm stroke. The lifting operation took six hours at an average speed of 7 m per hour.

STRUCTURES

Freyssinet-Hebetec A safe, simple and cost-effective lifting system

Building on its traditional business activity, prestressing, and its knowledge of instruments, Freyssinet branched out into other cable and high-capacity jack applications. One such application is lifting, which is required whenever the use of cranes is neither warranted nor possible (single operation, accessibility, capacity). In certain cases, it is better to build or assemble a structure, such as a bridge deck or a roof, on the ground and lift it into place once it has been completed. A case in point is water tower tanks, for which scaffolding construction is costly, complex and risky above a certain height. Freyssinet's turnkey solution combines design of the operation, supply of equipment (cables, jacks and support structure) and execution. "The lifting operation is quite spectacular and always draws a big crowd of onlookers," says Jean-Luc Bringer, director of Freyssinet's Cables and Handling agency, "but it is also technically very complicated. We have developed and patented control and monitoring systems specific to this application. During the entire lifting sequence, the operation is controlled and monitored by computer to track the jack pressure and altimetry measurements supplied by a battery of remote laser sensors installed on the structure to be lifted and at fixed points. By continually monitoring all these parameters, we are able to avoid damaging the structures."

GROUND TECHNOLOGIES

CSM Bessac The synergies of a manufacturer and contractor

"The company operates in two different sectors as a result of its history. It was founded at a time when companies strove to cover all aspects of their business activity, including manufacturing its own tools," says CSM Bessac CEO Bernard Théron.
It all started in Toulouse in the mid-1970s when Michel Bessac, who headed a company specialising in pipeline drilling and pipe jacking, decided to mechanise execution and build a machine that could both drill the tunnel and install its retaining structures. The first model, which gave the company its name CSM (which stands for Creusement Soutènement Mécanisé – mechanised drilling and retaining) Bessac, was soon further perfected to drill under the water table by means of compressed air confinement[1] (this technique was referred to as the "Bessac type tunnelling machine" in the industry).
In the 1990s, in a move that brought CSM Bessac into the industrial age, Soletanche acquired the company in order to cover the full range of underground works and avoid depending on a manufacturer. New skills (automation, design) were brought on stream, state-of-the-art programmes were adopted in the design office, and the company began to market tunnelling machines and to expand internationally. Revenue rose from FF60 million in 1995 to €60 million in 2009. Today, the combination of being a civil engineering works contractor and an industrial manufacturer continues to be a strong asset for the company, since control of the plant and equipment is key in underground works and the ability to second specialists on the ground lends a strong competitive advantage. But the changing business context has driven change in the company. "We do not manufacture micro-tunnelling machines, which others can mass produce, nor do we exceed the 6 m diameter required for our installations," says Bernard Théron. "However, in diameters of between 2 and 6 m we do make all models (roadheaders, compressed-air roadheaders, mud pressure) and we maintain and repair machines in all categories. Meanwhile, we are making the most of our design capabilities, ability to innovate, and feedback from the field to develop prototypes that meet specifically identified needs." Since the company began operating in this area, these machines have attracted attention and enhanced its reputation. Several machines have won prizes – examples being the Roll & Rock machine (FNTP Innovation award in 2001) and the Proccope[2] sewer cleaner (FNTP award and VINCI 2009 Innovation award) – pending, who knows, a new prototype being finalised in the CSM Bessac workshops *(see opposite)*.

(1) The company did not stop there and also began manufacturing earth pressure tunnelling machines at the beginning of the new century.
(2) See Resonance *no. 1, page 39.*

01

02

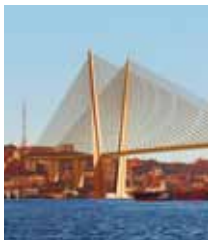
03

01 At its site in Saint Jory in south-western France, CSM Bessac develops and manufactures machines that exactly meet the needs of its customers.
02 In its contracting activity (pictured here, construction of the outfall in Rabat, Morocco), the company's technical capabilities ensure safe project execution.
03 A good illustration of the company's expertise: the roadheader used in the Toulouse metro.

In pictures

The tunnel dismantling machine

In the Hong Kong underground, a 150 m existing tunnel section at the rear of a station obstructed the westward extension of the Island Line metro. To dismantle the section under 32 m of water, and to enable the mud pressure tunnelling machine to bore the new tunnel, CSM Bessac worked within a consortium made up of DTP, Maeda and lead company Bachy Soletanche Group to develop a new type of machine. Called the TDM (tunnel dismantling machine), it will have the opposite purpose of a tunnel boring machine: its job will be to dismantle and remove the reinforced concrete and cast iron arch segments and fill in the tunnel.



The world leader in ground technologies, structures and the nuclear sector, **Soletanche Freyssinet** has a presence in some 100 countries.
The Group offers an unrivalled range of specialist civil engineering expertise and brands.
Its 18,000 employees focus on responding to client expectations through solutions tailored to the unique features of each project and contribute to improving the technical performance and durability of structures.

www.soletanchefreyssinet.com

SOLETANCHE FREYSSINET

SOLETANCHE BACHY | MENARD | TERRE ARMEE | FREYSSINET | NUVIA