SOLETANCHE FREYSSINET

resonance

The magazine of the SOLETANCHE FREYSSINET group

Group — The range of expertise of a new world leader

Soletanche Bachy — Completion in sight for the 2nd phase of Port 2000

Freyssinet — 16,469 segments for 62 km of urban viaduct in Dubai

Nuvia — Decommissioning of a nuclear facility

Menard — Record-breaking dynamic compaction project in the UAE

Terre Armee — Historic contract in South Africa

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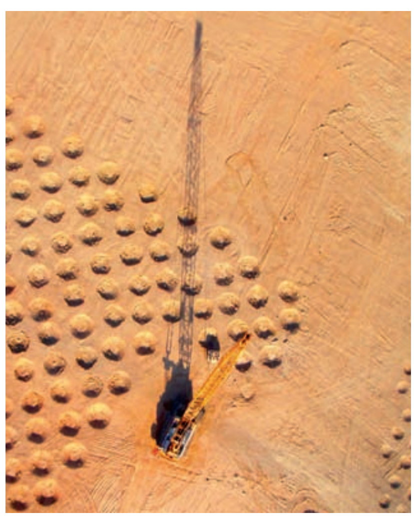

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EDITORIAL
— BRUNO DUPETY

Chief Executive Officer,
Soletanche Freyssinet

> It is by making resonate the expertise, networks and resources of the new Soletanche Freyssinet group that we will continue to grow, with benefits to our clients, everywhere in the world.

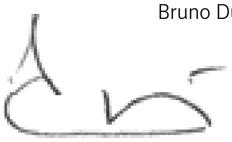
Here it is, the new magazine of a new group, Soletanche Freyssinet, replacing *Ancrage Magazine* and *Soils & Structures*. Its name, *Resonance,* conveys an image of openness and future developments, and is also the name of the plan for synergies between the Soletanche Bachy and Freyssinet groups launched at the beginning of the year. The companies that form our two groups were destined to join forces because they are both close and complementary. Close because they all operate in highly technical business activities in the construction and civil engineering field. Close also in their common culture of innovation and the value they all place on technical excellence. Most of these companies arose from inventions that in their day were major technological breakthroughs. Since then, they have incessantly enriched their expertise and developed new products. Close, too, because the two groups have since their beginnings built up strong international business, both through major projects handled as exports and subsidiaries that are well established in their home countries.

This cultural closeness goes hand in hand with the complementary nature of their respective expertise. The Soletanche Freyssinet group, the world leader in its line of business, encompasses an unrivalled range of expertise in civil engineering. It brings together brands and companies, each one at the forefront of its speciality and a benchmark for its market: Soletanche Bachy, Terre Armee and Menard in foundation engineering and ground technologies; Freyssinet in structures; and Nuvia in the nuclear field. When working together on the same structure, they can account for a large part of a project's technological added value. Likewise, by integrating our networks we will be able to deploy that expertise worldwide through our operations in close to 80 countries.

The Soletanche Freyssinet merger does not involve merging our operating teams, and we remain loyal to our principle of organisations that correspond to our different business lines. A new brand architecture has been launched that reflects both that distinctness and membership in the new group.

The objective of *Resonance* is to harness the exceptional potential of the synergies created by the merger. Those include developing new integrated offers that combine our technologies and enable us to support our clients, and spurring more collaboration between our R&D teams and a new sharing of competencies among our cross-division services and operating subsidiaries. It is by making resonate the expertise, networks and resources of the new Soletanche Freyssinet group that we will continue to grow, with benefits to our clients, everywhere in the world.

Bruno Dupety



Group

— Synergies

Key figures
€2.5 billion
in revenue (2008)
18,000 employees
Offices in almost 80 countries
and operations in 100 countries

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01 Freyssinet
02 Menard
03 Nuvia
04 Soletanche Bachy
05 Terre Armee

THE EXPERTISE OF A NEW WORLD LEADER

Soletanche Freyssinet brings together an unparalleled array of brands and technologies in specialised civil engineering.

Foundation engineering and ground technologies

Soletanche Bachy — A specialist in geotechnical and foundation engineering, Soletanche Bachy carries out projects of every type in this field, including new works such as foundations for car parks and buildings, renovation, asset rehabilitation, site investigation and quarry reinforcement. From the basis of its specialist expertise, the company has developed main contracting skills for complex projects that have a significant underground component, such as tunnels and metro systems. It also has a range of specialist know-how that is implemented by some 15 subsidiaries working in soil and underground technologies (maritime and river works, tunnel boring, trenchless works, polluted site remediation, detailed ground analysis, etc.).

Menard — From design to execution, Menard provides foundation solutions based on ground improvement techniques. Its methods eliminate the need for the deep foundations generally used for surface structures. They are particularly suitable for sites that are to support with big surface and distributed load.

Terre Armee — Inventor of the Reinforced Earth process, Terre Armee provides earth reinforcement technologies on the border between geotechnical and structural engineering. These techniques are used mainly for the construction of road structures. The company also erects precast arches (TechSpan), combining the structure and backfill.

Structures

Freyssinet — Freyssinet builds, repairs and maintains structures of all types: transport infrastructure (bridges, tunnels), industrial facilities (reservoirs, silos, offshore platforms), commercial facilities (supermarkets, warehouses), high-rise buildings, historic monuments, and so on. Drawing on its longstanding expertise in prestressing and structural cables, Freyssinet has developed an extensive range of innovative solutions to support its clients, from project engineering, construction methods and structural fittings to monitoring devices and systems.

Nuclear

Nuvia — Nuvia is the brand name for Soletanche Freyssinet's nuclear division, which brings together a range of complementary expertise to serve nuclear operators. Its skills in project management, radiation protection and safety are applied throughout a nuclear facility's life cycle: engineering and construction; operations in a nuclear environment; clean-up, decontamination and decommissioning of facilities and/or processes; waste treatment facilities.

04

Brand architecture

A new visual identity has been created for Soletanche Freyssinet and its subsidiaries. The aim is to establish a modern, consistent image for the entire entity.

05

Remi Dorval
Chairman and CEO of Soletanche Bachy

"The main characteristics of our two original companies are their highly technical business activities, first-rate teams and their strong international presence. From that starting point, it's possible to build all kinds of joint efforts. One example would be the development of integrated offerings for storm water basins or port projects. We can count on our teams to be creative! The benefits of the merger will be seen most quickly in the international arena in terms of market coverage, resources dedicated to project development and then execution capability."

Jérôme Stubler
Chief Executive Officer of Freyssinet and Nuvia

"The merger between the holding companies of Soletanche and Freyssinet means we can expand our offerings by developing joint products and/or projects, such as technically sophisticated car parks with diaphragm walls and prestressed concrete floors, or even prestressed foundations for wind turbines. On some projects, our combined areas of expertise will lead to us executing up to 60% or 70% of the work, thereby becoming the main contractor for specialised works and giving direct, responsive access to our companies' technologies. Even in the nuclear sector, you can imagine technical niches in areas such as soil remediation or the creation of specific barriers. We're only at the start of a promising process of combining our technologies!"

Snapshot
Union at the foot of the Major

It was the end of 2008 on the construction site of the Marseilles coast road. At the time when Freyssinet and Soletanche Bachy were preparing for their merger, the photographer's lens caught a very concrete image of the complementarity of the two companies: a temporary Geomix retaining wall (Soletanche Bachy) and the strengthening of the masonry arches (Freyssinet) of the Major esplanade. It was a collaboration that heralded many others, some of which are already to be found in these pages *(see also p.32)*.

Award
No accidents at Al Raha Beach

Al Raha Beach is the Emirate of Abu Dhabi's 500 hectare project of extension into the sea, which was completed in 2006 by a consor-

tium bringing together Soletanche Bachy and NSCC *(photo opposite)* and represents 3 million working hours. The project is exceptional for its size, and equally so for its results from the point of view of safety, since no accident occurred during project execution. Last 4 August, that performance won the consortium the congratulations of the Safety Department of Aecom, the project managers. On that occasion Karim Chéniour, the Soletanche Bachy project manager, was given a certificate by Peter R. Jones, senior project manager of Aecom.

Synergies
Austress Menard and Soletanche Bachy working together in Australia

At the end of 2007, a major project for the construction of deep foundations using barettes and diaphragm walls on the Gold Coast in eastern Australia presented an opportunity for Austress Menard, one of the country's leading players in the field of geotechnics, and Soletanche Bachy, which had not been active in its own name in Australia for several years, to come together in a joint tender. This partnership, in which Austress Menard with its local knowledge and Soletanche Bachy with its technical expertise were equal partners, led to the winning of a contract worth approximately AU$20 million, which was completed in 2008. This first move having proved successful, the management of the two companies decided to continue the experiment and to respond together to

client demands for major infrastructure projects that require the use of extremely varied technologies, ranging from standard deep foundations to ground improvement solutions and jet grouting.

Certification

At the beginning of September, Austress Menard, the Australian subsidiary of Menard, received triple certification: quality (AS/NZS ISO 9001: 2008), H&S (AS/NZS 4801: 2001) and environment (AS/NZS 14001: 2004).

Safety

Homesafe, an original approach made in UK

Safety, which is such an essential part of the procedures and methods used by employers on construction sites, remains to a significant extent the responsibility of each person – as confirmed by all analyses. To encourage all their employees to change their personal behaviour and improve in this field, the UK subsidiary Bachy Soletanche has developed an original campaign by the name of Homesafe. Its principle is that the attitude to safety called for by the company should not be limited to work time but should continue into daily life, so that after their day's work, employees should return to their home safe and sound and keep safety in mind in everything they take on in their private life. The first wave of Homesafe was launched in 2008 and was accompanied by a wide variety of communication tools that were not without a certain British humour. This campaign is designed to be the mainstay of Bachy Soletanche's preventive approach.

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01 Safe and sound in all aspects of life.

02 The communication tools: cartoons to recall at home the safety rules that are essential at work.

Training

The environment on the agenda at Soletanche Bachy

To support and increase the skills of the many employees recruited in the course of the last three years, Soletanche Bachy increased its training opportunities in France by 25% in 2009. Several new courses intended for all categories of personnel have been added to the list. All now include an environmental component.

New contracts

Greece — Terre Armee

VINCI Construction Grands Projets, the constructor of the Egio-Patras section of the projected Elefina-Tsakona motorway, has assigned to Terre Armee France the design and provision of 18 retaining walls (25,000 m^2). The works will begin in November and will last for 18 months.

Mexico — Soletanche Bachy

The TEO project (Túnel Emisor Oriente) is an outfall of 60 km in length and up to 150 m in depth in Mexico. As part of the project, Cimesa, the Mexican subsidiary of Soletanche Bachy, has been awarded the completion of two new structures. The L11 and L14 shafts will service the passage of the tunnel boring machine. They come in addition to shafts L10 and L13 (entrance and exit shafts for the TBM) that Carso assigned to Cimesa in spring 2009. The construction of the wall of shaft L11 commenced at the beginning of August.

Romania — Nuvia

The Romanian agency for the treatment of radioactive waste (Andrad) and the operator of a storage site for radioactive waste located in the north-west of the country (Ifinn-HH) recently awarded Nuvia Ltd a contract for an upgrade of the facility. The assignment will be led by Jane Smith Briggs, project manager at Nuvia Ltd, who has extensive experience of storage sites in Eastern Europe.

France — Soletanche Bachy

Siaap, the Paris waste management authority, has awarded Soletanche Bachy, as part of a consortium, the second section of the VL9 main sewer (feeding the Valenton wastewater treatment plant). In particular, the works will include the construction of 3,185 m of gallery (interior diameter 3 m); a deep shaft with diaphragm walls constructed by the Hydrofraise method; a standard deep shaft; the civil engineering and the fitting out of all these shafts. Currently in its preparatory phase, the construction will begin in early 2010. The earth pressure balance TBM will be provided by CSM Bessac.

Kuwait — Menard

As part of the development of new towns promoted by the Kuwaiti authorities, Menard has signed a contract for ground improvement by dynamic compaction and ballasted blocks with a surface area of 3,700,000 m^2 on the outskirts of the capital. The works commenced at the beginning of October and will continue for 20 months.

Certification

Following an audit carried out 20 to 24 July 2009 by BV Certification, Soletanche Bachy HQ, Soletanche Bachy Agence France and SAM received H&S (OHSAS 18001) and environmental (ISO 14001) certification. No incidents of non-compliance were recorded. These latest certifications come in addition to quality certification ISO 9001: V2008.

Corporate responsibility

Solidarity on the fringes of a project

During the stay cable replacement works on the Penang Bridge, started in 2008 in Malaysia, Freyssinet has been working with the local organisation Ora Malaysia Berhad (House of Hope) through the intermediary of project manager Pascal Martin-Daguet. Founded in 2006 to help families at risk, the organisation's main objective was to set up a reception centre in a disused industrial building. The Freyssinet team used its expertise to assist in this project. New initiatives have been undertaken since then to fund-raise for House of Hope and support its work: the organisation of nautical games (Paddle of Hope), and a competition to produce the artwork for Freyssinet Penang's 2009 New Year card and Freyssinet Malaysia's calendar. With Pascal Martin-Daguet as its sponsor, the bid to provide transport for the members of the organisation was presented to the VINCI Foundation in summer 2009, and was awarded a grant of €19,500 for the purchase of a minibus. Since the completion of the project last September, Lee Kok Sem, the managing director of Freyssinet Malaysia, has taken over as direct sponsor of the organisation and its follow-up.

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01 In late 2008, Pascal Martin-Daguet presented the prize to 12-year-old Sharvin Raj al Sivanatha, winner of the competition organised to provide the artwork for Freyssinet Penang's 2009 New Year card and Freyssinet Malaysia's calendar.
02 The winning design.

Synergies

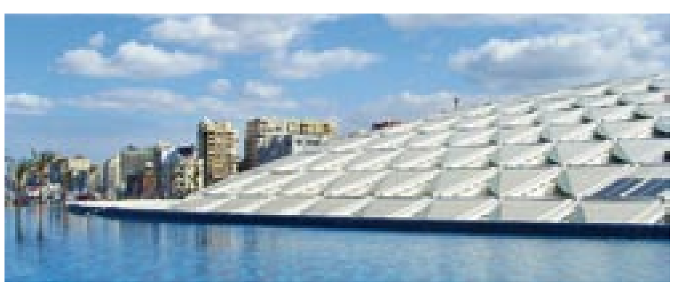
Freyssinet and Terre Armee set up in Chile

Soletanche Freyssinet's synergy strategy achieved concrete results last summer in Chile. Wanting to be present in this country, where Soletanche Bachy Chile had been established for 40 years, Freyssinet and Terre Armee decided to create a subsidiary there. It was set up under the name of Freyssinet Tierra Armada Chile SA. At the start it will base its growth on the client network of Soletanche Bachy Chile, with the intention of also becoming a leader in its field in the country.

Conference

Soletanche Freyssinet present at the International Conference on Soil Mechanics

The International Conference on Soil Mechanics and Geotechnical Engineering, which takes place every four years, brings together the world specialists in the discipline. Its 17th meeting took place last 5-9 October in Alexandria (Egypt) under the theme "Academia & Practice of Geotechnical Engineering". Menard, Soletanche Bachy and Terre Armee were all present and participated directly in the work of the conference. Serge Varaskin (Menard) was one of the contributors to the 6 October session on construction processes. Philippe Liausu (Menard, and also chairman of the technical commission of the French Soil Mechanics Committee), Pierre de Lavernée (Soletanche Bachy) and Nicolas Freitag (Terre Armee) also took part in their own specialist fields.



The conference took place in Alexandria's new library, opened in 2002.

Acquisition

SolData incorporates Acouphen Environnement

Acouphen Environnement, the French leader in the field of environmental noise management, became part of SolData last 31 July. The well-known expertise of its 23 employees in the industrial sector will enable SolData to extend the range of its acoustics services and offer unrivalled provision in both monitoring and expertise.
In return, the international network of SolData should provide a strong basis for growth for the new company. Acouphen Environnement will eventually be known as SolData Acoustic.

Acquisition
Last April Freyssinet acquired NECS (Numerical Engineering and Consulting Services). Created in 2000 and employing six staff (engineers and researchers), NECS has specialist expertise in structures (buildings, bridges, tunnels, etc.), the use of numerical tools and modelling the behaviour of materials.

Training

Freyssinet launches the PT (Post-Tensioning) Academy

By the end of 2009, the first courses of the PT (Post-Tensioning) Academy will take place at Freyssinet. This set of training courses, centred on Freyssinet's historic business, will replace the course on "The implementation of prestressing" that had been given until now. "We've made the change because we want to improve the content and make it available to a wider public," says Paul Hease, who is in charge of Q-H&S-E and is steering the project. The PT Academy will provide several modules for study: theory of prestressing, site management and practical courses. In addition to operators and those in charge of implementation, this training is now also available for works managers. It is intended to provide the course internationally. In France the courses will be held on the new site of Freyssinet International & Cie at Saint Eusèbe (Saône-et-Loire).

Prestressing: a technical process and a specialist activity.

Diary

2009/2010

November

14-17 Freyssinet and Reinforced Earth India participate in the 70th Indian Road Congress (presentation of the Freyssibar prestressing bar) – Patna (India).

17 Organisation by Soletanche Bachy of a "Ground technologies" seminar on ground improvement, soil mixing and works related to the environment – Hotel Radisson, Lyons (France) – Registration on www.soletanche-bachy.com

17-18 Presence of Freyssinet at the ultra high performance fibre reinforced concrete (UHPFRC) international workshop organised by French civil engineering association (AFGC) – Marseilles, France.

May

26-28 Participation of Soletanche Bachy at the conference organised by EFFC (European Federation of Foundation Contractors) and DFI (Deep Foundation Institute) on "Geotechnical challenges in urban regeneration" – London.

29 The Group participates in the 3rd Congress of the fib (International Federation for Structural Concrete) – Washington (United States).

New contracts

United States — Soletanche Bachy
The Engineer Corps of the United States army of the Seattle district has awarded Nicholson Construction Company, an American subsidiary of Soletanche Bachy, the contract to build a seepage barrier for the Howard A. Hanson Dam, near Cumberland (Washington State). The work includes the installation of a 135 m double-line grout curtain into the dam's right abutment.

France — Freyssinet
After completing a contract worth €700,000 during the first half of 2009, the Ile de France agency of Freyssinet France was given an additional phase of works worth €200,000 by the manager of the Massena car park in Paris. The contract is for strengthening work using metal stanchions and shotcrete, as well as various repairs.

Algeria — Menard
During the summer Menard was awarded a contract by Petrofac to carry out the consolidation works of a platform of more than 400,000 m^2 at El Merk by dynamic compaction. On the platform a central processing facility will be constructed for Sonatrach-Anadarko, a consortium specialising in oil drilling. Due to the urgency of these works, which are critical to the operation, five rigs had to be used to ensure a delivery time of less than three months.

France — Terre Armee
On the site of section 9.2 (Violay-La Tour de Salvagny) of the A89 motorway, Terre Armee France has won the contract to design, supply and provide technical assistance for five retaining walls with a total surface area of 7,600 m^2. Three techniques will be used: TerraPlus concrete facings with a specific matrix, TerraPlus facings in fair-faced concrete, and TerraTrel facings with a mineral finish.

India — Freyssinet
After the collapse of the piers of the bridge at Lakadiya and the failure of an attempt to restore it to its original form, the Gujarati authorities gave the green light to Freyssinet's proposal to construct a cable-stayed bridge. The structure will have a 100 m span and four lanes, one of them pedestrianised. Freyssinet is undertaking the design of the structure, and also the provision and installation of the stay cables, which will be installed in the first half of 2010.

Projects

SOLETANCHE BACHY

— Port 2000/ France

Feedback and first deliveries

The second phase of the Port 2000 project in Le Havre, northern France, is on track. "We're going to deliver three berths between now and the end of October, and another three by July 2010," said deputy project manager Norbert Seiler at the beginning of the summer. Soletanche Bachy built the four berths for phase 1 of the port development between 2001 and 2005. For this new stage, the company's tasks include the construction of 2,100 m of diaphragm walls and infrastructure over two zones under the terms of three contracts worth €220 million. The first part (berths 6 to 10: 1,812 m) is located on the platform reclaimed from the sea to the west of the existing berths; the other (berth 5: 318 m) is to the east, in a sector where the dock has been extended. Although the works phasing has been done in the usual way, measures have been taken to integrate feedback from the first phase. For example, to minimise the diaphragm wall's exposure to flooding during the complex earthworks phases in front of and behind the structure, weep holes are to be inserted in the wall and, over half the total length of the wall, the earthworks to the rear have been reduced from 17 m to 14 m.

Another of the site's special features is the huge reinforcement cages for the diaphragm wall. As they have to be "monolithic", they are a record 42 m high, 5.5 m wide and 1.35 m thick, and they weigh up to 62 tonnes! It took two cranes to lift them and, to avoid distorting the steel reinforcements during lifting operations, a kinematic system and special spreader bar had to be developed. To achieve the objective initially set – to double the port's container traffic capacity and accommodate the largest vessels (up to 8,000 containers) – two other berths (11 and 12) still have to be built at the western end of the reclaimed platform. These are currently under study at Grand Port Maritime du Havre and could be launched in 2010 as soon as operators have been identified. Their construction would be the final phase of this long-running project.

Civil engineering phasing and infrastructure

The first stage of the site is to launch work on the diaphragm wall and on the plastic concrete cut-off wall, both at the same time. The cut-off wall forms the watertight box within which pumping will provide a dry environment for the earthworks. The other works phases will then start one after the other. As soon as 150 m of diaphragm wall have been built, the earthworks will start on the front side. These are needed for the execution of the civil engineering structures: the "dock shield", which protects the main sea-side structure, and the capping beam, which bonds the diaphragm wall panels and supports the dock-side gantry rail track. Meanwhile, earthworks will also be carried out on the rear side so that the curtain of sheet piling can be built. The diaphragm wall will be retained by passive anchors attached to the sheet-piling curtain. Once this area has been backfilled, the foundation for the rear gantry rail track can be built. After the front side has been filled with water, the earthworks will be continued for about 10 m using dredging equipment. And then the platform, set at 50 cm from its final level, will be ready for hand-over.

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Key features

Diaphragm wall: 130,000 m^3
Plastic concrete cut-off wall: 200,000 m^2
Civil engineering: 45,000 m^3 of concrete
Dredging and earthworks: 12,000,000 m^3
Steel (cut-off wall and civil engineering): 20,000 tonnes
Sheet piling: 3,000 tonnes

Participants

Client: Grand Port Maritime du Havre
Project management: Technical department of Grand Port Maritime du Havre
Works consortium: Soletanche Bachy (lead company) and Atlantique Dragages

02

01 The works are almost completed up to the edge of the existing berths and are continuing on the western part of the reclaimed platform.

02 Following construction of the diaphragm wall, already completed in this 2008 photo, the other works are moving ahead: front-side earthworks, civil engineering, rear-side earthworks, construction of the curtain of sheet piling, rear foundations for the gantry cranes.

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FREYSSINET

— Saint Cloud viaduct/ France

Path-breaking solutions for changing prestressing cables

The success of a project often lies in good preparation – and good preparation sometimes needs innovation. This seems to be the lesson that a team from Freyssinet France's Ile de France–Normandy Regional Office has learned from the operation recently completed on the Saint Cloud viaduct. Christian Lacroix, regional office manager, summarises the project: "Our contract covered that part of the construction located on the Saint Cloud side, from the junction with the A13 motorway up to the other half of the viaduct, which crosses the River Seine. It consisted of replacing the 32 additional prestressing cables *(see p.13)*, in which corrosion phenomena had caused strands to break."

Working from inside the viaduct, the team had to cut out these cables (170 tonnes in all), remove them from site and install and tension new cables. On each of these aspects, the pre-contract documentation assembled by Denis Tissier, project manager at Freyssinet France, and by Freyssinet's technical department, anticipated difficulties in terms of feasibility, safety and ergonomics. As soon as the operational team took over, in October 2008, Alain Huchon, Freyssinet France's technical director, and Guy Gonidec, site manager, started on the preparation.

The first and most obvious difficulty lay in the logistics – the section of the construction on which Freyssinet had to work was 554 m long, and everything, except for the team members and the new strands, had to reach its point of use through a single opening 80 cm in diameter located close to the abutment. As the manual transfer of the old cables, even cut up into short lengths, was out of the question, an automatic conveyor was adapted and installed. "It was a trolley with a load capacity of 450 kg (i.e. 10 lengths of 1.5 m of cable), which was battery-operated and ran on an angle iron track," explains Guy Gonidec. "And that is how all of the lengths of old cables were transported to the collection point."

As cutting was involved, safety was a priority: "As the cables had been injected with cement slurry, they could not be destressed and taken out strand by strand. We had to cut them, which is a very dangerous operation as, when the cable breaks, it releases all its energy at once and destresses like a whip." The solution to avoid this risk consisted of using a remotely operated cutting kit.

Two other ad hoc solutions were also developed to facilitate the work: a hydrodemolition tool (2,500 bar pressure), to enable the extraction of the cables grouted into the structure for the 5 m between cross beams; and a handling device for the prestressing equipment. Running on the conveyor track, the device was used to install this heavy equipment (250 kg) at the required height (3 m) for tensioning the strands. Once that had been sorted out, there still remained the problem of placing the new strands in position, which could not be done via the access hatch. Improvisation provided the solution: the cables were inserted via the lamppost openings, from a 19 tonne service vehicle parked under the viaduct as close as possible to the installation point.

"The openings were cut at the rate of three cables per night, starting in the first two weeks of March 2009," said Guy Gonidec. "We worked our way up to the cantilever and then came back to the abutment, dealing with the prestressing of the west box beam, and then set off again for the second return trip. On average, each crossing took a month and a half."

Participants

Client: Direction Interdépartementale des Routes d'Ile-de-France (Dirif)
Project management: Direction Interdépartementale des Routes d'Ile-de-France (Dirif)
Works: Freyssinet France, Ile de France–Normandy Regional Office

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A ground-breaking structure

When it was built, between 1972 and 1974, the 1,100 m Saint Cloud viaduct was impressive due to the length of its spans (the longest over 100 m), its horizontal radius of curvature of only 360 m and the record width of its multi-cellular box beams (20.4 m). The boldness of its design in fact exceeded the standards in force at the time and made no allowance for thermal gradient or redistribution of creep stresses, the importance of which can be seen especially on large structures.

Cracking occurred in certain spans from 1978 onwards, just four years after the viaduct was brought into use. This led to the programming of upgrading works, namely strengthening work using additional prestressing cables, carried out in 1980. It is these additional cables that have just been replaced.

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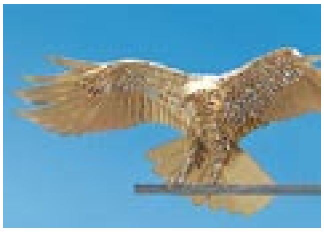
03 - 07 Hydrodemolition at the positions of the cross beams and a handling device for the prestressing equipment were among the innovative solutions implemented on a site where skill and experience had to be used to solve handling problems.

01 Cutting off the ends of the strands.

02 - 05 - 06 Shoring and installing the sheaths.

08 Assembling the protective sheaths.

04 Placing the new strands in position.



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01 The name "Golden Ears" refers to a nearby mountain that was originally called Golden Eyries, referring to the eyrie (nest) of the Golden Eagle. As the bridge is dedicated to them, several gilded metal eagles decorate the structure.

02 Before the deck was continuous, the teams had to reach their workstations by boat, impossible when the river was frozen.

FREYSSINET

— Golden Ears Bridge/ Canada

When experience proves its worth

Opened to traffic in mid-June 2009, the Golden Ears Bridge is the central link of a new 13 km road that will make Vancouver, Canada's third largest city, easier to get to or to bypass. "The main construction crosses the Fraser River, 10 or so kilometres upstream from the Port Mann Bridge, a bowstring structure with two traffic lanes in each direction, which is chronically saturated," explains Brice Le Treut, site manager for the project. "It comprises a hybrid, extradosed prestressed bridge, formed from five continuous cable-stayed spans of 968 m, extended by two access viaducts of a total length of 1.4 km."

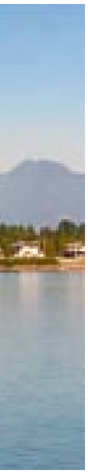
Participants
Client: Translink
Design: Buckland & Taylor Ltd
Main contractor: Golden Crossing
Constructors JV: Bilfinger Berger, CH2M Hill
Specialist contractor: Freyssinet Limitée - Canada

The Freyssinet team arrived on site in mid-2007, a year after the start of the foundations. It supplied and installed the prestressing of the access viaducts, of the cross beams of the deck pylons (320 tonnes) and of the 160 stay cables. "The great sophistication of the design caused a delay in its finalisation," adds Brice Le Treut. "We had to make arrangements with the main contractor to keep to the programme. The steps taken were to combine the raising of the pylons and the installation of the stay cables, phases that are normally separate, and of working both a day shift and a night shift."

As the deck is made from prefabricated units – steel beams and concrete slabs brought to site by barge – the average cycle for installing two precast segments and four stay cables was four days. "We recorded very few stoppages due to the weather," pointed out Le Treut, "as the climate in British Columbia is less marked by extreme temperatures than by a lot of rain. But you quickly forget the rain when the horizon clears and you can see the magnificent chain of the Rocky Mountains and the very intact natural environment of the site."

Vibrocompaction in the river bed

Having proposed a financial alternative for the works to be carried out in the river bed, Geopac, the Canadian subsidiary of Menard, was awarded the contract for ground improvement prior to the construction of the piers. A solution using vibrocompaction at sea, carried out from a barge, was thus used to increase the density of the river bed, as an alternative to the technique using stone columns with a lobby system. On the land section, "traditional" stone columns were installed to a depth of more than 35 m. These works covered a volume of soil of 300,000 m^3 and were carried out in association with Fraser River Pile and Dredge Ltd.



Q&A

Brice Le Treut
Site manager

What made the team working on this site so special?
On this project we were subcontractors to Bilfinger Berger, with whom we had previously completed various structures, including the Centenary Bridge in Panama, opened in 2004. Bilfinger Berger wanted to use the same teams here as in Panama, as they had been trained and had contributed to keeping to a particularly tight programme, both for the civil works and the specialist works. We therefore joined up in Vancouver with a team of 14 experienced workmen, highly motivated not only by the acknowledgement of their skill and experience and by the level of remuneration proposed to them, but also by the knowledge that what they would achieve in this country would be a first.

01

01 The new La Reyssouze bridge.
02 The Racouze tunnel had to be re-dimensioned to make space for installing overhead lines and other equipment associated with TGV trains.

02

SOLETANCHE BACHY

– Carpates Line/France

Express track for the TGV high-speed train

France's railway infrastructure manager (RFF) decided to modernise and electrify the Haut Bugey line, known as the Carpates Line, between Bourg en Bresse and Bellegarde sur Valserine in eastern France in order to reduce the Paris-Geneva journey time to under three hours. Starting in April 2007, Soletanche Bachy, lead company of a consortium formed with DG Construction and Roger Martin, executed the works in package no. 1, which covers a 25 km section between Bourg en Bresse and Bozolon railway stations. "What made this project stand out was its diversity: our teams worked on structures, stations, tunnels, and so on, all in very different environments, and we used a very broad range of expertise and techniques," explains Guillaume Cornali, works manager at Soletanche Bachy. Initially, the focus was on three points: the creation of an underpass almost 500 m long so that the level crossing at Bourg en Bresse could be removed; reconstruction of the La Reyssouze bridge, replacing an old stone bridge; and modernisation of the Racouze tunnel. The 1,700 m long tunnel was bored in limestone in the 1860s and had to be altered significantly for TGV trains. Works included creating emergency refuge areas, re-dimensioning and shotcreting the roof, installing overhead lines, anchoring the side walls, lowering the track bed, creating a concrete base slab in clayey areas, installing gutters and so on. The project also included soil nailing, building rigid frame bridges, waterproofing works, installing noise barriers and refurbishment of platforms at three stations. Hand-over took place in June following a final adjustment to the track bed.

Participants
Client: RFF
Project management: Inexia
Works consortium: Soletanche Bachy (lead company), DG Construction, Roger Martin

01

SOLETANCHE BACHY/ TERRE ARMEE
— Gautrain/South Africa

01 The changing conditions typical to dolomites complicated the drilling of the 76 piles to the north of Centurion.
02 Gautrain is RESA's biggest ever contract and also its most complex in terms of organisation and logistics.

Two specialist contributions

By the time everyone's attention is focused on the 2010 Football World Cup, South Africa will have been the arena for the continent's most extensive construction site – and one of the world's biggest, too. The Gautrain project, which is being carried out under the terms of a concession contract worth a total of €2.5 billion, consists of creating a high-speed rail link between Johannesburg, the city's O.R. Tambo International Airport, and Pretoria. Some 6,000 people from all civil engineering sectors are working on the site, which stretches 77 km, with 15 km underground and 10 km over viaducts. The participants include Soletanche Bachy and Terre Armee's local subsidiary, Reinforced Earth Pty Ltd (RESA).

Dura Soletanche Bachy completed 76 wide-diameter bored piles this summer in a dolomite area to the north of Centurion. These will serve as the foundations for viaduct piers. "This project was a real challenge for our geotechnical engineers," explains Brian McDonald, operations director at Dura Soletanche Bachy. "At some points, the dolomite substratum was very hard (600 MPa) and included pinnacles (irregular columns, some measuring more than 50 m high) covered by a layer of eroded ground containing boulders and cavities." A total of 450 ground investigation boreholes were drilled in order to optimise the type of foundation needed for each pier. The solution selected for 13 piers was a pile cap founded on piles 90 mm to 1.3 m in diameter and 20 m to 50 m deep. The piles were rotary bored and anchored in sound rock using a BG 36 drill rig capable of exerting a downward force of 40 tonnes and achieving a torque of 36 rpm.

It was also on this project that RESA won its biggest ever contract. The company is designing, manufacturing and delivering components for the 75 structures: retaining walls and abutments for bridges and viaducts. The contract represents a real challenge for the company in terms of organisation and logistics because the structures are being built simultaneously, which means it has to coordinate the design, manufacture and delivery of hundreds of different facing panels and dozens of types of reinforcement strips. The operational phase started in 2007 and construction should be completed at the beginning of 2010.

02

Participants
Concession grantor: Gauteng Provincial Government
Concession holder: Bombela Concession Company (Murray & Roberts 25%; Bouygues 25%; Bombardier 25%; Strategic Partners Group 25%)
Civil engineering consortium (within the assembly manager): Bombela Civil Joint Venture (BCJV) comprising Bouygues for France and Murray & Roberts and SPG for South Africa
Specialist contractors: Dura Soletanche Bachy (foundations), RESA

MENARD/ SOLETANCHE BACHY

— Essington Avenue, Philadelphia/United States

First large-scale CMC project

01

In February 2009, Menard's US subsidiary, DGI Menard, in partnership with Nicholson Construction Company (Soletanche Bachy), the main contractor, launched its biggest ever controlled modulus column (CMC) site. It totals over 10,200 CMCs for the development of a vast food distribution centre for wholesalers and retailers. The structure comprises a 10.4 m high building with a surface area of 51,000 m^2 and a 33,000 m^2 peripheral loading area. It is located on a 25.5 hectare former car salvage, scrap yard and landfill site near Essington Avenue, just a few minutes from the international airport and Philadelphia city centre.

Nicholson Construction Company was contacted regarding the foundations for the basic project, which was to consist of a structural foundation, 30 cm thick, supported by driven piles. "When I first heard about the project," says Dino Kartofilis, regional manager at Nicholson Construction Company, "I thought it was the perfect opportunity for DGI Menard and Nicholson to work together and propose a design-build foundation system as an alternative to the basic solution."

"That's right," adds Seth Pearlman, chairman of DGI Menard. "CMCs are rigid inclusions that produce uniform ground improvement. They offer a number of benefits, mainly in terms of cost, for this type of project where there are stringent settlement criteria over a large surface area carrying a fairly heavy load."

The solution proposed – and ultimately accepted – consisted of using CMCs to support all the internal and external columns, as well as the wall bases, and the slab-on-grade foundations of the building and loading area. They are distributed below the slab based on the load value. As a result, they are installed closer together under the footings, which were dimensioned to support 192 kN/m^2. The entire system was designed to guarantee total long-term settlement of less than 25 mm, with a column-to-column differential limited to 13 mm. In addition to the cost savings associated with the process, synergies developed by the J-V partners made the proposal more competitive from a planning point of view, in particular by preventing risks of delay. "Over the past six years, we have installed CMCs for small and medium commercial and industrial areas, as well as docks," says Seth Pearlman. "This project takes us to a new level and we fully intend to use this experience to promote CMCs for large-scale projects such as the logistics warehouses completed by our colleagues in Europe."

01 The CMCs are installed 0.9 m below the level of the finished floor, with a 0.76 m load transfer platform between their upper end and the underside of the slab. As the site had been used previously as a landfill, an airtight membrane has been placed immediately below the slab to contain any decomposition gases.

Participants

Client: O'Neill Properties Group
Project management: Merion Construction
Works: Nicholson Construction Company and DGI Menard partnership

FREYSSINET

— Dubai Metro/ United Arab Emirates

A 62 km urban viaduct

01 For part of its route, the metro runs alongside an urban motorway with 12 lanes of traffic.
02 When the technique using trusses was not possible (crossing of a civil engineering structure, or intersections or flyovers, etc.), other methods were used instead: installing on props or construction by cantilevering.
03 Ten trusses were used to install the typical bays (from 28 m to 32 m), which represent 94% of the length of the construction.
04 At Jebel Ali, an area of desert of 500,000 m² was set aside for the manufacture and storage of the concrete segments.

As the latest stage of a spectacular, ongoing development that will last several decades, in 2009 two superlative projects were completed in Dubai: the world's highest tower at the present time (Burj Dubai: 818 m) and the longest automated rail system in the world (77.4 km). The particularity of the metro lies in the fact that, for almost all of its length, it is overhead, running on a 62 km viaduct above the crowded roads.

The completion of this construction within a period of 32 months can certainly be considered an exploit. "For the works consortium," explains Eric Coppi, project manager (Freyssinet), "we had, in this short period of time, to cast and install 16,469 precast, prestressed concrete segments. That adds up to a production and installation rate of 45 segments per day at the peak."

On an equally grand scale, the precasting area was set up in 2005 on a 500,000 m² site. Located out in the desert at Jebel Ali, the end of the Red Line of the metro (the 47 km non-amendable section of the project), it included 64 casting units, 11 gantry cranes from 80 to 100 tonne capacity and nine tower cranes. It required up to 1,100 people working in shifts 24/7 from December 2006 to December 2008, when the last segment was cast.

At the other end of the chain, considerable technical and human resources (950 people) worked exclusively on installing the segments in as many as 21 different locations at the same time. Ten self-launching trusses were used, in particular, for installing the standard sections. These sections, 28 m to 36 m long (seven to 10 segments), comprise 94% of the construction. Bringing them to site in a dense urban environment was not always easy, but the real difficulty in keeping up the work rate lay elsewhere: "Problems with the management of urban utilities caused delays in the delivery of the piers, leading to changes in the fixing sequences and sometimes to modification of the programmes for the manufacture of the segments," said Eric Coppi. The eight transfers of trusses initially programmed increased to 35. So, with each transfer representing a month's work, the cumulative delay reached 27 months.

As the contract completion date of 15 August 2008 for the deck for the Red Line approached, acceleration measures were agreed, in order to make good the delay. They were drastic: they required 150 bays (5.3 km) in the town centre to be installed during July 2008, with hand-over four days ahead of programme. Maintained for the completion of the Green Line (the conditional section of 15 km), confirmed in February 2007, these same resources meant that the final segments could be installed in April 2009, three months earlier than anticipated.


01


02


03

Participants
Client: Rail Transport Agency (RTA)
Project management: Systra-Parsons joint venture
Works consortium: Freyssinet, VSL, Rizzani de Eccher

"The trusses are like giant ants made of 500 tonnes of steel, 80 m long, that come to life throughout the city as night falls and advance individually at the rate of three to four bays per week."
Eric Coppi

Q&A

Eric Coppi
Project manager, Dubai LRT

This very technical site also needed a lot of labour. What are the keys to success with a workforce?
There were as many as 2,300 people working on site, who, as on other large international projects, did not share the same culture or the same customs or religion. In this case, the workers were mainly Thai and Indian. These men are the basis of our resources and it's our duty to respect them. We made a particular effort for the living accommodation, set out next to the precasting area in Jebel Ali, where we served more than 6,000 meals a day in four different dietary requirements. Our approach to their well-being opened up communication with them and led to safe working. The involvement of everyone, via site inspections and 15-minute safety sessions in the workers' languages, etc., enabled us to exceed the remarkable target of a million hours worked with no accident requiring a stoppage.

04

After the metro, the light rail system

In August 2008, the final segment of the metro lines had not yet been cast when Freyssinet began working on a new site: a 2.2 km long viaduct for a light rail system, to be built in Dubai by 2020. Constructed on Al Sufouh Road, along the marina, this 14.5 km line will link the main urban centres of the Emirate and will be connected at three locations to the metro Red Line and also to the monorail serving Palm Jumeirah. The package awarded to Freyssinet-Gulf by the Alstom Besix consortium (ABS) covers the working design and the precasting and installation of approximately 900 concrete segments, together with the prestressing and the supports for the construction. Hand-over of the site is scheduled for May 2010.

SOLETANCHE BACHY

— Tyne Tunnel in Newcastle/United Kingdom

Complex works phasing for an under-river crossing

At Newcastle-upon-Tyne in the north-east of England, the new road tunnel under the River Tyne aims to double the capacity of the structure opened in 1967. The 1,600 m structure is a cut and cover tunnel on the river banks and a 360 m submerged tube tunnel directly under the river. Bachy Soletanche Ltd is in charge of the tunnel portals, consisting of 1,070 m of cut and cover using diaphragm walls (0.8 m to 1.2 m thick, 17 m to 33 m deep) and contiguous piling (1.05 m in diameter) on the north and south banks, as well as 240 m of slurry cross walls.

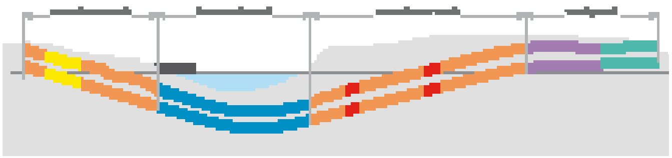
Works phasing was very complex due to the number of participants (river works, foundations, earthworks, civil engineering, utility lines, main services), the presence of networks and the limited space available on the site. Seventeen different phases *(see p. 21)* are needed for the diaphragm walls, the delivery of which determines the start-up on time of other activities. To complete the project successfully, a lot of equipment is needed. "One of the difficulties is to bring in and use several kinds of equipment side by side in this restricted space," explains Claire Doby, a Bachy Soletanche engineer and project manager. Three mechanical grabs, four hydraulic grabs, a Hydrofraise, two piling rigs and three sand removal and bentonite production units are in use. Although the site is more than 2 km long, the works are being carried out in a narrow urban corridor with limited platforms for working, small access points and many activities being performed simultaneously. The new tunnel is scheduled to open to traffic for December 2010.

Participants
Concession grantor: Tyne & Wear Passenger Transport Authority
Concession holder: TT2 Ltd (Bouygues TP, HBOS and HSBC)
Main contractor: Bouygues TP
Specialist contractor: Bachy Soletanche Ltd


01


02

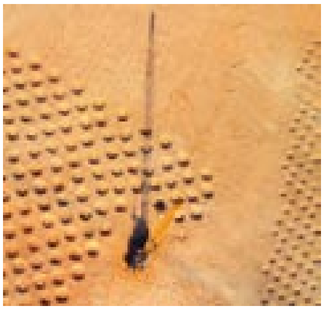
01 The lack of space is one of the site's difficulties.
02 The cut and cover earthworks were able to start after the struts had been installed.



- Conventional cut and cover using diaphragm walls
- Cut and cover with slurry cross walls beneath the excavation base
- Caisson tunnel
- Tunnel constructed using traditional method
- Contiguous pile wall cut and cover
- Surface structure works

Six techniques and 17 works phases

On both the north and south sides of the river, the works started by creating "transition" diaphragm walls (cut and cover-caisson links) and the future tunnel approach roads, and by constructing contiguous piling. Then, on the river banks, two transition shafts were built, followed by the installation of walls in the deepest sections of the cut and cover tunnel. On both banks, the priorities depended on the specific constraints: the presence of utility lines making it necessary to build two sections of the tunnel using conventional methods on the south bank; the presence of utility lines and, more importantly, the fact that the existing and new tunnels overlap for about 80 m on the north bank making the construction of cross walls necessary to serve as struts beneath the excavation base.



01

01 In this type of project, it is essential to optimise the compaction parameters such as the arrangement of the impact points and the weight of the pounders.
02 11 dynamic compaction rigs were in action 24 hours a day and six days a week throughout the duration of the project.

MENARD
— Al Falah Community Development Project/Abu Dhabi

A record both in area and output

A few years ago Abu Dhabi launched a vast urban extension plan consisting of the construction of 50,000 houses over the next 20 years. The Al Falah Community Development is one section of this immense project, aiming to construct, between now and 2013, a city comprising 5,000 villas, 2,100 apartment buildings, a hospital, a shopping centre and 14 schools on an area of 12 million m^2 located about 40 km from the centre of Abu Dhabi. Approximately 5 million m^2 of the land was unsuitable for construction, and needed treatment with three objectives in mind: to achieve a load capacity of 150 kPa for isolated footings of 1.5 m x 1.5 m and 3 m x 3 m; to limit the total settlement under the footings to 25 mm and the differential settlement to 1/500; and to ensure non-liquefaction in the case of a magnitude 6 earthquake with acceleration of 0.15 g. The solution produced by Menard, which already has a great deal of experience of working on projects in the region *(see p. 23)*, was to use dynamic compaction, the most suitable technique for the site conditions, the specifications, and for budget and schedule considerations.

The agreed schedule of eight months including planning represented a real challenge. To meet it, Menard brought in 11 dynamic compaction cranes which were in action 24 hours a day and six days a week throughout the duration of the works. Four sets of soil investigation equipment – two PMTs (pressuremeter test devices) and two CPTs (cone penetration test devices) – were present on the site. There was also a full mechanical team and site facilities including offices, accommodation and a restaurant for the 120 workers.

Before the actual works began, Menard undertook a series of investigations of the ground. The CPT results made it possible to optimise the dynamic compaction parameters and to move into full production mode only a month after the signing of the contract. Work progressed at an average monthly rate of 800,000 m^2. On completion, a series of soundings established that the objectives of the treatment – load capacity, resistance to liquefaction and post-construction settlement – had been achieved. Thanks to this organisation and to the ceaseless work of the teams, the 4,850,000 m^2 platform was ready for hand-over in April 2009, a month before the due date. Thus the largest contract ever undertaken by Menard was a brilliant success.

Participants
Client/Contracting authority: Aldar Properties PJSC
Project management: Fluor Mideast Ltd
Specialist contractor: Menard

02

Millions of square metres consolidated in the Middle East

In recent years Menard has made a name for itself in the region for other large-scale dynamic compaction projects. The first in the Emirate of Abu Dhabi, in 2004, involved the consolidation of a total of 3.5 million m^2 for the municipality of Al Ain in Al Faqa'a and Al Quo'a, close to the border with Oman, as a preparation for the construction of developments of 100 and 450 villas. More recently, the company undertook the consolidation of the platform for the King Abdullah University of Science and Technology in Saudi Arabia. The project consisted of a surface area of 2.7 million m^2 consolidated in eight months, including the mobilisation of 11 cranes. More recently Menard completed the dynamic compaction of a platform of 650,000 m^2 at Fujairah in Abu Dhabi, on which oil tanks 110 m in diameter and 20 m in height are to be built.

01

02

01 Assembly of the prefabricated beams and slabs to create the quay's framework.
02 Construction of the new quay proceeds without interfering with use of the infrastructure.

SOLETANCHE BACHY

— Montevideo port/Uruguay

85,000 m² expansion of the Cuenca del Plata terminal

Soletanche Bachy has employed many methods to build quay walls: diaphragm walls in Le Havre for Port 2000 (France), immersed caissons on improved soil using stone columns in Patras (Greece), sheet-pile caissons at the M'Bopicua river port (Uruguay), and more. In Montevideo, a "Danish" quay, built on piles, was used to extend the quay to 350 m and expand the storage area by 85,000 m² at the Cuenca del Plata container terminal and give it a capacity to berth two Post-Panamax container ships simultaneously.

The quay is 350 m long and 30 m wide. It is built of four lines of 60 driven metal piles, 1,000 and 1,100 mm in diameter. To avoid disrupting terminal operations, the work was done with the leap-frogging method: all construction phases took place on mobile platforms that advanced on the quay's vibro-driven piles as they were completed. The consortium formed by Soletanche Bachy and Saceem to build the turnkey project opted for this technique because of its very low impact on maritime traffic and easy connection to the existing quay.

The work also involved stabilising the existing structures by jet grouting and sheet piling, as well as improving the storage area's soil by vibroflotation.

After Le Havre, Abu Dhabi, Dubai and Mozambique, Montevideo, which was inaugurated on 12 October 2009, marks yet another milestone in Soletanche Bachy's experience in maritime projects.

Participants
Client: Terminal Cuenca del Plata
Contracting authority: ANP (National harbour administration)
Works: Soletanche Bachy, Saceem

TERRE ARMEE

— National Highway 6/India

TechSpan arches for 12 animal underpasses

The NH-6 (National Highway 6) is a nearly 2,000 km road running through four states in India and linking Calcutta, in the north-east, to Hazira, in the north-west. National Highways Authority of India (NHAI) awarded a 20-year concession to a consortium to upgrade and widen a 320 km section of the road in the states of Chhattisgarh and Maharashtra. Part of the road goes through a listed forest and agricultural areas and is embanked. To enable livestock and wild animals to cross, the concession holder decided to build 12 animal underpasses and awarded the work to Reinforced Earth India, the Terre Armee subsidiary in India.

"For speed of execution and environmental considerations, the passages are built of TechSpan arches in two dimensions: 10 x 4 m and 7 x 3 m," says Somnath Biswas, the subsidiary's managing director, "but we will also supply and install 50,000 m² of Reinforced Earth retaining walls (TerraClass facing panels) using the GeoMega® connection system *(see also p. 36)*."

Prefabrication of the structures began in November 2008. In July, four arch structures and 20,000 m² of walls were ready. The project is scheduled for completion in March 2010.

Participants
Client: National Highway Authority of India
Project management: Ashoka Buildcon Limited
Specialist contractor: Reinforced Earth India Pvt Ltd.

The RECo-India project team posing in front of segments of a partially built arch for an animal underpass.

01

02

FREYSSINET

— LNG Terminal
at Map Tha Phut/Thailand

A marriage of experience and expertise

01 Freyssinet is supplying and installing 1,600 tonnes of prestressed concrete for the two tanks, with 252 horizontal cables and 504 27C15 anchor bolts countersunk in six ribs, and 240 vertical U-shaped cables and 480 19C15 anchor bolts.

02 To complete this first on schedule, Freyssinet Thailand is relying on its experience in prestressing bridge decks.

For the past year, Freyssinet Thailand has been involved in the construction of liquefied natural gas (LNG) tanks for the receiving terminal in the industrial area of Map Tha Phut, approximately 200 km south of Bangkok (Rayong province).

The two tanks, with a capacity of 160,000 m^3 each, are being built for PTT LNG Company Ltd, Thailand's leading energy company. These projects are part of a government programme to stabilise energy consumption. A third tank of the same capacity will be built in the next phase. "This is Freyssinet Thailand's first application of prestressing to this type of structure," says Mathias Kaminski, business development manager and the project manager. "The subsidiary approached the operation calmly. It relied on the know-how of its teams, particularly in prestressing structure decks; the recognised experience of its managers, such as Komgrid Jomvenya, site manager at Freyssinet Thailand; and the expertise of the Group, which has a long track record in building this type of structure."

Tank construction got off to a good start and by August 2009 was 70% completed. The schedule calls for completion of the tanks in December 2010, but Freyssinet could reduce the execution time by optimising the tensioning phase.

Paticipants
Client: PTT LNG Company Ltd
Project management: consortium comprising GS Engineering & Construction, Hanyang Corporation, Korea Gas Corporation and Daewoo Engineering Company
Prestressed concrete supply and installation: Freyssinet Thailand Ltd-Freyssinet International & Cie partnership

TERRE ARMEE

— FasTracks for Denver/
United States

From design and supply to complete construction

Last June marked the beginning of the operational phase of FasTracks, a major public transit project in Denver, Colorado. Highlights of the contract are the creation of six commuter rail lines and the extension of three existing lines, representing nearly 200 km of new rail links by 2017. The first section to be tackled, in 2008, was the West Corridor, between the centre of Denver and Golden. The approximately 20 km corridor runs through several parks and residential areas. The project involves many retaining structures, and Reinforced Earth Company USA (RECo, Terre Armee's US subsidiary) won a $3.4 million (approximately €2.4 million) contract to design and supply materials for 22,000 m^2 of Reinforced Earth walls (about 60 structures).

For the other corridors requiring the construction of many bridges and retaining structures, RECo has partnered with Slaton Brothers Construction, another Freyssinet subsidiary operating in Denver. RECo is negotiating for the design, supply and installation of 18,580 m^2 of other structures, while Slaton Brothers will be responsible for project management.

Participants
Client: Regional Transportation District of Denver (RTD)
Project management: Denver Transit Construction Group
Specialist contractor: Reinforced Earth Company USA (RECo)


01


02

NUVIA

— Creys Malville power station/France

Rappelling 10 m up on the Superphénix dome

NTS finished dismantling the reactor dome at the Superphénix site *(see p. 27)* at Creys Malville in eastern France in March 2008. This operation, the first structural work of this magnitude to be carried out on the building containing the reactor, was a major milestone in the decommissioning of the former power station, which is set to continue until 2027. "In terms of both studies and works, this was the company's first decommissioning operation on this scale," says NTS director Hervé Ridoux.

A call for tender was issued 11 years after the power station was shut down for good. It covered the removal of the 25 m diameter, 370 tonnes steel structure standing 10 m above the former reactor to make room for decommissioning operations within the nuclear island. The company was to cut up the structure and remove the sections, treated as conventional waste, as well as the cladding of the fuel transfer and storage drum[1] and the travelling crane[2]. The facility no longer contains any fuel, but still contains some sodium (coolant). NTS, which is free to define its own methods, therefore had to design its working scenario around a number of major constraints. Project manager Sébastien Diaz describes the restrictions: "We had to ensure the stability of the dome during all the cutting phases; contain the plasma cutting equipment to prevent spark projection to the lower level and fire; safely move 20-tonne components above the main tank containing the sodium by polar crane; and remove waste to the site's cutting and transit area. These difficulties were compounded by additional requirements: among other things, we had to cut the pieces to fit the dimensions of the waste hopper (15 m x 5 m, 30 m depth), avoid compromising ongoing maintenance, minor dismantling and operational activities at the site, cope with working at height on a curved surface, and find a solution to the problem of gas emissions generated by the combustion of lead paint."

To tackle all these issues, NTS used its own expertise and when necessary called on other resources inside and outside the Group. NTS designed the cutting methods (plasma, thermal lance) and containment and ventilation systems. Freyssinet's technical department modelled the cutting scenario, which provided for 26 sections weighing 6 to 25 tonnes each, and designed the sling system. Preliminary tests were carried out at the NTS facilities in Vitrolles to design and validate the ventilation system and the lifting anchor points. Six employees received special training in rope work *(see p. 27)* and cutting tool operation.

"All operating methods had to be validated ahead of time," says Hervé Ridoux. "The environment was a crucial factor in the definition of operating methods and the cost of the project." As the cutting system had to be revised for the heavy steel components (100 mm thickness at the flanges, as opposed to 40 mm in the standard sections) and the ventilation system adjusted, and because some initial data was lacking, the initial four-month execution schedule had to be extended by two months.

1 - System used to position fuel rods in the reactor.
2 - Mobile crane used to perform lifting operations under the dome.

Participants
Client: EDF Ciden
Project management: EDF Ciden
Specialist contractor: NTS


03

01 - 02 - 03 The 370 tonne metal inner dome was cut into 26 pieces, which were carefully dimensioned to pass through the waste hopper (15 m x 5 m, depth 30 m).
04 Each section was lowered, placed on a trailer equipped with a special structure and transported to the cutting area.
05 - 06 Since most of the cutting work was performed by rappelling, workers received prior training in rope work. Their equipment included ventilated masks with filters to protect their eyes.


04

05

06

The Superphénix

Developed in the 1970s to forestall a possible uranium shortage, the Superphénix is a prototype sodium-cooled fast breeder reactor. It was commissioned in 1985 and shut down in 1998 on the decision of the French government. The main differences between the Superphénix and conventional power stations are its fuel – plutonium derived from reprocessing fuel from ERP reactors – and its use of industrial-scale liquid sodium coolant, a technique that it pioneered and that may again be used in future generations of fast breeder reactors.

Q&A

Sébastien Diaz
Project manager

What is the speciality of NTS?
“Special” projects, so called because they are quite often unprecedented. We always expect the unexpected, and we therefore do a lot of work with the methods department. We adapt to problems as they crop up and do our best to predict and mitigate them. The job is exciting because we’re always learning new things. For this project, we had to come up with a way of moving around the sides of the dome and guiding the cutting tool at the same time. The only solution was to “rappel”, using two ropes arranged in a triangle. We went to the mountains for a week to learn the rope work technique. We also had to learn how to handle thermal lances because the cutting technique that was originally planned for the heavy plates had to be abandoned.

01 At Cross Street, a main artery in the business district, the usual difficulty of working in city centres is compounded by particularly complex geology.
02 At Bugis, work is carried out in a less difficult urban environment.

SOLETANCHE BACHY
— Downtown Line 1/Singapore

The height of design-build complexity

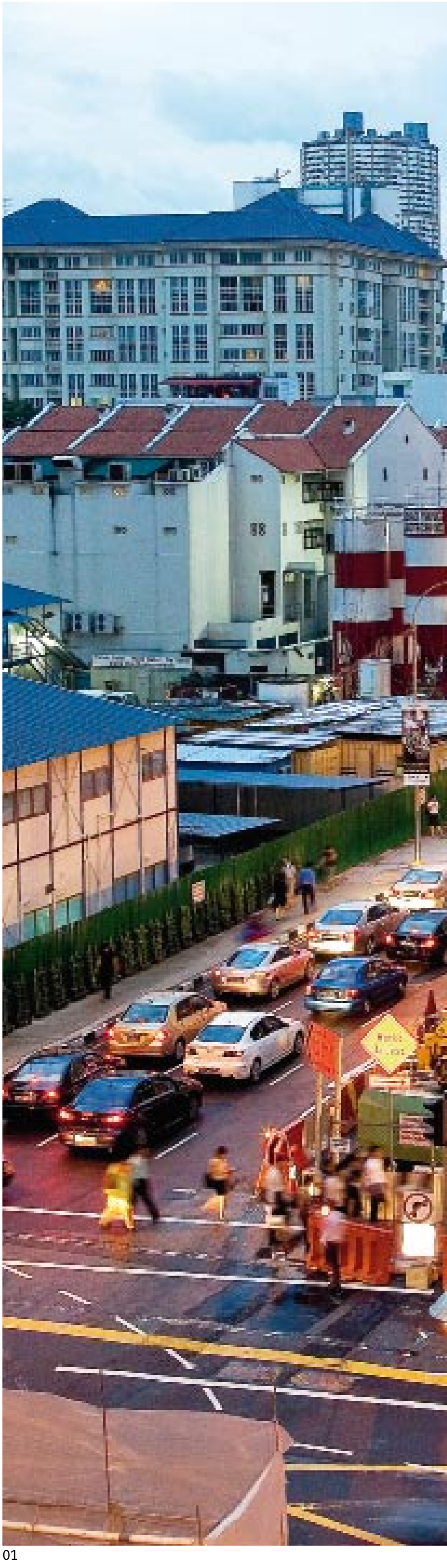
In 2008, Singapore's Land Transport Authority (LTA) set itself the ambitious goal of building a new metro line and extending the existing network by 2020. The new Downtown Line is a 40 km line with 33 stations running entirely underground that will link the new Marina Bay business district in the south with the island's north-western and eastern districts in 2016. Construction, primarily cut and cover, will take place in three phases. Only the first phase, the 4.3 km DTL1 central section between Chinatown and Bugis, has currently got under way. This section has six stations, of which three connect to other lines, and is to be opened in 2013. Each station, together with one tunnel works package, is covered by a separate contract. Soletanche Bachy has worked or is working on three of these: Bayfront (WP 906, execution only), for which the diaphragm walls and foundations were handed over in January 2009; Cross Street (WP 903), in conjunction with Korea's Samsung Engineering Construction under a design-build contract, currently at peak activity; and Bugis (WP 903, works only), awarded in early 2009, which will be built in a consortium with the Singapore Koh Brothers company.

Cross Street lies under a five-lane one-way avenue that crosses the city centre. It will serve the city-state's financial district, shopping district and historic Chinatown city centre. As the contract called for the five traffic lanes to be kept open during the entire construction period, a dual-lane temporary viaduct was built above the site. This made room for operations using large machinery, but cut the site in two (at several points, the working space available for the construction of the diaphragm wall was only 8 m wide).

"As with every site in a dense urban setting, utility lines were a major constraint," says WP 908 deputy project manager Frédéric Hubert. "We had to work under them and around them and in some cases re-route them. But in this case, we encountered further specific difficulties that compounded the complexity of the project." One of these is the fact that the tunnel crosses the vault of another metro line, the East West Line (EWL), with a clearance of only 0.5 m. To avoid heave and collapse of the surrounding terrain during upper structure earthworks, the Soletanche Bachy technical department developed a special system using a mat of metal pipes between two diaphragm walls and metal reaction frames fitted with jacks. The site's geology also makes execution more difficult. "Under the soft surface marine clay there are layers of hard bouldery clay that cannot be bored through because of nearby sensitive buildings and the operating metro line."

Another special feature of the project is that to reduce movement in the soft clay layer, reinforcement has been provided to improve soil consolidation between the diaphragm walls, either by jet grouting or, where conditions permit, building cross walls.

Work began on the Bugis connecting station, which lies under the existing EWL station, in April 2009 and will continue in less difficult geological terrain but with the same rigorous scheduling organisation and phasing. "In fact," says Frédéric Hubert, "the construction of Bayfront, which was carried out full steam ahead, gave us, and I think the client, momentum and confidence for the ongoing work."



01

Key features

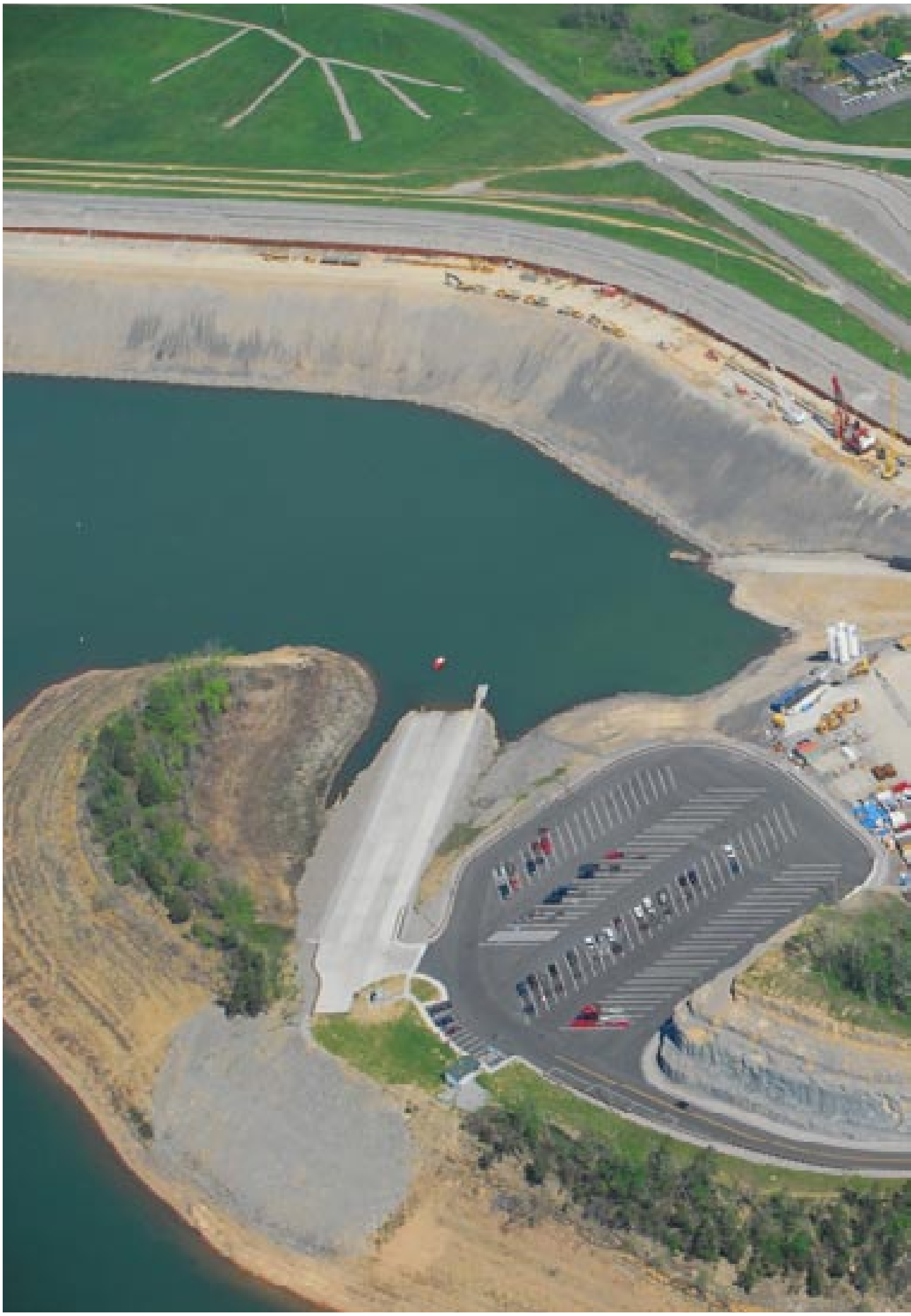
Diaphragm wall: 214 panels (30,217 m^3)
Station length: 180 m
Station concrete: 28,000 m^3
Tunnel length: 325 m
Tunnel concrete: 11,482 m^3
Jet grouting: 49,490 m^3
Bored piles: 4,950 m
Earthworks: 128,900 m^3

Participants

WP C 908 (Cross Street)
Client: Land Transport Authority of Singapore
Architect: Ong & Ong
Design-build consortium: Mott McDonald (design), JV Soletanche Bachy, Samsung Engineering & Construction (lead company)

WP C 903 (Bugis)
Client: Land Transport Authority of Singapore
Design: Arup Singapore
Works: Soletanche Bachy (lead), Koh Brothers Building & Civil Engineering

02



01

SOLETANCHE BACHY

— Wolf Creek Dam/ United States

A 46-month rehabilitation programme

The Wolf Creek Dam, on the Cumberland River in Kentucky, is the ninth-largest reservoir in the United States. It was built between 1941 and 1950 on karstic land, which has led to seepage under the 1,200 m dyke. The US Army Corps of Engineers awarded a $340 million contract to a joint venture between Soletanche Construction and Treviicos for a cut-off wall through and under the dam. Work began at the end of 2008, and the project is expected to take close to four years. It will employ up to 190 people of five different nationalities.

First, the grouting begun under a previous contract will continue up to 100 m in depth, using sonic drilling. A concrete wall will then be built up to 85 m deep between the two grouting lines: 50 m the length of the earthen dam body and 35 m in rock of variable resistance (50 to 200 MPa), with a verticality tolerance of a maximum of 0.15% over the 85 m and with a guaranteed minimum thickness of 600 mm. Execution is scheduled in two phases: a 55 m deep, 1.80 m thick temporary wall to protect the dyke; a permanent wall, drilled through the temporary wall, composed of secant piles (1,270 mm in diameter) or a combination of piles and barrettes lowered to a depth of 85 m.

The preparatory work began at the start of October 2008, with widening of the work platform, the creation of site access roads and the delivery of materials. Two Hydrofraises and four reverse-circulation drill rigs were employed. Simultaneously, the execution documents required by the client were prepared and submitted. Additional instrumentation was installed, and site surveys conducted. At the end of July 2009, the diaphragm wall was under construction.

Participants
Client: US Army Corps of Engineers
Works joint venture: Soletanche Construction, Treviicos

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01 - 03 The work platform along the entire 1,200 m of dyke was widened by 5 m, by backfilling the embankment slope.
02 Preparations for construction of the temporary wall.

Expertise

01

Process
Geomix, soil-concrete walls without spoil

Geomix, introduced in 2006, is the most recent of Soletanche Bachy's soil mixing applications. The technique originated in the Nordic countries and Japan in the 1950s. It stems from a simple idea: mixing native soil with a bentonite-cement grout and using it as a construction material. Soletanche Bachy began employing the product in the 1990s, developing the Colmix process and more recently Trenchmix (mixed by a chain trenching machine) and Springsol (a simple column built with an opening tool). Geomix, which won the FNTP Innovation Award in 2007, applies the Hydrofraise technology to soil mixing and combines the advantages of both in the Cutter Soil Mixing (CSM) tool, which can be mounted on a wide variety of carriers. Like conventional walls (concrete diaphragm walls, slurry-reinforced walls, thick slurry cut-off walls, etc.), the Geomix wall is made of primary and secondary panels arranged side by side.
As the ground is cut, it is broken up. The excavated material is brought to the top of the cutting head, where a binder is injected and mixed with it. As new material is brought up, the movement of the machine transfers the mixture from the top to the bottom of the tool. The CSM supervision system provides real-time monitoring of all key parameters: soil-grout mix homogeneity, quantity of binder injected into the volume of soil treated and vertical position of the structure. The process offers numerous advantages and is emblematic of Soletanche Bachy's ongoing endeavour to devise solutions that protect the environment. The technique reduces the amount of material excavated by 70–100%, and thereby the need to consume large amounts of resources to extract and remove the spoil. It requires little or no concrete or other outside materials (except cement) and as a rule there is no need to build guide walls.

Based on the experience it has acquired with cement grout and drilling fluids as well as wall cutting, Soletanche Bachy can offer optimised formulations tailored to the specific features of each site. If need be, wall structures can be reinforced with metal beams sunk into the fresh soil-grout mix. The technique has numerous applications: waterproofing, retaining walls, ground improvement and stabilisation, soil and aquifer remediation. Geomix, so far primarily employed in the United States and Poland, was used in several projects in France and Switzerland in 2009: a temporary retaining wall for the coastal highway in Marseilles *(see below)* and waterproofing in Lewarde in northern France and Viège in Switzerland.


01


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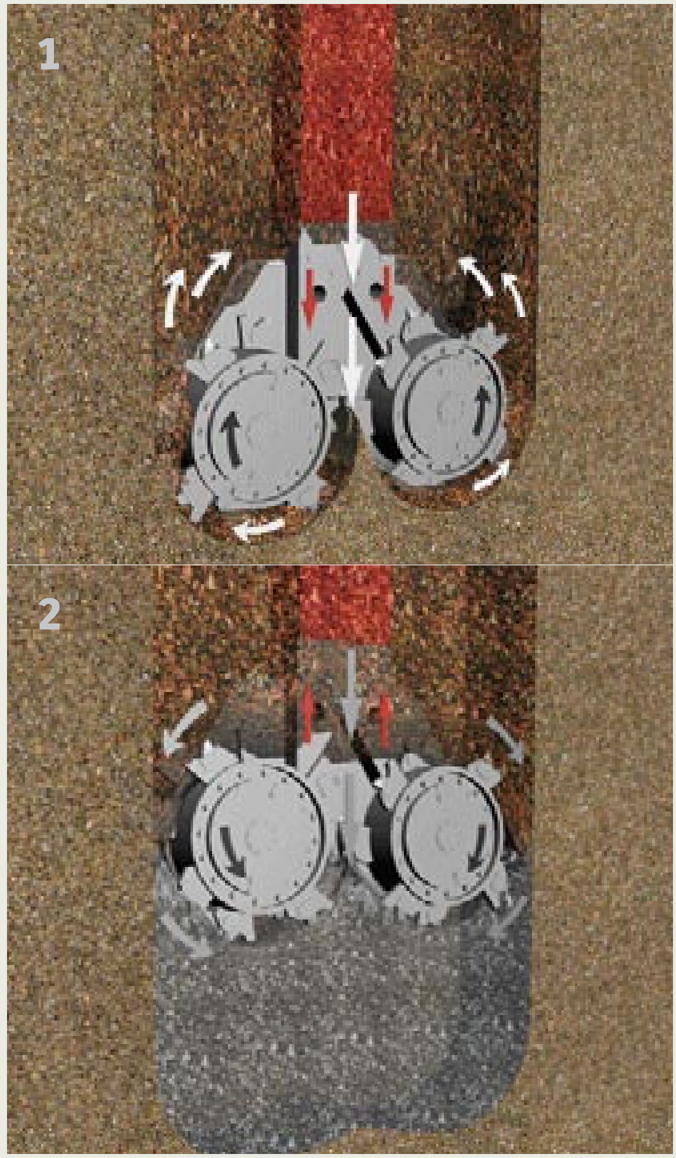
01 Like a conventional diaphragm wall, the Geomix wall is built of adjacent panels.
02 The cutter soil mixing system breaks up and displaces the soil and mixes it with the binder.
03 During the operation, the supervision system monitors and records all process parameters.
04 The technique does not require construction of guide walls.

1,700 m^2 Following the execution of the cut and cover diaphragm walls for the coastal highway currently under construction between the A55 motorway and the Old Port district of Marseilles, a sewer collector inside the future tunnel had to be moved to a location between the diaphragm wall and the retaining arcades of the nearby La Major Cathedral esplanade. To prevent subsidence of these structures during earthworks, a 7 m deep, 250 m long (1,700 m^2) Geomix retaining wall was built, with its upper part supported by the diaphragm wall *(see p. 16)* along the arcades.

04



A two-stage process

The ground is broken up as it is cut. The excavated material is brought to the top of the cutting head, where a binder is injected and mixed with it. As new material is brought up, the movement of the machine transfers the mixture from the top to the bottom of the tool.

02

Know-how
A winning foundation raft-prestressed floor combination in Mexico City

01

The offer proposed for three projects in the upmarket Paseo de la Reforma neighbourhood in Mexico City, which combined Soletanche Bachy and Freyssinet techniques, made sense to the clients. As Pierre Guiot du Doignon, managing director of Cimesa (Cimentaciones Mexicanas SA), a subsidiary of Soletanche Bachy, explains it: “In September 2008, after VINCI acquired Soletanche Bachy but before the merger was contemplated, we joined forces, in the Freyssinet “group spirit”, in Mexico City. We worked together to design the 2,600 m^2 ground-floor slab and infrastructure (seven underground levels with a total surface area of 18,200 m^2) of Reforma 90. This is a high-end property development along the Paseo de la Reforma, Mexico City’s answer to the Champs Elysees, for which we won the foundation works package.” Building on its good working relationship with the client, Cimesa strove to offer a comprehensive solution for the building’s infrastructure that was both economically effective and readily interfaced – which is not always easy when the metal frame of the superstructure is also used in the underground structure. The solution proposed was neither revolutionary or technically unprecedented, but the integrated offer combining diaphragm walls, piles, top down excavation and intermediate prestressed concrete floors – plus the advantage of dealing with a single contractor – won the approval of the developer

Floor prestressing: saving execution time and materials

The two main advantages of prestressing applied to floors are that floor thickness can be reduced from an average of 40 to 20 or 25 centimetres and floor spans can be lengthened, so that fewer posts are needed. This reduces the dead weight of the floor and hence the foundation volume. In seismically active zones, the horizontal forces acting on the structure are thereby curtailed. When the foundation raft of the Deportivo Chapultepec car park was built the use of this process accelerated execution by eliminating stringers the structure was handed over ahead of the planned completion date.

02

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and the contract for Cimesa and Freyssinet. This first joint project rapidly spawned two further operations. The first, which started at the same time as Reforma 90 but proceeded more rapidly (it was completed in October), was the Deportivo Chapultepec car park, also located near the Paseo de la Reforma. Cimesa, which had confined itself in its initial bid to the baseline solution consisting of a 5,000 m^2 reinforced foundation raft, called on Freyssinet to propose an alternative solution. "We proposed a post-tensioned prestressed slab using bonded wires," says Anik Jean of the Freyssinet construction department. "The technique is little used in Mexico, where they prefer to use greased sheathed strand prestressing, which has greater strength in a structure directly in contact with the subsoil. The bonded wire technique, on the other hand, is well suited to ultimate limit state behaviour – and Mexico City is, of course, very subject to seismic activity."

For the client, the alternative solution had the added advantage of speeding up the works and hastening the completion of the structure.

The third project, handed over in April of this year, was a 640-space car park with four underground levels at Republic Square designed jointly by Cimesa and Freyssinet. The project combines all aspects of the turnkey solution sought: lower consumption of materials thanks to the use of prestressed floors, dimensional optimisation, control of interfaces and cost reduction for the client.

Having won the contract in July 2009, Cimesa and Freyssinet started work in September 2009. "The advantages of Freyssinet prestressing combined with Cimesa processes have opened up new opportunities for us in the building market and we are seeking to apply them in a wide variety of fields, offering clients integrated Cimesa-Freyssinet solutions," says Luis Rojas, managing director of Freyssinet de Mexico SA.

01 On the Reforma 90 project, the use of foundations comprising prestressed floors optimised the technical interfaces and enabled the client to work with a single contractor.

02 - 03 The Avenue of the Empress, which became the Paseo de la Reforma, was opened up by Emperor Maximilien in the 19th century to link the National Palace and Chapultepec Castle. Today it is one of the capital's main arteries, connecting the centre with the western part of the city.


01

03
Process
GeoMega®, the all-terrain connection

Reinforced Earth walls have been winning out against reinforced concrete walls since the 1960s due to their strengths in terms of cost, ease of application, durability and variety of facing systems. To date, this technology has been used to build about 35 million m^3 of retaining structures worldwide. But although it has a wide range of applications, it was not suitable for aggressive environments such as dock walls, corrosive backfills or where there is risk of infiltration of de-icing salts, which could lead to the corrosion of its metallic elements: reinforcements and facing-reinforcement connections. A step forward was achieved in the 1990s with the introduction of geosynthetic reinforcements (Freyssisol system), but major progress was made in 2005 with the development of the GeoMega® process. "In 2003, we focused our research on a solution that would eliminate all metallic components between the facing and the GeoStrap® (synthetic reinforcement). This led in 2004 to the integration of a sheath in the facing panel during precasting, which made the concrete itself act as a connection," explains Nicolas Freitag, R&D director at SoilTech, the technical department of Terre Armee Internationale. "The technical specifications were relatively straightforward," he continues. "All we had to do was get the GeoStrap® to make a loop inside the concrete. The difficulty lay in the shape of the loop because the two 'arms' of the reinforcement had to come out of the facing panel horizontally and on the same plane. Using a trial and error approach, we manipulated the reinforcement until we found the appropriate shape. It looks like the Greek letter 'omega', hence the name of the connection."

It was used for the first time on the retaining wall of a roundabout at Morzine in eastern France. Thereafter, applications really took off, reaching about 20 projects worldwide in 2008. Research continued, meanwhile, to extend the use of GeoMega® to all Terre Armee's facing systems, and in-depth studies were carried out to propose a new reinforcement fibre that would extend the technique's field of application. "You have to sow the seeds today to reap innovations tomorrow," adds Nicolas Freitag. The focus now is on finding solutions to new issues – the very strong increase in the cost of quarried fills, difficulties in obtaining them in urban environments, the growing availability of materials from recycling processes but with a very high pH – and developing new applications for Reinforced Earth (maritime and river structures, protective structures, etc.). Further progress is already on the horizon with the development of a new generation of reinforcements, EcoStrap™*. This new reinforcement, which is capable of withstanding backfills with a pH of more than 9, has been tested twice in 2009.

* Resonance *will return to this subject in a future issue.*


02


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01 Three colour-coded sizes of sheaths are available.
02 Installation of the sheath in the mould before pouring the concrete.
03 Precasting facing panels.
04 Facing panel equipped with GeoStrap® strips.
05 Slip road wall construction site at Tampa, Florida (United States).

04

Solution

Foreva®, the quality label for repair solutions

Freyssinet has for a long time been applying expertise that has been tried and tested through numerous contracts and over 60 years of experience in the field of structural repair and strengthening. After reflection in 2007, the company decided it wanted to provide its clients with a comprehensive “supplier-applier” guarantee. And that was the beginning of the Foreva® label, which brings together the exclusive repair solutions implemented by Freyssinet and using products developed in partnership with the best manufacturers in the sector. The Foreva® solutions, designed for repair activities, include dry shotcreting, resurfacing, carbon fibre reinforcement, composite waterproof coatings, concrete reinforcement protection coatings and other such technologies for concrete, metal or wooden structures of all types, including ancient monuments, industrial facilities, bridges and tunnels.

Foreva® is a label awarded by a committee only after an internal certification process covering the performance of the solutions and associated products, as well as the expertise. A solution is thus only eligible if it meets the criteria set out in the label charter: strong marketing potential, proven performance and total expertise in implementation.

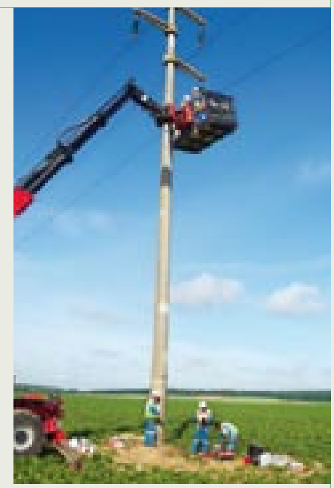
Foreva® solutions have been implemented for most of the company’s repair or strengthening projects since 2007. In addition to making Freyssinet’s range of products and services easier to understand and giving clients a comprehensive guarantee, this approach enables the company to capitalise on its experience, share best practices internally, train employees, choose the most suitable materials and optimise product logistics. Foreva® is also a Sustainable Technology approach that fits perfectly with the group’s QHSE systems.

01


02

01 Repair solutions bearing the Foreva® label guarantee the client services that combine high quality work and product performance.
02 The products eligible for the label are developed in partnership with manufacturers based on very stringent technical specifications.

200 In total, 200 L of corrosion inhibitors (Foreva® Inhib 400), 300 mL of carbon fibre fabric (Foreva® TFC) and 3 tonnes of resurfacing mortar (Foreva® M110) were used to repair and strengthen 40 pylons along the Carrières–Persan high voltage line.



Repair and strengthening for RTE

In mid-May 2009, France’s power transmission operator (RTE) launched works to enhance the safety of the 63 kV Carrières–Persan line, which was erected in the greater Paris area in 1949. The corrosion of the pylons’ reinforcements had caused concrete spalling, increasing the risks of the line breaking. The works, which were completed in September, consisted of replacing 16 km of electric cable and its suspension equipment, as well as six pylons. Most of the other 40 pylons (out of a total of 75) were repaired and strengthened by Freyssinnet’s Ile-de-France branch. Only light repair work – application of Foreva® M110 and M100 resurfacing mortar – was required to treat superficial damage to the concrete on 27 posts. On 13 others, where the steel sections had suffered corrosion losses of up to 20% in places, Foreva® Inhib 400 corrosion inhibitor was applied and, where necessary, the structure was strengthened with Foreva® TFC carbon fibre fabric. Lastly, the lower part of five pylons was strengthened by adding a 1 m high section of concrete (of the Foreva® Premix C500 type) with reinforcement and reinforcement sealant. Four teams from the company’s Palaiseau office completed the repair and strengthening work in two months at a rate of one post per day.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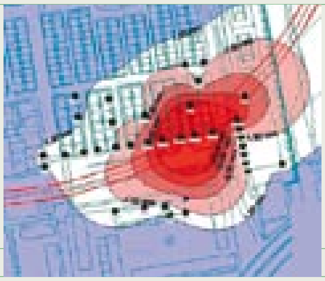

02

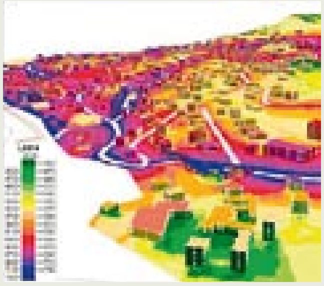

03

01 Sensor and Gorgon data acquisition unit for monitoring noise and vibrations.
02 Geoscope: monitoring deformations recorded on the surface during the construction of a tunnel.
03 Cyclops system on the Toulon tunnel construction site.
04 Noise mapping (red and blue indicate areas of maximum intensity).

05

Business
SolData, the science of instrumentation and the spirit of service

"Fifteen years after the Jubilee Line project, which triggered the creation of SolData as a specialist subsidiary of Soletanche Bachy, there has been a definite increase in demand for instrumentation and monitoring. However, the context within which the business is carried out has changed a great deal," says Jean-Ghislain La Fonta, chairman of SolData. "It's no longer a matter of merely meeting the construction sector's needs for enhanced safety. Now it's necessary to provide all kinds of clients with a comprehensive range of services that enable them to control the impact of their business on the environment in the widest sense of the word, and to identify and control risk situations."
Keeping pace with this change, SolData has adapted its original tools and systems – sensors, acquisition systems, Geoscope software combined with alarm systems and reporting – to make them more flexible and efficient, and to build a lead over its competitors. SolData now equips dams on a turnkey basis and has been selected for instrumentation and data management at prestigious sites such as the laboratories in France and Switzerland that carry out studies for nuclear waste burial.
Since 1995, drawing on its strong technical partnership with France's national geographic institute (IGN), SolData has developed a family of highly innovative, automated topographic measurement systems: Cyclops, Cyclops Evolution and Centaur. These are proving extremely useful on project sites and they have enabled SolData to win significant instrumentation contracts, such as the one for the Amsterdam metro in 2000. The most recent advance was made with Centaur, which eliminated the need for targets. It is suitable for monitoring the vertical deformation of motorways, roads, airport runways, bridge decks, etc. In fact, the progress made in its capacity for calculation and analysis is constantly broadening the field of monitoring. So much so that today SolData can propose digital 3D models of the ground by helicopter and precision levelling by satellite, techniques that are becoming essential for monitoring urban projects or for the maintenance of major infrastructure such as railway lines.
The development of environmental monitoring – vibrations and noise – is opening up new opportunities for growth *(see p.8)*.
SolData also offers a very wide range of manual measurements (constraints, deformation, geotechnical and hydrogeological parameters, vibration and acoustic measurements, etc.), test and control. Together with the geophysical measurements taken by Européenne de Géophysique (EDG), these form a unique skills set that is in demand worldwide.


04

74 Cyclops With only one device to measure several dozen targets and needing no wired power supply, the Cyclops system is easy to use and measures movements of between 1 mm and 100 m. At present, over 350 Cyclops units are deployed worldwide (100 in Barcelona, 95 in London, 90 in Amsterdam and 30 in Budapest, with others in Toulon, Kiev, Moscow, Abu Dhabi, Salt Lake City, Hong Kong, etc.).

Contract examples
2003-2007: Barcelona metro (monitoring 40 km of the city during the construction of the metro tunnel and stations on Line 9).
2006-2012: Budapest metro (measurement of deformations and vibrations; acoustic, hydrogeological, geotechnical and geothermal measurements during the boring of Line 4 of the metro).

The origins of SolData
In the foundations business, where visual control of operations is not always possible, operators need to be able to check the parameters of the work they are carrying out, such as injection pressure and flow and the verticality of a tool. Even before their merger, both Solétanche and Bachy had equipped their machines with on-board systems in order to check all these parameters. Between instrumentation of a machine and that of a structure, there was only one step. It was taken during the extension of the London metro's Jubilee Line, which was launched in 1993, when the authorities asked that prestigious structures such as the Ritz, St James Club and railway viaducts dating back to the Victorian era be monitored to avoid incidents. SolData was created as a result of the successful execution of that project.

06

In pictures

Innovation in sewers

No, this impressive piece of equipment is not a new tunnel boring machine – it's the prototype "Proccope". This innovative system, developed by Soletanche Bachy subsidiaries Sol Environment and CSM Bessac, maintains and cleans sewers, a job previously done with rudimentary or inappropriate tools. The new system streamlines and accelerates this work. It is made up of a continuous cleaning tool, a protective ventilated operator's cab and a sand and grit removal tool. In 2008 it was used to clean the 6.5 km Rueil branch of the Sèvres-Achères collector, cleaning the tunnel at a pace of 250 m per day, three times faster than conventional processes, and removing 4,500 tonnes of sediments in 48 days.

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