Soils & Structures

THE FREYSSINET GROUP MAGAZINE

REALIZATIONS A FIRST IN AUSTRALIA FOR THE MENARD VACUUM METHOD

COMPANY NUKEM LIMITED

HISTORY SHOTCRETE

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REINFORCED EARTH

Expertise in industrial applications

Freyssinet

Reinforced Earth

MENARD

Sustainable Technology

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Completion of the SOBRR stay cable installation

Thailand. Work has just finished on the Southern Outer Bangkok Ring Road (SOBRR), between Bang Phli and Suksawat, on a bridge crossing the Chao Phraya river in an industrial area. The structure is a symmetrical cable-stayed bridge with two 950 m long pylons and a 500 m main span. The structure has six traffic lanes. After supplying the 168 white stay cables of the main bridge, Freyssinet and Freyssinet Thailand completed the installation and adjustment work in June. The work lasted 12 months and involved 55 people.

Obituary

United Kingdom. Gordon Wright died on 14th March this year, aged 74, in Devon, England, where he and his wife Pauline had retired in 1986. Gordon Wright was Managing Director of PSC Equipment Ltd, the company that preceded Freyssinet Ltd in the United Kingdom. He joined PSC in 1957, as a Sales Engineer, when the company was the Freyssinet licensee, and was appointed Managing Director in 1967. STUP acquired the controlling interest in PSC in 1972, following which Gordon established subsidiaries in Hong Kong, Malaysia, Indonesia, Singapore and Nigeria, contributing significantly to the international development of Freyssinet and its pre-eminence in the English-speaking world. Everyone who knew Gordon will remember him as a warm, exceptionally dynamic man. The Freyssinet group would like to extend its sincere condolences to his family.

No fear of heavy loads for Reinforced Earth

Canada. In Snider Diamond, near Toronto (Canada), the Group's subsidiary Reinforced Earth designed and supplied the elements for and assisted with the construction of a 10,000 m^2 Reinforced Earth railway interchange. Clad with TerraClass cruciform facing panels, the structure has been designed to withstand the heavy loads of a goods transport line that crosses a suburban railway line. An architectural treatment has been applied to the facing on the part of the wall facing residential buildings.

88 stay cables on the Danube

Hungary. The Megyeri bridge is under construction in Budapest. This 4 km long structure is a key component of the city's new ring road, and will cross the Danube to link Buda and Pest, the western and eastern halves of the Hungarian capital. Pannon Freyssinet, the Group's Hungarian subsidiary, is in charge of the design and installation of the structure's 88 stay cables, which will take place with the assistance of the Freyssinet Structures division between now and 2008. With pale gray outer pipes and ranging in length from 55 to 163 m, the cables are fitted, depending on their length, with IEDs (Internal Elastomeric Dampers), IHDs (Internal Hydraulic Dampers) or IRDs (Internal Radial Dampers). The bridge will be open to traffic in 2008.

Canal bridge raising

France. As part of the European class Va enlargement (1,500/3,000 tonnes) of the Dunkirk-Escaut-Lille canal, nine road bridges must be raised along this essential link of the Nord – Pas-de-Calais regional waterway. This major operation, scheduled over 18 months, has been entrusted to Freyssinet. After lifting the decks, the structure's bearings will be rebuilt, the abutments reinforced and new expansion joints installed.

1,500,000 m² of dynamic compaction

Saudi Arabia. Ménard has been awarded the soil imparement contract for 1.5 million m² platform for the planned construction of the King Abdullah Science and Technology University. The site is located approximately 50 km north of Jeddah, on the shores of the Red Sea. The work will involve dynamic compaction and dynamic replacement.

"SUSTAINABLE TECHNOLOGY" AT THE SERVICE OF THE NUCLEAR INDUSTRY

Freyssinet played an active part in the French civilian nuclear programme when it was launched by the government in the 1970s. The business leaders and engineers of the day made the technical choices that contributed to the durability and safety of the construction of the reactor buildings. As a result, the prestressing in all of the vaults in France used the Freyssinet system. At the same time, our teams were involved in structural maintenance, strengthening, monitoring and repair activities, enabling us to acquire new skills, particularly with regard to working in a radioactive environment. We have been expanding rapidly in the nuclear field since 2004, first taking over Salvarem, which has expertise in decommissioning and radiation safety, and then Mecatiss, which specialises in fire protection and sealing. Next, Millennium joined us in 2006, boosting our engineering capabilities in the field of criticality in particular, followed in 2007 by Essor, which provides service and logistics for nuclear operators. This means that we now have an excellent set of specialities covering all phases of the nuclear cycle of construction-maintenance-service-deconstruction and involves some 500 employees in France. We have just considerably expanded the geographical scope of these activities with the acquisition of NUKEM Limited in the United Kingdom in May. This 900-strong company (including 400 engineers and scientists) is represented on many of the key nuclear sites in Great Britain; its activities and expertise strengthen and supplement those of the French operation.
As France and the United Kingdom are the two main nuclear nations in Europe, Freyssinet is now in a leading position in all activities to provide support to nuclear operators.
We are currently capable of successfully tackling the new phase of development of nuclear power in a great many countries worldwide. It is a power source that produces low greenhouse gas emissions and provides an alternative to fossil fuels (petrol, gas, coal).
It is a programme that involves land remediation in France, Great Britain and elsewhere in the world. Our teams have the right expertise for these complex technical operations. ■

Bruno Dupety
Chairman of Freyssinet

On Route 18

United States. Since Spring 2006, Reinforced Earth has been involved in the reconstruction of Route 18, one of the main routes in New Jersey. The company is more specifically involved in the construction of new hard shoulders designed to improve safety and ease traffic congestion in the very built-up areas. For the project, RECo designed and supplied the access ramps for four bridges and seven retaining walls, and was also responsible for the design and methods used for the safety barriers and parapets on the access ramps. To blend in with the environment and look like real stone, the structures' facings were hand-painted and coloured. The contract is to be extended with the supply of a prefabricated TechSpan arch, which will be built at a later date.

15,800 m² of Freyssisol walls

Morocco. Northern Morocco is an important trade route between Africa and Europe, but suffers from a lack of road links. To open up the region, the Mediterranean ring road project is underway, which will see the improvement of 250 km of existing roads and the construction of 300 km of new roads. On the El Jebha-Beni Boufrah section, a mountainous area of Moroccan Riff characterized by slopes that are often unstable, Terre Armée France and the Italian Salini group suggested Freyssisol walls as an alternative to very high, reinforced concrete buttress walls. A total of 21 structures were ordered, with heights ranging from 8 to 16 m and lengths from 100 to 500 m (total area: 15,800 m²). The work started in November 2006 and should be completed at the end of 2007.

Stone columns in the heart of Paris

France. In the 13th arrondissement of Paris, Ménard carried out a major project involving the installation of 3,800 ml of stone columns for Sicra (VINCI Construction France), prior to constructing a 6/7 storey building with 2 underground levels. The solution proposed by Ménard was selected as it was more economical than a structural floor supported on deep pile foundations. With the Ménard solution, the columns only extend to a depth of 5 m instead of 25 m with the piles. 750 columns, supporting a general raft foundation, were therefore installed to treat a total surface area of 3,000 m². This is only the second time that this Ménard technique has been used in the construction of high-rise buildings. For the company, the project conditions were both atypical, due to the urban setting, and difficult, due to the location of the work platform at the bottom of the excavation and the need to coordinate the work with other companies.

Earthquake-resistant soil improvement

France. In Bourgoin-Jallieu (Isère), Ménard has installed 2,800 controlled modulus columns (CMC) at a depth of 6 m to improve the soil in an earthquake zone on which a clinic is to be built. To prevent damages to the structure from potential earthquakes, a 40 cm backfill isolating cushion was installed between the top of the CMC and the foundation slabs, and reinforcing bars (HA20) have been installed on the upper 2.50 m of the columns.

Record prestressing project

Dubai. Work has begun in Dubai on the construction of one of the largest shopping centres in the world, which will also be the site of one of the highest towers. This site is crossed by artificial channels linked by a number of bridges. Freyssinet Middle East is involved in the construction of four of these, with lengths of 400, 210, 167 and 140 m, and is supplying the prestressing (1,520 t) and providing technical support. For this project, the company had to create a 70 m long concrete model prestressed with a 37-strand cable to determine the effectiveness of the sheath injection.

Dynamic replacement, dynamic compaction and CMC

Germany. In Hamburg, BVT Dyniv, the German subsidiary of Ménard, completed a Dynamic replacement project (70,000 m^2) for a platform on which the H&M warehouses will be constructed. The subsidiary also started work on two projects in Tuttligen, near Stuttgart: a dynamic compaction operation for a logistics warehouse and a CMC project for a housing complex.

Sliding under the PLM line

France. For the second time last spring in Avignon, the Freyssinet Centralised Cables and Handling Department (SCCM) used the patented APS (Air Pad Transport System) sliding technique coupled with heavy-duty shoring (Megasteel). This time, the structure installed under the Paris-Lyon-Marseille line was a 2,200 tonne rail bridge. The operation was successfully completed in two and a half hours.

33 floors of prestressed concrete floors

Malaysia. On the island of Penang, in the north-west of Malaysia, prestressed concrete floor has again been chosen for a high-rise building project, the Skyhome (33 floors, 55,000 m^2), which is currently under construction. The design, supply and installation of 300 metric tonnes of steel required for the lot has been entrusted to Freyssinet's Malaysian subsidiary. The scheduled completion date is September 2007.

Stay cables and prestressing

United States. In Parkersburg, on the borders of West Virginia and Ohio, Freyssinet is involved in building a new bridge crossing the Ohio, the Blennerhasset Island Bridge. This 265 m long structure has a prestressed deck suspended by two planes of 26 stay cables. Freyssinet is responsible for installing the stay cables and prestressing the deck.

Access ramps in series

Brazil. As part of the RJ-140 expansion project in the State of Rio de Janeiro, the Group's Brazilian subsidiary Terra Armada has been assisting with the construction of two bridges since September 2006. It has designed and is supplying the materials for the Reinforced Earth access ramps covering an area of 7,870 m^2. Further north, in the town of Natal, Terra Armada has designed similar structures to access a new 1.78 km long and 21 km wide bridge crossing the Potengi river. The walls, clad with TerraClass panels, cover an area of 5,646 m^2.

Signature Bridge in Moscow

This 100 m high plus metal structure under construction on the outskirts of Moscow is not the highest peak of the Russian mountains in a new theme park, but the keystone of the arch of the Serebryany Bor bridge, a geometrically complex structure with a groundbreaking stay cable arrangement that put the calculation capabilities of a number of software packages to the test (see also p.24).


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EXPERTISE IN REINFORCED EARTH: INDUSTRIAL APPLICATIONS

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1. French legislation stipulates the construction of retaining walls around liquefied gas tanks. To meet this requirement, Reinforced Earth barriers clad with TerraSet facing panels were fitted around the ammonia tanks on the Montoir-de-Bretagne site, in the autonomous port of Nantes – Saint-Nazaire in 1998.

2. . Reinforced Earth retaining walls in the Steepbank mines in Canada.

3. Thanks to its flexibility, Reinforced Earth can be used to build spectacular structures like this open-air storage silo or glory hole built in Alberta, Canada in 1983.

Reinforced Earth technologies have widened their scope of application to beyond just roads in thirty years, demonstrating their advantages in the industrial world. Mines, storage facilities, river and marine sites haveall used retaining walls, storage silos and dump or protective structures designed by companies in the global Reinforced Earth network. An overview of markets and business in North America, Australia and South Africa.

Marking Reinforced Earth's success in the field of roads, the durability and simple installation of TechSpan arches and retaining structures explain their ever-increasing use in industrial applications. The technology adapts to any structure, regardless of height, load, appearance or shape. Tailored for specific applications, these prefabricated solutions can also more often than not be installed by the clients themselves after a short training course. It's simple then, and it's also fast:
"Construction pace is normally dictated by the rate of backfilling and compacting," observes Andrew Smith, director of RESA (South Africa), "and when the earthworks are finished, so is the structure." For John Shall, key account manager with RECo USA, another major advantage is "the support for the product provided by a team of highly experienced engineers and technicians, both in the design office and on site".

Other selection criteria

The qualities of Reinforced Earth solutions are winning over industry. "We are targeting private clients who are far more open to alternative solutions; the price is not always therefore the selection criterion in a call for tenders," emphasizes Thomas Brunet, Operations Manager for RECo Canada. Nicolas Freitag, R&D director of Reinforced Earth, notes an interest in its field of specialization: "With these applications, our R&D unit can more easily propose innovations ▸▸

▶▶ that will then give us new impetus in roads. We intend to make the most of an anchored Composite Earth® structure built last year in South Africa." Finally, industrial applications have the advantage of generating long-term relationships with clients. Having built a first structure for fifteen to twenty years, they come back to the company for various adjustments such as allowing heavier machinery through, raising the structure, extending its lifespan etc. The most significant of all the industrial applications of Reinforced Earth MSE walls is in mining, a sector that is undergoing tremendous growth worldwide. "Due to the huge quantities of backfill generated, our solutions represent a major asset in this sector," continues Nicolas Freitag. In Canada, RECo has long been proposing that its mining clients use their spoil as backfill for retaining walls. "This has to be taken into account in structure design and construction techniques and laboratory tests are therefore necessary to check the interactions on a test wall. It pays off, however, as mining companies can save considerable sums of money," says Thomas Brunet. Reinforced Earth builds not only retaining walls but also truck dump structures on mining sites. Once extracted, the material must pass through a crusher or screening unit, machines which are fed from above. Access ramps have to be built so that the dumpers can tip their loads into the supply hoppers.

Conveyer tunnels

In Australia, where Reinforced Earth also supplies TechSpan arches to create conveyor tunnels, the Reinforced Earth dump walls can be up to 15 or 20 m high and are covered with different types of facing, concrete (TerraClass) or steel (TerraMet), "depending on the distance from the mine to the precasting site and the mining product corrosion potential," explains John Ritchie, RECo (Australia) sales and marketing director. The South African company RESA provides TerraClass, TerraMet and TerraTrel facing panels primarily for dump structures, but also for coal storage and protective structures, not only in Africa but also Central America and Russia. It has specifically developed a very rigid TerraTrel facing panel for dump structures.

Partly linked to mining activities, storage facilities – from open-cast mineral reservoirs (storage slots) to munitions shelters – are the second largest industrial application for Reinforced Earth.

Their uniqueness lies in the fact that special foundations are not generally required. John Shall mentions the use of TechSpan arches in the construction of protective structures designed for munitions storage for defense applications: "This solution, which has the advantage of being very quick to build, is econom- ▶▶

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1. The Reinforced Earth dump structures on the Australian New Acland mining site are designed to withstand the maneuvers of a 280 tonne dumper over a 25-year period (see also page 27).

2. On the site of the Sishen mine (South Africa, Reinforced Earth built a 14 m high wall using the TerraTrel and TerraNail techniques (anchored Composite Earth® is used to build a very high MSE structure only a very short distance from a wall).

3. In Tokyo (Japan), the Eco-Cement plant is supported by a 2,230 m² Reinforced Earth structure peaking at 10.50 m.

"By recycling their spoil as backfill for the retaining walls, Reinforced Earth enables mining companies to make considerable savings."

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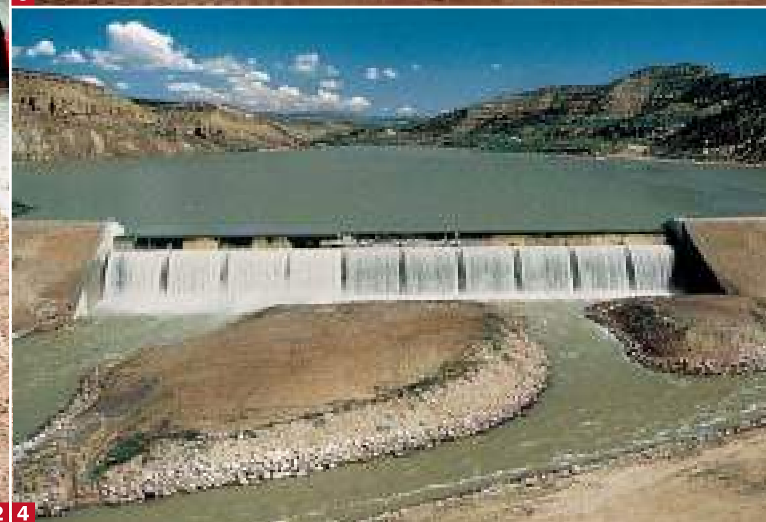
The retaining walls can be used as ramparts offering a shield against explosions, fires and accidental spillages.

►► ically comparable to other techniques such as pour-in-place concrete and steel structures, but is far longer lasting – and very easy to install given that it is prefabricated." In South Africa, RESA has won several contracts for mineral reservoirs, coal storage – slot storage facilities and glory holes, "small cone-shaped storage silos", explains Andrew Smith, RESA director. He adds that the company is currently working on two structures of this type – 9,600 t and 50,000 t – totaling 20,000 m^2. Certain other industrial sectors are also interested in retaining walls as protective structures, as they can be used as a shield against explosions, fires or accidental spillages. "These ductile structures can absorb substantial amounts of energy without breaking," says Nicolas Freitag. They are therefore used in Canada and the US in the construction of bases for liquefied natural gas tanks. The Reinforced Earth structure serves as a containment vault in the event of leaks, preventing the gas, oil or any other blazing product from dispersing into the environment, particularly toward neighboring tanks. In South Africa, this flourishing market extends to some novel uses. "Metal-faced protective walls have been built along the taxiways of a military air base," indicates Andrew Smith.

Marine and waterway-landscaping

The final section of Reinforced Earth's range of industrial applications covers specific structures for river and marine sites: quays, quay walls for industrial docking facilities and overflow weirs. Submerged structures require special reinforcement. Reinforced Earth is also called on to design unconventional applications: "We used Reinforced Earth MSE structures to construct an upstream dam wall and the surrounds for the spillway. We are currently raising an existing dam in South Africa by means of a wall of very modest height," adds Nicolas Freitag. When asked what the most promising applications are for the future, John Shall pinpoints the energy sector, whereas Andrew Smith is banking on the mining industry: "The Indian and Chinese economies, with their high level of demand, are causing an increase in the production of raw materials. River transport equipment will therefore have to be adapted to these new production volumes." In Canada, RECo anticipates that the gypsum, gold, diamond and zinc mines and coal storage facilities will continue to bring in business. Thomas Brunet nevertheless believes that the future success of the company depends also on its ability to adapt: "We are frequently called on to discuss a client's unique require-



1. **Construction speed and durability make TechSpan arches combined with Reinforced Earth a highly beneficial solution for building storage igloos and shelters.**

2. **On mining sites, the TechSpan arch-Reinforced Earth combination (here with TerraTrel facing) is used to build conveyor tunnels.**

3. **In Alberta (Canada) in 2001, Reinforced Earth was used for the first time to build the bases of oil tanks on the Muskeg mining site. 8,480 m² of circular walls were constructed for 6 structures, 2 with a 54 m diameter and 4 with a 43 m diameter.**

4. **The Reinforced Earth used for the dam reservoirs saves on the volume of backfill used and optimizes the sizing of the by-pass, water intake and drainage conduits.**

ment, where a specific solution is needed. With this in mind, we have developed a new, cheaper retaining wall facing that we call TerraTrel Lite."

The benefit of technical advice

In Australia, where the Reinforced Earth name is extremely well-known, clients regularly contact RECo for technical advice. "The company's decision to provide this service undoubtedly constitutes a competitive advantage, which should continue to open doors to us," believes John Ritchie. "Our after-sales service and the effectiveness of our products will contribute to maintaining our reputation and our leadership." Nicolas Freitag predicts that the most promising activities are dykes and mining structures, "but not necessarily in the countries that currently have the highest construction figures. Some deposits will be worked out. Others will therefore have to be found and new structures created. Nickel mines are currently expanding in Bulgaria, whilst mining operations are picking up in New Caledonia, Africa and South America. All these fine prospects will help us move slightly further away from dependence on one main client – road construction." Thomas Brunet remains pragmatic, emphasizing the issue of quality of service as a component of success: "It is up to us to provide a rapid response and timely delivery…" Leaving nothing to chance, the Reinforced Earth companies also plan to play the synergies game. "With an increasingly coordinated market approach, in conjunction with Freyssinet and DGI Menard, we will outstrip the competition through our ability to respond more globally to the industrial market," foresees John Shall. Thomas Brunet shares this view: "We are involved in joint ventures on projects with other companies of the Group, and global consulting engineering companies appreciate our ability to offer international contacts." "In Australia, we are still a long way from taking full advantage of belonging to an international group," acknowledges John Ritchie, "but we hope that collaboration with other Reinforced Earth companies will become a reality in the near future." RESA in South Africa is already well ahead of the field as it is working very closely with Terra Armada in Brazil on projects for Portuguese-speaking African countries like Angola. ■

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SOILS/BALLINA BY-PASS

A first in Australia for the Menard Vacuum Method

A trial for atmospheric consolidation of soft clay (Menard Vacuum) is currently underway, the first of its kind on the Australian continent, placing Austress-Menard in a good position to propose the solution for a major road by-pass project south of Brisbane.

RUNNING ALONG THE EAST COAST OF AUSTRALIA, the Pacific Highway is the only road link between the cities of Brisbane and Sydney, separated by some 1,000 km. For more than 10 years, the Road & Traffic Authority (RTA) of the State of New South Wales have been carrying out some major works to upgrade this old and narrow road to a modern motorway standard. A famous "black-spot" along the Pacific Highway remains, when the road goes through the tiny city of Ballina, located 200 km south of Brisbane. However, the construction of a bypass road has met tremendous difficulties as it crosses the old estuary of the Richmond river: 7 out of the 12 km of planned road have to be built over a flood plain where the subsoils consist of highly compressible alluvial deposits, up to 25 m deep in some places. Since 1998, consolidation trials of the soft clay have been conducted in this area based on the traditional vertical drains and fill preloading method.

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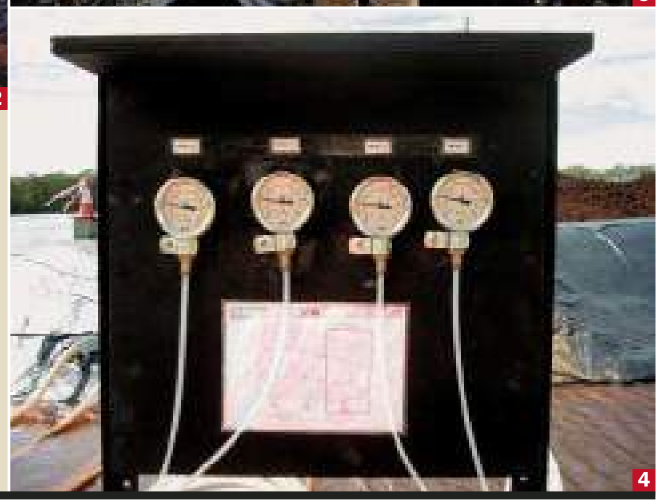

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The Menard Vacuum process is an atmospheric consolidation technique used, like preloading, to consolidate saturated compressible soils with low permeability (clay, silt, peat etc.). It consists of installing a vertical and horizontal draining and vacuum pumping network in the soil to consolidate. The system is covered with an impermeable membrane (1) and surrounded by peripheral confinement trenches that anchor the impermeable membrane and ensure the soil to be consolidated remains saturated (2). The depression created by the pumping system (3 and 4) under the impermeable membrane means atmospheric pressure can be applied to the soil, with general values reaching – 60 to – 80 kPa depending on the overall system performance (equivalent to the preloading of 3 to 4 m of fill surcharge).

These large-scale trials were judged to be rather inconclusive, and early 2006, RTA made the decision to experiment the vacuum consolidation process proposed by Austress Menard. A 10,000 m^2 area, at the embankment of the Emigrant Creek bridge south abutment, was selected by RTA for the vacuum trial and included in the larger package of the "Ballina Initial Works". In the tender process, Austress Menard was nominated as the vacuum specialist contractor by RTA; the works were eventually awarded in August 2006, to the works branch of RTA: RTA Operations "This trial, which is a first here in Australia for the Menard Vacuum Method, takes place in a very favorable climate of cooperation between the parties involved," says Daniel Berthier, technical director of Austress Menard, "and the Australian geo-technical industry is following the outcome of the project with particular interest." The works began in November 2006, in synergy with various subsidiaries of the Group, including expatriate personnel of the Korean branch Sangjee-Menard, who are working together with Australian personnel to ensure the transfer of this delicate technology.

Vacuum ready two months ahead of schedule

After RTA Operations, completed the preparatory works of the working platform, two rigs were mobilized to install the Menard vertical drains at depths ranging from 12 m to 25 m. The perimeter trenches were built and the horizontal drains, geotechnical instruments, membrane and pumping system were then installed in January 2007. Everything was in place to start vacuum pumping by 12th February 2007, two months ahead of schedule. The vacuum operation, however, only began on 1st March, after RTA Operations resolved the environmental management problem posed by the potentially acid water (acid sulphate soils) extracted from the ground during the consolidation process. Since then, the recorded results correspond fully with those predicted: after only four days, the quite homogenous depression under the membrane reached the required – 70 kPa and stabilized after two weeks at – 81 kPa. The accelerated settlement following the start of the vacuum operation was very clear, and the installation of the backfill above the membrane could begin on 12th March, with no risk of instability, with vacuum operations scheduled to last a minimum of six months, these are very encouraging results for the vacuum trial, leading us to believe that the vacuum process could also be retained for soil stabilization in the future Ballina Bypass Main Works. An answer is not far away. RTA launched a tender for these works at the beginning of April with a view to opening the road in 2011. ■

PARTICIPANTS

- **Owner:** RTA.
- **Consultant engineer for soils:** Coffey Geosciences.
- **Contractor:** RTA Operations.
- **Specialist Contractor:** Austress Menard.

STRUCTURES/**FERNEY TUNNEL**

Night time sliding operation on the jet runway

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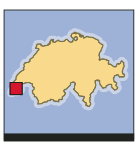
After being transported from the prefabrication site by a 180 t-capacity gantry crane, the new cover slab is placed on the sliding equipment installed at the south opening of the tunnel. The sliding operation, over 6 m, only takes place once the new slab is assembled and 'bonded' to the old one. Right: view of the runway moved after 4 launching operations.



In Geneva (Switzerland), Freyssinet Suisse was involved in repairing the Ferney tunnel cover slab under the international airport runway. This highly technical operation took place by sliding during the short night-time slots when air traffic was interrupted.

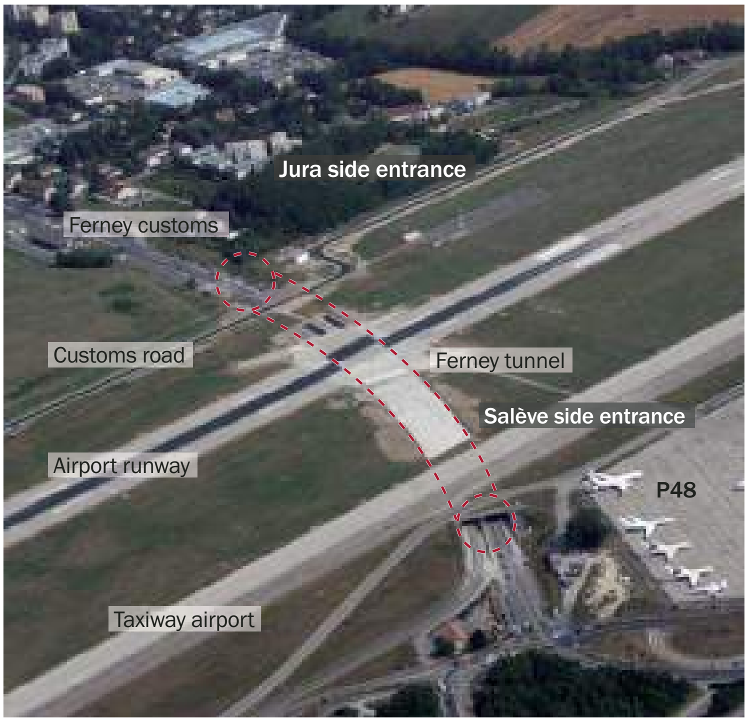
SINCE JULY 2005, the project to repair the runway of the international airport in Geneva, Switzerland, is continuing with the Ferney tunnel. The cover of this cut-and-cover road tunnel built at the beginning of the 60's has to be repaired and strengthened to withstand the stresses linked to larger aircraft dimensions. Since it was not possible to suspend the use of the airport's only runway, and its daily operation from 6 a.m. to midnight, a one-off method was developed for the work. "Proposed by Jean-François Klein from the Tremblet SA design office, the solution consists of replacing the existing slab with a new prestressed and prefabricated slab slid on three sliding beams," explains C. Deleuze, the consortium project manager. "Overall, the work represents 25 million Swiss Francs (approximately 15 M€) and the project's prestressing and sliding operations have been entrusted to Freyssinet Suisse. A number of months were required to develop and prepare the work before the first sliding operation could take place over the night of 5 to 6 October 2006."

On the runway and in the tunnel

The preparatory stages, which were subject to pinpoint scheduling to ensure the prefabricated elements were available and could be used without losing any time, took place on the runway and in the tunnel. On the runway, above the tunnel, two lines had first to be drilled for the interpile sheeting, marking out the shape of the new structure. In the tunnel, the three walls supporting the existing slab had to be taken down and replaced with three rows of temporary steel supports equipped with sliding equipment. The connection between the cover slab and the runway slabs was refitted. On either side of the runway, two openings of some ten meters in width were then cut in the tunnel cover, one on the Salève (south) side, to install the launching device and assemble the new slabs, the other on the Jura (north) side, to recover and demolish the old slab. "The pre-sliding operations finally began on 5 October: removal and sliding of the "closing" slabs over 6 m on the north side of the runway; installation of the prefabricated slabs on the shifting devices at the supply-side opening using a mobile 180 t-capacity gantry crane; bonding and prestressing of the slabs with Freyssibars; injection of the bars and application of the "over-concrete" (wear slab)," lists François Prongué, technical director of Freyssinet Suisse. "Next, four jacks went to work, each with a 300 t-capacity (1,200 tonnes in total). These were leased from Hebetec, Freyssinet's heavy lifting specialist subsidiary, and took just one hour to move the sliding carriage, effectively moving some 7,000 tonnes over a distance of 6 m. Before the runway was re-opened on the morning of the 6th, the cover slab still needed to be 'locked' in its new temporary position using 8 lateral jacks. The moving covers of the openings needed to be re-closed, all work areas needed to be made safe and all mobile equipment set up on the runway for the sliding work needed to be removed." The work took place at a rate of one sliding operation per week. At the end of February, the new cover slab was completely installed. The project, however, is not yet finished. Between now and July, new reinforced concrete walls must replace the sliding lines installed in the tunnel, the openings must be closed, the structure must be made waterproof, safety recesses must be created and the entrance portals must be repaired. ■

PARTICIPANTS

- **Owner:** Aéroport international de Genève (AIG) and Département de constructions et de technologies de l'information (DCTI).
- **Design:** Tremblet ingénieurs civils SA – Genève.
- **Main Contractor:** Implenia consortium Construction SA – Induni SA.
- **Specialist Contractor:** Freyssinet Suisse.



STRUCTURES/**KONIN BRIDGE**

Launching operation over 3,170 m

LAUNCHED IN 2006, THE KONIN BRIDGE PROJECT (Poland), a bridge crossing the Warta roughly 200 km to the west of Warsaw, is in full swing. This 1,675 m long bridge is among the longest in the country, and consists of four separate structures, a 200 m long extradosed bridge (three spans) and three 456, 540 and 480 m viaducts (8 or 9 spans).

30 to 40 m long spans.

With the exception of several areas where the deck has to be cast, the 30 to 40 m long curved or straight decks are installed by successive launching operations. In charge of the operation, "which, in reality, represents a launching distance of 3,170 m because these are double spans," observes director Krzysztof Berger, the Polish subsidiary Freyssinet Polska is also in charge of prefabricating the spans in four bays installed in-situ. For the launching, sliding bearing devices were installed at the top of the piers, and temporary bearings installed at regular intervals to support the cantilever of the deck during the maneuvers. Besides the deck construction methodology, Freyssinet Polska was also responsible for installing the prestressing (Freyssinet C system) for all the structures. ■

PARTICIPANTS

- **Owner:** Municipality of Konin.
- **Consultant:** Scetauroute.
- **Design Firm:** Transprojekt Gdansk.
- **Specialist Contractor:** Freyssinet Polska.

STRUCTURES/**PROJECTS IN SOUTH KOREA**

Noteworthy strapped cables and multitube saddles

Having already taken part in the construction of a number of prestigious structures in the country, the Group's South Korean subsidiary, Freyssinet Korea, was recently involved in three projects using the most recent stay cable solutions.

ON THE MAGLEV LINE

WITH THE ASSISTANCE OF THE SOUTH KOREAN MINISTRY OF SCIENCE AND TECHNOLOGY, a 1 km long magnetic levitation link route was opened last April in Daejeon, the country's fifth most important city and considered to be its science capital. After Germany and Japan, South Korea is the third country to use Maglev (magnetic levitation) trains, which operate on the basis of magnetic fields. Linking the Daejeon park to the Science Museum, the route goes over an elevated track on piers and crosses the Daeduk motorway on a cable stayed bridge built by Freyssinet Korea. The 55 m long and 1.35 m wide deck is supported by 10 12HD15 stay cables, which are fixed at the top and bottom by means of straps. "The cables, after being prefabricated in eight days if you include the supply of the materials, were installed using a crane and tensioned in just three days", points out JY Kim, managing director of Freyssinet Korea. ■

PARTICIPANTS

- **Owner:** National Science Museum.
- **Main Contractor:** Dong Won Construction.
- **Design:** : Korea Railroad Technical Corporation.
- **Specialist Contractor:** Freyssinet Korea.

CONTINUOUS CABLES

IN THE SHINDAE DISTRICT (Kyongsang-bukto region), the South Korean subsidiary assisted with the construction of an extradosed structure crossing a waterway on the Daejeon-Geumsan road section. This 246 m long bridge, with a width ranging from 20.57 m to 22.57 m, has two 45 m approach spans, two 78 m cable stayed spans and one 12 m high pylon. "The installation was incredibly quick for this project too, and it took one month to install 16 stay cables," remarks JY Kim of Freyssinet Korea, "thanks to using an innovative technique. Consisting of Cohestrand (31 strand) units, the cables effectively crossed the pylon continuously by means of multitube saddles produced by the South Korean subsidiary." ■

PARTICIPANTS

- **Owner:** Chungcheongnamdo Construction.
- **Consultant:** Dohwa Consulting Engineers Co., Ltd.
- **Main Contractor:** Daelim Industrial Co. Ltd.
- **Design:** Yooshin Engineering Corporation.
- **Specialist Contractor:** Freyssinet Korea.

EXPRESS HANGERS

IN THE NORTH OF THE COUNTRY, Freyssinet Korea was asked to install the hangers of the Sam Bong 3 motorway bridge that links South Korea and North Korea. For this 46 m long and 48 m wide structure, the subsidiary used 31-strand units protected by pipes (of various colors) and fitted with low anchorage adjustable straps at each end. It took just seven days to prefabricate, install and adjust the five hangers. ■

PARTICIPANTS

- **Owner:** Korea Land Corporation.
- **Main Contractor:** Dong Won Construction.
- **Design:** Kyong Ho Engineering.
- **Specialist Contractor:** Freyssinet Korea.

720 tonnes of strands were used to prestress the floors of the TradeHub 21 building.

STRUCTURES/**PRINT MEDIA HUB AND TRADEHUB 21**

Double success for prestressed concrete floors

Two projects have just been completed in Singapore, adding to Freyssinet's long list of successful prestressed concrete floor projects in the region.

IN LINE WITH CONTEMPORARY TASTES AND PRACTICE, modern architectural trends are tending towards clear spaces offering the least layout constraints and lending themselves simply to conversions of any kind. Aside from prestressing floors by post-tensioning, which allows you to create vast platforms with a minimum number of columns and significantly reduce the floor thickness, not all construction techniques can meet this type of requirement. In Singapore, where the use of PT slabs has been widespread for a number of years, these have again been recently used in two major projects: Print Media Hub and Tradehub 21, for which Freyssinet supplied and installed the cables. For the Group's Singaporean subsidiary, work on the two projects, although extremely diverse, began at the same time in April 2006. In Print Media Hub, a five-storey industrial building located on the Tai Seng avenue, 275 tonnes of prestressing steel were installed to create some 28,000 m² of floor capable of withstanding live loads of 15 kPa. "The floor span reached 12 m and was divided into six casting zones during the construction work," explains Teng Wee Tan, director of Freyssinet's Singaporean subsidiary. "Besides the cables, we installed the Fressibar prestressing bars, a first for the country, to fix the suspended columns to the second floor."

An eleven-storey factory

The second project, Tradehub 21, involved the extension of an industrial complex and included the construction of an 11-storey factory (called block F), which is the main structure, and another two-storey terraced structure, totaling 136,900 m².

720 tonnes of prestressing steel were installed for the floors. The works schedule was very tight and Freyssinet had to put four teams in place at peak work times, where production reached a rate of 11,164 m² of concreting per month.

The company also supplied and installed the prestressing for the access ramp to the first eight floors of block F. "We collaborated with the project consultant for the design of the prestressed concrete floors, which was complicated given the imposing dimensions of the buildings," continues Teng Wee Tan. With average spans of 8 m, the floors can withstand a live load of 10 kPa and there are special areas that can withstand 15 kPa. The slabs were divided into 12 zones for the main building, which alone represented 80% of the work. ■

PARTICIPANTS

Print Media Hub
- **Owner:** United Engineers Development Pte Ltd.
- **Main Contractor:** Greatearth Construction Pte Ltd.
- **Consultant:** DE Consultants (S) Pte Ltd
- **Specialist Contractor:** PSC Freyssinet (S) Pte Ltd

Tradehub 21
- **Owner:** Midview Realty Pte Ltd.
- **Main Contractor:** Yee Hong Pte Ltd.
- **Consultant:** Ronnie & Koh Partnership.
- **Specialist Contractor:** PSC Freyssinet (S) Pte Ltd.

SOILS/**MONTERREY METRO**

1,400 m of tunnel made from TechSpan arches

Major rail network expansion work has been completed in Monterrey (Mexico). Freyssinet de México – Tierra Armada has contributed to the work by fabricating and installing 1,042 TechSpan arch elements.

The new 8 km long Monterrey metro line has 7 stations. Its overland route is 6,600 m and underground route is 1,400 m. The backfill height above the TechSpan arches ranges from 1.50 to 8.50 m.

IN 2005, PUBLIC BODY STC METRORREY, which operates public transport in Monterrey and manages its infrastructure, launched a huge project to extend the underground rail network by almost 23 km. One of the new links under construction, line 2 from San Nicolas to Escobedos, called on the expertise of the teams at Mexican subsidiary Freyssinet de México – Tierra Armada, which has installed a 1,400 m underground tunnel made from TechSpan precast arches. “This is a variation on the original solution consisting of installing reinforced concrete caissons cast in-situ,” points out Enrique Sanroman, managing director of Freyssinet de México – Tierra Armada. “Preference was given to the TechSpan arches because precasting the elements on a peripheral site would significantly reduce disruption in the center of Monterrey.” Located 12 km from the site, the precasting site produced the 1,042 elements making up the tunnel between November 2005 and March 2006, beginning with 4 moulds and finishing with 14.

On the straight or slightly curved sections, over a length of 1,025 m, the tunnel is 7.90 m wide and 6.10 m high. On the curved sections (225 m), the width of the arches reaches 8.30 m with a height of 6.25 m. The backfill height over the arch keystone ranges from 1.50 to 8.50 m. “This delicate project took place right in the center of town,” explains Enrique Sanroman, “particularly in two places where the tunnel has to pass under an underpass – Alfonso Reyes Ruiz Cortines street, and under a postal railway track – A. Reyes avenue. Added to these constraints was the discontinuity of the route, which was interrupted by various items of equipment (electrical transformers, vents) and an underground station.”

Walls and foundation slab

Structurally speaking, the TechSpan arches sit on two 0.50 m thick and 1.80 m high walls, with their main section built on a foundation slab with a thickness of between 0.60 m to 0.85 m. Being built on different soil types, consolidation work was necessary. In areas where the structure is situated under the water level, three trenches and pump stations were created to evacuate any water infiltration.

The assembly work took place from 20 December 2005 to 7 February 2007. The first 3.5 km long section is scheduled to open in September 2007 and the line should be fully open in mid-2008. ■

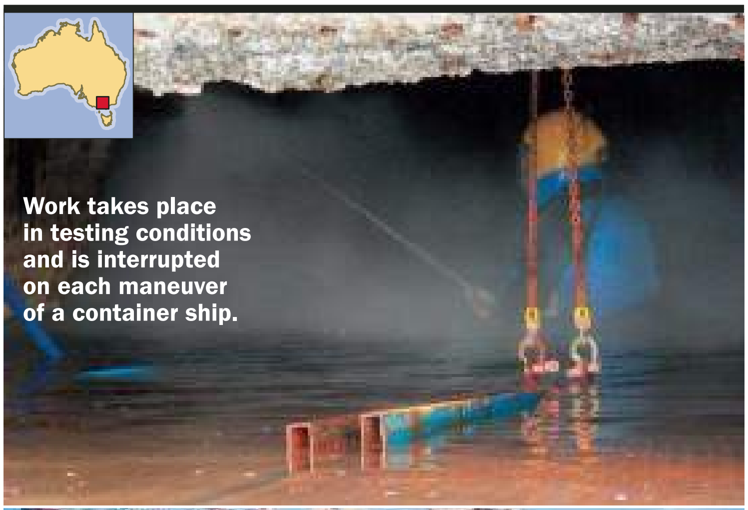
STRUCTURES/**SRINAKARIN-THEPARAK CROSSROADS**

A no-disruption method

ON THE BANGKOK RING ROAD (Thailand), a new overpass should ease the very heavy traffic congestion at the Srinakarin-Theparak crossroads. The structure's 400 m long and 22 m wide deck consists of sixty 30 m long prefabricated L beams. The approach span beams were installed using a crane, but the central section beams required a special method to avoid disrupting or stopping very heavy traffic flow on another bridge located further down. "Given Freyssinet's well-known experience in deck construction, we were asked to study and install a beam hoisting solution," points out Borvornbhun Vonganan, managing director of Freyssinet Thailand. The company came up with a system consisting of prestressing bars and jacks installed on a gantry crane. "This is a mobile apparatus that slides on stringers fixed at the pier head," continues Borvornbhun Vonganan. The beams are taken to the lifting site (under the deck) by lorry. The gantry crane then takes them and hoists them above the piers and then lowers them into their final position on their permanent bearings. Three beams per day were installed without disrupting the traffic. ■

STRUCTURES/**SWANSON DOCK WEST**

Repair site under a dock



Work takes place in testing conditions and is interrupted on each maneuver of a container ship.

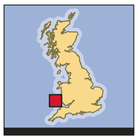
IN THE PORT OF MELBOURNE, AUSTRALIA, Freyssinet was entrusted with the repair work to Swanson Dock West, an old, highly corroded 30-year old dock. This 994 m long and 14 m wide structure consists of 80 reinforced concrete beams and 1,160 steel piles. As a result of a very aggressive marine environment, the structure's concrete elements had cracked and parts of the steel elements (piles and sheeting piling) were damaged. With a view to ensuring the ongoing service of the structure over the next 30 years as a minimum, repairing the structure is a difficult job, since all work must take place under the dock. Operators therefore work in close cooperation, legs in the water, on special platforms suspended from the structure. The works themselves are governed by very strict safety rules, and have to be stopped at high tide and upon each maneuver of a container ship (since the dock is still in service). The project consists of two main parts: the repairs to the concrete, carried out in three successive phases: hydrodemolition, steel repairs, application of shotcrete and cathodic protection of the beams. Anodes are installed on the submerged section and the tops of the metal piles are protected by sheathing. Work takes place in successive sections, based on a schedule predefined with the operator. Work should end in February 2008 following 18 months of work. ■

PARTICIPANTS

- **Owner:** Port of Melbourne Corporation (POMC).
- **Consultant engineer:** KBR.
- **Consultant:** Maunsell.
- **Specialist Contractor:** Austress Freyssinet (VIC) Pty Ltd.

STRUCTURES/**SOUTH HOOK TERMINAL**

Key cooperation on a landmark site



Freyssinet Ltd and CCSL in collaboration with Freyssinet France are undertaking a 10 M? contract and a major reference for similar projects with the refurbishment and protection of the South Hook LNG Importation Jetty (United Kingdom).

AT THE WESTERN TIP OF WALES ON THE MILFORD HAVEN estuary refurbishment works of an old disused tanker terminal to create an LNG (liquified natural gas) terminal started in Autumn 2005. A major part of the refurbishment consisting of refurbishment the South Hook jetty, a 2 km structure built over thirty years ago, and has been awarded to the Freyssinet teams. “One of the reasons we were selected,” explained Patrick Nagle, chief executive of Freyssinet Ltd, “is the existing cooperation in our group, as we are probably the only contractor in the United Kingdom capable of linking cathodic protection and shotcrete expertise with local management on this scale.”
While Freyssinet Ltd in fact supervises the construction and manages the logistics of the works, its subsidiary CCSL (Corrosion Control Services) is responsible for the cathodic protection of the steel piles and reinforced concrete, and Freyssinet France, called in to supplement the repair team, brings its shotcrete expertise.
This 10 M€ contract, the largest one for this kind of work signed to date in the UK has to be completed by the end of 2007. The terminal will then be capable of receiving liquified natural gas from the North of Qatar, the largest reserve in the world.

Additional expertise

The CCSL design of the system is a central part of the work, namely the cathodic protection of the reinforcement and the submerged steel piles. “It is a process especially appropriate for the marine environment, one that prevents corrosion of reinforcement in concrete or steel in seawater, by running a DC electric current through it”, explained Jim Preston, the CCSL manager.
By comparison, the damaged faces are repaired and strengthened with shotcrete by the Freyssinet France spray guns. “Freyssinet Limited asked for technical assistance and to send operators on site”, said Alain Maguet, a shotcrete specialist who works in the Freyssinet France technical office. This assistance is appreciated all the more as the site progresses in an especially tricky context: the wind, the cold, and the rain make the work tough. “Besides” Alain Maguet added "the site where we are working is practically out in the open sea with tides of around 8 m making the

To treat and prevent the corrosion of the concrete reinforcements of the jetty, Freyssinet and its subsidiary CCSL installed a cathodic protection system based on running an electric current through the reinforcement. At the same time, damaged structures such as the piers are strengthened and repaired using shotcrete (1 and 2).

The Group optimized procurement on account of the unusual location of the site and the limited access to the jetty (3).

work even more complicated, since we are only able to spray the concrete on the piles at low tide." For all that, there is no allowance for the spray guns to make mistakes since the shotcrete bond to the existing structure has to be perfect to ensure that the cathodic protection is long lasting. Besides, limited access to the jetty, procurement difficulties (products have to be packed in bags), and lastly the savage nature of the environment requiring great attention to be paid to personal safety, end up making the work a genuine challenge.

The other challenge on the site lies in several cultures working together. It is moreover one of the most attractive aspects of this project for Patrick Nagle: "This site has an international side: the UK, Belgium, France, Qatar and the United States are represented here. It is a genuine opportunity to share different working approaches and methods, but all with the same purpose." Skill building like this especially means that Freyssinet Ltd will be able to use the South Hook site as a reference for other work of the same kind. "There is real potential for similar contracts in the UK," Patrick Nagle pointed out "and in future we hope to focus our operations in this direction." ■

PARTICIPANTS

- **Owner:** JV Qatar Petroleum (70%) – ExxonMobil Corporation (30%).
- **Chief engineers:** Besix/Kier JV. Works.
- **Contractors:** Freyssinet Ltd, Freyssinet France, CCSL.

STRUCTURES/**SEREBRYANY BOR BRIDGE**

A high-tech bridge alongside a national park

North west of Moscow (Russia), Freyssinet was responsible for the modelling studies and installation of the stay cables of an unusual structure, a new motorway bridge built over the Moskova river that runs alongside the Silver Forest national park.

OF ALL CURRENT MOSCOW PROJECTS, of which there are many, one of the most impressive is the Krasnopresnenskaya motorway project (total cost of some 1.3 billion euro), which links the city center to the ring road and the motorway to Riga. Numerous exceptional structures are built on its route, particularly around the Silver Forest national park, where the route follows a 1,700 m long two-level tunnel with a diameter in the region of 14 m (the top part of tunnel is used for road traffic and the bottom part for the metro). Most exceptional of all is the Serebryany Bor bridge, the project's architectural crown.
This unique 1,100 m long structure, with a main bridge of 800 m, consists of a deck suspended by stay cables and a monumental arch peaking at 102 m.

In the riverbed

"Every aspect of this project is original" believes Boris Artukhov, operations director of Freyssinet Russia, "due both to the novel arrangement of the stay cables on the central deck (span of 420 m and 45 m wide) and the position of the structure in the river. The structure is built on the Moskova riverbed itself, which it follows instead of crossing it perpendicularly." The reason for this unusual design lies in the fact that

"To facilitate the adjustment of the stay cables and correct angular deviations that would risk damaging the complex shape of the arch, Freyssinet developed a compatible spherical anchoring system with the patented stuffing box. A special laser guide system was also developed, ensuring the 72 stay cables could be installed with ultra-precision in just eight weeks," indicates Christophe Blanc, Freyssinet's commercial export director.

trespassing on the Silver Forest national park, which is a conservation area, is prohibited. The arch is supported on the shores of the residential district of Krylatskoye on one side of the river and sits in the river on the other, just a few centimetres from the riverbank of the national park. Both steel parts, the deck and the arch, were built at the same time. Installed on temporary bearings 7 m apart and awaiting cable staying, the 45 m wide and 3.20 m high deck was installed by launching, with the exception of the curved sections which were installed by crane. In parallel, the piles created by jet grouting were sunk to a depth of 8 to 10 m to anchor the two double arms of the arch. A total of six months was required to assemble the arch, the elements of which (10 x 11 m along the main section and 10 x 5 m at the arch keystone) were installed by crane. With the deck and arch complete, the cable staying work could begin last February. "This is an unusual structure," explains Boris N. Monov, chief project engineer of the Gyprotransmost design office, "and the stay cable arrangement had to be optimised. Major calculations were made using various software programmes (Cosmos, Solidworks etc.) and numerous tests were carried out in a wind tunnel." The geometrical complexity of the structure, with a deck gradient of 2% (being a height difference of 8 m) between the west and east ends, required customised stay cabling with different cables lengths of units ranging from 20 to 45 strands, depending on their location, which are threaded into red sheaths with a protective helix helping to fight the effects of wind and rain. "When in service, the bridge will be subject to temperature variations of almost 20°C during the day, at certain times of the year,_ says M. Konikh, managing director of Organizator, the delegate contracting authority. "This was therefore a delicate structure to build, which is why we asked Freyssinet to model the arch and install the stay cables." The stay cabling began with the installation of the first four 14 m long cables, to the right of the arch, and continued up to the arch keystone. Internal Radial Dampers (IRDs), the most powerful of the Freyssinet range, were also installed on the longest cables (200 m) to absorb the vibrations.

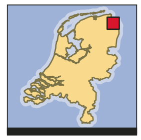
All that remains before the temporary bearings are removed and the stay cables permanently tensioned, is to assemble the steel structure (33 m long, 24 m wide, 13 m high and 1000 tonnes) of the panoramic restaurant on the deck. This will be lifted by Freyssinet using Hebetec (Freyssinet's heavy lifting specialist subsidiary) 400 t-capacity jacks and bolted to the top of the arch. After this, the lift to the restaurant must be installed and a red paint finish applied to the arch, and the bridge can open at the end of the year. ■

PARTICIPANTS

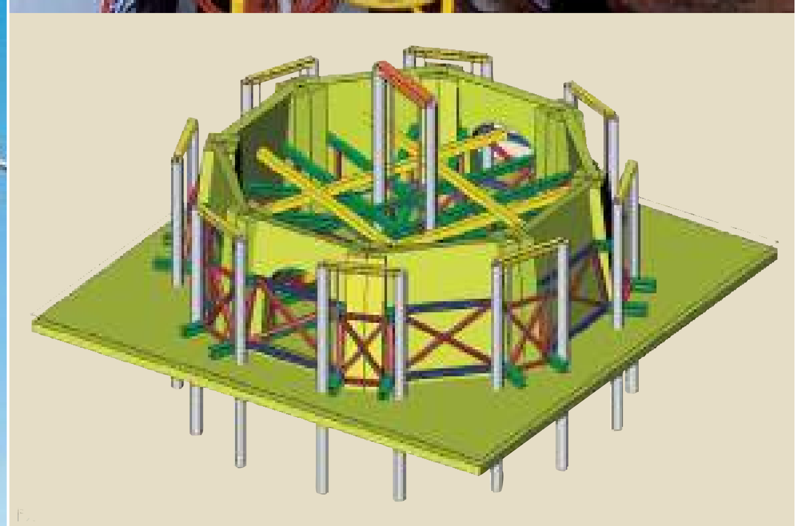
- **Owner:** Municipality of Moscow.
- **Consultant:** Organizator.
- **Architect:** M. Chumakov.
- **General and summary design:** Mostovik.
- **Principal design Firm:** Metrogyprotrans.
- **Execution and verification design firm:** Gyprotransmost.
- **Aerodynamics design firm:** Gypostroymost Saint-Petersbourg.
- **Main Contractor**: Mosmetrostroy.
- **Tenderer selected for bridge:** Mostotrest.
- **Supplier of metal arch:** Mostovik.

STRUCTURES/**ENDESMOLEN**

A windmill gains height



In the north of Holland, a municipality decided to heighten a windmill classified as an historic monument and entrusted the work to Freyssinet.



Modelling the windmill base and the lifting jack installation arrangement inside and outside the structure.

AT THE END OF THE 19th CENTURY, Holland defined the regulations for construction around windmills to achieve maximum output from these structures and to protect the neighboring areas from the movements of the blades. In Winschoten, in the north of the country, these regulations posed a problem since they prohibited any construction of a height of more than 10 m within a radius of 240 m around the region's oldest windmill, Edensmolen, erected in 1763 in what has become the very centre of the town. In September 2003, in order to bring a development project to a successful conclusion, the municipality decided to heighten the structure, which is classified as an historic monument, and entrusted the work to Freyssinet as general contractor.

Lifting in two phases

"The first phase consisted of demolishing the existing concrete foundations and masonry in order to install the necessary lifting jack reinforcements. The wooden structure was then partially dismantled and we lifted the structure in two phases, using the LAO (computer aided lifting) system for each maneuver," explains Caspar Lugtmeier, technical and commercial manager at Freyssinet Nederland BV. "The windmill was first raised by one meter, while the load was held on the steel reinforcement by means of 20 jacks. In the cleared space, new foundations were poured and the joist and the new foundations were then installed. In the second phase, the structure was lifted as high as 3 m with 16 jacks outside and 4 inside the windmill, and 8 prefabricated concrete columns were installed under the old columns." The 280 metric tonne structure was then lowered and installed on its new supports. The work was completed at the beginning of 2007 with the restoration of the masonry. ■

PARTICIPANTS

- **Owner:** Gemeente Winschoten.
- **Consultant:** Witteveen en Bos.
- **Main Contractor:** Freyssinet.
- **Design Firm:** Snetselaar.
- **Specialist Contractor:** Goorbergh Funderingstechnieken.

SOILS/**NEW ACLAND COAL MINE**

A complete Reinforced Earth package

As a company with significant experience in the field of civil engineering, Reinforced Earth has always prioritized safety and quality.

The company returned to New Acland to supply a second Reinforced Earth dump structure on the coal mining site, and on this occasion extended its service to construction.

In 2002, the Australian division of The Reinforced Earth Company designed a dump structure to supply the crusher at the open-cut coal mine of New Acland, around 150 km to the west of Brisbane in Queensland, Australia. Designed to withstand the loads generated by the movements of 280 tonne dump trucks over a 25-year period, this 14 m high and 533 m² structure was built using the TerraPlus concrete panel facing system.

Double capacity

Four years after the first structure was built, the mine owner's decision to increase its annual production from 4 to 7.5 million tonnes meant that extension works were required which would allow the doubling of the mine throughput. The project manager for the capacity upgrade, Sedgman Pty Ltd, immediately asked Reinforced Earth to supply a second structure. Although identical to the first structure, the new structure had an added challenge when Reinforced Earth was asked to not only design the structure and supply the elements, as is normally the case for the Reinforced Earth companies, but also to build the structure. "Sedgman suggested we build the wall," explains Gary Power, managing director of Reinforced Earth, "it gave our client some added assurance that the structure was being built exactly as per the design intent and, given the very close relationship we have had with Sedgman for many years, we were confident that we could work well together in constructing the wall ." After excavating a volume of earth of 15,000 m³ to create the space for the new structure and assessment of the foundation bearing capacity, Reinforced Earth began the construction work. The concrete facings were prefabricated at the company's Wacol site near Brisbane. "The factory is two hours from the site by road and we were able to schedule the delivery of the materials based on the progress of the work," says John Ritchie, marketing and sales manager of Reinforced Earth. Methodological programming needed to extend to all facets of the site organization, to ensure the construction works could not disrupt the operation of the mine and the comings and goings of the mine trucks. After the wall was completed, The Reinforced Earth Company finished off the project by constructing the concrete dump slab. After installation of the prefabricated steel reinforcement, Reinforced Earth carried out the concreting, and completed the entire job only nine weeks after starting the work. ■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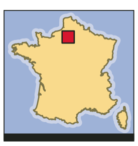
STRUCTURES/**ALLONNE BRIDGE**

Rotation on the A16



In France, near Beauvais, Freyssinet installed the prestressing and the stay cables of a new motorway bridge and demonstrated its expertise in an unusual process to spectacular effect: rotation of the structure.

IN THE COMMUNE OF ALLONNE IN THE OISE REGION OF FRANCE, a cable-stayed bridge modestly known as OA17 now crosses the A16. Built by the JV between Chantiers Modernes BTP (a subsidiary of VINCI Construction France) and Freyssinet Ile-de-France on the RN31 southern Beauvais bypass, the structure is 125 m long and has an 87 m front central span together with a 22 m rear counterweight span. Its concrete deck was cast on falsework with internal longitudinal prestressing in 19 and 27C15 units produced by Freyssinet, and its twin pylon culminates at a height of 47 m. “We also installed the 28 stay cables on the structure, with 18 cables distributed on either side of the main span (19T15 for the first 7 and 22T15 for the rest) and 5 on each side of the counterweight span (37T15),” says Martin Duroyon, project engineer at the Freyssinet SCCM (Centralized Cables and Handling Department). The sheathed, waxed and galvanized monostrands are inserted into a white extruded high density polyethylene (HDPE) pipe. “The pipe comprises a protective helical fillet, which helps fight the combined action of the wind and rain.” The originality of the structure does not lie so much in its dimensions, prestressing and stay cables as in the fact that it was not built in situ, but parallel to the motorway in order to avoid disrupting traffic, and therefore had to be put in place afterwards by rotation. This operation, made difficult due to the asymmetry and curvature of the structure, was carried out on 10 May by a team of five people. “The structure both rests on two bearings located underneath the pylons and on a counterweight abutment,” explains Jean-Luc Bringer, head of the SCCM department. The structure’s triangle of support is notably formed by the bearing which acts as the point of rotation, and a temporary support mounted on sliding plates and resting on a round stringer. 200 t jacks were used to launch the 7,500 t mass, and two additional 100 m stay cables were added temporarily in order to support the end of the main deck during rotation, until the structure was resting firmly on the east abutment. Once the bridge was in place, after 6 hours work, all that remained was to fit the superstructures and lay the road surface, carry out the final adjustments to the stay cables and fit the expansion joints. The project involved around fifteen Freyssinet personnel. ■

PARTICIPANTS

- **Owner:** Ministère de l'Equipement – Beauvais.
- **General project manager:** DDE de l’Oise.
- **Health & Safety Coordinator:** Cabinet Klein.
- **Main Contractor:** Chantiers Modernes BTP – Freyssinet Ile-de-France JV.

3

4

Structural rotation is a construction method that allows for structures to be put in place without disrupting traffic (road or river). The structure is built parallel to the road or waterway to be crossed and then moved into its final position by rotation. During the operation, the structure rests on special bearings: one pivot bearing that acts as the point of rotation, and bearings sliding on stringers, often by means of neoprene pads.
The technique is well known at Freyssinet, as it was notably used in 1991 for the Pont des Martyrs in Grenoble, France, and in 2001 for the Cernavoda Bridge over the canal linking the Danube to the Black Sea in Romania.

The 30 to 80 m long cables were adjusted using Freyssinet's Isotension system.

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STRUCTURES/**ADRIATIC LNG TERMINAL**

3,870 t of prestressing for a prefabricated LNG terminal

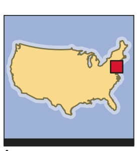
WHILST MANY LIQUEFIED NATURAL GAS (LNG) TANK projects are in progress virtually worldwide, a novel project for a complete terminal, the Adriatic LNG Terminal, is currently underway in Algésiras, Spain. This GBS (gravity base structure) of monumental dimensions – 180 m long, 88 m wide and 47 m deep – consists of two tanks and can hold up to 250,000 m³ of LNG. In addition to the storage structures, the project includes the docking and berthing gear designed to receive LNG container ships with a maximum capacity of 152,000 m³.

Cape on the Adriatic coast

After producing the foundation rafts, walls and the cover slab, Freyssinet, which is heading up the PT Adriatico consortium, began the installation of 3,870 t of vertical and horizontal prestressing for the walls and the cover and lateral slabs. After fabrication on dry land is complete, the structure will be floated and towed to its place of operation, 15 km from the Italian Adriatic coast, off Venice, a place chosen after lengthy studies in order to ensure the safety of the installations and minimal environmental impact. The terminal will be ballasted, partly submerged and anchored so that it rests on the seabed. When operational, it will supply the town of Venice. ■

SOILS/**BAYONNE TANK**

A CMC project in an oil storage facility



IN FEBRUARY AND MARCH 2007, DGI Menard carried out an original ground improvement project in an oil storage facility in Bayonne, on the west bank of the Hudson in New Jersey (United States). Several months earlier, damages were noted on one of the tanks, which was built roughly 30 years ago on an area of loose and deep backfill that were never been improved. The risk of failure of the tank led the facility manager to suspend operation. “We proposed the installation of controlled modulus columns (CMC) which, besides their technical and financial advantages, enabled us to meet the very precise needs of the client, IMTT, one of the key oil terminal operators in the United States. They wanted a solution to repair the tank without having to remove the roof,” says Frédéric Massé, vice-president of engineering of DGI-Menard. The company’s team, working closely with the equipment department of Ménard (France) and Enteco (Italy), modified the Enteco E500 drilling rig in order to significantly reduce the height of the mast. An 5.5 m by 5.5 m opening was then cut into the wall of the tank to provide an access for the rig. 220 CMC with a 30 cm diameter were installed at an average depth of 7.50 m in less than 3 weeks. ■

"JET GROUTING", A DEMANDING, HIGH-POTENTIAL TECHNIQUE

Unlike its other technologies that were mostly developed in-house, Ménard went to learn the craft of jet grouting in Italy, in the middle of the 90's, where the technique is commonly used. "At this time, the technique, which was introduced to France by engineer Claude Louis, was taking its first steps, but the company was interested in jet grouting as a technique to extend its range of soil improvement solutions," says Michel Bic, project engineer for Ménard. The principle of the process consists in drilling a small diameter hole in the soil and injecting a pure cement grout at very high pressure (up to 600 bars), which breaks up and mixes with the soil matrix to form a column (or block) of "soil-crete". As with Dynamic replacement or CMC, this is an inclusion technique, which nicely complements the other soil improvement techniques. Jet grouting can also be used to penetrate deep into the soil (up to 50 m) and make deep inclusions at the required depth of the compressible layer. "You create the geometry of improvement you want where you want," sums up Michel Bic.

Load transfer

The versatility of the technique means jet grouting can be used for structural underpinning and treating deep layers, applications perfectly suited to the technique. "In case of a building extension with additional stories and floors or if soil has undergone decompression, jet grouting columns allow you to transfer the loads to the deepest foundation bearing layers. "By overlapping columns side by side as "secant columns", jet grouting is an excellent technique to create impervious, straight or circular walls and even gravity walls. In ground with high presence of water contents, the technique is straightforward and quick alternative to lowering the groundwater table.

"In downtown Clermont-Ferrand, where artesian water exists at a depth of 3 m, a jet grouted "impermeable plug" at the bottom of a sheet pile cofferdam was used to excavate two levels of underground parking protected from water inrushes in 1995." The flexible technique of jet grouting requires more resources than other processes – a drill, a pump with a 450-600 horse power, a mixer, a cement silo – and time to set up the site, since the work cannot begin before the so-called calibration test columns are completed. "The peculiarity of the technique is that work is performed "in the dark" or "blind". This is why the calibration test columns are core-sampled so that the client can measure the quality of the work carried out and compare it against the design data and the team can determine the correct working parameters, such as rate of penetration and rotation, pressure and injection time. For this technique, experience is the key factor, and 15 years of experience means that Ménard has now perfect control of the essential parameters", assures Michel Bic. The company continues to invest to train its staff and to purchase new equipment to improve its jet grouting offering, which today represents one quarter of its business. ■

Jet grouting work on the LGV

In certain areas crossed by the future Rhine-Rhône LGV in the Haute-Savoie, karst features were found during the preliminary soil investigation. Karstic conditions are characterized by the formation of clay pockets or sinkholes due to the irregular erosion and solution of limestone by rain and underground water. On the sites of three main structures (rail bridges and backfill, soil walls under the viaduct piers) of lots B3 and C2, Ménard performed the remediation work using jet grouting. "The technique uses a small diameter drilled hole to create large diameter columns and was preferred to the pile solution, which would have required substantial preliminary drilling work. To offset the subsequent lateral forces on the structures and the soil alteration, the columns were also reinforced with steel tubes, which were installed as deep as 25 m in some places," says Benoît Pezot, project engineer and manager of Ménard.

NUKEM LIMITED: A HIGH-PROFILE PLAYER IN THE BRITISH NUCLEAR SECTOR

Having acquired British company NUKEM Limited in May, the Freyssinet Group has expanded its capability and increased its expertise in the field of specialist nuclear industry services. Overview.

NUKEM LIMITED

"We are delighted to be part of the Freyssinet Group. All of the elements are in place for us to continue our expansion in the United Kingdom and overseas. We are looking forward to integrating into our new parent company and taking advantage of the opportunities presented by an international group of this size," says Michael Down, Managing Director of NUKEM Limited.

The company is currently one of the largest and most dynamic independent specialist service providers in the nuclear sector in the UK. For the last 40 years it has produced safety cases and been involved in the design and construction of installations, complex nuclear decommissioning operations, waste management, land remediation and radiation safety. The company works with a number of ministries and regulatory authorities both in the UK and abroad, and its clients include prestigious bodies such as the UKAEA (United Kingdom Atomic Energy Authority), British Energy, AWE, British Nuclear Group Sellafield Ltd, the UK Department of Trade and Industry and the Ministry of Defence.

Located near the major sites

In recent years, the company has undergone exceptional growth and now has over 900 employees located all over the UK on or near the major nuclear sites, including Dounreay, Sellafield, Risley, Harwell and Winfrith. "We are structured so that we can meet our clients' needs," emphasises Michael Down. "Our services range from the design and turn-key construction of significant installations, through programme management and the monitoring of radioactivity in potentially contaminated land to safety consulting."

In a business sector as sensitive as the environment, innovation and safety are two major preoccupations for the company at all times, as recognised by the Contractor of the Year Award for Safety in 2006 for the design, construction, installation and commissioning of AWE's new waste treatment plant on its Aldermaston site. The facility uses a combination of evaporation and reverse osmosis technology, and is used to treat radioactive effluent so that it can be disposed of safely. Amongst other things, it enabled AWE to officially close the Pangbourne Pipeline into the Thames on 16th March 2005.

Board members, letf to right: Frank Cullinane, Director, Finance, Keith Collett, Director, Operations and Commercial, Dr Michael Down, Managing Director, Ken Jackson, Director, Projects & Engineering.

1

VITAL STATISTICS

- **2006 Turnover:** €120 million.
- **Workforce:** 900 employees, including 400 engineers and scientists.
- **Managing Director:** Michael Down

1. **NUKEM Limited provides radiation protection and monitoring services on the sites of its clients.**
2. **As part of the United Kingdom's contribution to the global G8 partnership, the company is involved in the decommissioning of redundant atomic submarines.**
3. **Removal of the East condenser end plates of the Winfrith heavy water reactor.**

Innovation is not lacking either, as can be seen in the numerous solutions developed by the company, such as the exclusive Groundhog™ system, which is used to survey land that is potentially contaminated with radioactive materials, or the work carried out in conjunction with Norwest Holst Ltd (VINCI Group) on the design and construction of the SDeP - Silos Direct Encapsulation Plant - for British Nuclear Group Sellafield Ltd.

The company's list of successful projects is extensive. For many years, NUKEM Limited has been involved in the decommissioning of the Dounreay Fast Reactor (DFR) in the north of Scotland, designing and building a NaK (sodium-potassium alloy) disposal plant. The reactor was the first in the world to export electricity to the national grid, and reached full output (15 MW) in 1963 before being closed in 1977. For the UKAEA Prototype Fast Reactor (PFR), which ceased operating in 1994, the company is contributing to the decommissioning and removal of the primary and secondary liquid metal coolant circuits. In conjunction with Areva NP, NUKEM Limited designed and operated the Sodium Disposal Plant (SDP) that is used to dispose of the 1,560 tonne of radioactive liquid metal coolant (sodium and NaK) from the PFR at a rate of 2.5 tonne/day. In 2001, the company won one of its key contracts at the UKAEA Winfrith site, WOMAD (Winfrith Operations, Maintenance & Decommissioning), which covered the remediation, decommissioning and final demolition of the Post-Irradiation Examination (PIE) building A59 and the design, construction and operation of the WETP in order to recover, treat and encapsulate the sludge from the external tanks for the Steam Generating Heavy Water Reactor (SGHWR). On the same site, the company also commenced the decommissioning and remediation of the SGHWR secondary containment. Since 2002, the company has been working closely with the British Department of Trade and Industry on the nuclear decommissioning programme in the former Soviet Union, as part of the UK's contribution to the G8 Global partnership. In the UK, NUKEM Limited is the main independent supplier of radiation protection services with a 10-year contract with the UKAEA for all of its sites, relating to radiation protection consulting, operational monitoring and approved dosimetry services. Very recently, in March 2007, NUKEM Limited signed a contract with BNG Sellafield Ltd for the Calder Hall Heat Exchanger Deplanting Pilot Project whilst at Dounreay the company is involved in the stripout of the PFR steam generation building and the three secondary sodium circuits; this is a real challenge as the company has to lay down a large number of sizeable components, including a 27 m steam pipe weighing 13 t, which are redundant. ■

In 2006, NUKEM Limited was given the Contractor of the year award for safety for the design, construction and commissioning of AWE's waste treatment plant on its Aldermaster site.

SHOTCRETE: a structural restoration technique

The shotcreting technique first appears in 1907 in the form of a mortar-spraying machine invented by the American Carl Ethan Akeley. For the last 100 years, the technique has been evolving constantly. Mastered by Freyssinet over more than 23 years, it is one of the Group's flagship processes in its repair business.

A new repair tool

1980 At the beginning of the 80's, Freyssinet becomes interested in shotcrete and seeks to perfect the process to expand its range of repair techniques, which, at this time, is dominated by the use of epoxy resin based products. At the initiative of Mr Bailly, this approach is used by the Methods division located in Nantes. Involved in 1979-1980 on the Caille bridge project (below), a 1920's structure linking Annecy to Geneva which crosses the Usses gorge, Freyssinet uses both techniques: epoxy resin based products and shotcrete. Shotcrete, which is still only used on an occasional basis by Freyssinet, is used by the French subsidiary of Torkret GmbH, the dry process shotcreting specialist.

Affirmation of the dry process

1984-1988 Freyssinet becomes the French specialist in the process and masters the two techniques: the wet process and the dry process (water added to the gunite from the end of the spray nozzle). The Group only uses the latter process for restoring the monolithism of a structure. This, for example, is the solution used to repair the supporting structure of the speed track of the Monthléry circuit in the Paris region. 350 m^3 of concrete, representing approximately 10% of the total volume of the structure, is installed between 1984 and 1986. In 1988 and 1989 the technique is first used abroad to repair the Annaba silos in Algeria (below).

Acquisition of Torkret

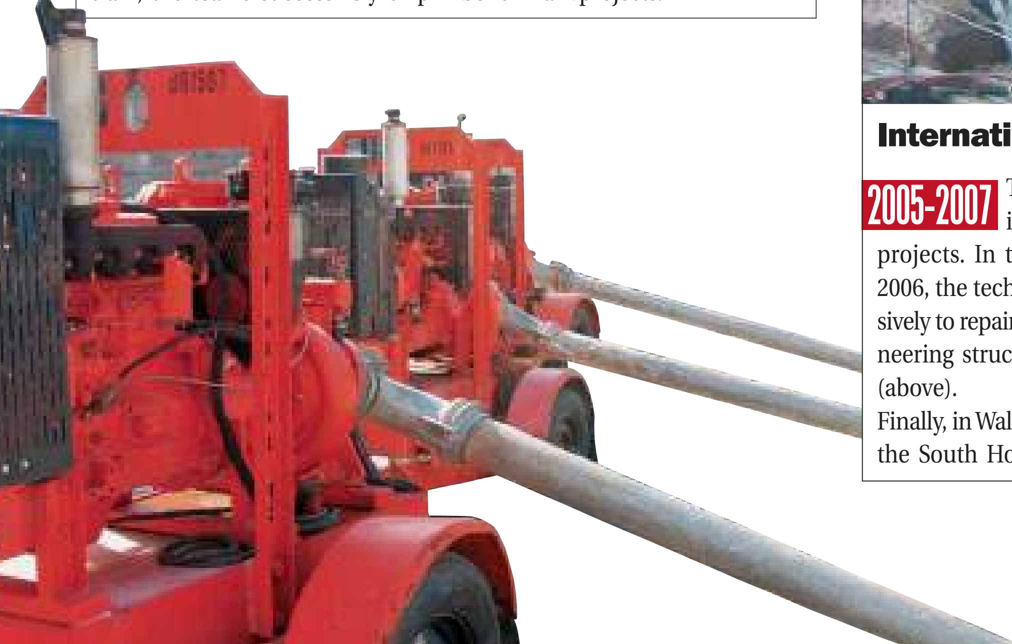
1984 The Group acquires the French subsidiary of Torkret. Becoming Torkret France, the company is set up in the Freyssinet offices of Coignières, Lyons and Marseilles. Transferring the technology to the other regions takes place by staff mobility and training initiatives.

Perfecting

1989-1996 In 1989, Freyssinet joins the Association pour la Qualité de la Projection des Bétons et Mortiers (ASQUAPRO), an association bringing together different public works players (contracting authorities, engineers, manufacturers, contractors, etc.). Alain Maguet, the Freyssinet shotcreting specialist, is the driving force.
The beginning of the 90's marks an evolution in the technique. Dry mixes conditioned in silos are developed by Alain Maguet to improve the site working conditions, reduce dust and guarantee the quality of the concrete.

A benchmark project

1997 Following the fire in the Channel Tunnel on the night of 18/19 November 1996, Freyssinet is responsible for all civil engineering works and uses a 300-strong team to repair approximately 750 m of damaged arch. Working on a fixed train, the teams successively chip away the damaged concrete, sandblast and then shotcrete the area, a technique chosen on account of the site's time and size constraints. Completed in seven weeks, this project gave respectability to the process and remains one of its benchmark projects.



Expertise is disseminated

2000 Freyssinet organises shotcrete training sessions led by Alain Maguet.

First qualification

2003 ASQUAPRO introduces a nozzleman qualification certificate at the end of in-house training. The same year, the first nozzleman qualification certificate is given to a Freyssinet employee.

International projects

2005-2007 The technique is used in two international projects. In the United States in 2006, the technique is used extensively to repair the Tidal Basin engineering structures in Washington (above).
Finally, in Wales, it is used to repair the South Hook Jetty, an 30-year old port facility situated at Milford Haven. Carried out by Freyssinet France, Freyssinet Ltd and CCSL, the operation notably consists of repairing and strengthening the structure's reinforced concrete piers, work carried out by the Freyssinet France shotcreting specialists (see also p. 22).

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