Soils&Structures

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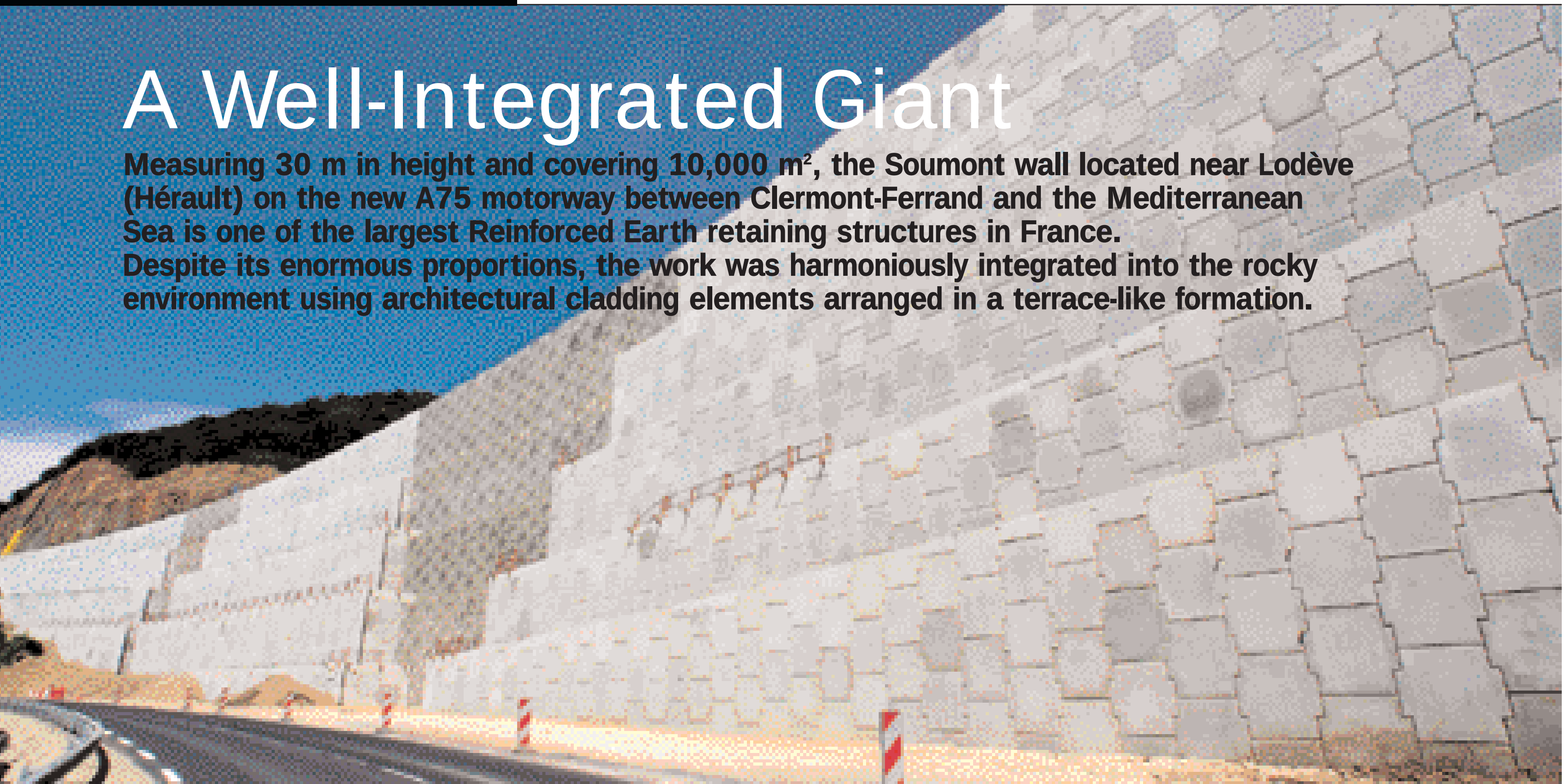
STAY CABLE
The System in Top Form



A Well-Integrated Giant

Measuring 30 m in height and covering 10,000 m², the Soumont wall located near Lodève (Hérault) on the new A75 motorway between Clermont-Ferrand and the Mediterranean Sea is one of the largest Reinforced Earth retaining structures in France. Despite its enormous proportions, the work was harmoniously integrated into the rocky environment using architectural cladding elements arranged in a terrace-like formation.

Dry Repair

Many structures were damaged during the floods that hit the south of France in 2002 and 2003. Freyssinet was called in to repair a portion of the Philippe-Lamour canal near Montpellier. Twelve 4 x 4 m square slabs were reconstructed with shotcrete, 160 m² of concrete facing was restored and 320 m of cracks and 71 joints were treated. Using a mobile coffer dam specially designed for this project, the repairs were successfully completed without the need to empty the canal.

128 Stay Cables for a Record-Breaking Span

Construction of the Cooper River Bridge in South Carolina (USA) is well underway. With a total length of 4,023 m, featuring a 900 m-long cable-stayed stretch and a central span of 472 m, this is the largest structure of its kind in the United States. Freyssinet will supply and install all 128 stay cables.

Reinforced Earth: 30 Birthday Candles in Japan

In June, Bruno Dupety, Freyssinet's Chief Executive Officer, attended the traditional KAI ceremonies organized by Sumitomo/Hirose and Kawasho, Reinforced Earth licencies in Japan. The most successful entities were given awards for excellence and Mr Niki, Hirose, Tanura and Yamamoto received a trophy celebrating the thirtieth anniversary of Reinforced Earth's licence in the Land of the Rising Sun.

Freyssinet Attends the *fib* Symposium

Freyssinet presented its latest accomplishments at the *fib* (International Federation for Structural Concrete) Symposium held in Avignon (France) between the 26th and 28th of April. This international event organized by the AFGC (French Association of Civil Engineering) brought together nearly 400 engineers, architects and experts from around the world. In addition to the official activities, visits to the Millau Viaduct, for which Freyssinet is installing stay cables, and the Mediterranean TGV line were organized.

IN BRIEF

USA
4,800 Controlled Modulus Columns. Between last June and August, DGI-Menard, the American subsidiary of Ménard Soltraitement, realized 4,800 Controlled Modulus Columns (CMC) south of Burlington in the State of Vermont to strengthen the soil on a plot for future construction of a store.

FRANCE
800 m² of Carbon Fiber Fabrics. Freyssinet France has begun work in the Atlantic Pyrenees region to strengthen the steps of the Bayonne amphitheater constructed at the beginning of the 20th century. A total of 800 m² of Carbon Fiber Fabrics and 13 tons of metal beams will be installed by October 2004.

SUDAN

5,200 m² of Reinforced Earth. Reinforced Earth's first contracts in Sudan involved the construction of Reinforced Earth approach ramps to the Tuti Bridge and the Al Gaba bridge, both situated in Khartoum. The surface areas of the cladding is 900 m² for the Tuti structure and 4,300 m² for the Al Gaba structure. The panels were precast by a local contractor with a pleasing bush-hammered architectural pattern.

SOUTH KOREA
Lightning-Speed Construction. With the assistance of the Vélizy Technical Department (France), Freyssinet Korea (South Korea) constructed the Doomul cable-stayed footbridge in the heart of Seoul last May in just eight days. This unique structure presents a 14 m wide central deck and is elevated 11 m from the ground by 12 stay cables, the longest of which is 20.2 m; Its tower stands at 18 m high.

Prestressed Floors for the Mirdiff Mall

In February 2004, Freyssinet Gulf LLC began the prestressing of 130,000 m² of floors for the new Mirdiff Mall in Dubai. This is the largest prestressing contract the company has ever signed in the United Arab Emirates. By March 2005, 1,000 t of strands will have been installed for several floors composed of full slabs and transverse beams spanning 19 m.

Flyby through History

Motorists in Ohio (USA) will soon be able to retrace the history of American aviation that took off in their region. A crossroads near Dayton has been renovated with 11,400 m² of Reinforced Earth covered with architectural panels presenting a 16-scene history of the story of the Wright brothers and their first Flyer.

Crossing the Corinth Gulf

Last August 7th, the Rion-Antirion Bridge in Greece was inaugurated with the passage of the Olympic flame for the 2004 games held in Athens. On this 2,252 m long bridge, built by VINCI Construction Grands Projets, Freyssinet installed 368 stay cables (4,500 t of steel) equipped with earthquake protection systems.

IBM Opts for Prestressing

Designed by the renowned Swiss architect, Max Dudler, the new IBM headquarters under construction in Zurich-Altstetten, is a 13-storey, 37,000 m² complex. Allreal AG is in charge of construction, in association with consultants Höltschi & Schurter and Walther Mory Maier. For construction of the slabs, the project engineers chose to implement a compact and easy-to-install prestressing solution like those designed by Freyssinet. Through the fruitful collaboration between Feldmann Bau AG (Bilten) and Freyssinet, construction was completed in just eleven months.

Birthday

Freyssinet Polska, the Group's Polish subsidiary, is five years old. Since its creation in 1999, it has participated in the construction of the country's most prestigious sites : Gdansk Bridge, cable-stayed bridge over the Vistula in Plock, etc., and has seen the incremental launching of bridges in Czerniakowski and Wroclaw. Currently, it is among the most active specialized of civil engineering companies in the country. Over these past five years, Krzysztof Berger, the general director, has created a team of talented young engineers; These include Arkadiusz Franków, geotechnical engineer, Andrzej Kandybowicz, works manager, Pawel Skrzypczak, financial director, Lucjan Talma, business manager, and, last but not least, Zofia Krawczyc who joined Freyssinet Polska in 1999.

Sols & Structures moves on

Sols & Structures will from now on be published every six months. It will have supplementary pages and deal with new areas. Two articles are already being scheduled for the next edition: earthquake resistance devices on the Rion-Antirion bridge and an article on the Polish agency, Freyssinet Polska.

JULIO MARTINEZ CALZÓN-MIGUEL GOMEZ NAVARRO

The Versatility of Stay Cables

Julio Martinez Calzón and Miguel Gomez Navarro are both engineers in the Spanish Engineering Consultancy Company MC2 and participated in the design of the Valladolid Science Museum footbridge*. They look back upon the genesis of this ground-breaking structure, and sketch their vision for the future of stay cables.

Soils & Structures. - **You helped design the Valladolid Science Museum footbridge. Would you classify it as a cable-stayed structure?**

It's a unique structure that's difficult to categorize. It would be better described as a footbridge that is prestressed with external cables and equipped with a cable-stayed component. An estimate of the proportions would be 80% prestressing and 20% stay cables. To better understand this fusion between external prestressing and stay cables, let's take a look back at the original project which was conceived by the architect José Rafael Moneo in collaboration with Enrique de Teresa, the Science Museum architect. This was originally based on the form of a fish basket, and to make this idea more concrete, we proposed using cables that would add to the total aesthetics of the footbridge while also stabilizing the pedestrian area. This produced the desired feeling of "spaciousness". In short, the structure evolved through modification of the positioning of upper, lower and lateral cables to yield the desired effect. In addition, the cross elements, the functional part of the footbridge, were given a hexagonal shape. Again, this reinforced the feeling of novelty and movement procured while crossing the structure. For the stabilizing cross cables, we contemplated using one single cable anchored to the lower part and wrapped around each ring or polygon of the footbridge. However, direction change problems finally forced us to use double cables. Freyssinet performed all the tests to validate this design with the Cohestrand. In summary, the structure could be defined as the dialogue or correlation between a very fine metal wire mesh and a woven net composed of only vertical and horizontal cables.

Julio Martinez Calzón.

Does this bold design make way for a new conception of cabled structures?

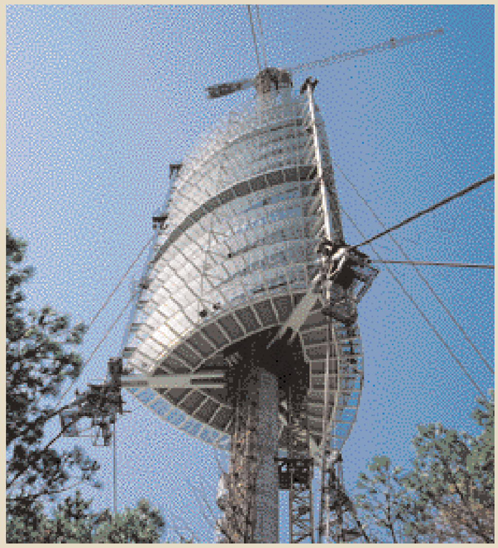
We showed a lot of creativity in the design of this structure, but didn't forge a model or type of design based on new cable combinations. We do believe, however, that cables can create a powerful aesthetic effect when they form a group. Isolated cables should be reserved for light, spacious structures such as building roofs, for example. Conversely, on a bridge, a group is crucial to the aesthetic outcome. Whether they are used for bridges or for building roofs, stay cables and their architectural arrangement are a whim, a fashion statement. Their future could be limited. During the 19th century, western societies were likewise infatuated with arch bridges, which later almost disappeared, replaced by lintels, only to resurface recently, like a fad.

So, cable-stayed bridges are a fad?

Not exactly. Clearly, the technique has been overexploited without justification in many locations, such as developed countries in response to client demand based on the desire for fashion or prestige. Our society has gone through three phases of stay cable structure development. During the first phase, structures that were large, interesting and innovative were built, but these have not aged well. The second phase was characterized by a less-selective use of the technique; This gave rise to the construction of very interesting structures, but also of ones that are more questionable. Lastly, the third and current phase benefits from high-quality stay cables and auxiliary elements, thus permitting the creation of durable, easy-to-maintain structures. The result has been real progress in the areas of watertightness, anti-UV protection, vibration control, and the high durability of individually-protected strands, etc. Stay cables are no longer used exclusively for structural or aesthetic reasons, but now, thanks to these steps forward, can serve as very interesting functional and architectural objectives. Their use can become truly active and effective.


Miguel Gomez Navarro.

Is the design of a cable-stayed structure like that of any other structure?
The use of stay cables requires the design of structures that could be qualified as "aerial"; These pass over functional zones at great heights, and are necessary when the goal is to completely free up the lower space of a site. In addition, it's important to remember that, besides providing support, stay cables are great aids during construction.
Structurally speaking, when used on large constructions, they offer great freedom of design and installation. Such characteristics are the result of developments in digital analysis and computers.
If modern architecture is to be regarded as complex, it's because these tools are available, are used in an increasing number of applications, offer more possibilities and new solutions.
In the framework of this increasingly active use of stay cable elements in architecture, we believe that parallel strand cables have more design potential and a larger range of applications than locked-coil strands, which are more limited to suspended structures and industrial uses. Locked-coil strands are less ductile under current civil engineering recommendations.


The Collserola Telecommunications Tower in Spain combines the use of steel stay cables (supplied and installed by Freyssinet) in the lower section with Kevlar cables in the upper section to avoid disruption of radio broadcasting.


The cables of the Valladolid Science Museum footbridge serve both as stay cables and prestressing elements.

What do you believe the future holds for cable-stayed structures?
Though current stay cable technology is satisfactory, we foresee continuing progress in the quality of materials and elements making up steel stay cables. We are, however, more skeptical about the development of composite materials in the short term, except in very particular cases such as that of the Collserola Telecommunications Tower. Here, steel stay cables were used for the lower section and composite Kevlar cables were used for the upper section to stabilize the mast (because metal pieces would have generated induction currents and, thus, could not be installed). Because of their cost and conditions of use demand for these materials will not become widespread rapidly, and their use will remain limited to specific applications. For the design of bridges, we could perhaps use mixed solutions in the future to surpass the current limits. In our opinion, however, the current traditional criteria, with a few minor improvements, will continue to decisively dominate the market for years to come. n

* *Also see page 18.*

The System in Top For

Freyssinet was a pioneer of the stay cable technique and has been working for the past 30 years towards perfecting it for designers and project owners. The Freyssinet system, based on state-of-the-art technology, has found its latest expression in the Millau Viaduct.

BY WAY OF AN INTRODUCTION TO THE PRESENTATIONS he gave in Asia last spring, (as part of the two conferences on stay cables organized by the Group - see page 22), Bruno Dupety, the CEO of Freyssinet, again highlighted the risk brought to his attention at the beginning of 2004 by Michel Virlogeux, consulting engineer: that this technology would become banal and that we would forget the great strides it has made over the last 10 years. Bruno Dupety shared this view with Jérôme Stubler, Freyssinet Deputy General Manager and Structure Division Director, and thus quickly decided to give top experts in the field a forum in which to share their experience before audiences in the region of the world that currently has the largest number of bridges are under construction: the Far East. The timing was perfect: this year Freyssinet marks the 30th anniversary of the Brotonne Bridge, the first cable-stayed bridge built in France (1974) and the tenth anniversary of the Normandy Bridge. The Freyssinet Management team was also able to boast current accomplishments such as the Group's participation in several important sites (including the Cooper River Bridge in the USA and Centennial Bridge in Panama – see page 16), two of which have attracted worldwide attention which is not confined to specialists: the Rion-Antirion Bridge in Greece and, most recently, the Millau Viaduct in France.

Millau: A technical and human success

On the 27th of August 2004, at precisely 12:04 pm, the final stay cable was placed on the Millau Viaduct, and, as he later admitted, Jean-Luc Bringer, the Freyssinet site manager, breathed a sigh of relief. Freyssinet held to the very short 12-week delay that was defined for the installation and tensioning of 154 stay cables, and thereby upheld its pledge not to disrupt the construction schedule for this important project, undertaken by the Eiffage group; The bridge will be officially inaugurated on the 17th of December. The main component of the assignment has been accomplished, yet a part of the team will remain on site until mid-November in order to complete the final crucial steps: cable tension adjustment, damper placement, injections, etc. Freyssinet worked extremely hard to respect the timeline, and achieved an exceptional level of organization within a team that m

DURING LAUNCHING OF THE DECK, 24 stay cables installed on pylons P2 and P3 were used as launching cables. Temporary saddles placed on the deck and pylons helped to limit angular deformations in the anchoring points.

A Quick Look at the Viaduct

The Millau Viaduct, that stretches across the Tarn valley, is 2,460 m long and is held by 7 pylons that are 340 m high. Its deck rises 270 m above the ground and the main spans are 342 m long. Designed to support a 4-lane motorway, the deck is composed of a 32 m-wide trapezoidal orthotropic box girder, made of steel; a central line of 22 stay cables per pylon holds the deck. The structure was completed as part of a concession contract; The construction contract was awarded to the Compagnie Eiffage du Viaduc de Millau (CEVM), that will operate it for 75 years, the building process was split between Eiffage TP (civil engineering) and Eiffel (metal deck), which respectively subcontracted to Freyssinet for nailing of the deck to the piers and supply, and installation of the stay cables (1,500 tons).

PARTICIPANTS

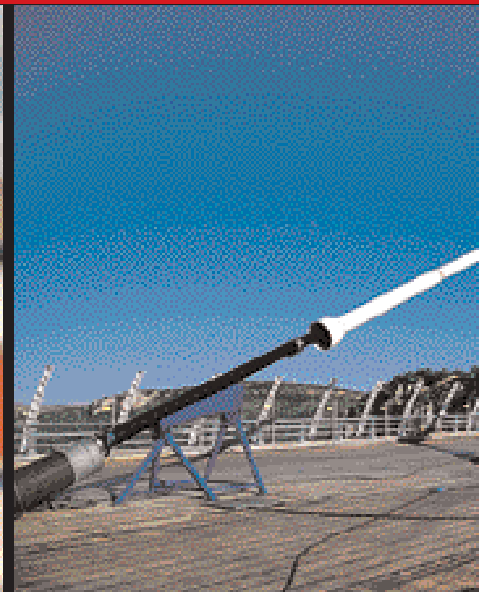
- **Owner :** Compagnie Eiffage du viaduc de Millau.
- **Engineer :** SETEC.
- **Architect :** Lord Norman Foster.
- **Designer :** Michel Virlogeux.
- **Project :** Thalès, Arcadis ESG, Serf.
- **Execution methods :** Greisch Ingénierie, Arcadis ESG, Thalès, Eiffage TP.
- **Main contractors :** Eiffage TP, Eiffel.
- **Specialized contractor :** Freyssinet.

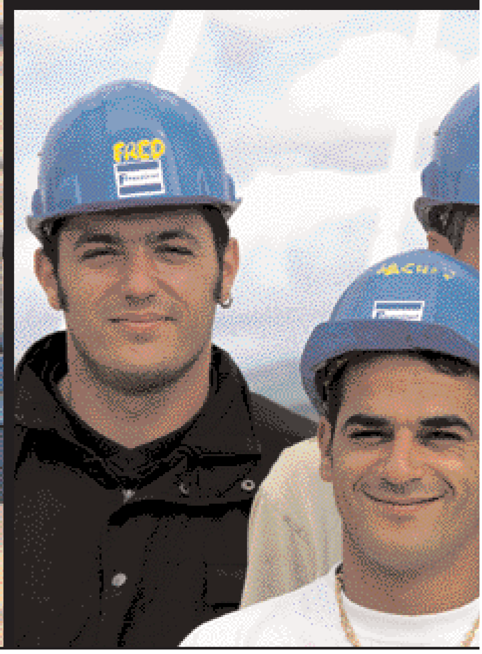
totaled nearly 100 people at the height of activities (much larger than normal team sizes). Such efforts are reminiscent of the level of involvement shown during the project to repair an arch of the tunnel under the English Channel in 1996, a project that is still vividly remembered in the company.

Immediately following signature of the contract in January 2002, Manuel Peltier, Freyssinet project manager, and Jean-Luc Bringer, employed in the Freyssinet France Technical Department in Gémenos (Bouches-du-Rhône) at the time (and long interested in a project that he had been "following for 11 or 12 years"), got down to the job of defining the profiles necessary for the site; These profiles were communicated throughout the Group. Almost 30 months later, the team at work in Millau during the summer of 2004 was a melting pot of French collaborators with accents from various provinces, several technicians from Portuguese and British subsidiaries, and actors from Major Projects who had just descended from the pylons of the Rion-Antirion. Comprised mainly of volunteers, who were "proud and delighted" to participate in this prestigious site, and whose average age, according to Jean-Luc Bringer, was between 25 and 30 years; the team, quickly got down to work with "very good morale", no doubt aided by the favorable summer conditions.

The stay cables, first installed on pylons P3 and P2, were used as launching masts, and the related tasks were completed: temporary nailing of the deck, temporary prestressing of the crossbeams on struts. The company was on site from the start date in June 2003

to complete these operations. The team was in full force following closure of the deck, as if on the starting line for a 2,460 m sprint – a race in which it needed to pace itself to the progress of the Eiffel team responsible for erecting the five remaining pylons while making sure not to slow down the waterproofing work behind it.
Simultaneously, a part of the team definitively nailed the deck to the piers. Instructions were to never interrupt production whatever happened. This objective was met through the on-site presence of a structural engineer and regular communication with the Belgian Engineering Consultancy Company BEG as well as the dedicated efforts of Jean-Luc Bringer to coordinate the team's operations with Eiffel. "Actually," says Jean-Luc, "only storms in August that required us to evacuate the deck sometimes several times per day made us fear that we wouldn't be able to keep the deadline." The data initially planned for delivery was the 9th of September and, thus, the Freyssinet teams' satisfaction today, the 27th of August, is well-merited…



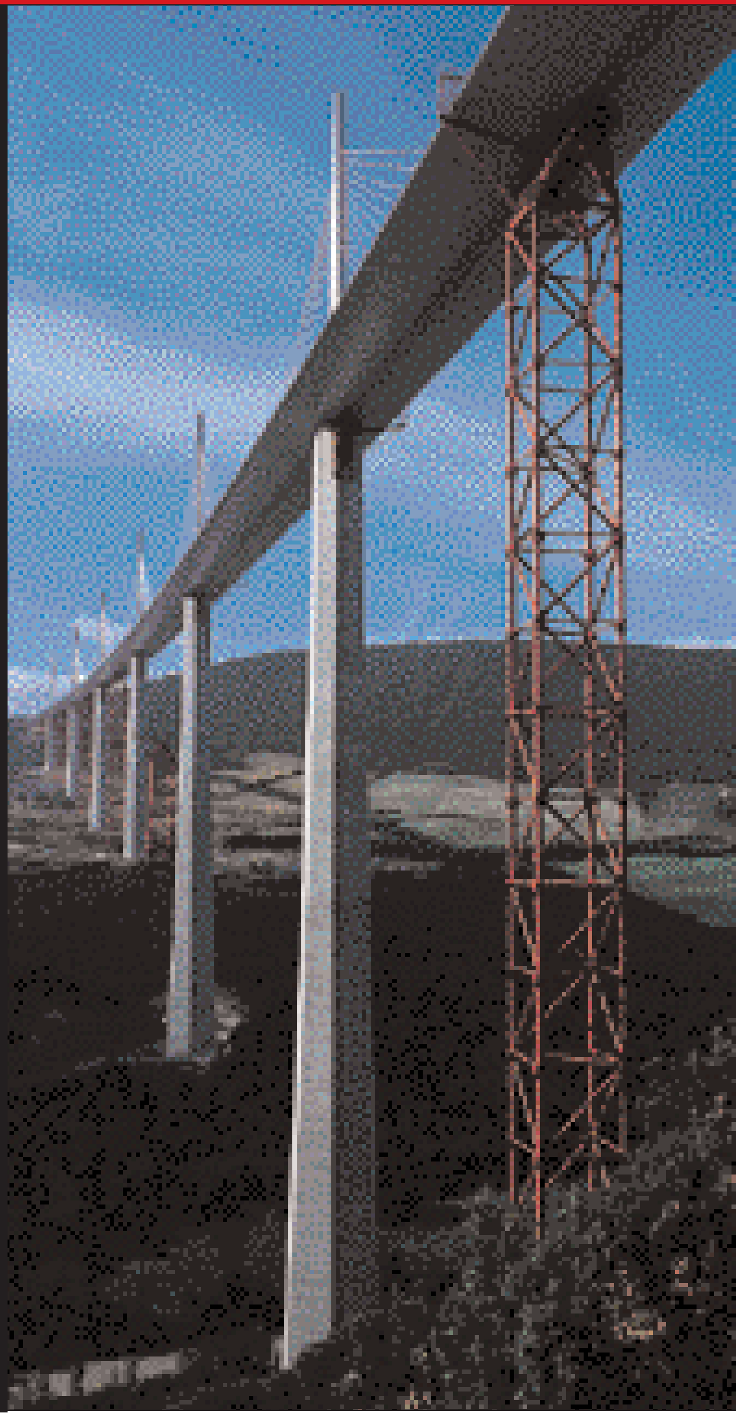


A Personalized Solution

The contract for the supply and installation of stay cables for the Millau Viaduct, the main contract awarded to the company as part of the project, forced Freyssinet to demonstrate the advantages of its system compared with the competition's pre-fabricated solutions. This challenged to the fears of experts that the market would be conquered by solutions made commonplace – in other words, that stay cables would sooner or later be considered as a "low-tech" product and not as a solution that offers a well-developed and high-performance technology.
Manuel Peltier, project manager, recalls that both Freyssinet and Eiffage responded to the first call for bids in the summer of 2000. Eiffage proposed a project with a concrete deck, but the Group's metal deck solution was chosen in the end. "Use of a metal deck led to much smaller total stay cable weight than that required by the concrete solution," he explains. "And the choice of Eiffel put Freyssinet in competition with the offers of pre-fabricated cable suppliers, solutions that are, in principle, in line with the philosophy of Eiffel whose frames pre-fabricated in Lorraine and Fos-sur-Mer are delivered ready for assembly on the site."
"Consequently, it was our job to demonstrate the numerous advantages of the Freyssinet stay cable system," continued Manuel Peltier.

Jean-Luc Bringer, Freyssinet site manager, grew up in the Millau region, and had been "following" this project for the past 11 or 12 years.

Its capacity to be dismantled strand by strand allows close for inspection in case of damage and replacement of the defective strand and not the entire stay cable. In addition, because the Freyssinet system is assembled on site and not delivered ready to install, it can be easily set to the final length and adjusted. "On the contrary, with a monolithic design, pre-fabricated cables cannot be dismantled and thus require cumbersome installation means compared to Freyssinet stay cables which are installed strand by strand." These weren't the only advantages Freyssinet could offer as incentives: the guaranteed life span of its stay cables



BROUGHT TOGETHER FROM THE REGIONS of Freyssinet France, but also from the Rion-Antirion site in Greece and from all subsidiaries (mainly from Portugal and United Kingdom), the Freyssinet teams totaled almost 100 collaborators in the final phases of stay cable installation. Freyssinet also contributed, though with fewer numbers, to the deck launching phase by performing tensioning and release of the launching cables.
On top of each pier a small team successively performed the operations to “un-nail” and then “re-nail” the deck.

exceeds the 75 years of the concession contract, and its system is qualified in application of the CIP recommendations for stay cables and the watertightness test of its patented cable guided/stuffing box device that protects the anchoring blocks from corrosion.

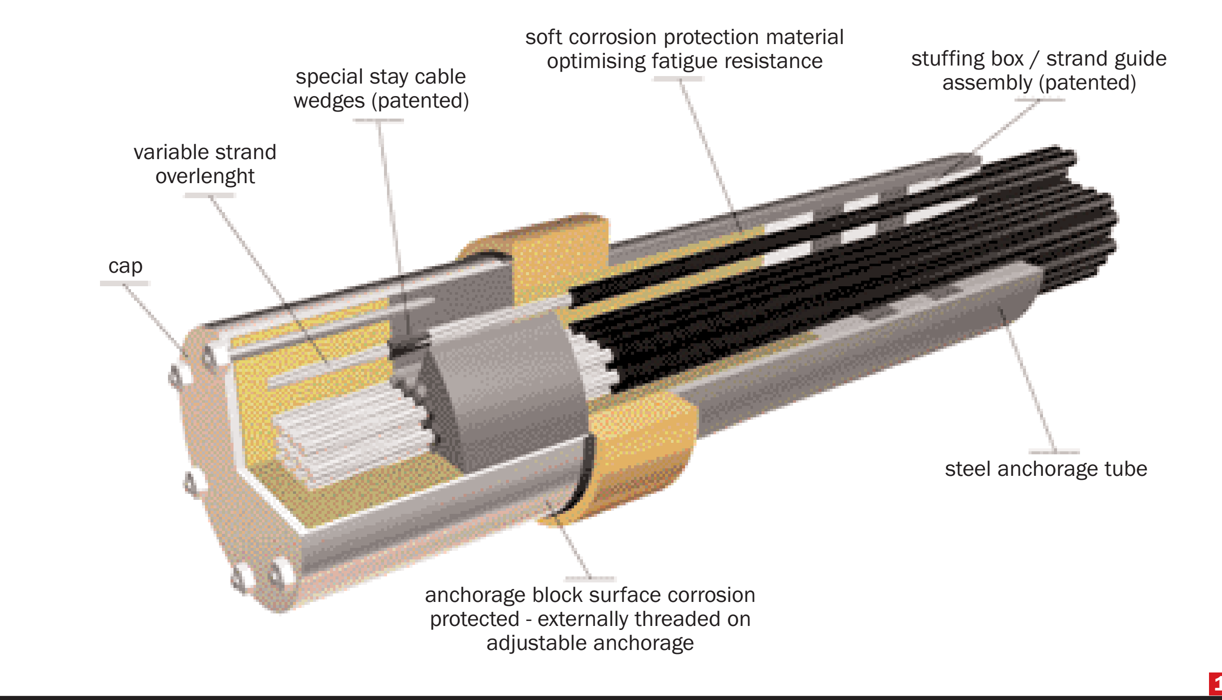
“This project was always viewed as an enormous challenge and we needed to provide convincing evidence of the company’s capability to complete work within defined deadlines. Freyssinet’s great body of experience obtained over the past 10 years in the construction of several bridges of the same size was probably the deciding factor for Eiffel,” concludes Manuel Peltier. n

ON SITE

Tools to Support the Methods

From June 2003 to April 2004 deck launching, performed during "breaks in the weather” that lasted on average four days, required double the effort from the Freyssinet teams. On the piers and temporary bents, installed to divide each 342 m span into 171 m sub-spans, this phase involved un-nailing of the deck following by re-nailing after launching.
On pylons P2 and P3 24 stay cables were used as launching cables to support the cantilevered deck and, under the effect of deck deformations, were successively tensioned when the deck reached the bents and piers and were then loosened. To limit and control angular deformation at the anchoring points they were installed on pylons and the deck was placed on special deviation saddles. “These devices,” explains Jean-Luc Bringer, “guarantee that the cable strands will not be subjected to combined stress due to tension and bending greater than 60% of the guaranteed breaking point and that the anchoring and anti-corrosion systems will not be damaged during launching.”

- Tested at pressures greater than 10 bars, the watertightness of the stuffing box (1) / strand guide developed by Freyssinet protects the cables from corrosion at the anchoring points.
- To control vibration, Freyssinet has access to a complete range of internal (3,4,5) and external dampers.
- A "needle" system (aiguilles), or interconnection cables (6), placed on each side of the stay cables corrects their parametric instability.
- In accordance with the most recent CIP recommendations, a 55-strand cable identical to the model used in Millau was subjected to a fatigue test in the Central Laboratory of Bridges and Roads in Nantes (France) (2) to qualify the Freyssinet system.
- The patented Freyssinet Isotension system (7) makes it possible to strictly apply the same tension to all strands in a stay cable.



1

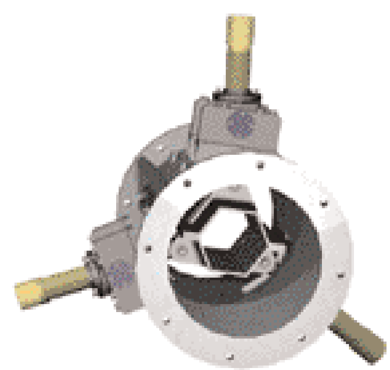
IED (Internal Elastomeric Damper).

3

IHD (Internal Hydraulic Damper).

4

IRD (Internal Radial Damper).



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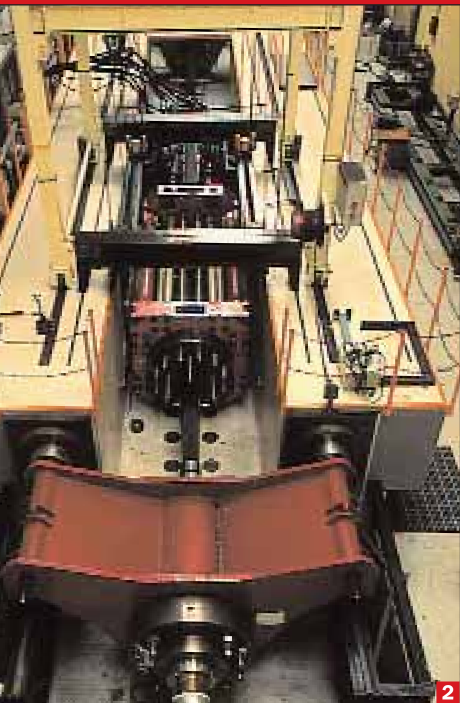
The Advantages of a State-of-the-Art System

The Freyssinet HD stay cable, that can be composed of between 1 and 169 strands, is based on the principle that each of its components are completely independent at all levels: anchoring, corrosion protection, installation, tensioning and replacement.

The common part of Freyssinet stay cables consists of a parallel bundle of semi-adherent T15.7 strands (called monostrands) threaded into a collective HDPE (high density polyethylene) sheath. The monostrands were developed and patented to ensure excellent durability and optimum anti-corrosion protection. The seven wires of the strand are galvanized and isolated from each other with petroleum wax. Since the mid-1990s the filling of the wax and extrusion of the sheath covering the wires have been performed in thermodynamic conditions that result in “semi-adherence”; thus guaranteeing that the strands withstand extreme thermal conditions. “Freyssinet stay cable anchors and high resistance steel blocks, in which the strands are individually anchored with jaws, are, mechanically speaking, mainly characterized by limited fatigue and residual resistance to breaking, that is caused due to fatigue,” explains Benoît Lecinq, Freyssinet technical director. The company subjected the system to intense fatigue tests

A computer model to design the dampers.



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6

7

by axial tension, in conjunction with cross fatigue, followed by breaking tests by tension.

A computer model to define damper size

The results from independent laboratories either meet or exceed the principal acceptance criteria of the CIP (French Interministerial Commission on Prestressing).

Moreover, anchor durability is closely correlated with its watertightness and corrosion protection. The watertightness of the cable stuffing box used with the Freyssinet system withstood pressures greater than 10 bars in tests. The Freyssinet stay cable anchors also passed the watertightness test recommended by the CIP. The anchor-cable system was encased in a 3 m tube filled with water. To simulate real environmental conditions, the cable was subjected, for seven weeks, to repeated cycles of tension and bending at water temperatures varying between 20°C and 70°C. Upon dissection at the end of the assay, no water infiltration was observed. Over the past few years cable vibration engineering has become one of the specialties of Freyssinet. The company developed a computer model to calculate absorption requirements and develop the most appropriate dampers. A precise diagnosis of stay cable stability is presented for each project and a complete range of anti-vibration devices is offered. In addition to external spiraled sheaths, Freyssinet can offer a large range of internal and external dampers. The internal dampers are installed in the anchors, and the external dampers are placed on an auxiliary support. To absorb “parametric instability” of the cables, a “needle” system was developed. This system is composed of interconnection cables that are unbroken and that are placed on either side of the lateral plane of stay cables. They were notably used on the Normandy Bridge.

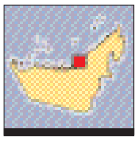
HISTORY

30 Years of Long-Distance Development

The stay cable technology composed of prestressing strands was first used on the Brotonne Bridge in France in 1977 and the Rande Bridge in Spain in 1978. At that time stay cables were a parallel bundle of strands inserted in a metal (Brotonne) or polyethylene (Rande) sheath, injected with the cement grout. The technology evolved during the 1980s with the creation of individual protection of the reinforcements, and improvement of anchor performance under fatigue using cleats. In 1988 while several cable-stayed structures were being built in the USA, using a technology similar to that used for the Brotonne Bridge, the Wandre Bridge in Belgium was constructed using, for the first time, stay cables with individually protected strands. Then a new trend appeared: injection of stay cables into wax (second bridge over the Severn in Great Britain in 1996). During the 1990s individual parallel strand protection became more diverse. To reduce the drag coefficient on the Normandy Bridge stay cables the individually protected strands were enclosed in an envelope composed of two half shells profiled into the shape of a double helix. Today, this envelope has been replaced by a continuous sheath that is aerodynamic and asthetically pleasing whilst also providing ultraviolet ray protection.

SOILS / **ALQUO’A PLOT**

A City in the Desert



In Abu Dhabi (United Arab Emirates), in the middle of the desert, Ménard Soltraitement treated a 3.5 million square meter platform by dynamic compaction in preparation for the future construction of 550 villas.

LOCATED ON THE EDGE OF THE VILLAGE OF ALQUO’A, one and a half hours by car from the city of Al-Ain and near to the border with Oman, a real estate project plans for the construction of a division of 550 villas among the desert dunes. This endeavor launched by the city of Al-Ain will house Bedouins currently becoming increasingly settled.

A 3.5 million square meter platform on which the buildings will be constructed was created in the sand. The summits of the dunes were flattened and the depressions, the equivalent of a surface area of 1 million square meters, were filled in. “The sandy desert soil was formed in successive layers without compaction,” explains Étienne Dhiver, the project engineer. In this loose state, the ground was at risk of settling under its own weight or that of the villas. To avoid such settlement that would damage the new buildings, Ménard Soltraitement stepped in. The company had two solutions at its disposal to guarantee a maximum of 2.5 cm of foundation settlement and provide the necessary ground bearing capacity: vibroflotation (or vibrocompaction) and dynamic compaction. “The first technique required quantities of water that exceeded possible supply in the middle of the desert and thus the second was the only logical solution,” specifies Dominique Jullienne, Manager of the Middle East Ménard Soltraitement subsidiary.

35 tons in Free Fall

For the large backfill operations up to depths of 25 m, the company relied on seven cranes capable of delivering nearly 900tons/meter on impact (equivalent of a 35 t masses released from a height of 25 m) and applied the new MARS process (Menard Automatic Release System) that allows the free fall of 35 t masses without energy loss due to braking or friction. “This automatic release system, developed for this site, optimizes the energy of ground compaction by increasing its deep impact and represents a technological advancement in the field of granular soil compaction,” tells us Étienne Dhiver. This technique also made it possible to complete treatment in merely nine months instead of the eleven months provided for in the contract. Michel Piquet, project manager, concludes, “We were able to finish the project at the end of June and thereby avoided the extreme heat of the months of July and August when temperatures rise above 50°C.” n

PARTICIPANTS

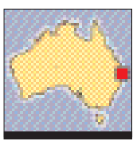
- **Owner:** city of Al-Ain.
- **Main Contractor:** Hyder Consulting.
- **Contractors:** Al Ghafly, Nael and NTCC.
- **Specialized Contractor:** Ménard Soltraitement.

THE MARS PROCESS (MENARD AUTOMATIC RELEASE SYSTEM) optimizes the energy from ground compaction by eliminating energy loss from braking or friction.

STRUCTURES/**BRISBANE AIRPORT HEAVY MAINTENANCE HANGAR**

Lift of a Heavy Weight

All the lifting jacks were connected to a central control system andcould be operated individually or in combination.



The delicate phase of construction of the largest Australian airport hangar, jacking of a 3,000 t truss to a height of 25 m, was assigned to Austress Freyssinet.

THE BRISBANE AIRPORT MAINTENANCE HANGAR is the largest facility of its type in Australia and it has marked a major coup for the Queensland State Government in cooperation with the principal contractor Multiplex Constructions. This “state of the art” building will feature a 160 m wide steel truss weighing 3,000 t supported by eight 40 m high concrete columns. The impressive proportions of the hangar will allow it to simultaneously accommodate three B767 aircraft or one massive Airbus A380-100 wide-bodied aircraft.

The construction procedure was simple, erect the concrete columns, fabricate the truss on a 3 m high temporary support, then lift the truss to its final position on the columns and mechanically lock it into place. Austress Freyssinet was responsible for the heavy lift. “To perform the operation, we attached specialist lifting jacks to steel platforms that were temporarily fitted to the top of the concrete columns” explains Tony Mitchell, the project manager. The two front columns each had 2 No x 400 t jacks and the six back columns were each fitted with 2 No x 150 t jacks. The jacks were hydraulically linked to a central control system where they could be operated individually or in any combination. In addition, video surveillance cameras combined with a laser survey system allowed for monitoring jack loads and the truss height from the central control.

Curve and Camber

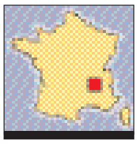
The lift was completed in three stages. “Pre-jacking the truss by the initial 5 m was the most difficult part of the operation due to the pre-camber of 1.5 m in the front section that would straighten under load.” advised Tony Mitchell. Months of planning was required to develop an incremental jacking sequence which would allow the load to transfer to the truss from temporary supports without overstressing structural elements. Deformation of the camber in the frontal truss under various loads and the method required to maintain the structure horizontal by compensating for the reduction in curvature was carefully studied. More classical in nature, the second phase hoisted the truss 25 m off the ground to its final position. All permanent steel connections were assembled and the load was then transferred from the jacks to the structure. Six Austress team members completed the lifting operation in three days and the hangar was handed over on the 21st of June 2004.

PARTICIPANTS

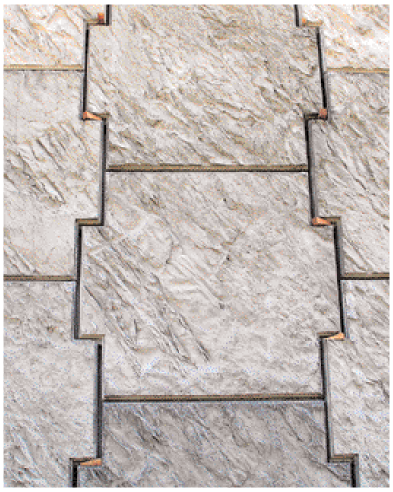
- **Owner:** Government of the State of Queensland.
- **Main Contractor:** Multiplex Constructions.
- **Specialized Contractor:** Austress Freyssinet.

SOILS / **A51 MOTORWAY**

A Mountain Record



Terre Armée SNC won a contract for the installation of 30,000 m² of Reinforced Earth walls on the Grenoble-Sisteron motorway (France). This record contract forced the company to adjust its production methods.



In addition to retaining walls, Terre Armée SNC was responsible for the studies and for the supply of materials for the construction of load bearing abutments for the upper passage of the Sinard, constructed by Campenon Bernard Régions. Ease of construction also contributed to the adoption of the Reinforced Earth solution.

THE MOTORWAY PROJECT OWNER, AREA, received the green light on July 2001 and work began on the Coynelle-Fau Pass section of the A51 motorway to the south of Grenoble. This new 10.5 km-long section will, by mid-2006 become an extension of the 16 km section already open to traffic between Claix and Coynelle since 2000. The road is situated in a mountainous region with steep slopes that required the use of split carriageways.

"Reinforced Earth is particularly well-adapted to this type of configuration where rocky terrain alternates with loose soil," explains Eric Lucas, technical director of Terre Armée SNC. In total, 10,000 m² of nailed walls and 30,000 m² of Reinforced Earth structures will guarantee stability of the slopes and support of the roadways. Five walls are currently under construction. The maximum height of one single rise is 18 m but, with superposing sections, the total height reaches 22 m in some locations. Their construction was assigned to the Guintoli-GTS-Bianco-Eurovia-MTS-Campenon Bernard Régions joint venture, that successfully bid for the work, which includes earthworks, structures and restoration of traffic. "This was a complex project for Terre Armée requiring a mixture of technical and architectural techniques," explains Pierre Sery, director of Terre Armée SNC.

PARTICIPANTS

- **Owner:** Area (Rhone-Alps Motorways).
- **Main Contractor:** Scetauroute.
- **Engineer :** Guintoli-GTS-Bianco-Eurovia-MTS-Campenon Bernard Régions joint-venture.
- **Specialized Contractor:** Terre Armée SNC.

Inspiration from the Cliffs

SoilTech, the technical department of the Reinforced Earth Company, performed a study to verify the behavior of the EPDM pads between the cladding panels. Concerning the aesthetic aspects, the Jourda agency designed a surface decorated with a motif reminiscent of the rocky cliff surroundings. All the scales were then prefabricated in a partner factory of Terre Armée SNC using underwater cement to guarantee concrete quality and resistance to freezing and deicing salts. Construction of the retaining walls began last May and will continue until August 2005. "With three teams at work, the rate of construction averages 170 m² of face area per day and reaches up to 200 m²," states a proud Pierre Sery. This rate of installation led Terre Armée SNC to acquire 67 forms, 60 of which are equipped with specific mats to reproduce the architectural pattern.

STRUCTURES/**CENTENNIAL BRIDGE**

Bridging The Two Americas

Ninety years after the opening of the canal, Panama recently inaugurated a new structure over the famous pass. Several entities in the Group participated in the project.

Located in an earthquake-risk region, the Centennial Bridge can withstand ground accelerations of up to 0.33 g.

FIFTEEN KM NORTH OF THE BRIDGE OF THE AMERICAS constructed 40 years ago, the Centennial Bridge (the celebration of the 100th anniversary of Panama's was held at the end of 2003) will hold the new east-west motorway built to reduce traffic on the old structure by 50%. This structure, built over the Culera valley, measures a total of 1,052 m and rises to 80m above the canal. With these proportions, the Titan floating crane can be passed underneath for lock maintenance and the canal can be later widened to 275 m.

The main bridge is comprised of two 200 m end spans and a 420 m central span. Access is gained through four spans varying from 46 to 66 m in length. Composed of regular 34 m-wide and 4.5 m-high concrete box structures, the deck of the main bridge was prestressed crosswise and lengthwise with steel cables (800 t) and is supported by 128 stay cables (1,400 t) anchored every 6 m and protected with white external HDPE (high density polyethylene) ducts. All these components were supplied and installed by Freyssinet. During construction of the bridge, the main challenge set before the main contractor, Bilfinger Berger, was the time constraint. To allow opening of the structure on the 15th of August 2004, the anniversary of inauguration of the canal by passage of the American ship Ancon on the 15th of August 1914, work was limited to 29 months. In addition, the contractor was required to organize work so as to never interrupt traffic in the canal. Particularly difficult during the sensitive phase of stay cable installation, this constraint was a factor in the choice of the construction methods used. The access spans were cast in situ on scaffolding while the main bridge was built by cantilever. The mobile formwork travellers were used to install both the segments on piers and the members. "Bilfinger Berger assigned us the formidable task of lifting the steel mobile formwork travellers," explains John Marchese, Freyssinet works manager on site. Once they were partially assembled at the base of the towers,

INTERVENANTS

- **Owner:** Ministerio de obras públicas, Panama.
- **Preliminary Design:** T.Y. Lin. Detailed Design, Consulting
- **Engineers and Temporary Work:** Leonhardt, Ändra und Partner.
- **Main Contractor:** Bilfinger Berger.
- **Specialized Contractor:** Freyssinet International & Cie, Austress Freyssinet, Freyssinet Iberian-American Division.

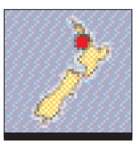
these two tools, each weighing 390 t, were installed using two 180 t-capacity cable jacks in addition to two 50 t jacks. Lifting was performed between September and October 2003. “The operation was divided into two phases: the first portion of the mobile formwork travellers was lifted 70 m and put into final place using temporary hangars. Then, the second part was hoisted up and attached to the first to form one unit. The installation of each mobile formwork travellers and subsequent safety controls took 10 hours.”

Raja Asmar, Freyssinet project director: “With two teams working in two shifts seven days a week, good coordination between the various collaborators on the site made it possible to achieve four-day manufacturing cycles per segment and per mobile formwork travellers.”

Once the bank spans and closure of the central span were completed, the mobile formwork travellers were brought down in June and July 2004. Because traffic could not be interrupted, the mobile formwork travellers could not be lowered in the middle of the canal. Using launching techniques, the Freyssinet teams brought the mobile traveling forms down the towers. They were then removed using four 180 t-capacity jacks attached to the deck with the strands passed through openings. Each removal took 8 hours.

SOILS / **UPGRADED INTERSECTION IN AUCKLAND**

Custom passage



The redevelopment of an important intersection in the City of Auckland, in which the New Zealand subsidiary, Reinforced Earth Ltd, participated, required all the ingenuity of its engineers.

FIRST BUILT 150 YEARS ago for military needs, the Great South Road remains one of the important north-south roads in Auckland. In the South Auckland industrial area it intersects with Sylvia Park Road, running east to west, before crossing the North Island Main Truck Railway by means of a steep, narrow bridge.

The combination of the intersection and adjacent bridge had created a traffic “bottleneck” which had grown steadily worse as traffic density increased – 37,000 vehicles are converging on the intersection daily. The current project consisted of widening the roads to add new lanes and building a new, wider bridge to current standards

The Contractor won the Project with an alternative design, involving staged construction of the bridge, and the use of temporary “Bailey” bridges to allow traffic to pass through the site during the work. The design featured extensive use of Reinforced Earth retaining walls, both temporary with Terratrel wire mesh facing, and permanent, with precast concrete TerraClass facing panels.

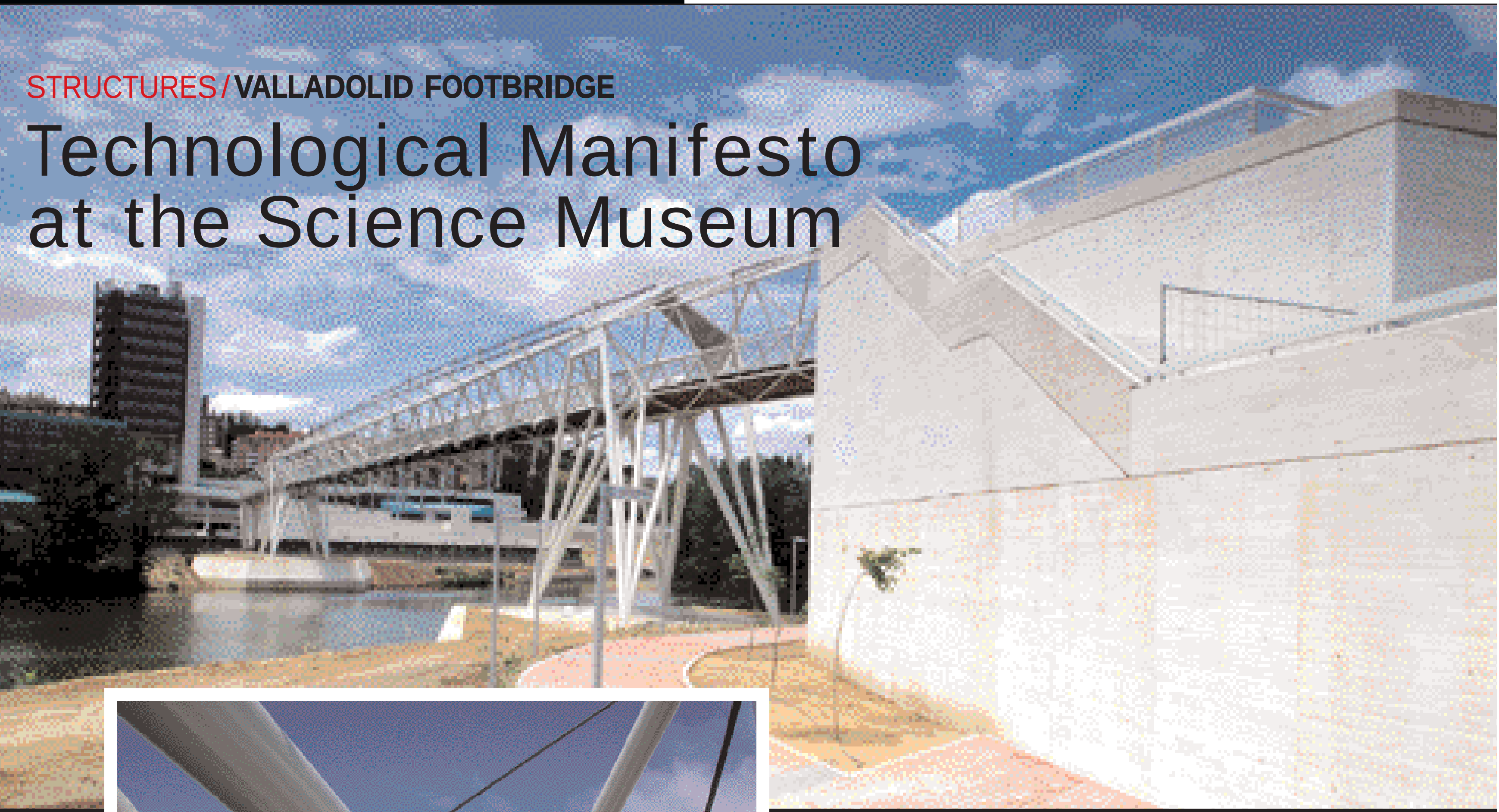
Solutions on a case-by-case basis

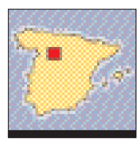
Though at first glance a conventional project, it held many surprises for the engineers of Reinforced Earth Ltd, requiring all their ingenuity. “The absence of an accurate map of the underground networks meant that we had to adapt our solutions on a case-by-case basis,” explains Don Asbey-Palmer, engineering manager of Reinforced Earth Ltd. The building of the southern abutment was complicated by the discovery that a 300 mm diameter high-pressure gas main was located in the middle of the structure, instead of to one side. As the pipe walls were not thick enough to carry the extra height of the new bridge, the structure was redesigned to use lightweight pumice fill. The staging of the bridge construction was achieved with the use of two, seven metre high TerraTrel temporary walls, with welded wire mesh facing panels

In total, some 1,552 square meters of permanent retaining walls with precast concrete TerraClass facing panels, as well as 280 square meters of temporary TerraTrel walls. The work began in January 2003 and was completed in July 2004.

STRUCTURES/ **VALLADOLID FOOTBRIDGE**

Technological Manifesto at the Science Museum





Conceived by the architects José Rafael Moneo and Enrique de Teresa, this contemporary/unique design for the Valladolid Science Museum's (Spain) new footbridge illustrates the creative possibilities available using with prestressing and stay cables.

OPENED LAST JULY 28TH, a footbridge designed with a fish basket in mind crosses the Pisuerga river and connects the city center with the Valladolid Science Museum. The 234 m structure is notably composed of a hexagonal prism inside which the pedestrians walk. After construction of the piers and cast in situ construction of a white concrete span, the elements were installed using a crane. The central span was put in place using a barge.

"This section, the longest in the structure, involved longitudinal and hexagonal prestressing," specified Patrick Ladret, technical director of Freyssinet SA in Spain. Each of the 15 sections was prestressed with a peripheral cable that passes over the six crests of the hexagon. This original design led Freyssinet to develop, under the supervision of the Engineering Consultancy Company MC2, a deviation saddle for inconspicuous passage of the cable and effective transmission of stress. Based on full-scale tests performed at PPC, the Group's factory, to measure the resistance of the strands to deviation, and, in the Freyssinet SA facilities in Zamudio near Vizcaya to verify their sliding onto the saddles, the solution proposed to MC2, and finally chosen "associates anchoring to the top and bottom crests of the hexagon, the major angular deviation points, and of the deviation saddles to the intermediary extremities," explains Alberto GonzáLez Bueno, study and business engineer for Freyssinet.

PARTICIPANTS

- **Owner:** Aguas del Duero.
- **Architects:** José Rafael Moneo, Enrique de Teresa.
- **Consulting Engineers:** MC2 Ingeniería.
- **Main Contractor:** Pisuerga alliance (Puentes y Calzadas and Joca Ingenieria).
- **Specialized Contractor:** Freyssinet SA.

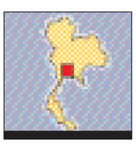
The patented Freyssinet Cohestrand cable system was chosen for its mechanical performance and anchoring was provided with System C blocks. Longitudinally, six external prestressing cables were arranged along the hexagon crests. Forming a 110 m parabola between the two piers, these cables were slightly deviated at the anchorage points and hexagonal prestressing deviation saddles. Patrick Ladret explains: "We had to find the best solution to fit the architectural design to offer prestressing with strands that could be individually disassembled if necessary." The large number of direction changes (90) excluded the use of saddles separating the strands individually for financial and technical reasons. Thus, external prestressing injected into the cement grout with 4C15 and 7C15 anchors was used. As integral parts of the structure, the ducts and strands were placed on the footbridge before the translation operations. "Like a catenary, specifies Alberto González Bueno, we used a temporary strand to install the ducts and individually thread the strands before injecting all the cement grout."

In addition to its mechanical function, the external prestressing cable grid looks like the fish baskets which inspired the architect's design.

Also see page 4.

STRUCTURES / **NEW BANGKOK AIRPORT**

A multipurpose gantry crane



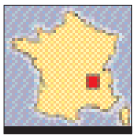
From design to methods, Freyssinet took responsibility for complete engineering of a device for a complex jacking operation.

THE THAI STATE is sparing no effort in welcoming foreign visitors and has begun work on a new International Airport outside Bangkok due to open in September 2005. Built using modern architecture, its seven story terminal (182,000 square meters) is located around thirty kilometers to the east of the capital and in the long-term should have a capacity of 100 million passengers a year.

Work began in 2002 with the construction and the erection of the monumental metal truss covering the main terminal building. By mid-2004 the work was progressing with the assembly of a second metal structure, intended this time for the concourse. Lifting operation done by mobile crane has to be discarded because of limited space. Freyssinet Thailand was awarded by Italian Thai Development Co. Ltd, the main contractor, the construction method and detailed design of the gantry and its support rail system. All the lifting work were carried out by the main contractor. "We supplied the studies and method statement, as well as the detailed drawings and calculation sheet for the lifting system," indicates Likhasit Kittisatra, of Freyssinet Thailand. "The real specialty of the system is that the gantry is not only capable of lifting and moving a segment of the structure but of rotating more or less within 30 degrees in plan view from center axis."

SOILS / BOURGOIN-JALLIEU PLATFORM

A Safe, Simple and Economical Solution



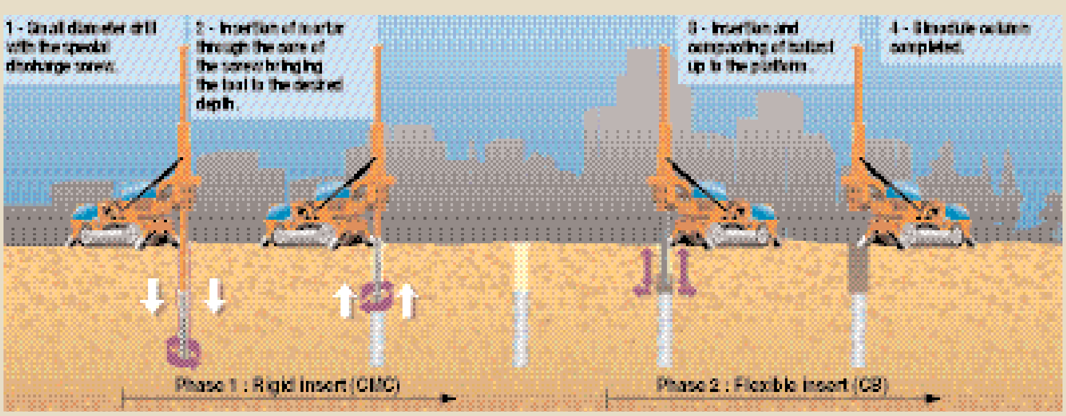
In Isère (France), the benefits of an innovative solution proposed by Ménard in joint-venture led the pack.

HOW CAN LOOSE SOIL BE IMPROVED to enable it to support both the dead and operating loads of a building? In order to allow the introduction of a do-it-yourself superstore in the Maladière industrial zone in Bourgoin-Jallieu (Isère, France), this question was placed before the geotechnicians of the Experimental Center for Building and Public Works Research and Studies (CEBTP). The initial analyses, revealed that the foundation of the 30,000 m² site comprised a highly compressible, 8 m deep clay-peat layer on top of a layer of sand and compact gravel. To prepare the terrain, a distribution mattress (primary backfill) was placed in in two zones. The first, designed to support the future slab, was made up of two 30 cm layers of inert compacted material followed by 47 cm layer of compacted gravel laid on an ordinary geotextile. Over the remainder of the terrain, this distribution mattress was 1.20 m thick made up of a single 60 cm layer of inert compacted material and a 60 cm layer of gravel laid on a geotextile.

Simplified Design

The specifications for soil consolidation required the installation of hard inclusions covered with a 1m thick layer of form and a reinforced concrete slab. Christian Ernst of Ménard Soltraitement: "Working together, Ménard Soltraitement and Keller-Fondations Spéciales proposed a solution based on the use of columns formed of hard inclusions in the clay-peat layer and topped, through the upper 2 m of backfill, with dry stone columns. “This method simplified the design of the structure itself compared to the original solution and made it possible to avoid "construction of large reinforced concrete slabs that would have been necessary to absorb the negative forces caused by the hard points (inclusions).”
In addition, these inclusions were at great risk of being sheared by the earthworks equipment during the backfill operations. Another clear advantage of the bi-modulus columns compared to hard inclusions throughout was their better resistance to earthquakes. Christian Ernst tells us: “The dry columns placed on top of the inclusions eliminated the hard point and interstitial settlement phenomena. Thus, the structure is guaranteed to withstand earthquakes.”
The process, with all elements accurately downscaled, was validated in test specimen assays, cone penetration tests and in situ tests with 150% overload of the columns. Measurements performed in parallel illustrated the homogeneity of settlement throughout the entire surface. n

PRINCIPLE OF INSTALLATION OF BI-MODULUS COLUMNS (BMC)

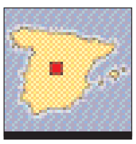


PARTICIPANTS

- **Owner:** Castorama.
- **Architect:** Paul Barbier.
- **Specialized Contractor:** Ménard Soltraitement (project leader) and Keller Fondations Spéciales joint-venture.

STRUCTURES / **AVE VIADUCT**

A Kit of 39 Spans



Precasting and installation: in Spain, the Group's subsidiary, Tierra Armada, participated in two phases of construction of a large railway structure.

Manufactured using B50 self-placing concrete to simplify casting into the mould, the U beams are composed of 10.5 t of passive steel, 64 m³ of concrete and 5.4 t of prestressing steel.

ON THE TOLEDO-MONCEJÓN SECTION of the future Spanish high-speed railway line, Tierra Armada helped construct the largest viaduct it had ever worked on. The 1,659 m long structure is composed of forty-two 36 m spans. With the exception of the 3 central spans that were cast in situ, the 39 others were composed of two precast parallel U beams. We were involved in different phases of this project, explains Salvador Lorente, general director of Tierra Armada. First off, in our Loeches factory near Madrid, we fabricated the 78 beams (39 pairs) as well as the pre-slabs and slabs. We then installed them on the structure. "Once delivered to the site by special wide load delivery, the beams, each weighing 160t, were installed by crane on the pot bearings on the head of the pier; These were then covered with pre-slabs equipped with connectors on which the slabs were cast. "To avoid beam movement during pre-slab placement and slab pouring, we temporarily connected the beams in groups of two using cables and four jacks," continued Salvador Lorente. On each span, 60 plates with 5.9 m lost frameworks equipped with connectors were placed on the precast beams to form the abutments of the viaduct and cover the U. To join the two parallel beams, 30 concrete plates with reinforced lost frameworks were installed. n

PARTICIPANTS

- **Owner:** GIF.
- **Engineer:** Inocsa.
- **Main Contractor:** Necso.
- **Specialized Contractor:** Tierra Armada SA.

Bruno Dupety.

CONFERENCES

The Freyssinet Stay Cable on Tour in Asia

Last spring, Freyssinet organized two conferences in Asia; This region of the world is where the largest bridge projects are carried out today.

The paradox of advanced technologies is that their applications often become commonplace. To prevent this risk and to increase knowledge of the recently-developed high performance stay cable systems, Freyssinet organized two conferences that brought together around 400 guests at the beginning of 2004. The first was held in Hong Kong on the 31st of March and the second in Tokyo on the 2nd of April. In his introduction, Bruno Dupety, the chief executive officer of Freyssinet International, stressed the public's fascination with cable-stayed bridges, and the fact that the great strides made over the past 30 years in terms of durability, mechanical performance and

René Walther.

installation will make way for even more daring projects. Honorary professor at the École polytechnique of Lausanne (Switzerland), René Walther presented the brief history of these structures. Illustrated with many images, his presentation gave an overview of the various stay cable configurations, from the central line of stays to the four-stay lines used for bigger structures; he highlighted the evolution of decks to composite solutions and of pylons to forms that

Karl Frank.

give architects more room for imagination and audacity. The durability of stay cables, key to the structural design, was discussed by Professor Karl Frank from the University of Austin, Texas (USA). Based on the example of the bridges of Maracaibo Lake (Venezuela) and Kohlbrand (Germany), he dealt with the problem of locked coil strand corrosion and showed the evolution

Michel Virlogeux.

to systems with parallel cables threaded into metal sheaths or HDPE. He also stressed the need to follow the recommendations of the *fib* to search for "multibarrier" stay cable protection methods. Michel Virlogeux, consulting engineer and designer, presented the vibration problems encountered by designers. Supported by mathematical illustrations, he presented the various types of vibration and "parametric excitation" and then detailed the devices available to eliminate or reduce these phenomena, such as sheath helicoidal fillets developed for the Normandy Bridge or the

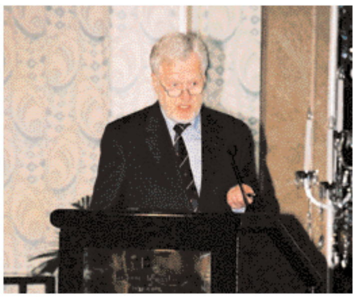

Maorun Feng.

damping of stay cables using special devices (needles, internal and external dampers). In Hong Kong, the chief engineer of the China Ministry of Communications, Maorun Feng, gave an overview of all large structures completed or under construction in his country since the mid-1970s. Over the last 10 years, construction of 23 cable-stayed bridges and 13 suspended bridges, all with a central span over 400 m, has been initiated, and 28 of them are already in service. The Chinese official explained that, in the future, we will witness cable-stayed structures with spans over 1,000 m. An example is the Sutong Bridge cur-


Jérôme Stubler.


Benoît Lecinq.

rently under construction that will become, in 2008, the longest bridge in the world with a 1,088 m central span. Jérôme Stubler and Benoît Lecinq, deputy general director and technical manager of Freyssinet respectively, presented the Freyssinet HD stay cable system (see the article on p. 6) and boasted the successful results from the CIP watertightness test to the auditorium. The consulting engineer, Reiner Saul, summarized in Hong Kong the evolution of cable-stayed bridges designed, controlled or supervised by Leonhardt, Andrä


Reiner Saul.

und Partner over the last decade. He stressed that parallel cable systems have become the solution of choice throughout the world. On the same subject, but this time in Japan, Yoshinobu Kubo, Professor in the Civil Engineering department of the Kyushu Technological Institute, reviewed the numerous cable-stayed structures constructed in his country after the Katsuse Bridge. Focusing in particular on the structural and aerodynamic evolution of structures, he pointed out that the size of central spans of cable-stayed bridges had increased by 12 m per year in Japan. He concluded that, based on tests performed in Japan on structures like the Shin-Onomichi, multi-strand stay cables would become the preferred solution.


Yoshinobu Kubo.

DEVELOPMENT

Launching of Austress Menard

After their successful collaboration during construction of the Townsville sugar terminal, one to consolidate the soil and the other to install the floor prestressing (see *Soils & Structures* no. 217), Ménard Soltraitement and Austress Freyssinet have created Austress Menard. Managed by Paul McBarron, this new entity will be active in geotechnic engineering and soil improvement in the region including Australia and New Zealand. It's portfolio of processes and techniques includes Freyssimix jet grouting columns, ground anchors, dynamic compaction, dynamic substitution and controlled modulus columns (CMC).

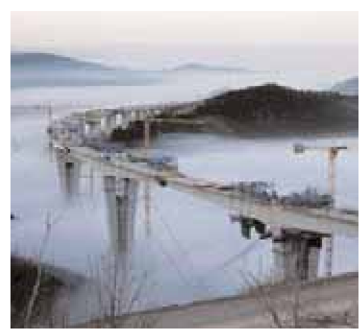
Austress Menard
37, Prime Drive Seven Hills
Sydney N.S.W 2147
austress@freyssinet.com.au

GROWTH

Opening of Freyssinet Adria

Following a few years of successful collaboration in the framework of various projects such as the Crni Kal Viaduct (Slovenia), Freyssinet and the Slovene company Primorje recently created a common subsidiary to develop the activities of Freyssinet and Reinforced Earth in Slovenia, Croatia and Bosnia. Andrej Kosir was named operational director. The new entity was baptized by the general directors of the two groups in the presence of the Economic Expansion Agency (PEE) of the French Embassy in Ljubljana, the press and Slovene television.

Freyssinet Adria
5270 Ajdovscina
Vipavska Cesta 3 Slovenia
Tel.: +386 5 36 90 331
Fax: +386 5 36 90 200


Measuring 1,056 m in length and 26.5 m in width, the Crni Kal motorway viaduct crosses the Osp Valley with piers over 110 m high. Constructed by the SCT d.d. and Primorje d.d., the structure used Freyssinet prestressing the piers and deck.

The Freyssinet Group around the world

Africa and middle-East

Egypt
Freyssinet Egypt
Giza
Phone: (20.2) 345 81 65
Fax: (20.2) 345 52 37

Kuwait
Freyssinet International & Co.
Safat
Tel.: (965) 906 7854
Fax: (965) 563 5384

South Africa
Freyssinet Posten Pty Ltd
Olifantsfontein
Phone: (27.11) 316 21 74
Fax: (27.11) 316 29 18

Reinforced Earth Pty Ltd
Johannesburg
Phone: (27.11) 726 6180
Fax: (27.11) 726 5908

United Arab Emirates
Freyssinet Middle East LLC
Dubaï
Phone: (971) 4 286 8007
Fax: (971) 4 286 8009

Freyssinet Gulf LLC
Dubaï
Phone: (971) 4 286 8007
Fax: (971) 4 286 8009

America

Argentina
Freyssinet - Tierra Armada SA
Buenos Aires
Phone: (54.11) 4372 7291
Fax: (54.11) 4372 5179

Brazil
Terra Armada Ltda
Rio de Janeiro
Phone: (55.21) 2233 7353
Fax: (55.21) 2263 4842

Canada
Reinforced Earth Company Ltd
Mississauga
Phone: (1.905) 564 0896
Fax: (1.905) 564 2609

Chile
Freyssinet - Tierra Armada S.A
Santiago de Chile
Phone: (56.2) 2047 543
Fax: (56.2) 225 1608

Colombia
Stup de Colombia
Bogota
Phone: (57.1) 257 4103
Fax: (57.1) 610 3898

Tierra Armada Ltda
Bogota
Phone: (57.1) 236 3786
Fax: (57.1) 610 3898

El Salvador
Fessic SA de CV
La Libertad
Phone: (503) 278 8603
Fax: (503) 278 0445

Guatemala
Presforzados Técnicos SA
Guatemala City
Phone: (502) 2204 236
Fax: (502) 2500 150

Mexico
Freyssinet de México SA de CV
Mexico DF
Phone: (52.55) 5250 7000
Fax: (52.55) 5255 0165

Tierra Armada SA de CV
Mexico DF
Phone: (52.55) 5250 7000
Fax: (52.55) 5255 0165

United States
Drainage & Ground Improvement, Inc - Ménard
Bridgeville, PA
Phone: (1.412) 257 2750
Fax : (1.412) 257 8455

Freyssinet LLC
Chantilly, VA
Phone: (1.703) 378 2500
Fax: (1.703) 378 2700

The Reinforced Earth Company
Vienna, VA
Phone: (1.703) 821 1175
Fax: (1.703) 821 1815

Venezuela
Freyssinet - Tierra Armada Ca
Caracas DF
Phone: (58.212) 576 6685
Fax: (58.212) 577 7570

Asia

Hong Kong
Freyssinet Hong Kong Ltd
Kwung Tong - Kowloon
Phone: (852) 2794 0322
Fax : (852) 2338 3264

Reinforced Earth Pacific Ltd
Kwung Tong
Phone: (852) 2782 3163
Fax: (852) 2332 5521

Indonesia
PT Freyssinet Total Technology
Jakarta
Phone: (62.21) 830 0222
Fax: (62.21) 830 9841

Japan
FKK
Tokyo
Phone: (81.3) 5220 2181
Fax: (81.3) 5220 9726

TAKK
Tokyo
Phone: (81.44) 722 6361
Fax: (81.44) 722 3133

Malaysia
Freyssinet PSC (M) Sdn Bhd
Kuala Lumpur
Phone: (60.3) 7982 85 99
Fax: (60.3) 7981 55 30

Ménard Geosystems Sdn Bhd
Subang Jaya Selangor
Phone: (60.3) 5632 1581
Fax: (60.3) 5632 1582

Reinforced Earth Management Services Sdn Bhd
Kuala Lumpur
Phone: (60.3) 6274 6162
Fax: (60.3) 6274 7212

Pakistan
Reinforced Earth Pvt Ltd
Islamabad
Phone: (92.51) 2273 501
Fax: (92.51) 2273 503

Singapore
PSC Freyssinet (S) Pte Ltd
Singapour
Phone: (65) 6899 0323
Fax: (65) 6899 0761

Reinforced Earth (SEA) Pte Ltd
Singapour
Phone: (65) 6566 9080
Fax: (65) 6565 6605

South Korea
Freyssinet Korea Co. Ltd
Séoul
Phone: (82.2) 2056 0500
Fax: (82.2) 515 4185

Sangjee Ménard Co. Ltd
Séoul
Phone: (82.2) 587 9286
Fax: (82.2) 587 9285

Thailand
Freyssinet Thailand Ltd
Bangkok
Phone: (66.2) 266 6088/90
Fax: (66.2) 266 6091

Vietnam
Freyssinet Vietnam
Hanoi
Phone: (84.4) 826 1416
Fax: (84.4) 826 1118

Europe

Belgium
Freyssinet Belgium NV
Vilvoorde
Phone: (32.2) 252 0740
Fax: (32.2) 252 2443

Terre Armee Belgium NV
Vilvoorde
Phone: (32.2) 252 0740
Fax: (32.2) 252 2443

Denmark
A/S Skandinavisk Spaendbeton
Vaerloese
Phone: (45.44) 35 08 11
Fax: (45.44) 35 08 10

France
Freyssinet France
Vélizy
Phone: (33.1) 46 01 84 84
Fax: (33.1) 46 01 85 85

Freyssinet International & Cie
Vélizy
Phone: (33.1) 46 01 84 84
Fax: (33.1) 46 01 85 85

Ménard Soltraitement
Nozay
Phone: (33.1) 69 01 37 38
Fax: (33.1) 69 01 75 05

PPC
Saint-Remy
Phone: (33.3) 85 42 15 15
Fax: (33.3) 85 42 15 14

Terre Armée SNC
Vélizy
Phone: (33.1) 46 01 84 84
Fax: (33.1) 46 01 85 85

Fyrom
Freyssinet Balkans
Skopje
Phone: (389.2) 3118 549
Fax : (389.2) 3118 549

Great-Britain
Corrosion Control Services Ltd
Telford
Phone: (44.1952) 230 900
Fax: (44.1952) 230 960

Freyssinet Ltd
Telford
Phone: (44.1952) 201 901
Fax: (44.1952) 201 753

Reinforced Earth Company Ltd
Telford
Phone: (44.1952) 201 901
Fax: (44.1952) 201 753

Hungary
Pannon Freyssinet Kft
Budapest
Phone: (36.1) 209 1510
Fax: (36.1) 209 1510

Ireland
Reinforced Earth Company Ireland (Ltd)
Kildare
Phone: (353) 45 431 088
Fax: (353) 45 433 145

Italy
Freyssinet - Terra Armata SRL
Roma
Phone: (39.06) 418 771
Fax: (39.06) 418 77 201

Netherlands
Freyssinet Nederland BV
Ez Waddinxveen
Phone: (31.18) 2630 888
Fax: (31.18) 2630 152

Terre Armée BV
Breda
Phone: (31.76) 531 9332
Fax: (31.76) 531 9943

Norway
A/S Skandinavisk Spennbetong
Snarøya
Phone/fax: (47.67) 53 91 74

Poland
Freyssinet Polska Sp z.o.o.
Milanówek
Phone: (48.22) 724 4355
Fax : (48.22) 724 6893

Portugal
Freyssinet - Terra Armada
Lisbonne
Phone: (351.21) 716 1675
Fax: (351.21) 716 4051

Romania
Freyrom SA
Bucarest
Phone: (40.21) 220 2828
Fax: (40.21) 220 4541

Spain
Freyssinet SA
Madrid
Phone: (34.91) 323 9500
Fax: (34.91) 323 9551

Tierra Armada Espana, SA
Madrid
Phone: (34.91) 323 9500
Fax: (34.91) 323 9551

Slovenia
Freyssinet Adria
Budapest
Phone: (386) 5 36 90 331
Fax: (386) 5 36 90 200

Sweden
AB Skandinavisk Spaennbetong
Malmö
Phone/fax : (46.40) 98 14 00

Switzerland
Freyssinet SA
Moudon
Phone: (41.21) 905 0905
Fax: (41.21) 905 0909

Turkey
Freysas
Kadiköy
Phone: (90.216) 349 8775
Fax: (90.216) 349 6375

Reinforced Earth Insaat Proje Ve Tic. A.S
Umraniye
Phone: (90.216) 484 4179
Fax: (90.216) 484 4174

Oceania

Australia
Austress Freyssinet Pty Ltd
Seven Hills
Phone: (61.2) 9674 4044
Fax: (61.2) 9674 5967

Austress Menard
Seven Hills
Phone: (61.2) 9674 4044
Fax: (61.2) 9674 5967

Austress Freyssinet Pty Ltd
Melbourne
Phone: (61.3) 9326 58 85
Fax: (61.3) 9326 89 96

The Reinforced Earth Company
Hornsby
Phone: (61.2) 9910 9900
Fax: (61.2) 9910 9999

New Zealand
Freyssinet New Zealand Ltd - Reinforced Earth Ltd
Auckland
Phone: (64.9) 2363 385
Fax : (64.9) 2363 385

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FREYSSINET - 1 bis, rue du Petit-Clamart - 78140 Vélizy-Villacoublay - France - Phone: (+33 1) 46 01 84 84 - Fax: (+33 1) 46 01 85 85 - www.freyssinet.com
Publication manager: Claude Lascols - **Editor:** Stéphane Tourneur (communication@freyssinet.com) - **Contributed to this issue:** Isabelle Angot, Krzysztof Berger, Jean-Luc Bringer, Laure Céleste, Stéphane Cognon, Khalil Doghri, Alberto Gonzales Bueno, Dion Gray, Michelle Haynes, Dominique Jullienne, Likhasit Kittisatra, Patrick Ladret, Salvador Lorente, Paul Mc Barron, Anna Marjanska, Tony Mitchell, Sylviane Mullenberg, Patrick Nagle, Don Palmer-Asbey, Manuel Peltier, François Prongué, Pierre Sery, Alain Tigoulet, Faustino Valero - **Editorial secretariat:** Jean-Marc Brujaille - **Layout:** Idé - **Photos:** Daniel Jamme Camara Millau, Jose Angel Murillo, JF Saborit, StT, Francis Vigouroux, Freyssinet and subsidiaries photo libraries - **Front cover:** Rion-Antirion bridge in Greece (Francis Vigouroux). **ISSN:** n°1763-0142.

ZOOM
Express Construction in Africa

On the future 265 km motorway under construction between Nhaoundéré (Cameroon) and Touboro (Chad), a site far from its bases, Ménard Soltraitement set an amazing record for speed last spring. Active six days out of seven, and in double shifts from the 10th of May to the end of June, the single team sent to consolidate the compressible zones (before initiation of earthworks) installed 27,000 vertical drains for a total of 360,000 ml. This was the equivalent of a daily average of 12,000 ml compared with 4,000 ml achieved by teams in single shift.