Freyssinet

SEPTEMBER/DECEMBER 2002 - No. 215

MAGAZINE

Folder

The benefits of the incremental launching

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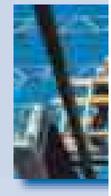
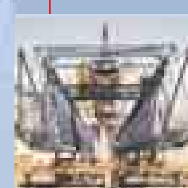
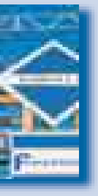




Freyssinet Magazine, 1 bis, rue du Petit-Clamart 78148 Vélizy Cedex – France. Phone: 01 46 01 84 21. Fax: 01 46 01 86 86. Internet: www.freyssinet.com
Publication manager: Claude Lascols. **Project leader:** Stéphane Tourneur. **Contributed to this issue:** Piotr Zamek (dossier), Sylviane Mullenberg, Laure Céleste, Isabelle Angot, Roger Lacroix, Jean-Philippe Fuzier, Andrew Verity, François Bignon, Paul McBarron, Michelle Haynes, Misao Sugawara, Bertrand Petit, Christian Lacroix, Teresa Perez, Stéphane Cognon, François Prongué, Geoffrey Holding, Albert Moizeau, Céline Melhman, Carlos Correa, Muhammad Adnan Ali, Chris Robinson, Patrick Ferraton, Alberto Azevedo Ferrao, Milena Mora, Likhasit K., Krzysztof Berger, Diane Griffiths, Isabelia Fernández, Amaya Arrondo, Dion Gray, Martin Van den Berg. **Layout:** Grafik Tribu. **Translation:** Netword. **Editorial secretariat:** Angeline Blard. **Photos:** Francis Vigouroux, Piotr Zamek, David Houlston, photothèque Freyssinet et filiales. **Cover page:** construction of the Czerniakowski interchange (Poland), photo Piotr Zamek. **Photo-engraving:** Trameway/Grafik Tribu. **Printing:** SIO.

Contents



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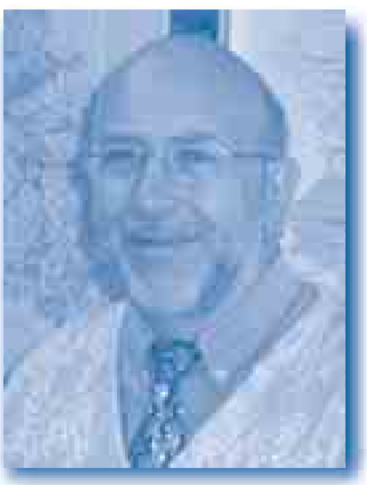
Point of view

HPC, the latest in concrete

BHP – high performance concrete – is strong, durable and ideal for the incremental launching construction method, and has many other advantages. Didier Brazillier is an expert in the subject, and talks to us about this highly technological material.



Didier Brazillier,
Technical Manager of the BHP2000 National Project
He is Manager of the Roads Service at the Yonne DDE (Departmental Development Authority).
'We can assure you that High Performance Concrete (HPC) provides a good solution for reducing bridge service and maintenance costs throughout the world.'

Freyssinet Magazine: What does BHP mean?

Didier Brazillier : The word 'BHP' – (HPC) High Performance Concrete – was originally a French name that has now become generalized throughout the world. It refers to concretes created in the middle of the 1970s for the construction of tall buildings in the United States, Canada and Northern Europe, and particularly in Norway for the construction of offshore platforms. The main criterion in these countries was high strength, in other words the production of concrete with very high 28-day properties. We chose the term 'BHP' in France because, apart from strength, we were looking for a complete set of related performances including durability. The overriding consideration at the Ministry of Development and Clients was to obtain the longest possible life of structures.

What is the difference between HPC and conventional concrete?

The water content has to be reduced to obtain high performance concrete. This is done by using super-plastifier additives that act as deflocculents. The result is a concrete that is still very fluid and that achieves strengths of 50 to 60 MPa. The granular skeleton can then be completed and voids in the matrix are filled in by means of ultra fines such as silica fumes, which are balls with a diameter of about one tenth of a micron. This arrangement further improves the compactness of the concrete and enables strengths of 80 to 120 MPa. We used concrete with a strength of 80 MPa for Jonches bridge.

What are the advantages of the HPC?

I will just mention three advantages. Firstly HPC has high strength, more than 60 MPa. Structurally, it becomes possible to make structures thinner, increase spans and slenderness.
HPCs also simplify construction methods. Concrete can be stripped earlier and construction and tensioning cycles can be optimized. These concretes increase in strength earlier, and when silica fumes are used, dynamic creep takes place more quickly and its absolute value is lower due to the improved compactness (a ratio of 1 to 2 compared with conventional concretes). In a bridge made of prestressed HPC, 80 to 90% of the final deformation of the construction takes place shortly after construction. It is then possible to adjust tendon or stay cable tensions without having to anticipate force redistributions.
Finally, HPCs are very durable. We have been working in this direction within the BHP2000 program that brings together about fifty different partners from a wide variety of industries (clients, main contractors, contractors, laboratories, etc.) and was set up at the initiative of the Ministry of Development and Research, to find uses of these concepts in civil engineering applications, and we have been working in cooperation with European laboratories to create consistent operating methods on carbonation of concrete and penetration of chloride ions. Five years ago, we made test cylinders from different concretes varying from B20 to B120 that we had pre-cracked to evaluate their behavior in the long term in different environments – seashore

BHPs ‘are systematically used on large projects such as the international Rhine bridge’.

with tides, mountain, etc. We now have sufficient hindsight to establish a scientific and empirical classification of different concretes with respect to each other. Having seen the encouraging results, we can confirm that HPC provides a good solution to reducing the costs of servicing and maintenance of bridges throughout the world. Specifically, carbonation of 30 or 40 MPa concretes reaches 25 to 30 mm after a few years, whereas the value for BHPs trapped in a confinement saturated by carbon dioxide after several months of accelerated aging, is only a few millimeters. This short period corresponds to about twenty years in reality!
We have made measurements on Joigny bridge and on Ré Island bridge built about ten years ago, which confirm the good results of the HPC in terms of carbonation and penetration of chloride ions.
Another non-negligible advantage is that HPCs are highly sophisticated materials that require very strict monitoring and therefore perfect traceability, which is an assurance of quality.

How will HPCs change?

Technological progress will be made with self-placing concretes and Ultra High Performance Fiber Concrete. The objective for self-placing concretes will be to improve the placement, rather than improving the strength or durability. Ultra High Performance Fiber Concrete are materials that eliminate the need for any passive reinforcement and strengths of 150 to 200 MPa are possible due to a very fine size grading.
We still need to improve the fire resistance for HPCs. Tests carried out at the CSTB (Centre Scientifique et Technique du Bâtiment - Scientific and Technical Centre for Building Construction) only gave an inkling of a solution. We have not yet succeeded in modeling the behavior of structures made from HPC under fire, any more than we have for ordinary concretes, but we have been able to show that B 60 concrete satisfies the conventional requirements of DTUs (Documents Techniques Unifiés - Technical Recommendations) and moreover, with particular construction requirements such as the use of a welded mesh type reinforcement, we can ‘sew’ the concrete in place to achieve safety for users.

Will HPC become widespread?

HPC is already used wherever standard precast elements such as pipes, precast beams with bonded wires, etc., are used. They are systematically used on large bridge projects such as the international Rhine bridge, but they are not always used on medium span bridges.
I think that we need to convince main contractors and architects now. This is one of the purposes of the national BHP2000 program. We are working on determining thresholds and operating methods to be able to write specifications defining a required durability rather than observing the durability after construction, and therefore requiring the use of specific materials. We also have a role to play in regulation. Up to now, there have been three main steps, with regulations for B40 concretes in 1988, B60 in 1992 and recently B80. Eurocodes are looking even further and mention B100, which suggests a new regulatory step in coming years.
We are also carrying out various actions at architect's schools, particularly through the Ecole Française du Béton (French Concrete School). HPCs enable good ‘upgradeability’ of structures, which is an attractive concept for this profession.
Another promising theme that is becoming stagnant for technological reasons is the combination of HPC and high performance reinforcement. Japan is working in this direction and the results so far are good.

Why was this material chosen to build the Jonches bridge (see article p.10) ?

Jonches bridge is a medium span structure for which a steel solution seemed best. We wanted to demonstrate that we could construct a bridge at equivalent cost, using HPC. In the long term, the HPC solution was even more economic due to the lack of major maintenance.
Furthermore, and very importantly, HPC contributes to sustainability. For the same functional solution, the volume of materials used is much lower for a HPC bridge than for a structure made of conventional concrete, in other words the amount of energy required is lower and there are few non-renewable elements. These bridges are designed to last, and therefore make a direct contribution towards sustainability.

For Jonches bridge, ‘we wanted to demonstrate that we could use HPC to construct a bridge at a cost equivalent to the cost of a steel bridge’.

Brazil

Freyssinet Brazil celebrates its 50th anniversary

The history of the Company began on September 23, 1952, when it was registered at the State of Rio register of commerce. Its name was then STUP SA (Sociedade Técnica para a Utilizaçao da Pré-Tensao), Freyssinet processes. Its first general manager was André Denizou, French Engineer from Campenon-Bernard who returned to France in 1954 and was replaced by the Brazilian Engineer Carlos Freire Machado. Freyssinet Brazil is now fifty years old and can take pride in the many prestigious projects to which it participated. Some of the most important include the Galeão Bridge in Rio de Janeiro (1952); the Rio – Niterói bridge in Rio de Janeiro (8.3 km on the sea); Tucuruí Rio Tocantins dam in the State of Pará, in Brazil (23 gates - 68 000 l/sec); the Iguaçu International bridge between Brazil and Paraguay; the three Brascan Century Centenário Towers in Sao Paulo; the Linha Amarela Viaducts in Rio de Janeiro; Lapa cable stayed bridge in Salvador de Bahia; the Feira de Santana elevated Reservoir in Bahia (2000 t); retaining walls for the Recife Metro (Pernambuco station); the two Centro Cultural Tomie Ohtake Towers and the Bank of Boston head office in Sao Paulo; and finally the main building of the Higher Court of Justice in Brasília.

Venezuela

Walls for Cocodrilo's Racquet Park sports club

Cocodrilo's Racquet Park is a prestigious private sports club at Cota 905 in the Caracas valley. In this area with broken relief, club shareholders decided to develop the site to form horizontal areas and to construct sports grounds and green areas set aside for leisure. Therefore, 1,700 m² of *Reinforced Earth* foundations were constructed to an average depth of 15 m, which blend perfectly into the landscape.

Switzerland

Car park in the heart of Lausanne

Freyssinet S.A. has been participating in the construction of an underground car park in the center of Lausanne, that started in September 2001 and is due to be finished in October 2002. The 147 m long and 32 m wide car park will provide 639 parking places on four different levels. The floors are prestressed by post-tensioning using 182 t of steel tendons, including 725 nos 4T15S tendons and 111 nos 13T15S tendons. This technical solution limits the number of columns and thus optimises the internal layout (peripheral walls and central columns).
This car park is designed so that a future extension will be possible.

Participants
Client: *Vinci Park & LO Holding S.A.*
Main contractor: *Losinger Construction AG*
Specialised contractor: *Freyssinet S.A.*
Civil Engineers: *CSD-Monod Lausanne*

Award

2nd price for Freyssinet in the Siemens competition

Freyssinet won an award on June 19, 2002 at the Siemens competition organized for the second consecutive year by Siemens France. The Group received the 2nd prize in the building / public works category for its *Régébéton* process.
This process patented by Freyssinet realkalinizes a carbonated concrete and decontaminates a chlorinated concrete. It consists of an electrolytic paste applied to the concrete surface. A sacrificial anode is embedded in the paste and is connected to the concrete reinforcement bars thus setting up an electric field that extracts chlorine ions. This technique treats a structure without modifying its operation, and maintains the original surfaces.
This process is now being put into application for the first time on one of the bridges on the Cofiroute network south of Tours, and on the A7 motorway south of Valence in cooperation with Sogea Rhône-Alpes.

Spain

Precast works for Torrente viaduct

Tierra Armada S.A., a subsidiary of Freyssinet in Spain, participated in the construction of the Torrente viaduct at Durcal near Granada; the company supplied some of the precast elements.
This curved structure is 444 m long and 13.5 m wide and is composed of two parallel decks comprising twelve 37 m long spans. Each deck is composed of four beams with a weight of 60.5 t and 2 m thick, at a center-to-center distance of 3.95 m.

Participants
Client: *Ministry of Public Works*
Main contractor: *Dragados et CNES*
Specialised contractor:
Tierra Armada S.A.

In memoriam

Henri Lemoine left us

Henri Lemoine died on July 28 2002. He was born on May 23 1916, and joined the STUP on September 1 1946 at the request of Louis Burgeat. He was entrusted with aministrative, legal and financial responsibilities for the recently created company. He was successively appointed as General Secretary, Deputy General manager, General Manager before becoming President of Freyssinet International (STUP) in 1980 and then retiring in 1981. He initiated many remarkable achievements such as the creation of STUP's R&D subsidiary, Europe Etudes company in 1961, or GPN (Groupement pour la Précontrainte Nucléaire) in 1976, a company specialised in prestressing applied to nuclar facilities. But Henri Lemoine was above all the company's pivot during 35 years. Convinced of the extraordinary potential of Eugène Freyssinet's invention, he will make prestressing a worldwide reality. Under his command, STUP will become a very unusual company with many activities including a design office, prestressing university, industrial company distributing its products, know-how and its art of construction throughout the world.
His human qualities, diplomatic talents and his capacity for hard work, helped federate the strong personalities surrounding him and develop the company's interests throughout the world. We express our sincere regrets to his family and to his love ones.

25 January 1979: Jean-François Deniau, minister for foreign trade, awarded the Export Oscar to Henri Lemoine, general manager of Freyssinet STUP.

Turkey

85,000 m² of bridges and tunnels

When the Turkish Motorways Department decided to build a motorway in the South of the country in 1993 (between Toprakkale and Iskenderun), it chose the *Reinforced Earth* technology for the construction of bridge abutments, access ramps and retaining walls. The Reinforced Earth Company (REAS) started working on the project in 1998 and since then has built about 85 000 m² of structures of all types made of *Reinforced Earth*. In terms of the total area, this is one of the largest *Reinforced Earth* projects carried out anywhere in the world.

United Kingdom

Extensions to Plymouth shipyards

Freyssinet has been awarded an extension to its subcontract for the Plymouth dockyard (Devonport Royal Dockyard) modernization program, to install 75 mm prestressing bars on the mooring station in the submarine dry dock complex. The extension to this contract includes an order for 89 additional ground anchors, all fully anti-corrosion treated and measuring 42.5 m long for a working load of 2,100 kN. They are installed at an inclination of 11° in a new reinforced anchor trench.
The installation and prestressing of the anchors take place during an 8 to 10 week program with restricted access and working areas; it is done at the same time as the work for demolition and reconstruction of the front wall of the mooring station and the anchor trench done by the main subcontractors.
By the end of this work, Freyssinet will have supplied and installed almost 500 ground anchors for Plymouth dockyards since 1999 (in 4 separate contracts).

Main characteritics:

Czerniakowski bridge

- Viaduct length: 806 m
- Number of decks: 2
- Number of spans per deck: 22 including 16 constructed by incremental launching
- Curved decks - radius: 1 300 m
- Centered post-tensioning: 235 t of prestressing steel per deck
- Service post-tensioning : 112 t of prestressing steel per deck
- Construction time: October 2001 – May 2003

Jonches bridge

- Bridge length: 135 m
- Concrete quantity: 2000 m^3
- Prestressing: 40 t of steel
- Re-bars: 230 t
- Formwork: 5500 m^2
- Structure weight: 2600 t

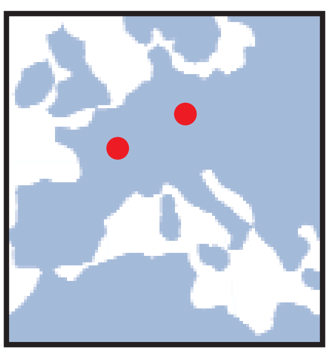
Two parallel decks form the Czerniakowski interchange. They are built using the incremental launching method.

digest

Road works

The benefits of the incremental launching

Freyssinet is now participating in the construction of two bridges, one in



Warsaw and the other in Jonches. An opportunity to discover two different bridges, each adapted to the configuration of its site and built using the incremental launching method.

The Warsaw Czerniakowski interchange, 590 m bridge pulled by a cable

The Siekierkowski project is almost 4 km long and is a major new road in Warsaw in Poland. Its far western end ends at the impressive Czerniakowski interchange.

THE SIEKIERKOWSKI ROAD IS LOCATED SOUTH of the Polish capital and will shortly be open to traffic. It will be the eighth bridge crossing over the Vistula and is designed to reduce traffic congestion. At the West end where much of it has already been built, the road is about 3.7 km long in the east-west direction. This is the distance between Siekierkowski bridge and the Czerniakowski interchange which is the end of the project. This interchange is now under construction, and will carry the new road over Czerniakowki street that carries traffic between the north and the south of the capital.
Two parallel decks are the main elements of the interchange. The two form a continuous curve with a radius of 1 300 m. There are also conventional link roads, some of which span over the crossroads at a height of almost 12 m.
The length of each deck is 806 m, and each carries two traffic lanes. They are built partly using the incremental launching technique. A 590 m long section of the total length of 806 m is built by incremental launching, composed of fifteen spans with an average length of 39 m.
'The last six spans at the far west end of the viaduct are cast in situ', says Michal Wójcicki, works supervisor for Freyssinet Polska. The structure is extended by an access ramp that uses the *Reinforced Earth* technique.

Formwork developed in France

Each deck is made of 19.50 m segments, each representing half a span. Pouring is done in two steps, firstly the bottom slab and the webs and secondly the top slab. Michal Wójcicki tells us that *'the formwork was developed by Patrick Ferraton, the methods manager in Freyssinet International's Engineering Department'*. In fact, Freyssinet is playing an important part in the project. *'We participated in the design, we defined the size of the segments, we chose the prestressing and incremental launching principles and we designed the sliding bearings'*. The Freyssinet's Polish subsidiary also designed the front nose, for which the drawings and the assembly were done on site. It also provided technical assistance for construction of the decks.

Incremental launching at 8 m per hour

Forty-eight hours after concreting, the segment may be tensioned by centered prestressing. Twelve 13C15 type tendons are necessary for the operation. *'Each tendon extends through two segments,* explains the work supervisor. *Consequently, when a segment is being tensioned, only six tendons are prestressed at any one time'*. They are arranged with two near the bottom and four near the top. The tension applied to each tendon is about 290 t to generate a neutral moment in the structure.
Incremental launching is done immediately after tensioning. Incremental launching takes place each week, for each deck. Generally, the operation takes 2h30, at a rate of 8m/h. The method chosen is 'pulling by cable'. There are four SL 230 type tension jacks (two for each deck), placed behind the first pier. *'The tension force for ten segments is equal to 2 x 100 t'*, says Michal Wójcicki. It is applied through 2 x 12 T15.7 strands. The number of strands at the end of incremental launching will increase to 2 x 19.

424 t tension in the final phase

A bracing system in front of the pier resists longitudinal forces applied to the pier during each incremental launching operation. A temporary reinforced concrete bearing pad has been installed between the abutment and the first

pier, to eliminate the risk of buckling of structure. A small innovation is that the formwork itself is also supported on temporary bearing pads. *'Thirty one incremental launching operations will be necessary to install a complete deck, plus one additional incremental launching to release the formwork'*, says the work supervisor. These operations must be completed at the end of this year.

The final step in the construction of the decks is the 'service' post-tensioning. This will be done at the beginning of 2003. It will be external and will be composed of four 19C15 tendons enclosed in 110 mm diameter HDPE ducts into which a cement grout is injected.

'Each cable will be about 80 m long, so that two spans can be connected together using the same implementation technique as for centered prestressing', concludes Michal Wójcicki. The final applied tensions will be 424 t on each set of nineteen strands.

Participants

Client: *Municipality of Warsaw - Downtown district*
Design office: *Transprojekt Gdansk*
Contractors: *Dromex - Mostostal Warszawa Consortium*
Main subcontractor: *Warbud (Vinci subsidiary)*
Prestressing: *Freyssinet Polska (subcontractor of Warbud)*

Doubling up the Jonches bridge, 2600 t pushed on sliding rails

A second Jonches bridge is under construction between the Appoigny and Auxerre in France interchanges to improve the crossing over the Yonne.

THE PROJECT TO BUILD A SECOND JONCHES bridge will make a second crossing over the Yonne, and forms part of the State-Burgundy region 12^{th} plan. The new 135 m long bridge will carry two new traffic lanes and a pavement to carry pedestrians and cyclists.

Incremental launching

To combine quality, speed and protection of the environment

The incremental launching construction method is based on construction of the deck close to the gap to be crossed, and placement by successive incremental launching operations. This technique can be adapted to all types of constant depth decks, including concrete, steel or composite bridges for spans of about 45 m. It is used mainly for bridges several hundred meters long composed of a large number of spans. However, the geometry of the bridge must be adapted to the method. A bridge is incrementally launched according to a precise program. The deck is built in successive segments, usually by in situ casting, behind the abutment on a fabrication area. Each element is then assembled to the previous element by centered prestressing. The formwork around the structure is then removed and the structure is placed on bearings so that incremental launching itself can be started. These bearings facilitate displacement of the deck while reducing the coefficient of friction. The structure is equipped with a steel front nose or a temporary cable stayed mast supporting the deck, to facilitate the deck landing on the different piers. Temporary supports may also be built to reduce span lengths during the incremental launching operations.

Several incremental launching techniques can be used as a function of the configuration of a site or the structure type. Incremental launching may be done using jacks:
- by pulling on a cable or an assembly of bars;
- by direct incremental launching;
- by a system installed on the abutment or the pier, so that the deck can be lifted or moved.

This technique has a number of advantages including:
- elimination of falsework and scaffolding;
- less formwork, used in a better manner;
- an increased manufacturing quality due to an area protected from the weather;
- the low cost of the means implemented;
- better protection of the environment;
- higher execution speed.

In Freyssinet magazine No. 211 (May-August 2001), Jean-Marie Cremer declared the following about the Sart canal bridge built by incremental launching: *'The choice of incremental launching for the canal bridge enabled us to build a bridge with a quality higher than the average. We chose this method because of its many advantages, our objective was not to beat the world record by incrementally launching 65,000 t'*.

A first in France

The bridge is built behind the abutments on the right bank of a prefabrication platform. It is then pushed on sliding rails towards its bearings across the river using hydraulic jacks with a capacity of 200 t. This construction method was chosen due to its advantages and particularly because it avoids the need for the construction of temporary supports in the river.
Five days were necessary for placement of the 2600 t structure at a rate of 3 m per hour. Incremental launching of this two-girder concrete structure is a first in France. A high performance concrete (HPC) was used to reduce the weight of the deck in order to facilitate incremental launching. This material is also more durable than 'conventional concretes'.
The deck of the new bridge contains 40% less prestressing steel and 36% less concrete than its existing twin bridge, while its surface area is 27% greater. It is post-tensioned by eight external tendons.

Participants

Client: *Government of France*
Contract Management: *Yonne DDA (Departmental Development Authority)*
Main contractor: *SNCTP Group, Freyssinet, Bauland*

Question to…

Philippe Merlaud, Manager of the Bridges Design and Construction Unit in the Yonne Department Civil Engineering Directorate

Why did you prefer the incremental launching solution for Jonches Bridge?
The option of pre-casting on falsework was very quickly put aside, particularly because the criteria imposed by the navigation service included shocks by 1000 t ships on temporary supports. This would have made it necessary to construct a major temporary structure on which the final bridge would have been built. We then studied two possibilities; construction of a launched composite steel-concrete structure, and an incrementally launched concrete structure; the second solution was selected to remain harmonious with the existing bridge.
Incremental launching of a structure of this type (two-girder concrete structure) was made possible due to the use of B80 high performance concrete (HPC), which enabled us to reduce the weight of the structure while achieving very good tension and compression strength. For comparison, the new Jonches Bridge is aesthetically very similar to its twin bridge (about ten years old), but its design is quite different. Its surface area is 25% greater while the concrete volume is one third less. The girders in the old bridge were cast in situ on falsework and are 120 cm deep and its top deck is 25 cm thick, while the corresponding dimensions for the new bridge are only 55 cm and 15 cm.
We wanted to design an optimised bridge in terms of materials, maintenance and durability. The choice of external prestressing is also consistent with this approach by participating to the slenderness of the structure and facilitating subsequent maintenance.

Motorway bypass

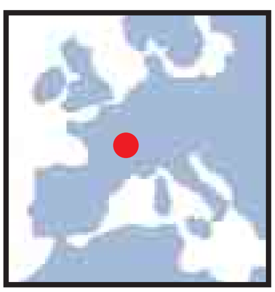
Record contract in Birmingham

Reinforced Earth UK is participating in the construction of the M6Toll, the first toll motorway in the United Kingdom.

The Birmingham northern relief road is the largest highway construction site now under way in the United Kingdom. Its name (M6Toll) was chosen as it is the first toll motorway in the United Kingdom. This bypass is designed to reduce traffic on the M6 motorway which carries some of the heaviest traffic in Europe. There are 45 kilometers of new road including many bridges are now under construction to achieve this.
Reinforced Earth UK, a subsidiary of the Group in the United Kingdom, has designed and supplied the *TerraClass* concrete facing panels and galvanised steel reinforcing strips to forty bridges on the scheme.
The work consists mainly in the construction of load bearing abutments with a few mixed abutments and retaining walls.
It is the largest contract even won by Reinforced Earth UK; the Company will have delivered almost 23,000 m^2 of surfaces with more than 500,000 m^2 of reinforcement between August 2001 and August 2002.

France

Poincaré Bridge in Lyon

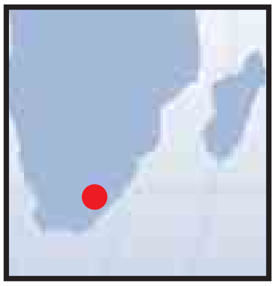


Repair above the Rhône

Poincaré bridge upstream from Lyon needed some repairs. Freyssinet did this work.

The RN 383 highway between Villeurbanne and Caluire upstream from Lyon crosses the Rhône on a reinforced concrete bridge with a total length of 272.5 m. This is Poincaré bridge, a strategic bridge for traffic in the Lyon area, which serves the Tonkin and Doua districts in Villeurbanne, the international city and La Pardieu districts in Lyon, and the North ring road.
This bridge consists of five spans composed of six girders with variable depths carrying an 18 m wide road surface (six traffic lanes each 3 m wide), and was partly damaged; the bearing struts were degraded as a result of water infiltration at expansion joints, causing cracks, spalling and oxidation of exposed steel.
Therefore, Freyssinet carried out a feasibility study and replaced the bearing struts. The work started on the span at the left bank in March, the first phase of work was the placement of a temporary steel structure capable of releasing the load carried by each line of struts using jacks, and a lever effect. Afterwards, the load was removed from the bearing rods that were then replaced by 600 mm high stainless steel struts. Freyssinet also replaced the expansion joints, repaired the concrete, replaced the inspection gangways and repaired the foundations.

Miscellaneous infrastructures



Two sites for the 'renaissance'

South Africa would like to make its mark on the international scene and is now attempting to achieve a socio-economic renewal. Infrastructures are slowly being improved in the field.

A new terminal for Johannesburg airport

SINCE JANUARY 2001, FREYSSINET POSTEN, Freyssinet's South African subsidiary, has been working on the construction of the new terminal for domestic flights (DOMTEX) at Johannesburg airport.
Due to the importance of the work, this site has been divided into several packages. The largest applies to the main building, for which Freyssinet Posten has post-tensioned more than 55,000 m^2 of waffle slabs using the Freyssinet monostrand system.
Spans are 15 m in both directions and comprised of 525 mm deep waffles with a 125 mm slab supported on 1,200 mm wide beams.
In addition, Freyssinet Posten secured the post-tensioning to the new car-park extension and the extension to the terminal building. While on site, Freyssinet Posten also carried out specialist repair work comprising of grouting and handling.

Maitengwe bridge restores communication

FOR THABO MBEKI, THE PRESIDENT OF South Africa, the new century will be '*Century of Africa or the African renaissance*'. The African political scene has changed at the beginning of this century. The African Unity Organization, that has now become the African Union or NEPAD (New Partnership on African Development) has evolved, and some countries in the South African subcontinent are now attempting to eliminate commercial and customs barriers. Social questions and economic aspects are also being considered and many investments are being made in the infrastructures in the region. Thus, new water reservoirs and new roads are under construction.
The bridge over the Maitengwe River is a good example of this 'renaissance'. The Maitengwe River forms the boundary between Botswana and Zimbabwe, and the village of Maitengwe straddles the river and the international boundary. The river only flows on the surface for two weeks a year and then disappears under the sand. The Government of Botswana decided to build a bridge across the river to facilitate communication between inhabitants of the village and between the two countries. The bridge includes four prestressed concrete spans. The contractor is Murray & Roberts, and Freyssinet Posten is responsible for post-tensioning, using the Freyssinet multistrand system. The tendons are composed of fifteen 15.7 mm diameter strands tensioned both ends simultaneously.

Railways

Taipei – Kaohsiung at 300 km/h

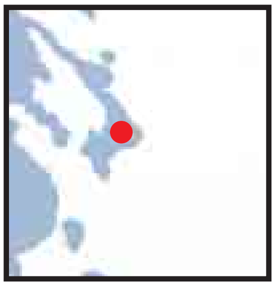
A symbolic shovelful symbolized the start of construction of the high speed railway between Taipei in the north of Taiwan, and Kaohsiung in the south, at the beginning of 1999.
Work on this enormous site spanning two centuries has been continuing at full speed ever since this date.

THE 348 KM NEW HIGH SPEED RAILWAY CROSSES the largest built-up areas and the most important industrial, government and business centers on the western side of the island of Taiwan. It comprises many structures including 253 km of bridges and viaducts, 63 km of tunnels and 32 km of embankments. This line is the first infrastructure project in Taiwan based on the BOT (Build-Operate-Transfer) system for a 35-year period. Trains will travel at a maximum speed of 300 km/h along the line, taking 90 minutes to travel between the two cities.

Freyssinet is working on 5 of the 12 sections

The civil engineering work for this major project has been broken down into twelve sections. Freyssinet is working on five of these sections, on contracts C210, C215, C230, C240 and C291. Contract C210 covers 11 km. Along this section, Freyssinet has designed and supplied 240 pot bearings and is in charge of the construction of two 160 m and 170 m long cantilever span decks. The Company is responsible for the conceptual and detailed design of the mobile formwork travelers deck construction methods, and for the supply and installation of 700 t of prestressing steel. Contract C215 is the longest section, with a length of 40 km.
Four methods of construction are encountered on these exceptional long viaducts: the full-span precast method which is employed on a continuous 30 km stretch, and the cast-in-situ methods with Mobile Scaffolding System; the Free-cantilever travellers and conventional ground shoring.
Freyssinet is participating in construction of eight viaducts built by cantilever construction, with lengths varying between 110 and 220 m. Apart from the study on viaduct construction methods and designing of the mobile formwork travelers, the Group's contract also includes the supply of almost 3500 pot bearings and the supply and installation of 3000 t of prestressing tendons. The pot bearings are designed to withstand uplift forces to prevent the griders from over-turning under seismic action.
Freyssinet's work for contracts C230 and C240 (23 and 21 km long respectively) applies to the supply of prestressing materials and equipment and supervision of the post-tensioning work.
The service provided for the 29 km section in contract C291 is similar but excludes supervision of prestressing operations.

Kurobegawa railway bridge



A successful combination of steel and concrete

FKK, Freyssinet's licensee in Japan, has been participating in the construction of Kurobegawa bridge since March 2001. This is a major bridge on the Hokuriku Shinkansen high speed railway line.

THE HOKURIKU SHINKANSEN IS ONE OF JAPAN'S high speed train lines. Like the rest of this railway network, it is being constructed within the framework of an economic development plan for the country and is intended to promote activities in the regions through which it passes. This new 600 km long line will join Tokyo and Osaka, and passes close to Nagano, Toyama and Kanazawa. Kurobegawa bridge is on this line near Nagano and Tayama. It is a 761 m long box girder post-tensioned by internal and external tendons including 19K15 anchors, composed of fifteen spans: six 344 m long continuous spans with corrugated webs (between piers P4 and P10), six continuous 300 m long spans and three 45 m, 40 m and 32 m long spans.

A first in Japan

This structure is the first prestressed corrugated web railway bridge to be built in Japan. Designers needed to draw up an efficient means of making the junction between the steel and the concrete in this configuration, which in the past had only been used for motorway structures. Thus two solutions were envisaged; the first was to not bind the steel with the concrete; and the second, which was adopted, was to make the two materials composite. This was achieved using plane steel plates bolted to the folded webs.

Materials with limited maintenance

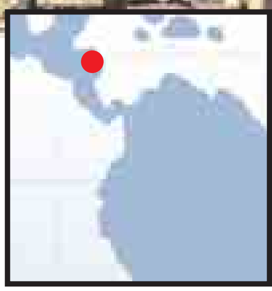
The trend over several years has been to build steel structures (particularly bridges) that only require low maintenance. Therefore, it was preferred to use materials that are resistant to atmospheric aggression and therefore that can be installed without any coating.
However, its use was excluded in coastal areas where the salt content in the atmosphere is high. Improvements to the material now enable its use without any protective coating in locations where it could not be used before. Construction of this bridge will be completed in February 2004.

Participants

Client: *Japan Railway Construction Corporation*
Design: *Japan Bridge & Structure Institute Inc.*
Main contractor: *Oriental Construction Co, DPS Bridge Works Co. and Kowa Concrete Co partnership*
Specialised contractor (prestressing): *FKK*

Reconstruction

Three restored bridges



Following the damage caused by hurricane Mitch, Freyssinet de México has been working on the reconstruction of three bridges near Tegucigalpa, the capital of Honduras.

Hurricane Mitch crossed Central America in October 1998. The Republic of Honduras was more severely affected that its neighbours and it suffered severe damage to motorway and road infrastructures, which is still hindering commercial development of the country. The Japanese government decided to provide financial assistance by granting the reconstruction of three bridges, the *Juan Ramon Molina*, the Río Hondo and the *El Chile bridges*, close to Tegucigalpa (the capital of Honduras), to consolidate its friendship with Central American countries. The work was then awarded to the Konoike Construction Ltd from Japan.

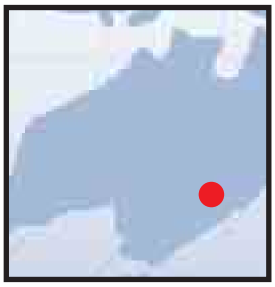
Taking account of flood risks

These bridges consist of simple spans with 'T' precast concrete girders, prestressed intermediate and end cross beams and a transverse prestressed concrete slab over its entire width. Freyssinet de México is working for the subcontractor, Kier International from United Kingdom, and participated in the precasting of forty-six concrete 'T' beams to form the deck. A total of 240nos. of 12T13 longitudinal prestressing tendons were installed. The beams were assembled temporarily using prestressing bars. The work continued with the construction of cross beams and the deck slabs that are transversely prestressed with 630nos. of 1T22 tendons. Due to the topography of ground and the risk of flooding during future hurricanes, the very large and very heavy beams were placed using falsework (launching girder) supplied by Freyssinet. This launching girder is capable of lifting 150 t elements, and was used on the three structures at a daily rate of up to three 40 m long beams weighing 130 t.

Participants

Consulting company: *Central Consultant Inc. and Pacific Consultants International*
Main contractor: *Konoike Construction Ltd*
Subcontractor: *Kier International Group*
Specialised contractor: *Freyssinet de Mexico, S.A. de C.V.*
Freyssinet construction methods: *Iberia-American Technical Department*

Bermuda shopping centre



Dynamic replacement and compaction

Austress Freyssinet has entered a partnership with Menard Soltraitement to stabilize a site on which a 32,000 m² supermarket and retail complex will be built!

Eastlink Projects is planning to build a shopping village complex immediately adjacent to an existing residential housing estate, as part of the Varsity Lakes development in Robina on Queensland's Gold Coast in Australia. The 6-hectare site on Bermuda Street (opposite Bond University) will be developed in two stages. Stage 1 consists in building a 32,000 m² supermarket, specialty retail shops, fast food outlets, a petrol station and associated car parks.

A very precise specification

This site had lain dormant awaiting a suitable cost-effective use, due to its difficult underlying ground conditions. The geology varies greatly since it includes medium dense to dense sands in the southern end, and 5 to 6 m thick very soft organic clays in the north eastern end, overlain by very old topsoil.
The building specification allowed for a maximum settlement of the foundations equal to 40 mm and maximum differential settlements of 15 mm in 10,000 mm. In order to meet these design requirements as closely as possible, Austress Freyssinet worked with Menard Soltraitement to develop a fully turnkey design and construct a solution utilizing dynamic replacement and compaction techniques. This integrated solution proved to be more efficient and economic than the use of concrete piles. Construction and implementation of the ground improvement processes was thus started and required 41 days. Due to the close proximity of residential housing, Austress Freyssinet took great care not to disturb existing residences; and through careful monitoring, the company was able to minimize vibrations and noise, keeping them well below allowable levels.

Skills at all levels

A large construction site was necessary to implement this solution, on which Austress Freyssinet worked as the Main Contractor. A fixed contract was agreed upon, which included the following phases:

1- Preliminary phase:
- Construction of temporary site access
- Cleaning and grubbing
- Preparation of the 70 000 m³ borrow pit for building platform materials
- Condition surveys of 19 residential houses immediately adjacent to the site

2- Ground improvement phase
- Additional site investigation and trial compaction
- Dynamic compaction – 10 000 m²
- Dynamic replacement – 10 000 m²

- Ironing compaction – 12 000 m²
- Verification testing – Plate load tests and pressuremeter tests

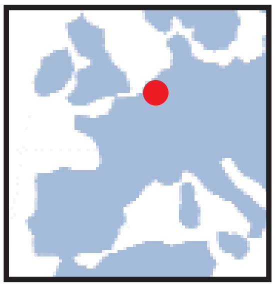
3- Earthworks
- Winning, transportation, placement and compaction of about 50 000 m3 of bulk fill
- Excavation and drainage
- Final trim of building platforms
- Turfing of drainage areas
- Environmental, storm water and acid sulphate management

The work commenced in April 2002 and was successfully completed in July 2002.

Participants

Client: *Eastlink Projects Pty Ltd*
Consulting engineers: *Weathered Howe Pty Ltd*
Main contractor: *Austress Freyssinet Pty Ltd*
Specialised contractor: *Menard Soltraitement*
Earthworks: *Lund Constructions*

A4-A5 link road



Cruciform-shaped TerraClass walls

Terre Armée b.v. in the Netherlands participated in the construction of three viaducts to connect the new A5 motorway to the existing A4, in early 2003.

Construction of the new A5 motorway close to Schiphol airport in the Netherlands is well advanced. This new 8 km segment is being constructed by The A5 Building Team (a group composed of the government, a design office and five contractors), and should be open to traffic in 2003.

Among the programmed work, this project includes the connection of the new A5 to the existing A4 motorway, which necessitated the construction of several link roads and three viaducts. The bridge 'KW 402 a' and 'KW 402 c' abutments are supported on steel piles linked by sheet piles. Terre Armée b.v., a subsidiary of the Freyssinet Group in Holland, designed single piece panels coated with a *TerraClass* surface to conceal the sheet piles. The largest panels are 6.41 m high and weigh 4 t. The main contractor made a special set up for fast and safe installation of the elements.

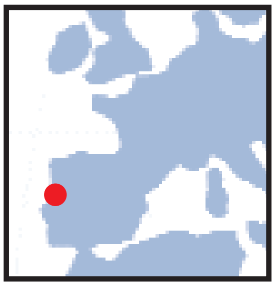
A total of 876 m² of panels are to be installed on the abutments of the two bridges. The wing walls of bridges KW 402 a and c, and access ramps to bridge KW 402 b, will be made from *TerraClass* retaining walls. A total additional area of 4,063 m² of *TerraClass* walls will be constructed during the third and fourth quarters of 2002.

The joint use of single piece panels and standard *TerraClass* walls will harmonize the abutments and wing walls by improving the aesthetics of the cruciform shape.

Participants

Contractor: *Ministerie van Verkeer en Waterstaat; Rijkswaterstaat*
Consultant: *Oranjewoud b.v.*
Contractor: *Joint-venture between Kunstwerken A549, BAM-NBM Beton- en Industriebouw b.v., HBG-Civiel b.v.,Van Hattum en Blankevoort b.v., Koop Tjuchem b.v., Dura Vermeer Groep b.v.*
Design office and specialised contractor: *Terre Armée b.v.*

Infant D. Henrique bridge



A very thin arch

Freyssinet – Terra Armada cooperated for construction of the Infant D. Henrique bridge, a very thin arch bridge built in the heart of a World Heritage site.

THE PROJECT TO EXTEND THE PORTO METRO line, particularly the section between St. Ovídeo–Vila Nova de Gaia (in the south) and Porta São João hospital (in the north), will cross over the existing Luis I road bridge over the Douro. This solution – which would create a severe disturbance for road users who would be deprived of any connection between the towns of Vila Nova de Gaia and Porto separated by the river – required the construction of a new bridge over the Douro, namely the Infant D. Henrique bridge.

Therefore, an international call for bids for the design and the construction of the future bridge was published in the official European community journal in May 1997. The contract was awarded to the EDIFER/NECSO group which proposed the construction of a very thin arch bridge. The designer paid very special attention to the aesthetics of the structure in this site classified as a World Heritage area, to make it blend perfectly into its environment, to adapt it to the escarpments on the bank and make it architecturally harmonious with the other bridges over the Douro.

280 m arch

The 371 m long Infant D. Henrique bridge is a reinforced and prestressed concrete structure built span by span with cast in situ segments. It is composed of four spans above the Douro (28 m, 35 m, 280 m, 28 m), and two spans (19.5 m and 12 m) prolonging the bridge on the Porto side. The 20 m wide deck will carry 2x2 traffic lanes separated by a central barrier and 3 m wide footpaths on the sides. The 280 m long arch has an overall depth of 25 m which is quite exceptional for this type of structure. The deck is a box girder with a constant depth of 4.50 m, except for the central 70 m part which is 6 m deep where it meets the arch (1.50 m thick). The top slab is 11 m wide with two 4.50 m side cantilevers. During the construction phases, the arch was supported on temporary piers and a cable stayed system between the deck and the arch, which supported the arch and controlled the geometry of the bridge by preventing the structure from tipping. On this bridge, Freyssinet – Terra Armada contributed to the supply and installation of the final prestressing, the temporary stay cables, expansion joints, bearings and design of deck and arch construction methods that made use of temporary stay cables.

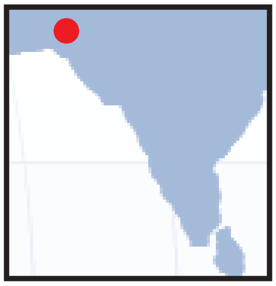
Participants

Client: *Metro do Porto, S.A.*
Main contractor: *EDIFER / NECSO*
Specialised contractor: *Freyssinet – Terra Armada Portugal*

Key figures

Rock excavation: 10.000 m^3
Concrete: 22.500 m^3
Reinforced steel: 3800 t
Prestressing steel: 660 t
Ground anchors: 120
Scaffolding above the ground: 22.000 m^3
Formwork travellers: 2

M3 motorway



5,000 m² of Reinforced Earth walls!

Freyssinet Middle-East LLC is participating in the M3 motorway project.

THE M3 MOTORWAY NOW UNDER CONSTRUCTION is a 52.5 km toll section between Faisalabad, the Pakistan capital of the textile industry, and its 4.5 million inhabitants, and the town of Pindi Bhattian. It also joins the existing M2 motorway between Lahore, the capital of the province of Punjab with 6 million inhabitants, and Islamabad, the capital of Pakistan.

This motorway crosses sixteen existing roads and one railway line. Therefore, Freyssinet Middle-East LLC which is participating in the project, decided to use *Reinforced Earth* walls for the construction of all abutments for overpasses with a 50 m long box girder, and for the railway bridge.

A prestressed concrete arch bridge will be built at the junction of the M3 and M2 motorways, and the *Reinforced Earth* technology will also be used for the construction of its abutment walls. The total area of *Reinforced Earth* walls in this project will be 5,000 m² and wall heights will be up to 9 m.

Participants

Client: *National Highways Authority*
Main contractor: *PAMIC (Pakistan International Motorways Consortium)*
Supervision Consultant: *NESPAK (National Engineering Services of Pakistan)*
Design: *Pakroads & Zeeruk Consulting*
Specialised subcontractor: *Freyssinet Middle-East LLC*

Bangkok shopping centre

Record prestressed concrete slabs

Freyssinet Thailand has contributed to the 'express' construction of a 22,678 m² shopping centre.

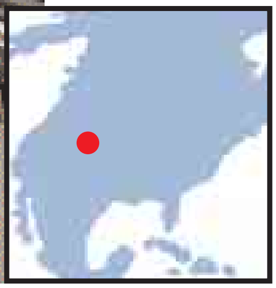
THE 22,678 M² BIG C SUPER CENTER IN Bangkok was built in only four months! This shopping centre is located on Suksawat Road to the south of the city, and comprises a 16,454 m² building and a 6,224 m² multi-storey car park.

The building structure consists of reinforced concrete columns supporting beams that in turn support a prestressed slab. Freyssinet Thailand has supplied and installed the prestressing for the slab consisting of 4S13 and 5S13 cables. Each concrete pour covered an area of 1,400 m². A total of 138 t of prestressing strands were used.

The post-tensioning technique was chosen to be able to respect a particularly tight schedule which imposed seven day construction cycles; this technique reduced the total mass of the structure so that the formwork could be quickly removed from the undersides.

Participants

Client: *Big C Super Centre*
Contractor: *Siphaya Construction Co., Limited*
Specialised contractor: *Freyssinet (Thailand) Limited*



Motorway and railway expansion

The T-REX makes its first steps

Reinforced Earth is participating in the construction of the T-REX in Denver, Colorado. The company has designed more than 160 retaining walls and supplied more than 120,000 m^2 of surface area for this expansion project.

THE T-REX (TRANSPORTATION EXPANSION Project) project was fully financed without any increased or new taxes. It serves two purposes, first to improve almost 27 kilometers of two interstate highways, and second to extend the double track of the light railway transit (LRT) tramway by about 30 kilometers, in Denver, the capital of Colorado. Rail construction will include thirteen stations in the town center.

The improvements planned for the highways include two additional lanes in each direction along the most heavily traveled section of Interstate I-25, the only North/South motorway in Colorado. The new LRT line will connect the Central Corridor LRT to the Southwest Corridor LRT, to serve both the Denver downtown area and the fast growing southwest suburbs.

A fast construction project

The close cooperation between the Colorado Ministry of Transport (CDOT), the Regional Transportation District (RTD), the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) resulted in the development of an innovative solution to relieve congestion on the motorway carrying the largest amount of traffic in the state of Colorado.

The original intention was to have the T-REX expansion project designed and constructed over 20 years, but this period was reduced to six years using the Design/Build approach. In May 2001, Southeast Corridor Constructors (a joint contractor associating Kiewit Construction Company and Parsons Transportation Group) was chosen to do the design and construction for the entire project. The reasons for this choice are based on the contractor's ability to minimize nuisance to users, to respect budget constraints for the project, to supply a high quality project and to respect deadlines so that the entire new traffic axis can be put into service on June 30, 2008.

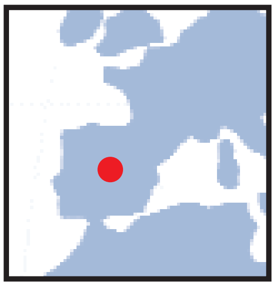
120,000 m^2 of Reinforced Earth walls

In January 2002, Southeast Corridor Constructors chose the Reinforced Earth Company to design and supply more than 160 *Reinforced Earth* retaining walls constructed with 1.5 x 3.0 meter precast concrete panels, some of which need to have a particularly high surface quality to satisfy architectural requirements. The total wall area is more than 120,000 m^2.

The Reinforced Earth Company was selected due to the extensive experience base acquired with *Reinforced Earth* structures supporting the LRT line and proven ability to satisfy the design and supply requirements for the project. Although some changes can be seen along the I-25 and I-225 interstates, the first year was set aside primarily for design work.

The Reinforced Earth Company enabled the Design/Construction team to complete 50% of the design of the highway and the LRT in a single step. Several walls are now under construction along the I-25 highway.

Soil treatment

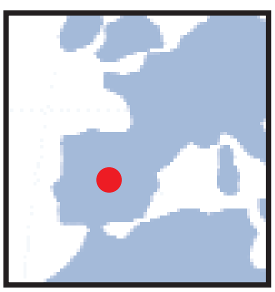


Two sites, five methods

Menard Soltraitement has been working on two large soil improvement projects in Spain during the year 2002.

THE FIRST SITE FORMED PART OF THE construction of the new Radial 3 motorway to double up the N3 between Madrid and Valencia at the exit from Madrid. The work applied to three work packages using different techniques.
The first package concerned treatment of 40 m thick anthropic fill from the old Tolsa sepiolite mine. This treatment was carried out on two areas called Tolsa A and Tolsa B. Tolsa A was treated by dynamic compaction (18,000 m^2) for construction of a 15 m thick fill for the Vicálvaro viaduct access road; Tolsa B was treated using 12 m deep controlled modulus columns (CMC) over an area of 8,000 m^2 with a total length of 30,000 m.
In the second package, the ground under the 12 m thick fill for the Jarama viaduct access road was treated by dynamic compaction over an area of 17,000 m^2. The third package consisted of installing 10 m deep 90,000 m long flat drains using the vibrobored method, which is capable of consolidating clayey grounds using lenses of compact sandy silts. The second site consisted of consolidating clay ground under 17 m thick fill for construction of the high speed railway line (AVE) between Cordoba and Malaga. The operation was carried out using 7 to 8 m long 70 cm diameter stone columns on a variable depth grid using two machines, to give a total area of 20,000 m^2 and a length of 60,000 m.
In this area, 30,000 m of 7 m deep drains had to be installed under a 7 to 8 m thick fill in some of the clay ground, using the static method.

Rivas metro



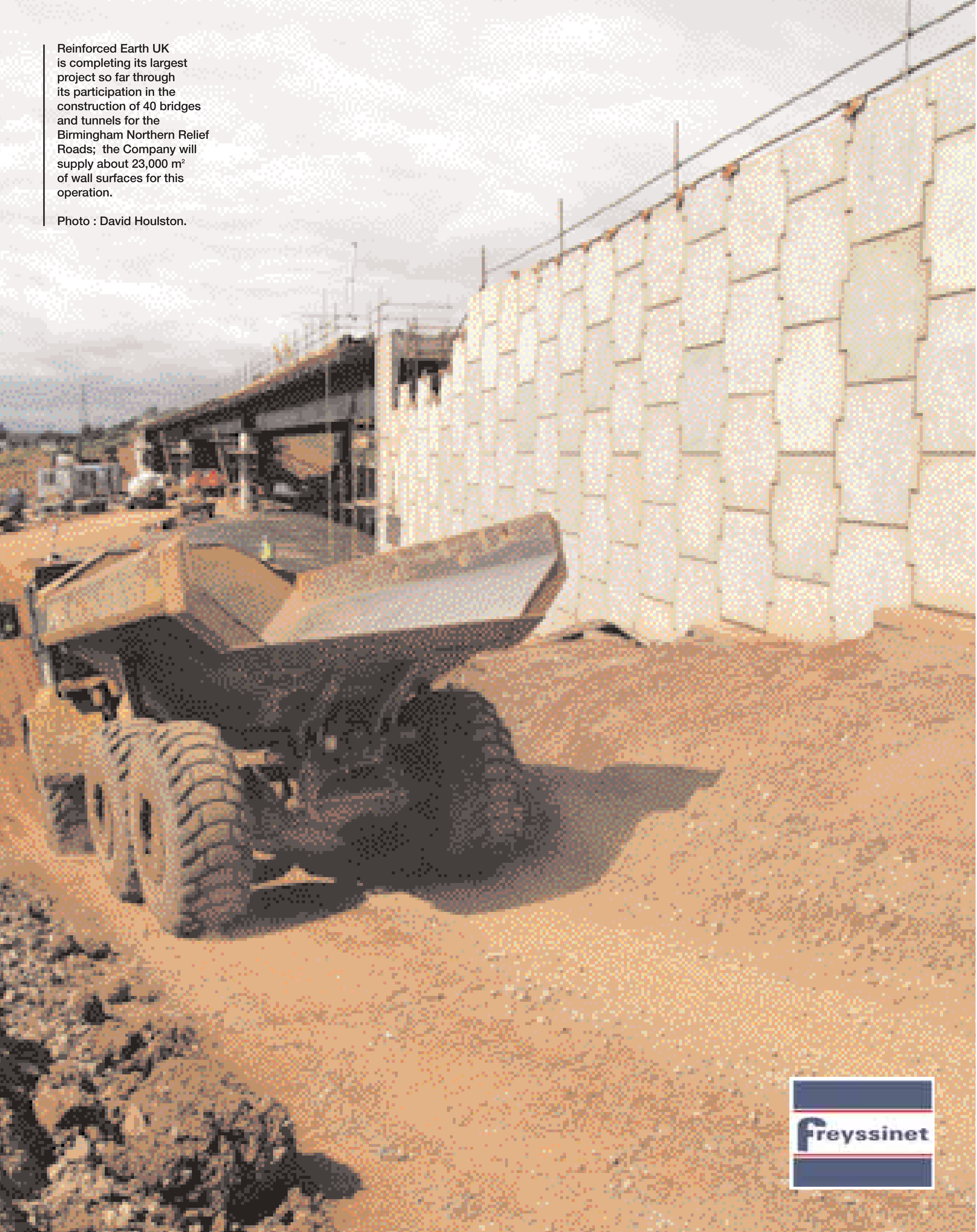
1220 m cover

Line 9 in the Rivas metro near Madrid has just been covered by a precast box beam.

TIERRA ARMADA S.A., FREYSSINET'S SUBSIDIARY in Spain, has just completed its participation in the construction of a structure that will cover metro line No. 9 between Vicálvaro and Argenta in Rivas, near Madrid.
This 1220 m long structure is entirely composed of precast elements. The beams in the top slab are directly supported on wall buttresses, which avoids the need for in situ construction of lintels. Construction of the box beam is followed by placement of the 15 cm thick top slab which is also precast. Construction was done at night to avoid disturbing or interrupting train traffic.

Participants

Client: *Independent Community of Madrid*
Main contractor: *Rivas Group*
Specialised contractor: *Tierra Armada S.A.*



Reinforced Earth UK is completing its largest project so far through its participation in the construction of 40 bridges and tunnels for the Birmingham Northern Relief Roads; the Company will supply about 23,000 m² of wall surfaces for this operation.

Photo : David Houlston.

Freyssinet