Freyssinet
MAGAZINE

JANUARY/APRIL 2003 - No. 216

Folder

Rescuing a historic structure

freyssinet

Contents

AMERICA

ARGENTINA
Freyssinet-Tierra Armada S.A.
Buenos Aires
Phone: (54.11) 43 72 72 91
Fax: (54.11) 43 72 51 79

BRAZIL
STUP Premoldados Ltda
São Paulo
Phone: (55.11) 3873 2734
Fax: (55.11) 3672 8502

Freyssinet Ltda
Rio de Janeiro
Phone: (55.21) 2221 8500
Fax: (55.21) 3852 7926

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 08 96
Fax: (1.905) 564 26 09

COLOMBIA
STUP de Colombia Ltda
Bogota
Phone: (57.1) 236 3786
Fax: (57.1) 610 38 98

Tierra Armada
Bogota
Phone: (57.1) 236 37 86
Fax: (57.1) 610 38 98

EL SALVADOR
Fessic S.A. de C.V.
La Libertad
Phone: (503) 2 78 86 03
Fax: (503) 2 78 04 45

GUATEMALA
Presforzados Técnicos S.A.
Guatemala City
Phone: (502) 2204 236
Fax: (502) 250 01 50

MEXICO
Freyssinet de Mexico S.A.
Mexico D.F.
Phone: (52.55) 5250 70 00
Fax: (52.55) 5255 01 65

Tierra Armada S.A.
México D.F.
Phone: (52.55) 5250 1726
Fax: (52.55) 5254 8665

UNITED STATES
Freyssinet LLC
Chantilly, VA
Phone: (1.703) 378 25 00
Fax: (1.703) 378 27 00

Ménard Soiltreatement Inc.
Orange, CA
Phone: (1.714) 288 84 47
Fax: (1.714) 639 87 01

The Reinforced Earth Company
Vienna, VA
Phone: (1.703) 821 11 75
Fax: (1.703) 821 18 15

VENEZUELA
Tierra Armada Ca
Caracas
Phone: (58.212) 266 47 21
Fax: (58.212) 267 14 23

EUROPE

BELGIUM
Freyssinet Belgium N.V.
Vilvoorde
Phone: (32.2) 252 07 40
Fax: (32.2) 252 24 43

Terre Armée Belgium
Vilvoorde
Phone: (32.2) 252 43 24
Fax: (32.2) 252 24 43

DENMARK
A/S Skandinavisk Spaendbeton
Vaerlose
Phone: (45.44) 35 08 11
Fax: (45.44) 35 08 10

FINLAND
OY Jaennebetoni
Helsingfors

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

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

PPC
Saint-Rémy
Phone: (33.3) 85 42 15 15
Fax: (33.3) 85 42 15 10

Terre Armée France
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

FYROM
Freyssinet Balkans
Skopje
Phone: (389.2) 118 549
Fax: (389.2) 118 549

GREECE
Freyssinet Hellas S.A.
Athena
Phone: (30.10) 69 29 419
Fax: (30.10) 69 14 339

Fredra S.A.
Athena
Phone: (30.10) 69 29 419
Fax: (30.10) 69 14 339

HUNGARY
Pannon Freyssinet Ltd
Budapest
Phone: (36.1) 209 1510
Fax: (36.1) 209 15 10

IRELAND
Reinforced Earth Co.
Kildare
Phone: (353) 4543 10 88
Fax: (353) 4543 31 45

ITALY
Freyssinet - Terra Armata S.r.l
Roma
Phone: (39.06) 418 771
Fax: (39.06) 418 77201

NETHERLANDS
Freyssinet Nederland B.V.
Waddinxveen
Phone: (31.18) 26 30 888
Fax: (31.18) 26 30 152

Terre Armée B.V.
Breda
Phone: (31.76) 531 93 32
Fax: (31.76) 531 99 43

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

POLAND
Freyssinet Polska Sp. z o.o.
Milanòwek
Phone: (48.22) 724 6893
Fax: (48.22) 724 68 93

PORTUGAL
Armol-Freyssinet S.A.
Lisbon
Phone: (351.21) 716 1675
Fax: (351.21) 716 4051

Terra Armada Ltda
Lisbon
Phone: (351.21) 716 1675
Fax: (351.21) 716 4051

ROMANIA
Freyrom S.A.
Bucarest
Phone: (40.21) 220 28 28
Fax: (40.21) 220 45 41

SPAIN
Freyssinet S.A.
Madrid
Phone: (34.91) 323 95 00
Fax: (34.91) 323 95 51

Tierra Armada S.A.
Madrid
Phone: (34.91) 323 95 00
Fax: (34.91) 323 95 11

SWEDEN
AB Skandinavisk Spaennbetong
Malmö
Phone: (46.40) 98 14 00

SWITZERLAND
Freyssinet S.A.
Moudon
Phone: (41.21) 905 09 05
Fax: (41.21) 905 09 09

UNITED KINGDOM
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

TURKEY
Freysas
Istanbul
Phone: (90.216) 349 87 75
Fax: (90.216) 349 63 75

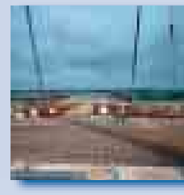
Reinforced Earth Company AIS
Istanbul
Phone: (90.216) 492 8424
Fax: (90.216) 492 3306

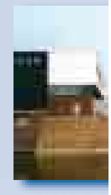
AFRICA

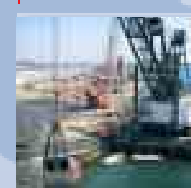
EGYPT
Freyssinet Egypt
Gisa
Phone: (20 2) 303 69 95
Fax: (20 2) 345 52 37

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







Freyssinet Magazine, 1 bis, rue du Petit-Clamart 78148 Vélizy Cedex – France. Phone: +33 1 46 01 85 40. Fax: +33 1 46 01 86 86. Internet: www.freyssinet.com
Publication manager: Claude Lascols. **Project leader**: Stéphane Tourneur. **Contributed to this issue**: Philippe Amiot, Isabelle Angot, Amaya Arrondo, Krzysztof Berger, François Bignon, Samuel Briet, Bill Brockbank, Laure Céleste, Stéphane Cognon, Jean-Philippe Fuzier, Zoran Gapic, Bertrand Garin, Albert Gilles, Michelle Haynes, Anik Jean, Roger Lacroix, Salvador Lorente, Paul McBarron, Jan de Meyer, Albert Moizeau, Sylviane Mullenberg, Patrick Nagle, Tomas Palomares, Susana Penas, Bertrand Petit, Jim Preston, Chris Robinson, Pierre Salanne, Pierre Sery, Alain Tigoulet, Martin Van Den Berg. **Layout**: Pierre Bonnerre. **Translation**: Netword. **Editorial secretariat**: Angeline Blard. **Photos**: Francis Vigouroux, Freyssinet photolibrary and subsidiaries. **Cover page:** Agen footbridge, photo: Francis Vigouroux. **Photo-engraving**: Trameway/Pierre Bonnerre. **Printing**: SIO. **ISSN**: 1636-4112.

Contents

ASIA

HONG KONG
Freyssinet Hong Kong Ltd
Kowloon Tong
Phone: (852) 27 94 03 22
Fax: (852) 23 38 32 64
Reinforced Earth Pacific Ltd
Kowloon Tong
Phone: (852) 27 823 163
Fax: (852) 23 325 521

INDIA
Reinforced Earth-Aimil Ltd
New Delhi
Phone: (91.11) 695 00 01
Fax: (91.11) 695 00 11

INDONESIA
PT Freyssinet Total Technology
Jakarta
Phone: (62.21) 830 02 22
Fax: (62.21) 830 98 41

JAPAN
F.K.K.
Tokyo
Phone: (81.3) 35 71 86 51
Fax: (81.3) 35 74 07 10

KUWAIT
Freyssinet International et Cie
Safat
Phone: (965) 571 49 74
Fax: (965) 573 57 48

MALAYSIA
Freyssinet PSC (M) Sdn Bhd
Kuala Lumpur
Phone: (60.3) 79 82 85 99
Fax: (60.3) 79 81 55 30

Ménard Geosystems Sdn Bhd
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
Freyssinet - Reinforced Earth Pvt Ltd
Islamabad
Phone: (92.51) 2270 443
Fax: (92.51) 2270 445

PHILIPPINES
Freyssinet Philippines S.A.
Quezon City
Phone: (63.2) 921 3789
Fax: (63.2) 921 1223

SINGAPORE
PSC Freyssinet (S) Pte Ltd
Singapore
Phone: (65.6) 272 96 97
Fax: (65.6) 272 38 80

Reinforced Earth Pte Ltd
Singapore
Phone: (65.6) 272 00 35
Fax: (65.6) 276 93 53

SOUTH KOREA
Freyssinet Korea Co, Ltd
Seoul
Phone: (82.2) 2056 05 00
Fax: (82.2) 515 41 85

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

TAIWAN
Freyssinet Taiwan Engineering
Taïpei
Phone: (886.2) 274 702 77
Fax: (886.2) 276 650 58

THAILAND
Freyssinet Thailand Ltd
Bangkok
Phone: (662) 266 6088
Fax: (662) 266 6091

UNITED ARAB EMIRATES
Freyssinet Middle East LLC
Abu Dhabi
Phone: (971) 2 445 88 18
Fax: (971) 2 445 88 16

VIETNAM
Freyssinet International et Cie
Hanoi
Phone: (84.4) 826 14 16
Fax: (84.4) 826 11 18

OCEANIA

AUSTRALIA
Austress Freyssinet Pty Ltd
Seven Hills
Phone: (61.2) 9674 40 44
Fax: (61.2) 9674 59 67

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

Reinforced Earth Pty Ltd
Hornsby
Phone: (61.2) 9910 9910
Fax: (61.2) 9910 9999

NEW ZEALAND
Reinforced Earth Ltd
Auckland
Phone: (64) 9 236 33 85
Fax: (64) 9 236 33 85

Freyssinet New Zealand Ltd
Auckland
Phone: (64) 9 236 33 85
Fax: (64) 9 236 33 85

Strategy

"Specialist services"

Freyssinet for structures, Terre Armée and Ménard Soltraitement for soils, are recognised international leaders in their specialties. Technological progress made by the Freyssinet Group, augmented by many innovations and motivated by an ambitious research and development policy, enables it to optimize the global performances of its achievements, particularly in terms of durability.

Bruno Dupety,
CEO of the Freyssinet Group
"We are doing everything necessary to keep our expertise, quality and innovation at the highest possible level."

Freyssinet Magazine: You define the Freyssinet Group's services as being specialist services. What do you mean by that?

Bruno Dupety: Our objective is simply to be the best in all our specialties, which incude construction, repair and maintenance of structures, and improvement and reinforcement of soils. Best performance means that we will do everything necessary in each of our specialties to have the superior expertise, quality and innovation. Let us be clear about this: we usually work on projects with major stakes in terms of safety, reliability, technical and economic performances and durability. When we apply prestressing for a tall building, or install stay cables for some of the largest bridges in the world, or build retaining walls for dozens of bridges along a motorway segment, when we consolidate several hectares of ground for the construction of a shopping center or an industrial site, we must accept a major responsibility and make a long term commitment. This is true for major projects, and is equally true for more modest projects. This is why, we do the best we can to provide the specialist's optimum solution to satisfy clients, engineers and main contractors who expect us to provide elegant solutions to their problems. Obviously, this specialist approach does not prevent synergies between our teams and companies before the project starts. Scientific and technical cooperation, mutual enrichment of skills and exchange of experience are all deeply rooted in our culture. Our intellectual is spread throughout our network of almost seventy offices in the world, with the support of our transverse services, such that a project carried out on any one continent will benefit the group's global expertise.

How is this quality requirement that you mention established?

In each of our specialties, we commit ourselves to meeting high performance criteria that are specified and known to our customers, and which are usually stricter than standards in general use in the construction sector. Obviously this quality question concerns our

Carbon fibre cables, installed on the Laroin footbridge in France, contribute to improving the durability of structures.

products, most of which are developed and tested in our own laboratories, but it is equally applicable to installation, respect for deadlines and durability. Regardless of the aspect concerned, such as the minimum strength of materials, the behaviour of stay cables during ageing, settlement performance of a site, and so on, the purpose of this requirement is always the same, namely to provide customers with the best possible quality and performance. Many of our projects have become are international structural and geotechnical references, and clearly demonstrate the success of this approach.

You tell us that technical expertise contributes to global optimization of a project. Could you give us some examples?

Boyne bridge, the first cable stayed bridge in Ireland, is a good example of performance in technical terms and for optimization of deadlines. Although we arrived on this project as a substitute, we succeeded in mobilizing our industrial resources and our site teams to install 56 stay cables with 37 to 73 strands, representing 360 tonnes of steel, in less than one month at the end of 2002. It was a significant advantage that we manufactured our stay cables and anchors ourselves.
In the field of soil improvement, the future A380 Airbus manufacturing site on a 1 320 000 m^2 area in Hamburg illustrates the advantages of our exclusive Ménard Vacuum process. This combines technical performance, ease of use and competitiveness, by considerably reducing consolidation times and also achieving unequalled reliability.
In mechanically stabilized embankments and precast arches Reinforced Earth companies are leaders as a result of continuous efforts to introduce and improve exclusive products. We have recently developed new metal ladders which significantly reduce the cost per m^2 for low structures. We have also developed special software and control our own production tools that are used to develop cladding on which a genuine architectural expression is possible in that each element forms part of a pattern. As an example an aquarium now forms part of the landscape on a motorway in the United States.

Innovation has always been a tradition within the group. What is your policy in this field and what is the most important recent progress?

Our research and development policy is based on three themes. Firstly, improvement of our existing technologies. For example, in stay cables, there are new vibration damping devices and high performance carbon fibre cables (installed for the first time on Laroin footbridge in France), these two innovations contributing to improving the durability of bridges, in prestressing, improvements to our range of anchors in order to reduce weight and provide a more compact cable, which is therefore also more economic, in soil improvement, development of bottom feed stone columns under air pressure for offshore work.
The second theme applies to new ideas that reach us from the market and that we improve with our own expertise, usually in cooperation with manufacturers. This is how we developed a carbon fiber fabric in recent years for the reinforcement of concrete structures, and more recently the Régébeton process for which we were awarded second prize in the building / public works category of the 2002 Siemens competition. This process consists of applying an electrolytic paste to eliminate chlorides that corrode concrete while protecting the original walls, thus preventing major reconstruction work. This category also includes monitoring and preventive maintenance systems for civil engineering structures, that we have helped to develop as part of our research on increasing the life of structures.
Finally, there are some radically new ideas that are very different from current practice. You will understand that I cannot talk about this type of research in detail. I will simply mention that our group has expanded and developed through major inventions, such as strand by strand stay cables in the Freyssinet system, dynamic compaction and vacuum compaction consolidation techniques used by Ménard Soltraitement and the Reinforced Earth system that has revolutionized construction techniques for retaining walls and bridge abutments. Our collection of 140 patents is a sign of this continuous technological progress that has been continuous throughout our history, and more than ever before we intend to continue this policy!

For retaining walls, “we are developing cladding on which a genuine architectural pattern is possible”.

Venezuela

Walls for INTEVEP

The managers of the Petróleos de Venezuela Anónimos company (PIDVSA) decided to build a sports complex on the heights of the town of Los Teques in the state of Miranda in Venezuela, for the employees of its INTEVEP subsidiary, which specializes in research and development of new technologies in the oil and gas industry. The topography of the selected site was steep and broken. *Reinforced Earth* technology was therefore chosen for construction of a foundation surface about 15 m thick with a total vertical surface area of 1 030 m^2. The process enabled the project to be completed within a short time and before the planned date!

Tahiti

Freyssisol near Papeete

The Tahiti Development Authority and its technical consultants decided to use Reinforced Earth technology to construct walls for the approaches, as part of the development of the River Punaruu interchange viaduct close to Papeete. The surface area of the walls was 1 000 m^2, and their maximum height 7.30 m. The walls are parallel and Terre Armée France therefore proposed the use of *Freyssisol* reinforcement using the “back to back” technique, to connect the two sides of the ramp to each other. The Terre Armée Company designed and supplied the wall surfaces, provided the moulds for precasting the surface elements, and also provided technical assistance for precasting and assembling the foundation blocks.

Mexico

Concrete canoes… using TFC

After a year's hard work, the group of seventeen students of the Faculty of Engineering at UNAM (Independent National University of Mexico), the prizewinner of the first national competition for concrete canoes, were rewarded for their efforts - by winning the right to represent Mexico in the National Concrete Canoes Championship, alongside 260 other universities! This competition was organized in Madison, in Wisconsin, in the United States, and was sponsored by the American Concrete Institute and Master Builders Technologies. This project combines research, architecture and construction and is based on the development of concrete techniques and other innovative materials. The manufactured canoes had to pass a floatation test and participated in several races. Freyssinet Mexico helped the students to make their Puma canoe, which required four preliminary designs to optimize its weight, stability, hydrodynamics and aesthetics. The students chose to strengthen their canoe using carbon fibers fabric *(TFC)* technique developed by Freyssinet, due to the flexibility of its two-directional reinforcement capable of matching the shape of the structure. The Puma canoe earned a respectable place in the final classification at this event, in which Mexico was participating for the first time, arriving in 25th place.

New Internet site

The Freyssinet Group is opening its new Internet site. This site will be updated regularly, and will be a rich source of information about the Group's latest news and its history, its offices and plants, and all its activities.

Enjoy your browsing on http://www.freyssinet.com !

Wales

More than 7 000 controlled modulus columns

Since the middle of 2002, the Morgan-Vinci Joint Venture has been working on the construction of the Newport Southern Distributor Road (SDR).
The work package for soil treatment in port areas and the adjacent tip was awarded to Ménard Soltraitement.
The soil on this site consists of a 10 to 12 m thick layer of poor quality alluvials, above which lies a heterogeneous and occasionally polluted fill material. There is a layer of gravels under the alluvials, with a consistency varying from dense to very dense. Apart from pollution in some areas, there is a large number of cable networks and pipes that make the project more complex. Ménard Soltraitement installed a network of more than 7 000 *Controlled Modulus Columns (CMC)* 10 to 16 m long, to improve the soil and make it capable of supporting 2 to 9 m thick road fill.
At the moment, two *CMC* machines are working on soil treatment of about 1.5 km of road. Columns are conventionally anchored into the hard layer by 1 m, over most of the site area. However the environmental constraints at the tip are very restrictive.
For example, the columns cannot pass through the alluvial clays.
The chosen grid is therefore much denser and expected settlements are slightly greater. The *CMC* technique should be used again, further along the line of the road.

Spain

Record abutment heights on the motorway

Tierra Armada, Freyssinet's subsidiary in Spain, worked on phase II of the motorway bypass project for the town of Las Palmas in the Canary Islands.
Tierra Armada designed and supplied all materials for construction of the abutments with a total surface area of 3 600 m². These 24 m high and 40 m wide structures are among the tallest ever built.

Participants

Client: *Canary Islands Motorway*
Engineer: *Necso-Ferrovial Joint Venture*
Specialised contractor:
Tierra Armada S.A.

South Africa

A bridge over the marshes

Sea Cow lake is north of the city of Durban in South Africa. It is about one kilometer from the Umgeni river that supplies water to the 5 million inhabitants in the Durban district. Although this marshy region is close to the city centre, it is almost completely undeveloped and it is still a breeding ground for fish eagles and for many other marsh birds. However, things are changing, and a new industrial centre is being built. Its promoters have worked closely with the authorities to define a project including the construction of several infrastructures.
These include a nine-span bridge now under construction to cross the river, the railway and the alluvial plain. Freyssinet Posten, the Group's South African subsidiary, was asked to work on this part of the project. The cast in situ prestressed concrete deck is 400 m long and uses 110 t of longitudinal and transverse prestressing cables. Freyssinet multi-strand systems were used for the construction of this first bridge.
Another post-tensioned bridge called the "N2 overpass" crosses the existing national road with its access ramps, and is now under construction by incremental launching. Freyssinet Posten is responsible for supplying and installing the prestressing. The N2 overpass will consume an additional 115 t of prestressing cable.
Apart from these two bridges, the development program for the zone includes a service station, industrial buildings and a prestressed concrete bridge providing access to them.
When this work is finished, the promoter will restore the marsh to its original condition… in other words, like it was a century ago, before man first explored it. There are even plans to reintroduce hippopotami!

digest

Main characteristics:

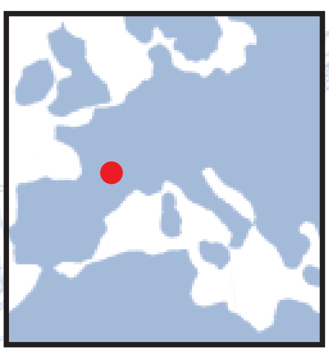
- First construction date: 1839
- Bridge length: 263 m
- Deck width: 2.30 m
- Tower height: 20 m
- Number of suspension cables: 2
- Number of hangers: 88

The solution proposed by Freyssinet consists of replacing the suspension, and the tower and deck cable anchors. This is a seventeen-month project.

Agen footbridge

Rescuing a historic structure

More than 150 years after it was built, Agen footbridge had become too hazardous for its users. After several hesitations between destruction and restoration, Freyssinet proposed a compromise solution. A story of a repair from bottom to top.



Steeped in history...

Agen bridge was built in 1839 to cross the Garonne and form a link between the town of Passage and the city of Agen. Its length of 263 m makes it one of the longest suspended footbridges in France.
Its first suspension used chains. This system was replaced by steel wires in 1883, 1894, and then in 1936. The existing structure comprises five spans, including three 29.5 m, 174.25 m and 20.6 m long suspension spans. The 2.30 m wide deck is a metal structure with wood decking. The suspension cables are supported on saddles fixed on 18 m high masonry towers. Two access spans on the left bank are constructed of lattice girders.

... but dangerous

The footbridge was completely closed in 1997, due to aging of the structure and a number of structural problems (dynamic loads could not be resisted satisfactorily due to the slenderness of the deck). However, after loud protests from its users, the structure was opened to the public again under very strict conditions; no more than fifteen persons at a time on the deck, closure of the bridge whenever the wind speed is higher than 45 km/h. At the same time, design work was started on a solution for a new unsuspended footbridge.

Destroy or restore?

The announcement of the end of this familiar landmark in Agen was the subject of many local discussions. But Freyssinet had already had the opportunity to do some maintenance work on the footbridge, and finally convinced the client that a rescue was possible.
Therefore, a call for bids was issued in 1999 to repair the structure, and to maintain operating conditions of the former footbridge.
This call for bids was unsuccessful, and so another call for bids was issued the following year; Freyssinet was awarded the contract based on an alternative solution.

An almost entirely new structure...

In the proposed solution, the suspension, cable anchors, towers and the deck had to be restored to new condition, and the suspended access spans had to be replaced by simple lattice girders. This project required seventeen months of hard work!
The old masonry towers built in 1841 were then dismantled stone by stone and replaced by two 20 m high steel masts, hinged at the bottom, and to which the saddles were fixed. These new shafts were founded on micro-piles drilled through the bottom of the masonry piers.
The suspension was replaced by two 60 mm diameter galvanized suspension cables, to which eighty-eight V hangers were fixed, each consisting of a 16 mm diameter cable anchored on cross-girders of the deck.
Furthermore, in order to improve the structural behaviour of the suspension span (particularly for resistance to wind and transverse stability), transverse cables were provided similar to the cables provided for the Tours footbridge over the Cher (magazine No. 210). These four cables are fixed onto new anchor foundations fixed to the ground by active tie-rods. The lateral cables are associated with the triangulated suspension, and apply a preload to it. Finally, the assembly forms a more stable and also less flexible structure than a traditional suspension system, and this arrangement makes new footbridge users feel safer and more comfortable.
The new installed deck consists of two beams made of steel profiles connected together by cross-girders parts. This configuration maintains the appearance of slenderness and lightweight that characterized the old structure. The deck was constructed using tropical hardwood.
The new deck was installed on top of the old deck, and the new structure was then used to dismantle the old structure.
The work was completed at the end of December 2002.

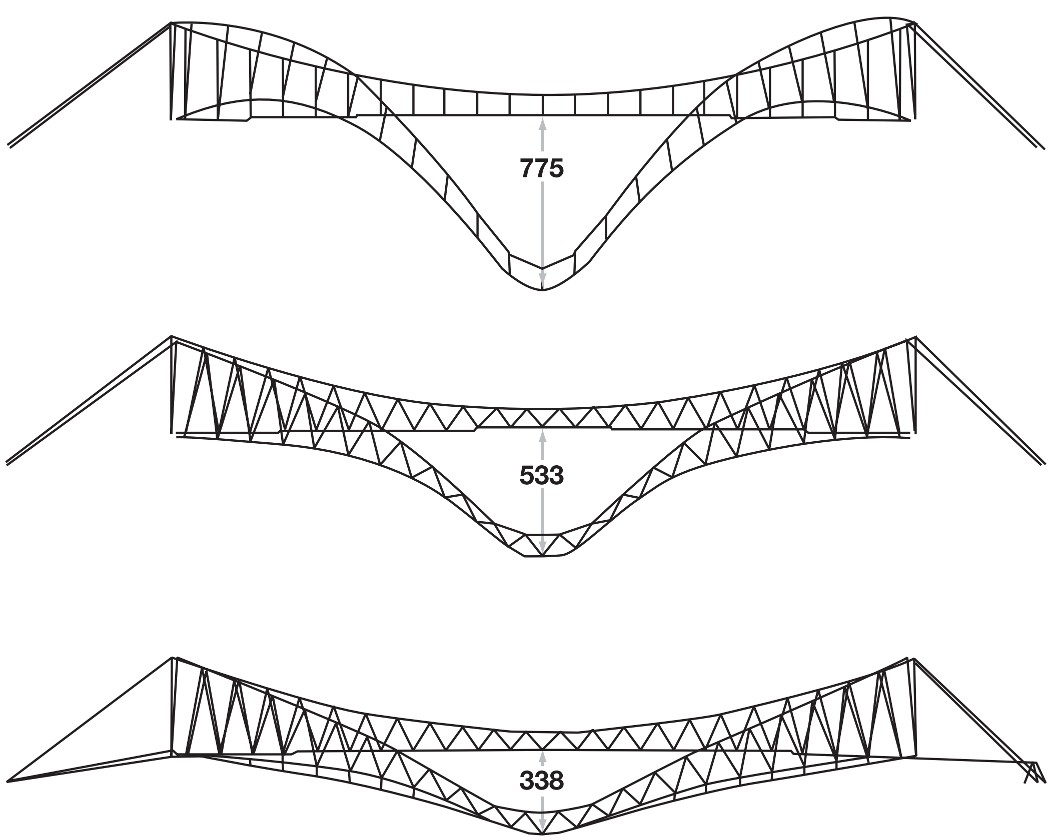
... perfectly consistent with history and the site

The general form of the new footbridge is generally similar to the original, although its structure is much more modern, and the local population unanimously appreciates it. The “La Passerelle” Association offered a stone block taken from the old towers to Freyssinet during the inauguration ceremony.

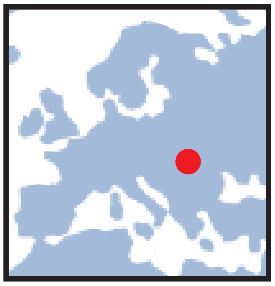
Participants

Client: *Town of Agen*
Engineer: *EEG Simecsol*
Architect: *Stéphane Brassie*
Main contractor: *Freyssinet*

Comparative study of deformation under concentrated load



Cora hypermarket



40 000 m² consolidated and drained

In August 2002, Ménard Soltraitement was awarded soil improvement and depollution work under the area to be occupied by a future Cora hypermarket to the East of Bucharest, in Romania.

A LARGE AMOUNT OF SOIL IMPROVEMENT and depollution work was necessary on the site on which the future hypermarket will be built. The area to be treated (40 000 m²) occupies part of the site of former brickworks that used sand and gravel present in the soil. The brickworks had excavated a pit 150 m wide by 450 m long with a depth of up to 16 m. This excavation was then used to deposit urban waste, and was then filled with inert materials so that a precast concrete element plant could be constructed and operated until 1990.

Soil improvement: between stone piers and stone columns

A deep foundation solution on piles was initially envisaged due to the poor quality of the fill, and the building would then have been supported entirely by a beam and slab system. The alternative soil improvement solution proposed by Ménard Soltraitement was based on surface foundations and slabs on grade. The depth of the ground to be treated (up to 16 m) was the reason for choosing a hybrid solution combining the stone piers and stone columns techniques.

The stone piers are an extrapolation of dynamic compaction in which the ramming energy is used to form large columns (2 to 2.5 m diameter) of compacted granular material by "dynamic substitution". These inclusions will then support surface foundations of the building and the slabs on grade.

However, the maximum possible treatment depth using this technique cannot exceed 7 m for energies usually used. Therefore, it was necessary to use stone columns to reinforce the soil at depth in the most critical areas (in other words in areas in which the depth of the existing uncompacted fill is greater than this treatment depth).

The load distribution induced by the piers gives a good stress distribution at the top of the columns. Furthermore, the surrounding ground provides better lateral restraint on the columns, essential for high bearing capacity, if they are compacted at depth.

4 months of almost uninterrupted work

The work was completed in four months, due to the use of two stone column machines equipped with 12 m and 18 m vibrating needles and compaction crane, at a working rate of 24 h per day and 6 d/week. Eventually, more than 5 220 stone columns were completed at an average depth of 15 m, with 750 stone piers and 800 compaction impressions.

Depollution by ventilation

Once the foundation problem had been dealt with, the bio-gas problem had to be solved. Household waste was still decomposing in the fill, and the accumulation of these decomposition gases (mainly methane), under the slab on grade creates a serious risk of spontaneous explosion.

The solution proposed by Ménard Soltraitement based on the "venting" technique, is exactly the same as that used on the Stade de France (in Paris outskirts).

This technique consists of circulating a sufficient quantity of fresh air in the ground to be depolluted, to dilute decomposition gases to reach a concentration threshold per unit volume low enough to be sure that they are not noxious (for risks of deflagration or poisoning). The resulting gases (noxious gases and fresh air for dilution) can thus be released into the atmosphere.

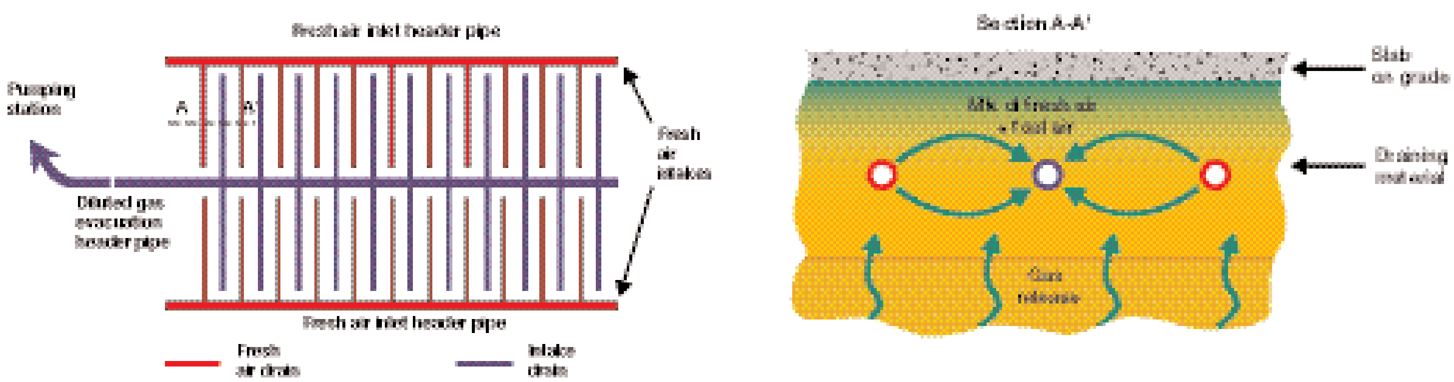
14 000 m of fresh air and intake drains

This dilution is achieved by installing a network of drains in a layer of draining materials. The system comprises firstly a network of intake drains connected through header pipes to a pumping station in which a negative pressure is created in these drains, and secondly a network of fresh air drains connected to the atmosphere through header pipes.
The air is routed as follows. It is drawn out of the atmosphere into the ground (under the slab on grade) through the fresh air drains network; it passes through the soil until it reaches the intake drain network, in which it is mixed with noxious gases; the gas mix then passes through the header pipes of the intake network as far as the pumping house, and is then released into the atmosphere.
The entire system is sized such that dilution is below allowable limit at all times (allowing for a safety factor).
These networks will be installed under the future building (40 000 m^2) and will have a total length of about 14 000 m of drains (63 mm diameter) and 5 600 m of header pipes (160 mm diameter). They should be laid early in 2003 before the slab on grade is poured, over a period of about two months.

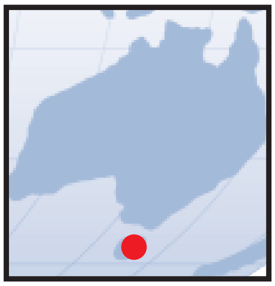
Participants

Client: *CORA*
Engineer: *IBT*
Main contractor: *Hervé Romania Srl*
Specialised contractor: *Ménard Soltraitement*

Principal plan showing the degassing network



Sorell Causeway road bridge



U beams exported to Tasmania!

Austress Freyssinet is participating in the reconstruction of the Sorell road bridge-jetty in Tasmania: a first in Australia.

THE SORELL CAUSEWAY ROAD BRIDGE IS A strategic part of the Tasmania road network. This bridge forms part of the Tasman Highway and is located at the eastern end between Pittwater Bluff and Midway Point, 20 km east of Hobart in the south of Tasmania. The bridge was finished in 1957, and at the time was the largest prestressed bridge in Australia. Due to increasingly severe signs of structural deterioration reducing its carrying capacity, the Department of Infrastructure Energy and Resources (DIER) decided to replace the bridge as soon as possible, in order to increase the total allowable load on it. Therefore, the new structure will be a U-beam composed of prefabricated segments based on the concept developed in France by Freyssinet and Jean Muller International. This concept has only been used in France (where Freyssinet has built several bridges for road development authorities) and in North America, so the Sorell Causeway bridge will be the first of this type in Australia.

Freyssinet is responsible for specialised prestressing

John Holland Pty Ltd designed and constructed bridge No. 1 and its accesses, demolished the existing structure, and all the auxiliary work defined in the specification. John Holland used Austress Freyssinet's know how in prestressing, for technical advice and construction techniques. John Holland was awarded the contract for prefabrication of the segments and for prestressing of the U beam, including a total of eighteen 25.5 m spans. The consultant for the design work was GHD, and Austress Freyssinet Pty Ltd was involved as the prestressing consultant during the design phase.

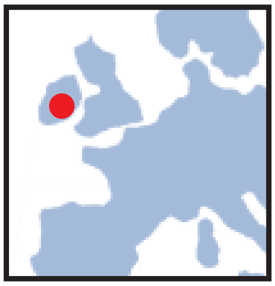
Optimise the use of prefabricated elements

The contract deals with two separate work packages. Work package A covered an 18-month design and construction period for the new bridge and its accesses. Package B which began after the new structure was put into service, is for demolition of the old bridge and construction of launching slips for emergency service boats . The contract was awarded on July 19 2001. Work package A was completed on January 19 2003, and the end of the project is programmed for July 19 2003. Prefabricated elements are composed of a very compact concrete to resist the marine environment. The prefabrication site was installed on an unused area 4 km from the site. Austress Freyssinet provided technical assistance and supervision for this site, specifically for fixing the reinforcing cage and for installing cable ducts according to the specified tolerance requirements. The bridge consists of two 1200 mm deep box-girders. The U-beam segments were launched from the previous span, and fixed with epoxy glue and temporary prestressing. Permanent partial prestressing was applied and the entire span assembly jacked into position and lowered onto the permanent bearings. Final prestressing was then applied and the launching beam moved onto the next span. The segments were prestressed longitudinally and transversely.

Participants

Client: *Department of Infrastructure Energy and Resources Tasmanian Government*
Engineer: *John Holland Pty Ltd*
Consultant: *GHD Pty Ltd*
Specialised Contractor: *Austress Freyssinet (VIC) Pty Ltd*

Bridge over the Boyne



56 stay cables to cross the Boyne River

Freyssinet Limited participated in construction of the bridge over the Boyne. This is now the largest bridge and the first cable stayed bridge in Ireland.

The Boyne bridge carries part of the new motorway under construction between Dublin and Belfast. When it is put into service at the end of 2003, this will be the first toll motorway in Ireland. A joint venture formed by the Irish Contractor Siac Company, and the English Cleveland Bridge Company was appointed to build this 170 m main span cable stayed bridge. An inverted Y tower supports the deck using 56 Freyssinet stay cables comprising between 37 and 73 strands each. The hybrid deck is made of box-girders made of steel, supporting a concrete surface layer.

Freyssinet Limited was awarded the contract for the supply and installation of stay cables in March 2002. Fast mobilization was a compulsory requirement, and within six weeks Freyssinet had installed the first pair of stay cables necessary to stabilize the tower so that the group could start launching the deck.

360 tonnes of strands

Freyssinet placed the 56 stay cables in the structure, including 360 tonnes of strands, between September and the end of November 2002. Freyssinet Limited worked in close cooperation with the Freyssinet International Major Projects Department for engineering aspects, the methodology and procurement. The Boyne bridge clearly shows the advantages of Freyssinet stay cables and the efficiency of work done in cooperation between Freyssinet, the contractor and the engineer. The essential characteristics of the Freyssinet system include fast mobilization and high erection speed, flexibility and ease of adaptation to Group requirements, adaptation to the project, flexibility and efficiency of its plant, and experience and quality of all personnel.

Participants

Client: *NRA (National Roads Administration)/ Meath County Council*
Engineer: *Roughan & O'Donovan Consulting Engineers*
Prime contractor: *CoentrepriseSiac / Cleveland Bridge Joint Venture*
Stay cables: *Freyssinet Limited*

THE TOWN OF DEN BOSCH IN HOLLAND decided to convert the West bank of the town into a clean, high security, and outstandingly beautiful area. As a result, Fortis Vastgoed Ontwikkeling N.V. carried out the construction of 24 luxurious villas in keeping with these values, on the former Concordia football field. Four units of six houses each were constructed on this site, and garden-terraces are sited directly on the lakefront behind the houses. The terrace walls are stabilized by *reinforced earth* walls. Three islands for leisure will also be built in the lake and will eventually be linked to dry land through footbridges.

Between TerraClass and TerraTrel

Two types of walls were selected to stabilize the sides. 500 m^2 of TerraClass walls and 1 000 m^2 of *TerraTrel* walls were built in eight weeks of work and the end result is impressive. The walls were built at a batter of 10° from the vertical for aesthetic reasons. Cruciform shaped *TerraClass* elements were used on the topsoil, up to an elevation of 26 cm above the lake level. A *TerraTrel* lattice wall system was installed on the lake, using Grauacke natural stone. The top parts of the stone layer are fixed in place by a *TerraTrel* double wall that forms a safety rail.

A long lasting solution

The estimated life time of this solution is 70 years. The sandy earthworks are reinforced by the use of 50x4 mm^2 galvanized steel sheet piles. The assembly is vandal proof, economic and long lasting, and pleasant to look at.

Pa

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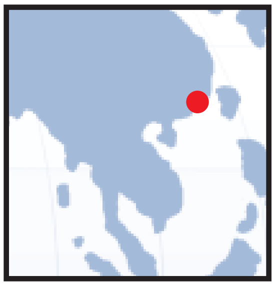
Hong Kong

Protection of quays



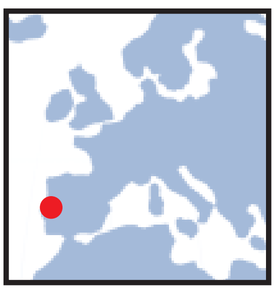
Kwai Chung Terminal 4

Freyssinet Hong Kong is participating in the protection of slabs of wharfs in a container terminal.

The operator of the Kwai Chung container terminal was quite satisfied with the cathodic protection installed by Freyssinet nine years ago, and wanted a similar system to protect the slabs of the wharfs in terminals. Corrosion of concrete reinforcement had caused spalling and other deterioration that allowed the penetration of sodium chloride. Freyssinet Hong Kong was awarded the first phase of the work in August 2002, and installed a cathodic protection on the underside of the concrete wharfs in the terminal, in cooperation with Corrosion Control Services Limited, a subsidiary of Freyssinet Limited. The protection current is provided by flat anodes installed in slits formed on the concrete surface and fully embedded in the repair mortar. Each part of the structure can be monitored, due to the breakdown into several anodic areas. With this concept, it is possible to consider generalization of the system to all wharfs. On this site, Corrosion Control Services Limited is doing the design, supply of specialised materials and engineering supervision, while Freyssinet Hong Kong is carrying out the supervision of access works, concrete repair and installation of cathodic protection systems. The completion of the work is planned for the end of July 2003.

Portugal

Serpa bridge



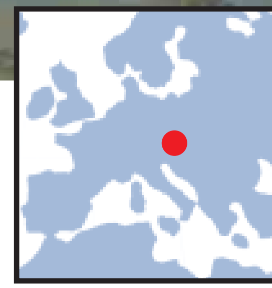
Computer aided renovation

Freyssinet-Terra Armada completed its first bridge strengthening project using replaceable external prestressing.

Serpa bridge on the E.N. 260 road in south-eastern Portugal crosses the Guadiana river between Beja and Serpa. This 400 m long prestressed concrete bridge with a total width of 15.40 m was built in the 1960s, and is composed of two variable depth box girders. A recent inspection of the bridge found severe deterioration of the structure; in particular, technicians found cracks along the webs of the box girders, advanced degradation of the bearings, large inclination of the concrete pendulum bearing on the sliding bearing side, and deformation of the profile along the bridge. The Portuguese Government issued a call for bids during the year 2000 for renovation of the bridge. The contract was awarded to Freyssinet-Terra Armada Portugal, which had proposed an alternative consisting of lifting the deck using the *LAO* (Computer Aided Lifting) technique while changing the bearings, thus reducing the construction timetable by about two months. Therefore, the work done by Freyssinet-Terra Armada Portugal included the construction design, and a gammagraphy campaign to check the actual position of existing prestressing cables, to treat cracks, strengthen the structure by replaceable external prestressing tendons consisting of two 24T15 cables for each box girder, and finally to strengthen the abutments. Due to the computer aided lifting system, the bearings on piers were brought back into the vertical position by means of temporary sliding bearings, and the expansion joints were replaced. Existing bearings on the concrete pendulum pier were also replaced by a *TETRON* bearing sliding on the mobile abutment.

Participants

Client: *ICOR (Instituto para Construçao Rodoviaria)*
Design Office: *Engº Armando RITO*
Main contractor: *Freyssinet-Terra Armada SA*
Construction survey: *Departemento Técnico de Madrid*



Goce Delcev bridge

A strategic route rescued from the water

The bridge over the Vardar river in the heart of Skopje has just been renovated after a very sad series of hazards. The story of a successful renovation operation.

A TERRIBLE EARTHQUAKE WITH AN AMPLITUDE of more than 8 on the Richter scale ravaged part of Skopje in Macedonia, on July 26, 1963. A project for reconstruction of the town was drawn up very shortly afterwards, but the plan was only progressively put into application. One key element in this reconstruction was the construction of a bridge over the Vardar river at the same location as the historic wooden bridge built in 1928 that had been carried away by the 1962 flood. The new bridge was called the Goce Delcev bridge, after the man who created the first Macedonian Republic at the beginning of the 20th century. The bridge construction work started in 1970. At the time, the central span was supported on a wooden falsework... that was carried away by a flood the next year! After this unfortunate episode, the bridge span was increased and steel falsework replaced the former wooden structure. The two parallel decks are 136 m long, with two 24 m long access spans and an 88 m long and 17.8 m wide central span. The concrete box girder is transversely and longitudinally prestressed by 12ø7 cables.

Structural problems

This bridge quickly became a strategic traffic route: it now carries 10 000 vehicles per day! But when it was put into service, shear force cracks appeared adjacent to the piers. The bridge gradually lost its camber, and the deflection reached 450 mm in 2000. This degradation was accompanied by severe infiltration of rain water inside the box girder, because of the lack of waterproofing. Thus, a strengthening plan was drawn up in 1994, started in 2001 and the constract was awarded to Freyssinet International and Cie.

A strengthening without traffic interruption

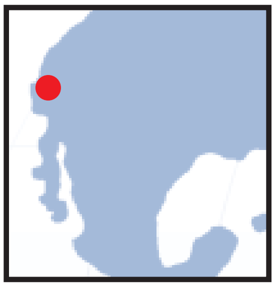
One of the first operations was to remove asphalt from the road and sidewalks surface, and the structure was then thoroughly cleaned. Damaged concrete areas of the deck sidewalks were made up and all bridge fittings were replaced, particularly including the placement of 72 m of expansion joints and 4 m of *WOSd* type sidewalks joints. A waterproofing membrane was also installed, although there had not been one on the existing bridge, together with gargoyles to evacuate rain water.

Web cracks inside the box girder were grouted. Freyssinet then applied additional prestressing using four 19C15 cables, and then installed a deck anti-uplift system on the abutments using four 7C15 vertical cables. The areas of maximum deflection were reinforced by gluing carbon fiber fabrics *(TFC)* over an area of 64 m². All work was completed without any traffic interruption.

Participants

Financing: *AFD (French Development Agency)*
Client: *Town of Skopje*
Engineer: *Louis Berger and PX Consultant*
Main contractor: *Freyssinet International & Cie, in cooperation with Freyssinet Balkans*
Design office: *EEG Simecsol*

Extension to the National City Marine terminal



"Vibro-replacement" for earthquake resistance

An extension program is under way at the National City Marine Terminal in San Diego, California. The new complex under construction is located in an seismic area, and benefits from the know how of Ménard Soltraitement.

Ménard Soltraitement was called in to participate in the work to prolong the Southern end of quay 24-4, which is part of the extension work on the National City Marine Terminal in San Diego. This extension work includes widening of the shoreline by driving sheet pile caissons and backfilling behind the newly constructed curtain. It will bear a pontoon extending outside the line of the sheet piles. The new pontoon will be built on driven piles and will be 340 m long by 25 m wide so that ships, each carrying more than 4000 European vehicles, can be unloaded.

Seismic considerations

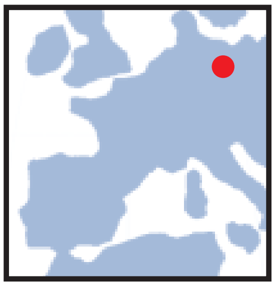
The work is done in the "San Diego Embayment", which is a sedimentary basin limited by a fault. Seismically, the site is located on the area of the Rose Canyon fault, the most active main ramification of this area being the Silver Strand fault which is approximately 4 km to the east. Seismic analyses carried out based on initial geological records indicate that most fill and deposits existing in the bay have a

strong potential for liquefaction at depths of up to 18 m. The effects of soil liquefaction include loss of foundation bearing capacity and side friction capacity, surface settlements and risks of circular slips in submarine slopes adjacent to the sheet pile curtain.

Consolidation work

It was considered of utmost importance to improve the characteristics of the materials used for filling the box girders and sloping material under the pontoon using the vibro-replacement method, to stabilize the system and ensure that the new pontoon would behave satisfactorily. This is a variant of vibro-compaction in which ballast is used to fill the hole bored by vibrating drill. This method is used with low size grade materials, since it reinforces the soil and drains water overpressures through the stone columns network.
The soil densification work currently being carried out is done after driving caissons and dredging the sloping material. They make use of the *bottom feed* system (ballast filled through the end of the vibrating probe) designed to operate under offshore conditions (slope densification). The installation of columns is closely controlled during execution of the work using the Emparex System (record of construction parameters) and offshore columns are positioned using a differential GPS.

Wroclaw viaduct



“Incremental launching” as a solution in extreme situations!

Construction work on the West ring road for the town of Wroclaw has been going at full speed for several years.
Designers recently needed to display all their ingenuity to build a crossing over three railway lines and a road carrying heavy traffic, using a viaduct.

THE FIRST RAILWAYS APPEARED IN WROCLAW in 1842. Several stations and railway lines were built to satisfy needs arising from continuous development of the town in the 19th century and then in the 20th century. These infrastructures break the town into separate areas and create major obstacles to the smooth flow of road transport, which is why designers needed to continuously think of more effective means of constructing crossings. The example of the construction of the Wroclaw West ring road viaduct is a good illustration.

Two construction methods

Wroclaw viaduct is more than 600 m long. The twelve tracks to be crossed (three railway lines) and the road are distributed over a width of 400 m, which is why it was decided to build the central part of the viaduct by incremental launching, and to build its ends in situ. The project actually included two parallel structures; one for the East road lanes and the other for the West road lanes. The project was built using prestressed concrete and used the Freyssinet C system. Associated work such as approaches were cast in situ. The West viaduct is 624 m long and the East viaduct is 610 m long. The longest span after the temporary piles were removed is 52 m. The depth of the segments in the main viaducts is constant and equal to 2.5 m. A total of more than 600 tonnes of prestressing steel was used, and construction of the decks took 14 months! The Freyssinet Group made an important contribution to this viaduct: Freyssinet Polska Sp. z.o.o. was responsible for launching and tensioning on site, under the supervision of Maciej Hildebrand. Freyssinet International and Cie's technical department designed and produced the drawings of the precasting area, the nose and the incremental launching equipment.

A total pushing force of 7000 kN

Different types of cables were used for construction of the viaduct, including 19C15 main internal cables, 19C15 external cables, 13C15 cables for incremental launching and sheathed greased monostrand transverse cables for the top slab. Each incrementally launched element is composed of 27 segments with an average length of 15.5 m and with a maximum length of 19 m. The spans were incrementally launched in successive lengths of 33.5 m and were equipped with a 26 m nose movement being controlled by a tensioning comb and four RS230 jacks. The maximum total force during incremental launching was up to almost 7000 kN! A single operator performed all tensioning operations, using a single control desk for wedging the SL230 jacks. These incremental launching operations are especially difficult, considering the fact that most parts of the viaducts are curved in the horizontal and vertical planes.

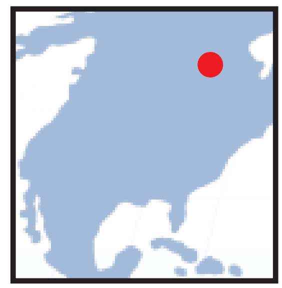
No disturbance to traffic

The construction time for each segment was one week. This work included two phases: the bottom slab and the two webs, and then the top slab. The segment was assembled by prestressing with the previous element using six or eight 13C15 cables, 24 hours after the top slab was cast. Transverse prestressing was applied at the same time. The assembly was thus incrementally launched above the railways and the road without disturbing rail or road traffic. After the segments built by incremental launching had been put into the final position and the external parts had been made on scaffolding, the keying joints were cast. Continuity cables were installed to achieve the required load capacity and continuity of the bridge. Almost 370 tonnes of cables were installed and tensioned during summer 2002, including lubricated external cables in HDPE sheaths. All cables were grouted using cement grout except for the transverse monostrands.

Participants

Client: *Wroclaw Roads and Public Transport Authority*
Consultant: *Mosty Wroclaw - Design and Test Office*
Engineer: *Budimex Dromex S.A.*
Specialised contractor: *Freyssinet Polska Sp. z.o.o.*

Canada



The Clemmer Bridge

Emergency reconstruction

Thanks to Reinforced Earth Canada's solution, the bridge providing access to the city of Perth East was replaced as a matter of urgency.

The Township of Perth East, in the South-West of Ontario, needed to replace the bridge crossing Smith Creek, a tributary of the river Nith. Inspections had discovered structural problems and, at the start of the 1980's, the authorities decided to reduce the traffic crossing the bridge. This decision had serious consequences for this major road leading to the town and its 12,000 inhabitants. In 2001, the local authority was warned that the bridge had deteriorated further and that the public service vehicles used for snow clearing, road maintenance and fire fighting could no longer cross it for safety reasons. It had to be closed or replaced. The first solution considered was to build a new 18 metre long cast in situ structure, estimated duration being three months. The second option, consisting of precasting segments and assembling them on site, was chosen as the more economical solution. The old structure was demolished and all the materials recycled. Then foundation footings were created and the half-sections of TechSpan arches placed on them using two 165-tonne cranes. The building of the arch took eight hours and the front walls were erected on both sides at the same time. The new Clemmer bridge is now made of a precast TechSpan arch and front walls made of TerraClass facing. The arche has a clear span of 18 metres, is 300 mm thick, 5.5 metres high and 10 metres long. In the words of Mr. Glenn Schwendinger, Manager of Public Works for the Township of Perth-East, "The use of this alternative proved cost effective and extremely efficient with respect to the time frame for the required road closure. Thank you for RECO's contribution to this success and the dedication of all your staff."

Saint-Symphorien bridge

Express repair!

After a barge collided with the central pier of Saint-Symphorien Bridge in Ancelles, Freyssinet was asked to repair the structure. The drum beater did not slow down once during this operation.

The Saint-Symphorien cantilever bridge was built between 1952 and 1953. It is a twin beam bridge with variable depth and three spans including two almost 50 m long end spans, and a central span composed of two 27.3 m cantilevers supporting a 16.5 m single span. There is a 1 m wide sidewalk on each side of the 6 m wide roadway. Transversely, the bridge comprises two concrete beams with variable dimensions stiffened by triangulated diaphragms.

The seriously damaged structure

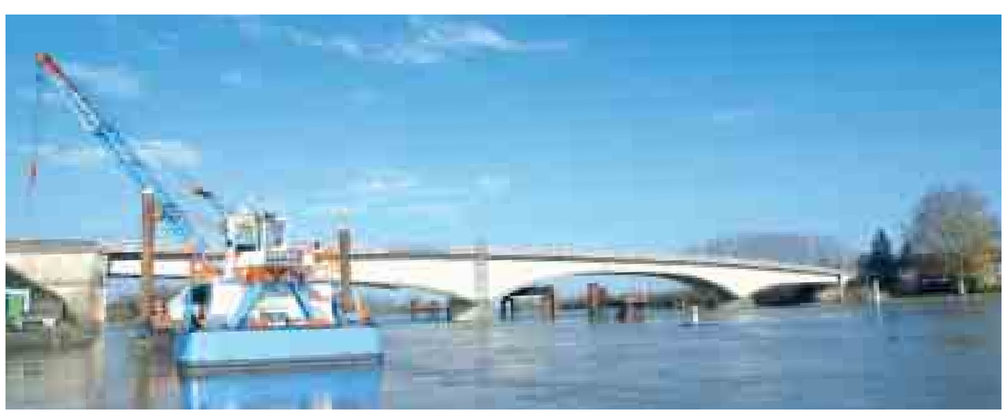
On June 23 2001, a barge going downstream on the Saône violently collided with the upstream beam of the right bank end span… and seriously damaged the structure: the lower part of the upstream beam was destroyed at the support; the web was broken and severely cracked over 7.5 m; the bottom of the downstream beam at the support and diaphragms close to the deck spalled and cracked, like the deck at the two ends of the upstream beam.
The structure was put into safe condition in December 2001 by means of a temporary bearing by lifting jacks with a capacity of 300 t. A gangway was installed in April 2002 so that pedestrians would be able to cross while waiting for the bridge to be repaired. Freyssinet was appointed to do this work and the repair began in mid-September 2002. In just three months, Freyssinet completely repaired all the damage caused by the accident, and also made the bearings of the simple span and all facilities conform (handrails, expansion joints, etc.).

Three months renovation work

The objective for the upstream beam before the repair was to realign the bridge and redistribute stresses in the area to be repaired. To achieve this, the bridge was firstly jacked using the lifting jacks placed on the temporary bearing, placed under the cantilever in the central span; secondly, cracks located in the damaged area were filled. After demolition of cracked areas and surface preparation by high pressure water demolition, complementary reinforcement was embedded in load resisting areas in which the existing reinforcement was insufficient. The demolished area was then rebuilt in three phases; reconstruction of the concrete at the beam bottom, concreting of the web including conservation of a central keying area, controlled compression of the beam using flat jack blocks and final keying of the whole section. Most of the work in the diaphragms consisted of filling the cracks. The upstream strut and the horizontal tie rod of the most seriously damaged diaphragm were reconstructed. Before filling the cracks, the downstream beam was entirely sand blasted and cleaned. The repair of the cantilever span bearings included removal or demolition of expansion joints. The span was raised by almost 1.5 m using a steel structure placed above the deck, to enable complete restoration of damaged areas at the ends of the beams. The fixed bearings of this span were removed and replaced by stainless steel bearings, mobile bearing struts were sand blasted and metallized before the jacks were removed from the assembly. New road expansion joints were installed after the operation was complete. The temporary structure and its supporting elements were removed at the end of the work.

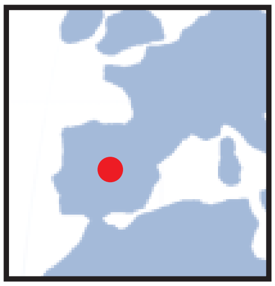
Participants

Client: *Saône-et-Loire department*
Engineer: *CETE de Lyon*
Main contractor: *Freyssinet*



Spain

Motorway structure



Concrete for a cut and cover tunnel

Tierra Armada, a subsidiary of Freyssinet in Spain, participated in construction of a motorway tunnel in the state of León.

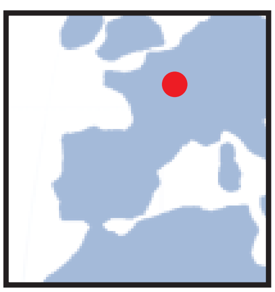
Tierra Armada took part in the construction of a cut and cover tunnel near Villafranca del Bierzo, in the Spanish Peninsula in the State of León. This structure, 2 x 170 m long, is 11 m wide and 5.5 m high, and includes two inclined openings. The central part of the right road tunnel was cast in place using a ready-mixed concrete truck, while the left road tunnel was cast in situ on a 0.15 m thick sacrificial formwork with exactly the same geometry as the precast end arch. The 20 m end of each opening and the inclined openings were entirely precast.

Participants

Client: *Ministry of the Economy*
Engineer: *Bierzo Group*
Specialised contractor: *Tierra Armada S.A.*

France

Faulquemont deviation



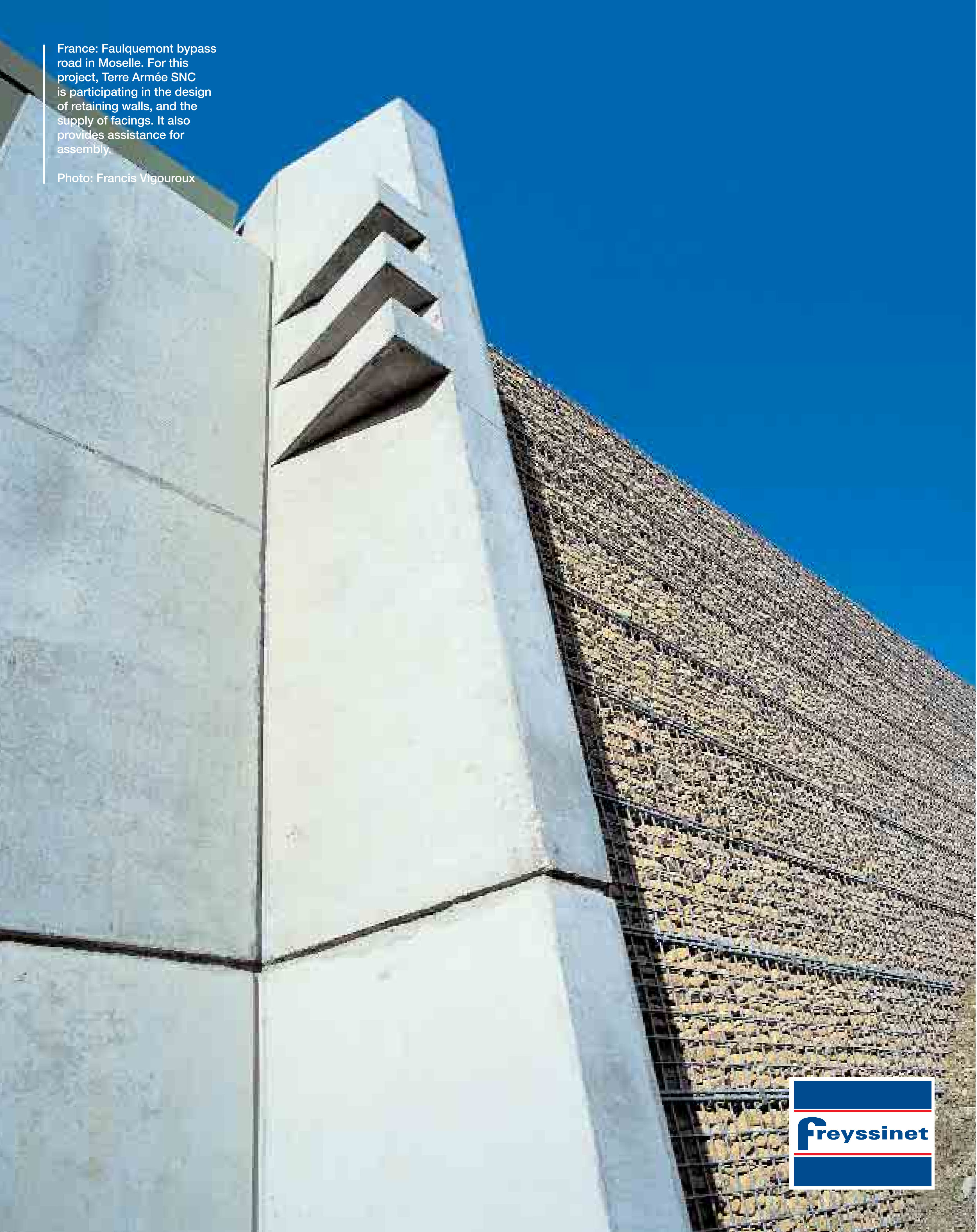
TerraTrel walls with natural rock appearance

Terre Armée SNC was asked to assist Valérian, the contractor, in the construction of eight road bridges.

The Moselle General Council appointed the EEG Simecsol/APAAR Group to be main contractor for work on the Faulquemont deviation, as part of an improvement to the RD910 (Pont-à-Mousson to Saint Avold road). The design of bridges produced by the architect, François Doyelle, required use of rock faced *TerraTrel* type walls which is a Reinforced Earth Group technology.
After the call for bids issued in 2001, these bridges were divided into three work packages. The contractor, Demathieu & Bard, was assigned two work packages and the third package was awarded to the Jean Bernard Entreprise company. Both of these companies subcontracted earthworks adjacent to the structures to Valérian. This is the context in which Valérian has been building side and facing walls made of rock-faced *TerraTrel* for these eight bridges since July 2002 – obviously with the assistance of Terre Armée SNC.

Walls up to 8 m high

TerraTrel is a technology in which reinforcement is used in association with galvanized welded mesh wall panels behind which the fill is completed by a 150 mm to 250 mm granular material over an average width of 50 cm. Some of these walls, up to 8 m high, are vertical, while others are slightly inclined. Terre Armée SNC's work started at the retaining wall design stage, and it has already provided Valérian with specific elements (surface panels, reinforcement and accessories), and technical assistance. The last work package for two bridges is now being awarded, and should be complete in spring 2003.



France: Faulquemont bypass road in Moselle. For this project, Terre Armée SNC is participating in the design of retaining walls, and the supply of facings. It also provides assistance for assembly.

Photo: Francis Vigouroux