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Italy

Brenner site

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Maintenance and repairs: an expert opinion

Professor Konrad Bergmeister, a specialist in maintenance and monitoring of structures, directs the Institute of Structural Engineering at Vienna University of Applied Sciences and is currently involved in the Brenner project. His vision of the development of maintenance activities is resolutely optimistic.

Konrad Bergmeister: "The cost of annual inspection represents 0.05% to 0.1% of the cost of building the bridge, and the cost of repairs varies from 1.2% to 4%".

Are maintenance and repairs of structures profitable markets?

Most definitely. Nowadays, these operations represent 45% of construction projects in Europe, compared with 55% for new construction works. But it is believed that the proportions will be reversed in 2003. There is a simple explanation for this: most structures were built after the Second World War, so 70% of the bridges in Europe are now more than 30 years old.

Why repair them?

Two factors have radically changed since the design and construction of these reinforced concrete structures. First of all, there has been an increase in air pollution that contributes to the corrosion of steel, not to mention the use of de-icing salt in our alpine regions. The low density of the concrete cover allows oxygen to attack the steel, which, once it is corroded, increases in volume. The concrete cracks and may delaminate. Of course, this requires renovation or safety compliance works.

At the same time, heavy goods vehicle traffic has increased considerably. On the Brenner motorway in Italy, it represents 40% of traffic. In addition to this increase in the number of vehicles, there has been the increase in the weight of truck loads, which can now reach up to 24 tonnes per axle. These bridges were not designed for these sort of loads.

Indeed, what changes do you find in their design?

Before, when drawing up a scheme, it was normal practice to consider several factors in succession: the construction methods, the cost of the scheme and, lastly, its integration into the environment. Now, in addition to these factors, which are still vital, we have to ensure the structure's durability. This requires us to consider the structure's conditions of use and its climatic environment, the quality of materials, and inspections carried out during construction. These structures are monitored to ensure that there is no excessive deterioration or deformation, and to plan maintenance work.

How is this maintenance carried out?

On the Brenner motorway, to take a current example, a team of eight people inspects the 33 km of bridges and 13 km of tunnels every day. Of course, this is visual inspection of the complete structures. But the team also takes a series of concrete core samples and then performs permeability and strength laboratory tests. We have thus devised a table for classifying the risks run by the structure and estimating the urgency of maintenance works. Many countries have now developed Bridge Management Systems. These programmes plan systematic checks and inspections. However, it is not always easy to carry out checks, and sometimes special equipment has

Freyssinet is currently working on a contract for acoustic monitoring and inspection of the Rande bridge in Spain.

to be used. It would be a good idea to take these factors into account from the design stage! Some specialist firms are starting to propose their services in this rapidly-expanding market. The complete structure has to be checked, and this can require sophisticated equipment.

Is visual monitoring the only possible means?

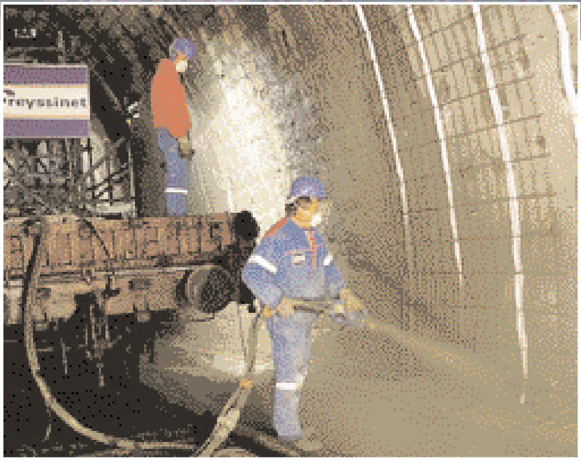
No. We have developed a system with optic fibre cables inserted into the very structure of the bridge to continually measure the bridge's deformation, its loading and its climatic environment. These data are sent automatically to a station with three levels of information: a green or red warning light for the monitoring operative, and more elaborate data or all information for scientific processing in the laboratory. Such a system is currently in place on the Brenner project. It is a world first. Other techniques are also used, such as subsurface radar or accoustic emissions.

More generally, what is the cost of maintaining a structure?

The cost of annual inspection represents 0.05% to 0.1% of the bridge's construction cost and the cost of repairs varies from 1.2% to 4%. This amount can be decreased to 0.1% if the structure is maintained continually. This shows the importance of regularly servicing the structure. As regards new optic fibre monitoring equipment, its estimated cost - for a 200 metres structure - can vary between 20,000 and 100,000 euros, according to the complexity of installing the system inside the structure.

What do you believe will be the features of the bridge of the future?

An interesting concept was recently introduced by the English: the "integral bridge". This consists in reducing the importance of elements that cause problems such as expansion joints, bearings, guard-rails, etc. The result is a structure that is more monolithic, etc., but great care has to be taken with the aesthetics. Of course, as I said before, from the design stage, you need to foresee the manner in which the structure will be inspected regularly, at the least cost and without interrupting traffic.
We are also working on materials that are less sensitive to corrosion. Ideally, we would no longer use steel. Composite materials such as carbon, aramide or glass fibre, could be interesting alternatives; however, their cost is high for the moment. Prototype structures have been built in various countries. I believe cable stayed footbridges have been built in composite materials.



Freyssinet has strengthened the Fix-St-Geneys tunnel in France by installing a 12 cm thick shotcrete ring.

An ideal composite material for cold-bonded strengthening of concrete, steel or timber structures: TFC, which is used by Freyssinet for strengthening or conformity of all types of structures.

Singapore

Building construction

Freyssinet Singapore will participate in the construction of nine 19-storey apartment buildings and a 7-level car park. The total floor area is 103 363 m^2 and the total prestressed area is 22 386 m^2. The apartment building floor slab is 180 mm thick. The maximum distance between columns is 8.5 m. The car park floor slab is designed as a slab and strip-beam system. The K system is used for prestressing the beams, while the slab is prestressed using the 4S13 system.

Vietnam

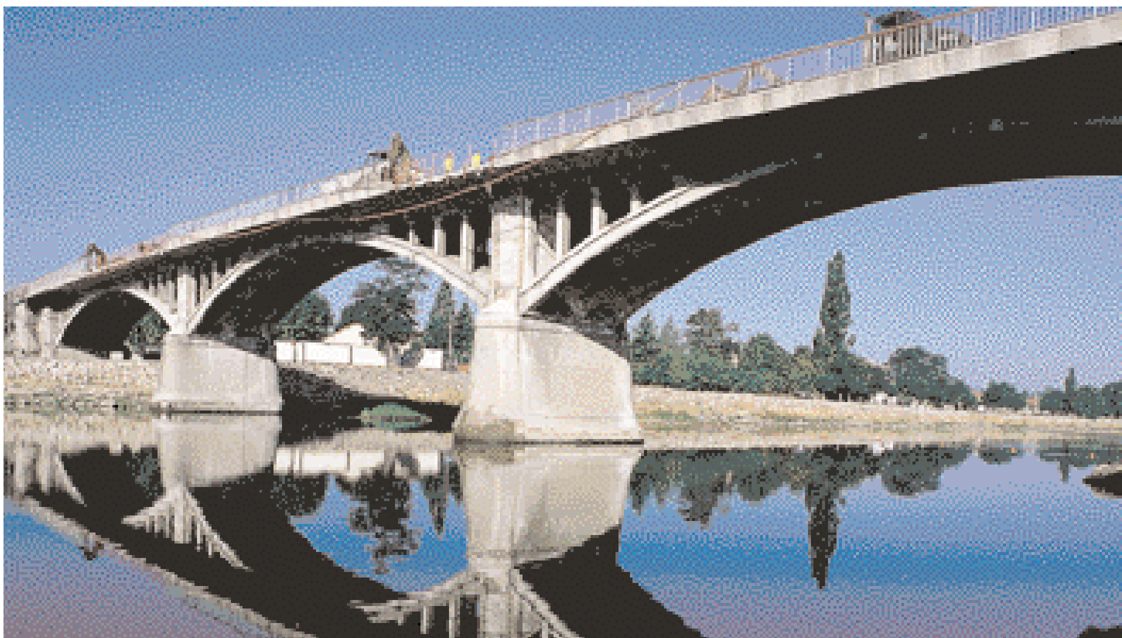
Inauguration of Saigon bridge

Saigon bridge to the North of Ho Chi Minh City was inaugurated on June 30 2000 in the presence of Vu Hung Viet, assistant Mayor of Ho Chi Minh City, Nguyen Tan Man, Vice-Minister of Transport and Communications, Michel Trinquier, French Consul in Ho Chi Minh City, Christian Saillard, sales advisor and Jean-Pierre Marchand-Arpoumé, Freyssinet Chairman. This bridge carries national road No. 1 along one of the country's main traffic routes, and was strengthened and widened from 19.6 m to 24 m. This work was done over a two-year period without any traffic interruption. Two new traffic lanes were built and the bridge carrying capacity was increased to 30 t.

Turkey

Aliaga: LNG storage

Freysas has just completed the largest car park in Europe at Ataturk airport, and is now starting an important new project in partnership with Freyssinet France. Freyssinet had already participated in the construction of the first Turkish LNG storage tank in Marmara Eregli in the early 1990s. Storage capacity needs have been increasing continuously ever since. Aliaga's LNG storage facility comprises three identical cylindrical tanks. Two are already under construction, the third is still at the design stage. The tanks are impressive at 35 m high, 80 m diameter, with 80 cm thick walls and a capacity of 170 000 m^3. Freyssinet is supplying and providing the prestressing and the 13K15 and 19K15 anchors, the galvanized steel ducts, and the tensioning and grouting equipment. The work started in February 2000 and should be achieved by April 2001.



France

Repairs to Saint Just-Saint Rambert bridge

A three arch bridge crosses over the Loire in the small town of Saint Just-Saint Rambert to the North of the Saint-Etienne built up area. Freyssinet has recently strengthened the bridge. The work consisted of demolishing the road surface slab adjacent to the piers, building concrete foundations and installing new prefabricated slabs to create a second expansion joint adjacent to each pier. Superstructure work also included demolition and reconstruction of pavements and cantilevers, the replacement of guardrails and lampposts, general waterproofing of the deck and construction of the wear layer. The second phase of the work includes reinforcing of the arches, piers and mini-piers by shotcreting and by the use of a waterproofing product. This work will be done using a set of boom lifts suspended under the bridge to avoid interference with road or pedestrian traffic.

Poland

Three cable stayed bridges

Freyssinet Polska, Freyssinet subsidiary in Poland, has just completed the construction of three cable stayed bridges. Bedzin bridge is located on the Warsaw - Katowice road (route No. 1) between Czeladz and Bedzin, and comprises a steel tower and a prestressed concrete deck. The bridge comprises 24 stay cables, individually HDPE protected, galvanized and waxed monostrands.
Freyssinet Polska has also participated in the construction of two cable stayed bridges on the new A4 motorway between Warsaw and Gliwice.
Luk Gandski bridge comprises two metal arches and a 17 m wide concrete deck using the C post-tensioning system.
Luk Erosa bridge crosses the motorway close to Opole, and consists of a 3.5 m wide prestressed concrete deck usingthe C system and a cable stayed metal arch.

Spain

Restoration of Santa Ines Monastery

Santa Ines Monastery was founded in 1375 and consists of a group of cloisters, annexes and courtyards in the very heart of Seville.
The dilapidated state of the convent buildings made renovation unavoidable, including complete restoration of the sacristies close to the chapter house. This work provided an opportunity to transform the existing roofs into roof decks. The inside ceiling was restored with wood joists and brick blocks recovered from demolition.

USA

Hotel repair in Washington DC

The Donohoe Development Company awarded Freyssinet LLC a contract to make emergency repairs to unbonded strands (accidentally cut when making a ventilation hole) in the top floor of the INN Residence Hotel in Washington DC. The operation consists of removing concrete around the strands and making an opening through the full slab thickness for a certain length along the tendons, connecting the tendons using intermediate couplers and anchors, retensioning the tendons from intermediate anchors, reinforcing the opening again by anchoring new reinforcing steel into the concrete, and closing the opening using high strength no-shrinkage mortar.

Dominican Republic

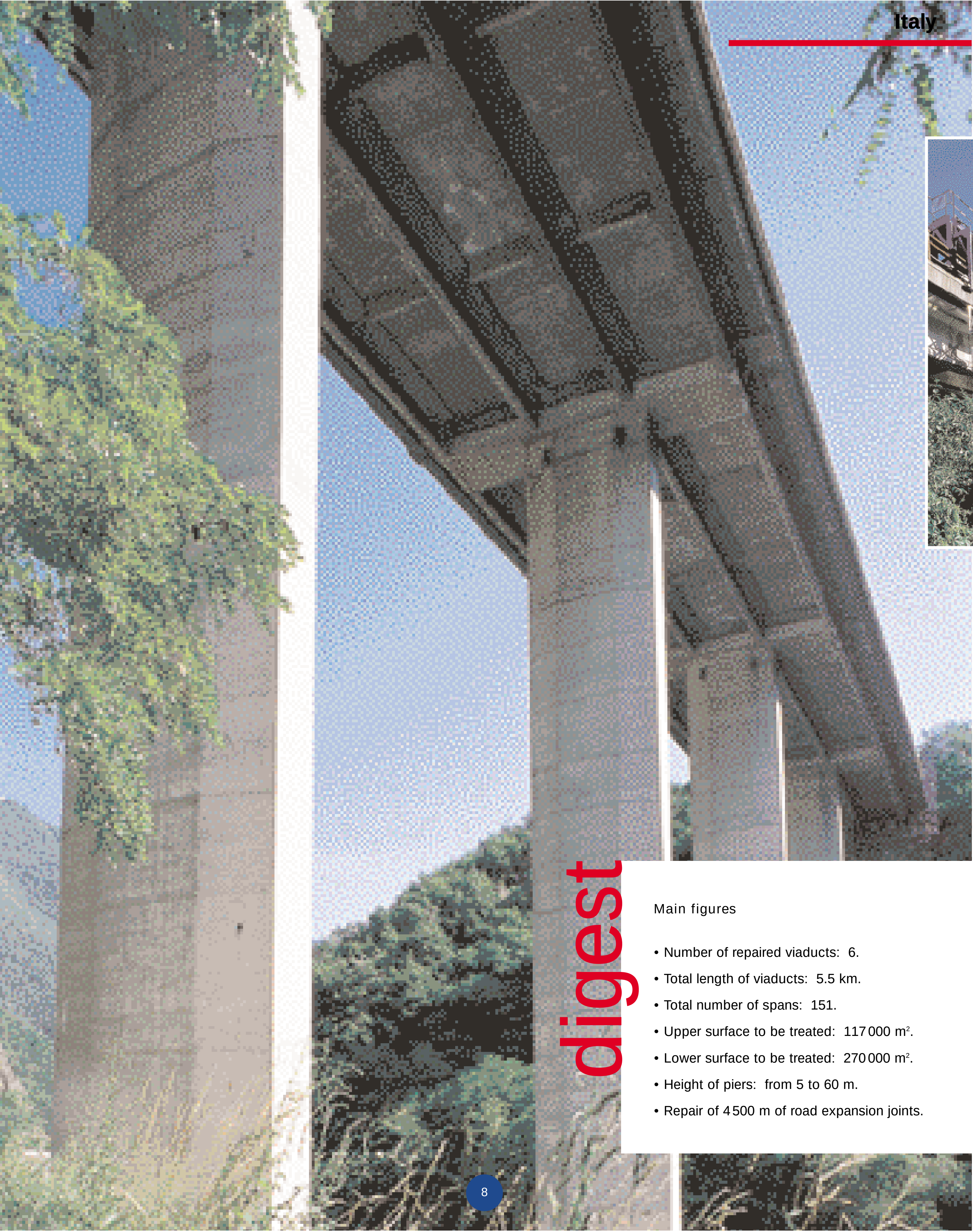
Rio Higuamo bridge

The total length of the bridge over Rio Higuamo in San Pedro De Macoris is a 606 m, including the 390 m central span. The steel deck is 24.90 m wide. The semi-fan type stay cables are supplied and installed by Freyssinet Italia, and consist of two layers each containing 44 stay cables; each tendon comprises between 37 and 73 T15S unbonded strands. Freyssinet also supplies and installs bridge fittings, mechanical bearings, large movement expansion joints and seismic dampers with an elasto-plastic behavior.

Puerto Rico

Roads PR-2 and PR-834

Freyssinet Mexico supplies the falsework and the prestressing for the construction of 324 beams for two sites. The first site is part of the construction and modernization program for road PR-2 (Kennedy Avenue), in San Juan, Puerto Rico, being built by the Ministry of Roads and Transport. The aim is to transform the road into an expressway to relieve traffic in the port area. The second site is being done for the Municipality of Guaynabao, and concerns the construction of the PR-834 bypass road. This will contribute to improving traffic towards Caguas. The main contractor for these sites is ICA Miramar Corp. and the design is being done by ICA Ingeniería and Euro Estudios.



digest

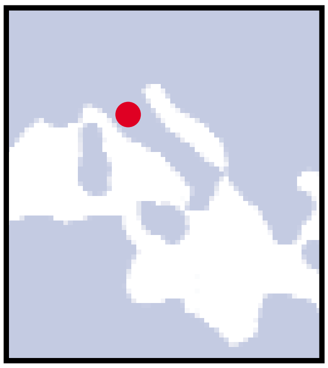
Main figures

- Number of repaired viaducts: 6.
- Total length of viaducts: 5.5 km.
- Total number of spans: 151.
- Upper surface to be treated: 117 000 m².
- Lower surface to be treated: 270 000 m².
- Height of piers: from 5 to 60 m.
- Repair of 4 500 m of road expansion joints.

Preventive maintenance

Repair of structures in the Brenner pass

Freyssinet is working on a segment of the A22 between the towns of Bolzano and Chiusa.



The A22 motorway is a major European traffic route. A preventive maintenance program was decided upon. Freyssinet was awarded six bridges which date from the 1960's.

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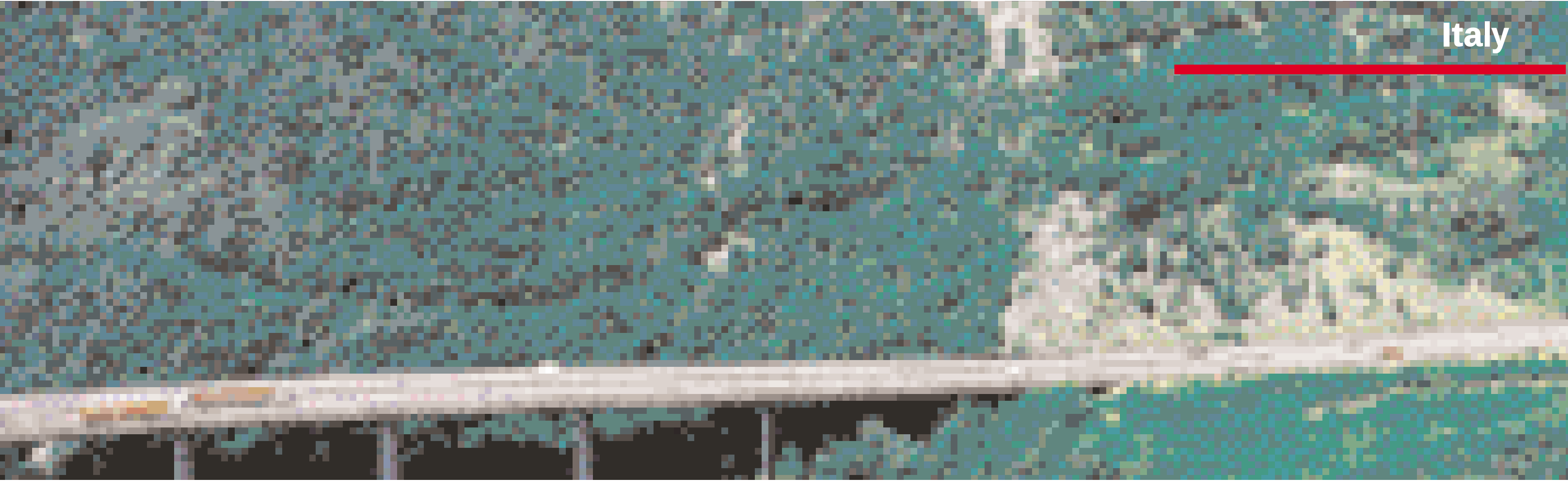


Since some of the piers are very tall, work on the underside will be done from mobile retractable platforms.

Work on the upper surface will be done under a mobile tunnel moving along rails as the work progresses.

This motorway route across the Alps joins Northern and Southern Europe, from Munich to Verona through Innsbruck, Bolzano and Trente.

The concessionnaire, Autostrada del Brennero, has been working with its Austrian and German conterparts to set up a preventive maintenance program for bridges dating from the 1960s.

70 persons, 6 viaducts and 151 spans

The contract awarded to Freyssinet concerns the segment of the A22 toll motorway in the Isarco valley, a tributary of the Adige river between the towns of Bolzano (the capital of Southern Tyrol) at an altitude of 265 m, and Chiusa at an altitude of 550 m. About half of this segment is composed of viaducts composed of simply supported spans with an average length of 35 m supported by hammer head piers mainly located on the side of the valley.

Freyssinet has a team of about seventy persons and is working on six 22.1 m wide viaducts with a total length of 5.5 km extending over 16.5 km, comprising 151 spans to be repaired. The six viaducts include the two Gries viaducts (about 418 m and 942 m long) and the Laghedo viaduct (103.5 m long), the two Micheletti viaducts (175 m and 1 258 m long) and the Campodazzo viaduct (2 12.9 m long). The area to be repaired is 117 000 m^2 on the upper surface, 270 000 m^2 on the lower surface and on piers.

Work on the upper surface

On the upper surface, the work consists of improving the waterproofing and preventing corrosion due to the use of deicing salt. The work is done over a width of about 11 m without interrupting traffic, which is diverted to the other half deck. The length of the bypass is limited to a maximum of 1 500 m, consequently work on the upper surface is carried out in eight successive phases, each lasting about 3 months.

For each bridge, the existing surface layer removed by grinding followed by scarification and the surface is partially treated by superficial water demolition using a robot for the road surface and a high pressure jet (150 MPa) for the sidewalks.

Additional reinforcement and a welded mesh are then placed before pouring rheoplastic concrete with a corrosion inhibiter procured from a concrete batching plant installed in Chiusa. This concrete is used to raise the height of the sidewalks and make surface repairs.

About 4 500 m of small opening road expansion joints are replaced at the same time. 80% of the joints are replaced and equipped with a stainless steel and rubber membrane, the remaining 20% are replaced by Freyssinet joints.

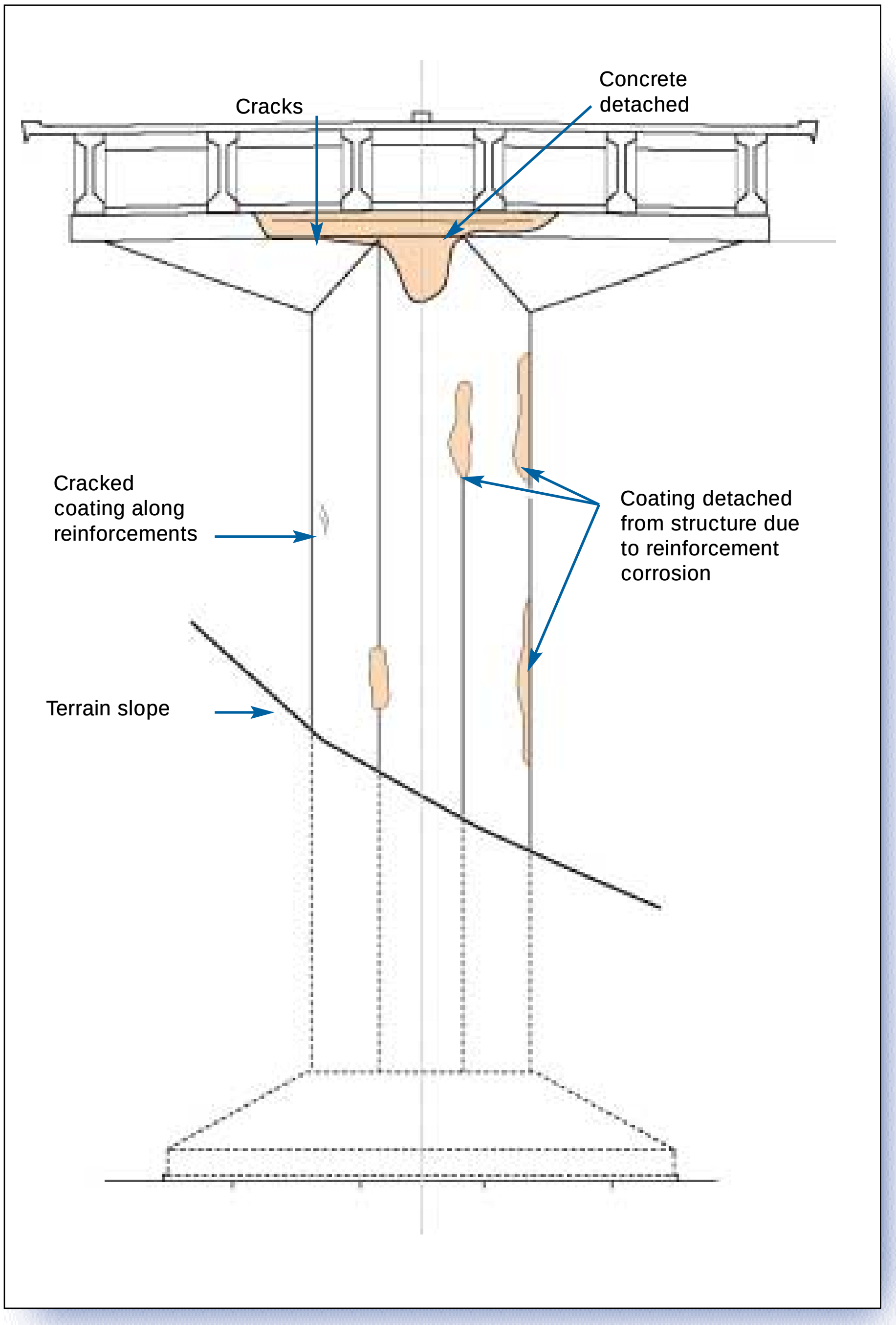
4 consecutive spans every 3 days

Repairs to the pavements require the installation of reinforcement anchored by resin and diamond drilling of pockets for the new safety rails. A 10 mm thick methacrylic resin mortar screed (that can be placed at temperatures down to -5°C) is then applied on the deck under a tunnel that can be moved along a 10 m wide and 150 m long rail, after shot blasting.

With this cycle, four successive spans can be made every three days (except in bad weather). The sidewalksand added sidewalksthickness will also be covered with a methacrylic screed after the new safety rails have been anchored.

Work on the underside

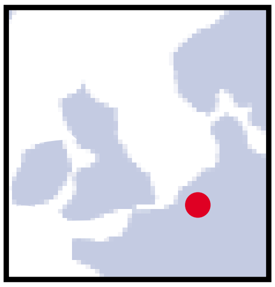
The work on the underside consists firstly of making up areas in which corroded steel can be seen, either due to lack of cover or due to runoff of rain water close to down spouts and road expansion joints. The next step is to apply a green coating to retard surface carbonation and enable better integration of the structures into the landscape. The main difficulty is due to the very tall piers with heights varying from 5 to 60 m and difficulties in accessing the underside and the bottom of the piers. The work is done from a 22 m wide retractable mobile platform and scaffolding and comprises local water demolition (pressure 150 MPa), making up of spalled concrete caused by corroded reinforcement using fibrous mortar and a curing product, general water sand blasting (40 MPa) and application of two coats of paint based on a methacrylic resin solvent. Narrow platforms (2.4 m wide and 23 m span) are used to do the work on the underside after the work has been done on the top surface. The work was started in October 1999, and completion is planned for April 2002.



Participants

Client and Engineer:
Autostrada del Brennero.
Main contractor: *Freyssinet.*

Cross section through a viaduct pier. Freyssinet's work forms part of a general structure maintenance program on bridges suffering from various deterioration dating from the 1960s.



Pont de l’Observatoire

This structure 200 m long including a bridge and a viaduct will join the new Guillemins TGV station to the E25 motorway.

An agreement between the SNCB (Société nationale des chemins de fer belges - Belgium railways), Euro-Liege-TGV (HST), the Wallon region and Sofico plan to create a link between the future TGV station in Guillemins close to Liege, and the E25 motorway through the Guillemins interchange. This access will be built by Sofico as part of the work on the E40-E25 link. The total length of the structure will be about 200 m and it will include an 80 m bridge overlooking the ends of the tunnel from the avenue de l’Observatoire, and a 120 m long viaduct running along the bottom of the hill up othe future car park entrance.

Composite deck: steel and concrete

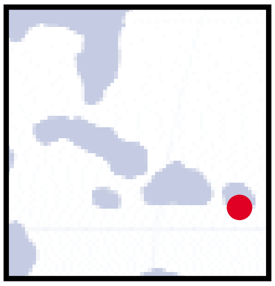
On October 31 1997, the Sofico Board of Directors appointed the Calatrava design office to design the structure so that it would blend in harmoniously with the station architecture. The design office suggested a steel structure with a composite steel and concrete deck. The viaduct consists of hammer head piers at a spacing of 9 m to support the deck. The steel piers are anchored into their foundations by 32, 40 and 50 mm Macalloy bars.

The bridge crossing over the tunnel ends is a bow-string type bridge with its deck curved in plan. A single arch (a 750 mm diameter 80 mm thick tube) located in a vertical plane holds deck loads through 42 hangers. The tie, consisting of a 1420 mm diameter 40 mm thick tube under the deck, is in the same vertical plane as the arch. Consequently, the transverse girders that define the curvature of the deck are all different. Freyssinet Belgium supplied and installed all hangers for this structure. They are composed of 7 stay cable type galvanized, unbonded strands inserted inside a brushed stainless steel duct. The upper dead anchors are fixed to the arch using clevises and pins supplied by Macalloy.

Participants

Client and Engineer: *SOFICO (Wallon Complementary Infrastructure Financing Company) and the MET (Wallon Ministry of Development and Transport)- Liege Roads division.*
Design office: *Bureau Calatrava.*
Main contractor: *E5-E9 Construction JV.*
Metallurgist subcontractor: *Poncin-Pirson group.*
Detailed design: *Hardy.*
Inspection office: *Seco.*
Specialized contractors: *Freyssinet Belgium.*

Prestressing



San Juan metro

Puerto Rico is the smallest of the Greater Antilles islands, and its first metro line will be opened in 2001 to improve road traffic.

The government decided to build a metro to handle the increased growth in the San Juan urban area and as part of the development plan for the Island. The metro, and the construction of new roads, will solve some of the traffic difficulties faced by Puerto Ricans.
Freyssinet has been participating in the construction of viaducts for this metro for three years. Apart from its underground sections built in trenches and the ground level sections, the network includes four superelevated sections at Bayamón, Hato Rey, Centro Médico and Villa Nevárez.
For the first section, Freyssinet Mexico is working as a subcontractor to the ICA Miramar Metro San Juan Corp. (ICA-Miramar), a joint venture between the Mexican company Ingenieros Civiles Asociados (ICA) and the Puerto Rican company Miramar Construction. For the other three sections, a joint venture was formed between Freyssinet de México and Freyssinet Spain that works in close cooperation with the NECSO-Redondo company formed by the Spanish Company NECSO and the local contractor Redondo Construction.

The structure

The superstructure consists of a box girder 5.70 to 9.90 m wide and 2.10 to 3.10 m deep, made using segments prefabricated in cells using the match cast joint method. The piers are cylindrical columns cast-in-situ with diameters of 1.50 m to 2.25 m, mostly supported on piles driven into the ground.
Typically, the viaducts are composed of two 36 m long continuous spans connected at their center by a segment on a monolithic pier and supported at the ends by pier heads in the form of an inverted T. The structure also comprises 36 m long simply supported spans and a few double cantilever segments up to 58 m long. Except for the double cantilever segments, the work is done span by span.

The Bayamón contract

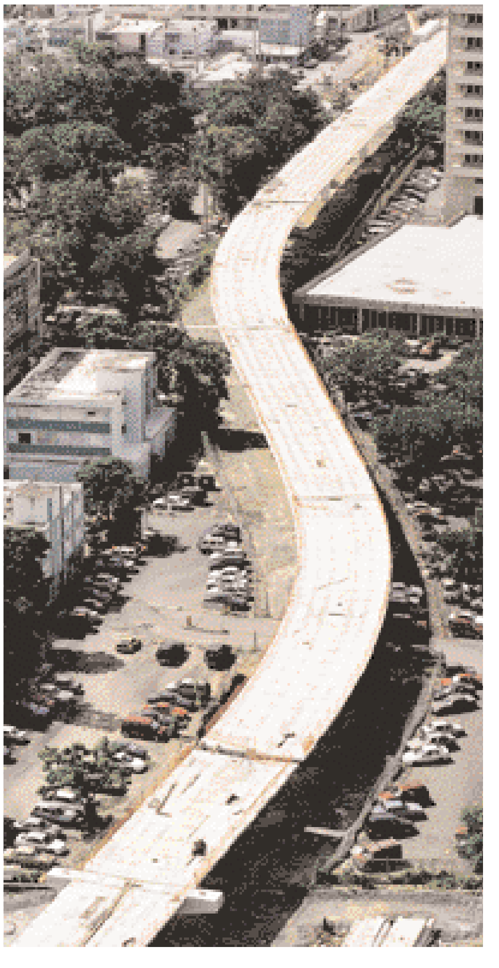
This 3 km long viaduct comprises 900 prefabricated segments and 40 cast in situ pier segments. ICA-Miramar appointed Freyssinet Mexico to be responsible for construction methods (in cooperation with the engineering department of the Latin center in Madrid), installation of prestressing, the supply of Tetron CD bearings and road expansion joints. 470 t of type 12 and 19K13 tendons are used for the post-tensioning. The transverse prestressing in the upper slab consists of 123 t unbonded monostrand cables. More than 200 m of various diameter prestressing bars were used for temporary assembly of segments during construction.

Contrats Hato Rey, Centro Médico and Villa Nevárez

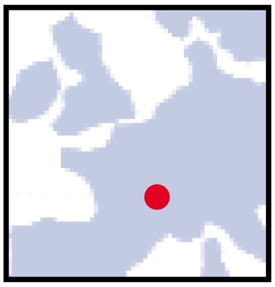
These parts represent 9 km of viaducts composed of more than 2 500 prefabricated segments and 120 cast-in-situ pier segments. Freyssinet supplied and installed the prestressing for this segment, that consisted of about 2000 t of 13, 19, 25 and 31 C15 external tendons. The transverse prestressing of the deck required 400 t of unbonded monostrand tendons.

Participants

Client: *Puerto Rico Roads and Transport Directorate.*
Engineers:
ICA Miramar Metro San Juan Corp. and NECSO/ Redondo, S.E.
Design:
Euro Estudios (México), Jean Muller International (USA) and Iberinsa (Spain).
Specialized contractors:
Freyssinet Mexico and Freyssinet Spain.

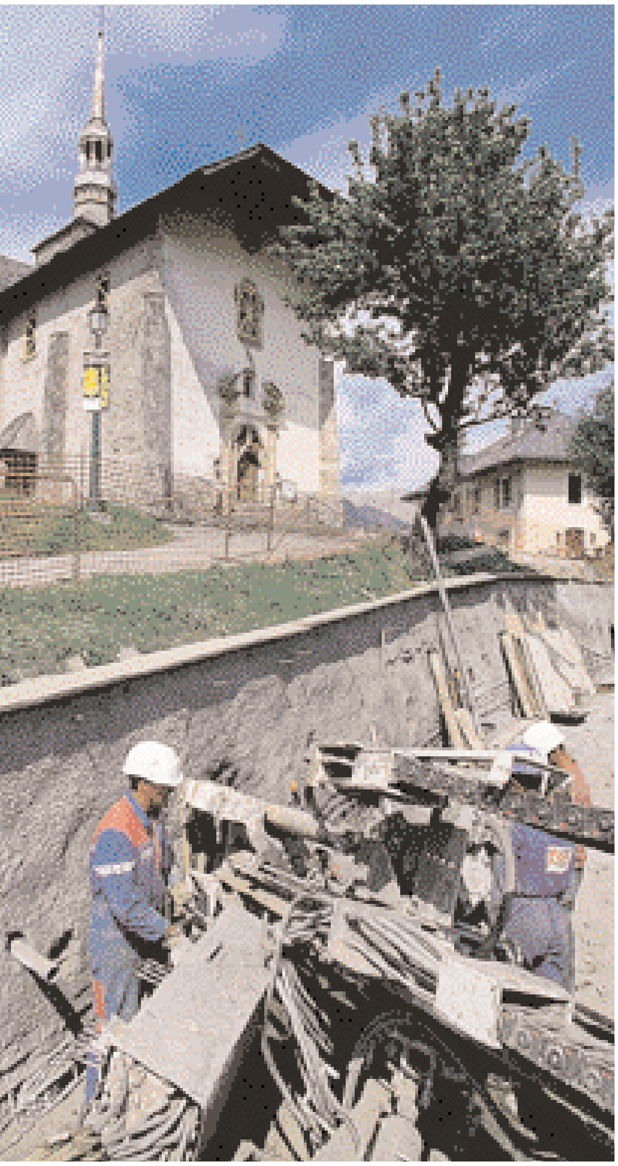


Hictoric Monument



Consolidating a church

Saint-Nicolas-la-Chapelle is an authentic village of the French Alps distinguished by its church with its bulbous cupola classified as a historic monument. Freyssinet strengthened this monument using micropiles and an anchored wall.



The village of Saint-Nicolas-la-Chapelle is located at the heart of the Arly high valley between Mont Blanc and the Aravis chain, and is justly proud of its church built in 1776. Cracks appeared in the vault of Saint-Antoine Chapel in 1861. A number of consolidation repairs were undertaken between 1910 and 1979. Cracks in the vault and its walls caused by lateral movement of the West wall are now 3 to 5 mm wide. The geological investigation showed that this church was built cantilevered from a rocky spur and on a moraine deposit that is sliding by 1 mm per year taking the west wall with it. Freyssinet has just strengthened this monument using micropiles and an anchor wall.

Retaining wall

Freyssinet built an anchored retaining wall on the downward side, to stabilize this sliding moraine deposit. This nailed wall is constructed in phases, and considering the profile of the structure, earthworks will be done firstly by removing material, and then secondly by backfilling. A 1 m wide draining system is installed every 2 meters. The wall is anchored by injected passive nails inclined at 10° from the horizontal, and by a set of active injected 500 kN anchors in two rows with lengths of 23 and 28 m, inclined at 10°.
After constructing sub-horizontal drains over a length of 16 m, the inside face of the wall is made by spraying a 30 cm thickness of concrete strengthened by reinforced concrete buttresses. The operation is completed by installing a draning system at the bottom of the wall, composed of a gutter type road drain and draining materials. Inspection chambers are provided so that the lower tie-rods can be inspected after the backfill has been completed.

Consolidation by micropiles

The stone structure is strengthened by 14 m long and 140 mm diameter micropiles with sealed 70/89 reinforcing bars. The top of the micropiles is embedded in reinforced concrete retaining slabs connected to a peripheral beam at the bottom of the wall. This beam is tied to the building foundations by means of niches in the thickness of the masonry.
Earthworks are done in sections along the west wall of the church, to construct the retaining slabs and the peripheral beam. Underpinning earthworks are also done in phases to make niches in the existing foundations. Once these earthwork operations have been completed, the formwork and reinforcing for the retaining slabs and the peripheral beam are fixed along the length of the church wall, the concrete is placed and a drainage network is built. The entire site is cleaned at the end of the operation and grass is planted to restore the environment.

Participants

Client:
Saint-Nicolas-la-Chapelle town hall.
Engineer:
Guy Desgranchamps DPLG architect.
Main contractor: *Freyssinet.*

Dynamic compaction

Paris Oise ZAC (business park)

Ménard Soltraitement used dynamic compaction to reinforce the soil in a business park.

The Faure and Machet company decided to set up on the Longueil-Sainte-Marie site (Paris Oise business park), however soil improvement is necessary on this site before construction can be started. Menard Soltraitement proposed a dynamic compaction technique using stone columns. This method is an extrapolation of dynamic compaction, in which the battering energy is used to form large compact granular foundations by "dynamic substitution" that reinforce the soft soil based on the stone columns principle. These stone columns are constructed using a process in which backfill and ramming phases are alternated using 15 t ramming mass, to obtain sufficient penetration into the backfill through the soft subjacent layers.

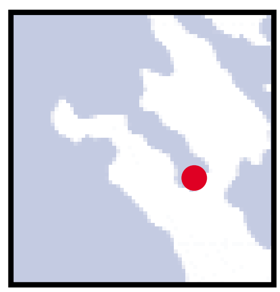
When necessary, an initial hole is made using a mechanical shovel to facilitate penetration of the mass into the depth and to limit surface swelling.

The work was done in three phases following three tenders. The first phase applied to an area of 28 000 m^2, the second 17 000 m^2, and the third 28 000 m^2. Menard Soltraitement worked on the last two phases when the building structure had already been constructed. Thus, due to the presence of the new buildings, a variant was adopted in which stone columns made with a vibrator and air lock were used.

South Korea

Vertical drains

Kangso stadium



Sangjee Menard is improving soils for construction of the grass hockey stadium in Kangso Gu.

South Korea will be host for the next Football World Cup and the Asian Games in 2002. This is why a large number of infrastructures are now under construction, such as the grass hockey facilities in Kangso Gu, near Pusan. These facilities cover more than 20 hectares, and as well as the main stadium that can hold more than 20,000 spectators, they include training areas and a number of buildings particularly for locker rooms and administrative services.

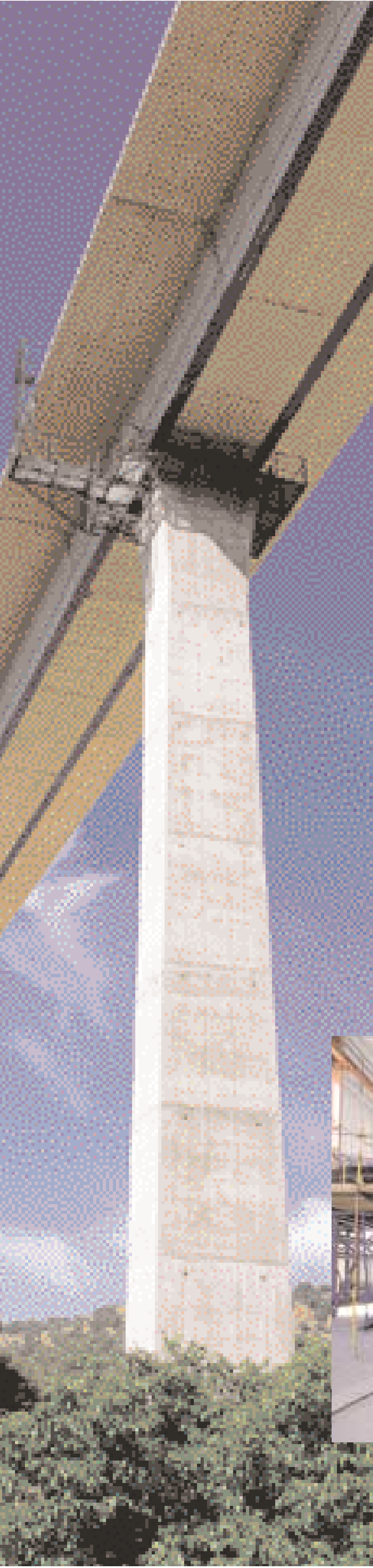
The site is installed on the banks of the Nakdong river on a layer of extremely soft clay about 20 to 25 m thick. The predicted settlement of the stadium for the initial design state is more than 2.50 m, the equivalent of one complete storey.

Samsung Engineering and Construction awarded a subcontract to Sangjee Menard Co Ltd, the Korean subsidiary of Menard Soltraitement, for soil improvement according to its proposed alternative using vertical Menard drains associated with preloading by backfill. This innovative solution was chosen in preference to the conventional piled solution.

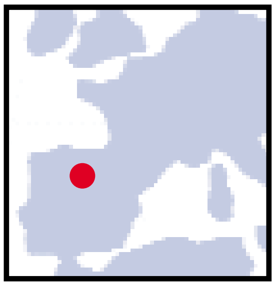
The first phase of the project started in 1999, and included the installation of more than 700,000 m of Menard vertical drains. The efficiency of the method backed up by Sangjee Menard's know how was such that another contract for the second phase of the project was awarded. This phase started in July 2000; it involves the construction of more than 1 000 000 m extra drains.

Participants

Client: *Town of Pusan.*
Main contractor: *Samsung Engineering and Construction.*
Specialized contractor: *Sangjee Menard Co Ltd.*
Commercial action and work management: *Song Ki-Hyun.*



High speed train



New AVE link

This 796 km long project for a high speed train (AVE) link from Madrid to France will be completed in 2004, and is one of Europe's largest construction sites.

The new AVE (tren de alta velocidad) (high speed railway) line will link Madrid and Saragossa with a travel time of 1 hour 15 minutes by 2002, and then Madrid and the French border with a travel time of slightly more than 2 hours 30 minutes by 2004.

All structures are built to resist forces generated by train traveling at speeds of almost 350 km/h, and braking, imposing particular technical characteristics. The project was designed to integrate perfectly into its environment.

Freyssinet SA, the Group's Spanish subsidiary, is participating in the construction of two parts (VIII and XV) giving a total of eight viaducts, and its main responsibility is the supply and construction of prestressing using Freyssinet's C system.

Part VIII, Gajanejos-Calatayud

The AVE line in this deeply undulating region between the towns of Arcos de Jalon and Santa Maria de Huerta in the province of Soria, passes over a series of six viaducts to cross the valleys, some of them up to 65 m deep. The deck width of these structures is 14 m, and their total length is 1 960 m. They are constructed by incremental launching. The geometry of all six viaducts is identical, and consists of a trapezoidal single cell box girder. Segment reinforcement cages are made on the ground on an area behind the bridge under construction, and then put into position by a crane into the formwork in which concrete is poured to form a box girder. When the concrete is sufficiently strong,

The AVE project requires the construction of a total of 93 viaducts and 26 tunnels. All structures for parts VIII and XV were built by successive incremental launching, the deck being built in a plant behind the viaducts under construction.

the box girder is joined to the previous girder by prestressing tendons. The structure with its steel nose is then incrementally launched and the post-tensioning tendons inside the webs of the box girder are inserted and tensioned. Freyssinet SA is working as a subcontractor to the NESCO company, and supplied and installed the prestressing for the viaducts consisting of the equivalent of 1 600 t of cables, 1 200 anchors and 850 couplers.

Part XV, Ricla-Saragossa

Two parallel viaducts close to Saragossa across a broad plain above a four-lane motorway. The width of the decks on these two viaducts is different. The narrower will carry conventional railway traffic, and the wider will carry the AVE train. The main difference from the other structures is their length of 1 400 m.

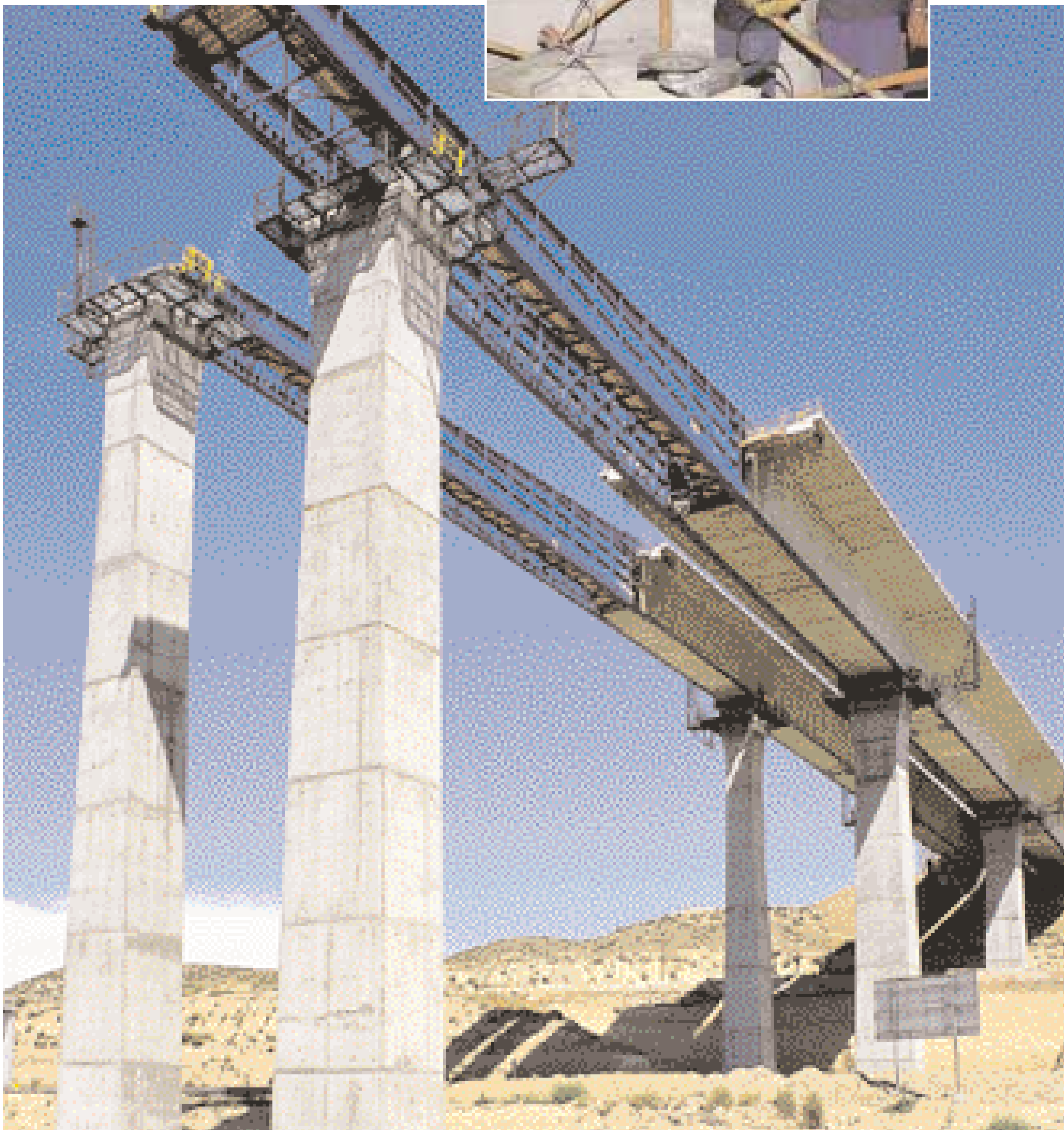
Like the structures in part VIII, the segments of the viaducts in part XV are poured behind the structures to form a box girder assembled as complete spans before the structure is incrementally launched. Freyssinet SA is supplying and installing the prestressing for the viaduct that requires 1 980 t of cables, 1 130 anchors and 1 088 couplers.

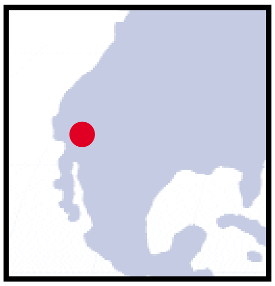
Apart from the prestressing work, Freyssinet SA also supplied and placed Tetron bearings and sintered Neoprene bearings on the viaducts for the two segments.

Participants

Client and Engineer:
Railway Infrastructures Directorate - Ministry of Public Works.
Main contractors: *NECSO.*
Specialized contractor: *Freyssinet SA.*

Some AVE viaducts have characteristics similar to the viaduct in segment XV shown below, almost 1 400 m long, and to viaducts 2 and 5 in part VIII, with lengths of 510 and 450 m and maximum pier heights of 54.52 m and 64.62 m respectively.





Morancie mine

Hybrid abutments, a world first

The use of the Reinforced Earth technology resulted in economic construction of a road bridge more than 24 m above a mine access road.

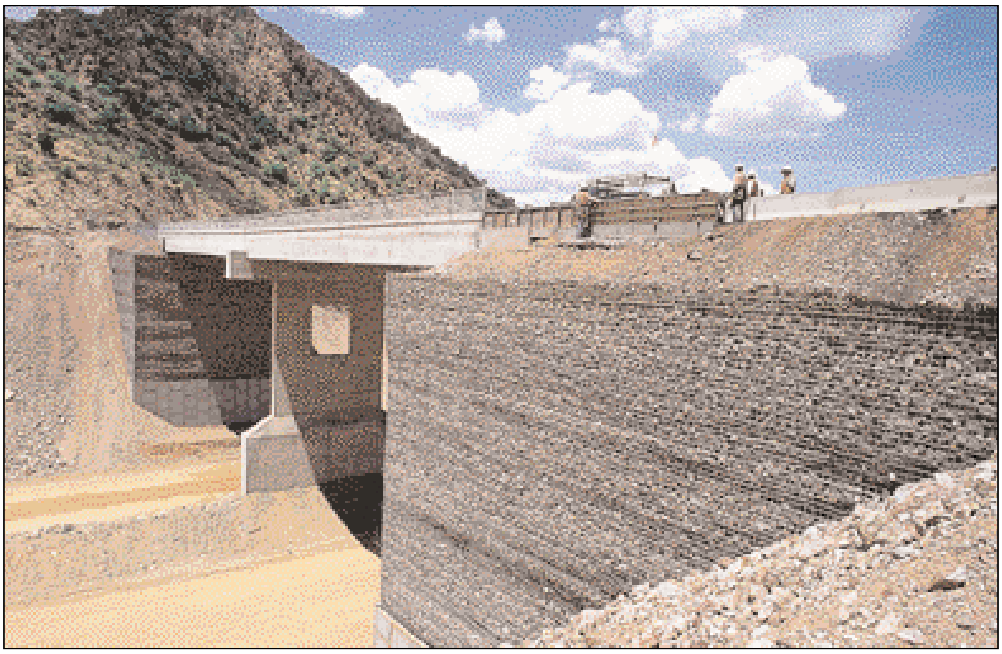
The story started in Morancie near Phoenix, in the middle of the Arizona desert, after the discovery of a high quality ore under a road. It was then decided to build another road across broken, mountainous country, including a two-span bridge supported by very tall Reinforced Earth abutments and a central reinforced concrete pier to cross a deep ravine.

Reinforced Earth and TerraTrel™ walls

The system is composed of galvanized steel reinforcing bars, backfill made of crushed rock and concrete and galvanized steel facing. The abutments are made of retaining blocks designed to support the weight of the ground and the concentrated bridge loads. These loads are distributed on Reinforced Earth structures through a reinforced concrete girder. The Reinforced Earth foundations are about 24 m high and the span of the bridge beams between the central pier and each abutment is 30 m.
The lower 9 m of the Reinforced Earth structures is composed of 18 cm thick prefabricated concrete scales and galvanized steel reinforcing bars. The concrete scales form a rigid envelope designed to protect the Reinforced Earth structures from vehicle impacts.
The upper 15 m of the two structures are made using TerraTrel™ panels, a galvanized welded mesh facing system.

A tricky design for the first use of this construction combination

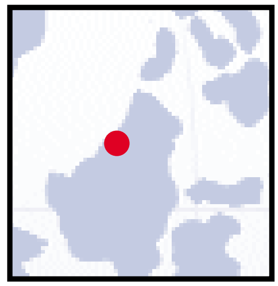
Two Reinforced Earth wall systems had never been combined in this way before, and its designers needed to take several factors into consideration. The structures have to resist extremely high loads due to the height of the wall and high bridge loads applied to the Reinforced Earth foundations, and keep the bridge bearing girders away from the TerraTrel™ mesh surface. The junction between the mesh surface and the prefabricated panels 9 m above the ground also needed to be designed, and finally the structures had to be designed to resist all potential seismic loads.
Reinforced Earth Co. delivered a complete engineering project, the materials necessary for construction of the walls, and technical assistance on site throughout the duration of the works.



Malaysia

Incremental launching

Sibu bridge



In 2001, Sibu bridge over the Rajang Batang river will replace the ferries used in the past for river crossings.

This 1 194 m long bridge crosses the Batang Rajang river about fifteen km from the town of Sibu in the State of Sarawak. It comprises two prestressed concrete access bridges constructed by successive incremental launching, and a central section built by cast in situ cantilever construction. Freyssinet PSC(M) Sdn Bhd participated in the different phases of the work for the design, fabrication, installation and commissioning of the formwork system for sections built by incremental launching and cantilever construction, the complete design and fabrication of the launching system, the steel nose and the carriage form traveler for box girder sections. Freyssinet also does the design, installation and tensioning of temporary and permanent tendons, and supplies Freyssinet CD Tetron PSC type mechanical bearings for the incrementally launched part. Freyssinet also supplies the cast-in-situ curved sections of the deck.

Participants

Main contractor:
JKR-Jabatan Kerja Raya (Malaysian Ministry of Public Works).
Consulting engineer:
KTA (Sarawak) Sdn.Bhd.
Main contractor: *The Galland/ Hidrogradnja/Ku-De-En consortium.*
Specialized contractor:
Freyssinet PSC (M) Sdn.Bhd.
Duration: *June 1999 to December 2001.*

Taiwan

Prestressing

LPG: 80 000 m^3 reservoirs

Freyssinet has completed the construction of three of the largest LPG reservoirs ever built in Taiwan.

Freyssinet has completed the prestressing work for three LPG reservoirs in Mia-Lao on the island of Taiwan. These reservoirs have a diameter of 76 m and are 22 m high, and were built by slipforming.

In the vertical plane, prestressing comprises 79 vertical type 12C15 U tendons, and 102 type 19C15 tendons in the horizontal plane. A total of 891 t of strands were installed between February and July 2000. Freyssinet Taiwan Engineering installed the ducts and prestressing tendons, and also supplied and constructed the prestressing platforms.

The reservoirs will form part of the Formosa Plastics Complex, the new gas terminal to be built in the center of Taiwan. These 80 000 m^3 reservoirs will be the largest liquefied petroleum gas reservoirs ever built on the island.

Participants

Client: *Formosa Plastics Corp.*
Engineer: *Tractebel Gas Engineering.*
Main contractor: *Ting Tai Contruction Co.*
Prestressing: *Freyssinet Taiwan Engineering.*

Freyssinet is participating in the construction of eight viaducts for the future AVE train link in Spain, by supplying and installing all prestressing for the deck.

Photo : Francis Vigouroux

freyssinet