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France

Footbridge over the Cher

freyssinet

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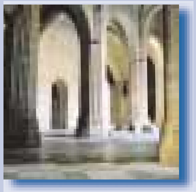

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Viewpoint

Tunnels, bridges and architecture: a new vision

Alain Spielmann is the architect for the footbridge over the Cher, in Tours. He talks to us about his profession today, and about the most recent architectural changes in structures.

Alain Spielmann, DPLG architect: "The role of the architect nowadays is to force man to think. I am in favour of an uplifting architecture."

Freyssinet Magazine: Architects appear to be more closely associated with the construction of large bridges and viaducts nowadays. Is this a new phenomenon?

Alain Spielmann: In general, French tradition has always been that designers and architects work closely together on major construction sites. But nowadays, it is true one result of competitions is that they are more systematically called upon to contribute to all types of construction programs, and are more frequently mentioned. Architects have been in the repair and reinforcement activity for many years, for example particularly for Paris bridges.
I myself was involved in the restoration of Paris bridges in the 1970s, with the objective of making the structure and the frame clearly visible. Note that the repair activity will become more widespread, as structures are brought up to standards or their functions are changed. Architects' studies and proposals bring a renewed approach, in structural engineering.

What is the role of the architect now?

A. S.: Architects still have the same freedom that they enjoyed in the past. However in my own experience, I feel much freer because I have a better knowledge of my work. This has nothing to do with external constraints, but rather with constraints that I have set myself and the new means available to us. We can now use extraordinary high performance tools for calculations and construction that we could not use before, thus widening our field of action. The role of the architect is to encourage man to think. I am in favour of an uplifting architecture, like the footbridge over the Cher in Tours suspended on a single cable with its red tubular and inclined towers, platform and wooden handrail.

How are the engineering and architectural businesses complementary?

A. S.: Our businesses share their enthusiasm for construction. What has changed is that new generations of architects and engineers want to express themselves, and at the same time, the public at large would like to live in an environment that makes it feel good. We are facing a demand that we need to understand, decrypt and explain. Our engineers must be creative in their own field and have the means to do so. They also need to be able to take account of the physical realities of materials and the psychological needs of men in order to develop specific concepts, forms, project desires without any architectural hindrance to the imagination. The subject is exciting precisely because it is difficult. We need to cooperate with engineers, unite our passions and our desires to build, and to join forces with them.

What architectural changes are being made in structures?

A. S.: In France, traditional age-old construction techniques are still frequently used in construction. We frequently find ourselves needing to deal with complicated problems due to old technologies, old fashioned techniques and generally being late in introducing the use of some techniques. Therefore, there is an extremely big difference between buildings in which industrial means are used and buildings built by crafts-

Architects have been in the repair and reinforcement business for many years, particularly for historic monuments like the Genil bridge in Spain that Freyssinet teams recently restored.

men, in which practices that have proven their value are used, but in which progress is much slower. On the other hand, we have a highly sophisticated concentration of means and technological development for the bridge construction industry, and this is not the case everywhere in the world. Note also the different scales. Spans in buildings vary from 5 to 7 m, whereas bridge spans can reach several hundred meters. Therefore two quite different approaches are necessary.

In any case, the trend in both fields is to reduce the weight of the structures. Lighter weight materials are used, with more powerful lifting equipment and more highly specialized personnel. Today's and tomorrow's structures are and will really be lighter, thinner, more transparent, more comfortable, but also sounder and will blend better into their environment. I think they will be more cheerful and brighter, more colorful with more fantasy, making a break with the current frequently somber fashion. We are moving towards structures that will be more imaginative while respecting the environment, and will have better sound and thermal qualities… without introducing extravagant expenses.

You recently talked about "constructed poetry"?

A. S.: Constructed poetry is an objective to be attained. It is a correspondence between a lifestyle and acquired know how that we translate into forms with our hands. I call that constructed poetry, and I think this expression is particularly meaningful in the construction of a bridge such as the footbridge over the Cher in Tours. The general public spontaneously recognizes it as such and feels it. This is a vital need, something common to everyone everywhere in the world, a common denominator.

How is it applicable to a bridge like the Cher footbridge?

A. S.: It was necessary to solve a problem, to build a bridge within a very short time within a very tight budget. After my experience with construction of the Blois bridge in which we were faced with foundation problems, I decided not to use supports in the Cher. Maintaining the tradition of builders in the past who had built suspension bridges over the Loire, I chose the same type of structure with a 235 m span, which was an economic solution. Therefore we worked with the engineers to design a structure derived from the structure designed by the engineer Mr. Le Ricolais in the form of a braced triangle. It is a simple structure with two V-shaped towers, a suspension cable and two 235 m lateral cables . We built a rigid structure from flexible materials, the cables. The result is a footbridge that blends well into its surroundings. We attempted to solve the problem and we found a solution that combines finesse of the bridge and the use of easily available materials. Our work blends into the present day context, and is a modern means of expression.

Is the belvedere in the middle of the footbridge your personal style?

A. S.: It has become so in time. I built belvederes on the bridges over the Allier, in Laval, in Blois, etc. I always thought that a building, bridge, construction, etc. should perform several different functions and be versatile. I included elements that would contribute towards helping people feel a part of the setting and appreciate it, to highlight its poetry. The belvederes and additional elements incite the public to take their time and really look at the bridge. They perform their function, and help people to feel comfortable on the bridge.

"In the building industry, there is a world of difference between buildings built using industrial means (like the Telekom Malaysia building) and buildings built by craftsmen."

United Kingdom

Medway Bridge Strengthening

Repair and consolidation works on the bridge over the river Medway had become urgent. This bridge was built in 1962, and needs to be upgraded to satisfy new roads and bridges standards in Britain and to carry new traffic flows from the coast due to widening the M2 motorway. The contract included the use of Freyssinet's C range anchorage system for external prestressing with unbonded strands and prior injection of cement grout (for the first time in the United Kingdom), to prestress the 95 m access spans and the 61 m long main span. Maunsell (the client), the Highways Agency (the consulting engineer), and Edmund Nuttall (the main contractor) appointed Freyssinet UK to install 96 tendons in the four quadrants of the bridge.

Replacing bearings on an airport viaduct

Gatwick airport uses a passenger transit system on a dedicated line composed of shuttles operating between the North and South terminals. The track is elevated and passes over the A23 motorway on a viaduct. The viaduct is composed of a continuous box girder with two 82 m long cantilever spans. The structure is supported on bearings on each abutment and on the central pier. Freyssinet replaced the two main guided sliding bearings on one abutment, four viaduct bearings, and repaired the other three. The contract included the design and placement of a temporary support system by means of jacks to raise the A23 bridge. The system was required to support high loads and absorb the dynamic reactions of the bridge caused by trains passing over every two minutes. The design also allowed for rotating and leveling the structure to realign the tracks between the abutments and the deck. Freyssinet designed and made all the new stainless steel bearings weighing 350 kg, and including anti-vibration elements.

Kosovo

Bridge repair

Freyssinet has widened the central pier, reconstructed the slab and pavements made of concrete and replaced the bearings and expansion joints, on the one hundred meter long Mitrovica bridge. Apart from these structural operations, the works also include the placement of additional architectural elements such as viewpoints on the bridge, the supply and placement of lighting, bank access steps and the construction of two decorative arches.
At the same time, Freyssinet is working on two other bridges in the Pristina region. Milosavo bridge that was completely destroyed during the war, and Vrani Do that was partially destroyed, are being rebuilt using precast elements.

South Korea

Seohae bridge

Seohae bridge is about sixty kilometers from Seoul and is the longest bridge in Korea.
It was opened to traffic on November 9 2000. The 7310 m long bridge joins Pyongtaek to Danji and carries six traffic lanes. Freyssinet supplied and installed the prestressing and the bridge equipment for some access spans, and placed the stay cables for the main bridge (see magazine No. 203, November 1998).
The 990 m long main bridge comprises an 870 m cable stayed part with a 470 m central span.
The deck is supported by two layers of cables each with 72 stay cables anchored at the top to two 180 m high towers. The stay cables fitted with DGD dampers are composed of unbonded strands in galvanized ducts. They are tensioned using Freyssinet's patented Isotension® process and are inserted inside a double spiral duct to counter vibration phenomena in this area affected by typhoons.

India

Retaining walls for access ramps

Like all other large cities, Mumbai (formerley Bombay) is facing serious transport difficulties that have been continuously increasing in recent years. In cooperation with the government of Maharashtra, the Maharashtra State Road Development Corporation Ltd (MSRDC) decided to build 50 road bridges and overpasses in the town. Reinforced Earth retaining walls were chosen for the construction of bridge access ramps. Different architectonic surfaces were used, varying from conventional plain panels to panels with diamond or ribbed patterns. The AIMIL-TAI joint venture has already constructed 15 000 m^2 of Reinforced Earth walls in Mumbai for the Chedda Nagar, Konkan Bhawan, Aarey-Goegaon road bridges, the Goregaon-Mulund bypass, the SION Roundabout and extension of the Chembur to Mumbai link.
These bridges are now open to traffic.

Homage

Sir Alan Harris

The engineer Alan Harris, the founder of the Harris & Sutherland Company, knighted in 1980, died recently at the age of 84 years. He had been awarded the French Croix de Guerre for his actions during the Second World War.
After the war, he joined Eugène Freyssinet at the STUP.
The company hired him, and he acquired theoretical design experience and practical experience on site. He returned to London in 1949 as Freyssinet's Chief Engineer and General Manager of the Prestressed Concrete company that operated under a license.
Alan Harris designed many structures such as silos and bridges, etc., and was particularly involved in education and the institutions.
He was President of the Institution of Structural Engineers, vice-president of the ICE and taught concrete techniques as Professor at Imperial College. We would like to express our profound sympathy to his wife, Lady Harris, and their two sons.

Australia

Burnley Tunnel

The Burnley Tunnel is 3.4 km long, carries three traffic lanes in each direction, and forms part of the City Link project, a Melbourne expressway. The D-shaped tunnel was drilled to keep a minimum cover of 12 m of moderately weathered to fresh mudstone under the Yarra River. The primary support system used shortcrete, rock bolts, and where necessary steel sets during excavation. After excavation, a waterproof membrane and concrete lining, 300 to 450 mm thick, completed the structure. Before that, the raft had to be stabilized by ground anchors and grouting. Austress Freyssinet were part of the remedial work team for the project and were awarded the contract for the detailed design, supply, installation and stressing of 1800 permanent rock anchors. Anchors were installed at a spacing of 1100 mm and drilled 10 m into suitable rock, and consisted of seven 15.2 mm diameter tendons and 40 mm diameter Macalloy bars.

Venezuela

Reinforced Earth walls at Prado Humboldt Park

The Venezuelan population is becoming more urban. This change is the reason why construction companies are building residential areas around the periphery of towns.
These areas very often include steep and irregular topography on which efficient, safe, fast and economic construction methods have to be found to stabilize the fill. The Prado Humboldt Park residential area is a good illustration. Fill at an average slope had to be stabilized to retrieve land, and access ramps had to be built for road traffic and for pedestrians, as part of this complex including six apartment tower blocks. The works were done using Reinforced Earth walls. The total surface area of walls, between Main Street and the various buildings, was 1055 m^2.

digest

Main figures

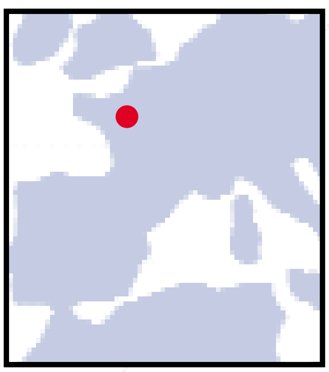
- Footbridge length: 235 m.
- Tower height: 35 m.
- Diameter of steel tubes for tower: 812 mm.
- Tower inclination: 69°.
- Deck width: 3.1 m.
- Number of segments in the deck: eleven 20 m elements.

The Cher footbridge is a lightweight braced triangular shaped structure, derived from the footbridge constructed by the French engineer, Mr. Le Ricolais.

digest

Suspended bridge

Cher footbridge



A new 235 m span footbridge has recently been opened in Tours. It makes use of a modern and uplifting architecture giving the impression of soaring effortlessly over the Cher.

Since the end of the year 2000, a footbridge has connected the center of the City of Tours to the quickly expanding Deux-Lions district occupied by businesses, homes, leisure centers, schools and universities. This 235 m span footbridge suspended from a single cable crosses over the Cher without any pier or other support on the islands over which it passes. Lateral cables are provided for dynamic stability of the assembly.

The structure comprises harmonious colors and a variety of materials including oven-lacquered guardrails, a wooden handrail and platform, and red towers, and is illuminated at night to form an outstanding landmark of the town. The circular lookout in the middle of the footbridge offers pedestrians a new viewpoint over the islands that have remained in their natural state, and on the river itself.

Lifting of the towers

The human, technical and industrial means used for the main elements of the bridge (the two towers, the support cable, the two lateral cables and the deck) are typical of what is required for a large project. The works started on both sides of the Cher by the construction of two concrete foundations anchored by 27 m long micro-piles to support the stands of the bridge towers, and a back foundation also anchored by 27 m long micro-piles for the suspension cable, and another two temporary micro-piles to resist forces due to deck launching operations. The forward foundations were connected to each other by a beam prestressed by Macalloy bars to resist horizontal forces.

The tower legs were then placed. They are 35 m high and composed of 812 mm diameter steel tubes prefabricated in the workshop and welded together. The legs were transported to site by truck and welded together to form an inverted V with a diaphragm near the top over which the suspension cable passes. The tower is hinged at the bottom, and was lifted using a 200 t mobile crane. This very tricky operation was done in

MORE THAN 20 YEARS EXPERIENCE IN CONSTRUCTION AND REPAIRS OF FOOTBRIDGES

Illhof,
France (1980)

Cotton Tree Drive,
Hong-Kong (1980)

Ville-sur-Haine,
Belgium (1988)

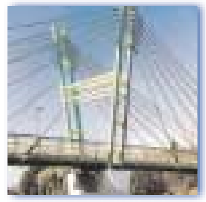
Bandar-Sunway,
Malaysia (1993)

Pas-du-Lac,
Saint-Quentin-en-Yvelines,
France (1992)

Grand-Tressan,
France (1989)

Collège in Lyon,
France (1996)

West-Kowloon,
Hong-Kong (1997)

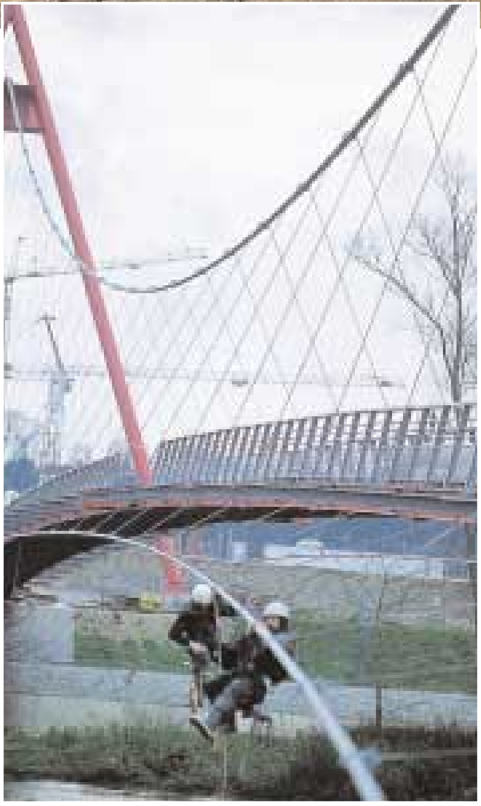


Brystrzyca,
Poland (1999)

Other realisations:
Poplar Walkway, Great Britain (1992) ; Pyrmont, Australia (1993), RW 16 in Rotterdam, Holland (1994) ; Izmir-Güzelyali, Turkey (1997) ; Indooroopilly, Australia (1998) ; Chartrouse, France (2000) ; footbridge over the Cher in Tours, France (2001) ; footbridge over the Sarre in Sarreguemines, France (2001) ; and many others...

Marc-Seguin in Tournon,
France (1999)

St Georges in Lyon,
France (1999)



The side collars and hangers were tightened by a team of mountaineers above the Cher.

half a day under the permanent control of a surveyor. During lifting, it was essential that the pulley block should remain on the longitudinal axis of the footbridge to avoid unbalancing the structure. The tower was raised to 69° and held in place by temporary struts. The tower inclination was calculated with a slight backwards tilt to compensate for the movement that would occur later due to the weight of the deck. Temporary strands were then installed between the two towers to place the main cable and the man-lift.

Placement of the main cable

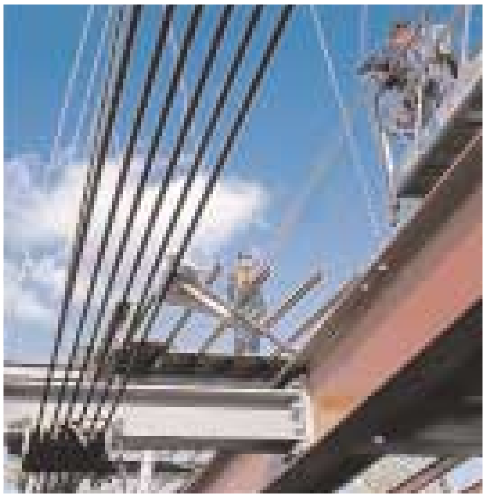
A T15 strand was launched from one bank to the other between the tops of the towers, with a sag of 16 m. Three other T15 strands were then installed and were used to place a self-powered suspended man-lift, from which works could be done on the cables and hangers. This man-lift was pulled by a tyrack and was remote controlled. An onboard generating set supplied power for raising or lowering the man-lift.
The four 60 mm diameter 320 m long cables forming the main cable were unwound from reals with hydraulic brakes and pulled by a 3 t winch from the opposite bank. A system composed of rollers and pulley blocks was used to pass the end fitting over the saddle at the top of the tower. The suspension cable is assembled by 30 collars at 7.5 m intervals.

Launching the deck

The deck was launched by applying a tension of 10 t to two groups of cables comprising 6 strands, between the suspension cable anchor foundations. Before this, the deck was assembled by 20 m segments, and elements were carried by crane to the launching area composed of U-rods and walker pads. A hydraulic wheels device was bolted to the abutment and was used to tilt elements on the strands. The pads with grease combs inserted between the deck structure and the strands facilitated sliding. A 3 t winch on the opposite bank pulled the deck, and a 2 t retaining winch was fixed on the launching area.
The deflection of the strands at the center of the structure was 4 m during launching. Once the element had reached its position, four hydraulic pullalongs installed on the deck and supported on the suspension cable were used to hoist the element to its geometric position. The final hangers were installed and the loads were transferred to them. The lift height at the center of the structure was 9 m, thus forming a genuine trampoline; the original slope of the bridge (3%) was restored during launching of the other elements. The eleven approximately 20 m long steel segments were prefabricated in the plant and then pulled and assembled in sequence. The platform was screwed into place as deck construction progressed. It is composed of 3.1 m long, 0.14 m wide and 0.03 m thick Angelin-Vermehlo tropical hardwood planks with an "anti-vertigo " profile and a slip resistant surface. At the same time, the guardrails (oven-baked with an Angelin-Vermelho wood handrail) and lights were fixed to the deck.
The works were completed by the placement of the two final lateral cables launched from the bank to provide complete transverse stability. A team of mountaineers was hired to tighten the side collars and the hangers for these eccentric cables above the Cher.

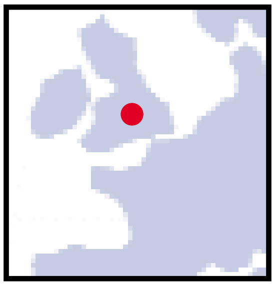
Participants

Client: *SET (Société d'Equipement de la Touraine- Tourain Development Company).*
Contract manager: *Scetauroute (agent) and the architec Alain Spielmann.*
Contractors: *Freyssinet France (agent) et Matiere.*



The deck was placed by incremental launching of the segments using a tensioned strands system between the banks of the Cher and pads with greased combs.

TechSpan® arches



High speed line

Channel Tunnel Rail Link provides a high speed line (300 km/h) that will eventually link London to the Channel tunnel terminal near Folkestone, in Kent.

The new line is divided into two parts. The first 74 km long part links the Tunnel to Fawkam Junction on the south bank of the River Thames and should be opened to passengers in October 2003. The second phase links Southfleet to Saint Pancras station in the heart of London and will be opened to Eurostar trains in December 2006.
On this line, contract 420 covers 20 km in the heart of Kent from Boxley to Lenham Heath. Two cut and cover tunnels were constructed close to the villages of Hollingbourne and Sandway. The initial proposal for these two structures was to construct the tunnels as in-situ reinforced concrete box structures. However, following a Value Engineering exercise the Reinforced Earth Companies proposal to use TechSpan® arch system was accepted.

TechSpan® system, the economic solution

The two tunnels are built by assembling two precast concrete TechSpan® units with a width of 14 m and a clear height of 8.5 m. The longer tunnel (Hollingbourne) is 360 m long, and Sandway tunnel is 170 m long. Backfill cover to the crown of the arches ranged from 0.5 m up to 5.5 m at the deepest section. The line crosses existing roads at Eyhorne Street (Hollingbourne tunnel) and Headcorn Road (Sandway tunnel). For this reason the tunnels were built in two phases, so that temporary road diversions could be setup over the partially completed structures. Finite Element Method Analysis was used to study the behavior of the tunnel and optimize material quantities, the thickness of the arch thus being reduced to 325 mm.
The TechSpan® foundations are supported on 3.5 m and 4 m wide independent strip foundations. These foundations were built directly on a dense sand deposit (Folkestone Beds Sand). The portals to the tunnels were formed using Reinforced Earth™ precast concrete TerraClass™ facing panels to form the headwalls and wing walls.
Construction of the first 170 m of Hollingbourne tunnel was started in April 2000 and completed just four weeks later. Completion of the two tunnels is planned for March 2001. This "high speed" construction and optimal use of materials makes this solution particularly economic.

Participants

Client: *Union rail.*
Contract manager: *Hochtief – Norwest Holst JV.*
Project management: *Rail Link Engineering (RLE).*
Design: *Rail Link Engineering (RLE).*
Specialized contractor: *Reinforced Earth Company Ltd.*

Soil improvement

Two electricity power stations

EDF International is currently building two power stations in Egypt. This project required soil improvement by Menard Soltraitement.

There is a close relation between both projects, East Port Said Power Plant and Suez Gulf Power Plant, since EDF international is constructing two identical electricity power stations with a unit capacity of 341 MW (combined fuel oil and gas). One of the power stations is located in the Sinai desert, and the other at the confluence between the Suez canal and the Red Sea. Both sites are being built at the same time with one six months in advance of the other, and both are in the form of a B.O.T. (Built, Operate, Transfer) concession; the power stations will subsequently be retroceded to the Egyptian Electricity Authority (EEA).

Two distinct techniques

The construction of the foundations for the two projects makes use of different techniques. A 20 m thick clay layer at a depth of about 10 m under the future power station platform was detected in Port-Saïd. The presence of this highly compressible clay subject to consolidation could cause high negative friction on the foundation piles in the long term, thus making the works tricky and expensive, with the use of tubing over the first 30 meters to separate the piles from the surrounding soil.
Menard Soltraitement was called in by the project engineer (EDF CNET) and suggested a solution to EDF that consisted of improving the soil across the entire site. The plan is to compact the soil over a period varying from four to nine months to achieve a degree of pre-consolidation equivalent to what would have occurred after 20 years under the power station load if no prior works were done. This was achieved by the construction of prefabricated drains throughout the thickness of the clay layer and the application of an overburden consisting of temporary fill. With this treatment, most of the originally planned piles were eliminated and the buildings were supported directly on the surface foundations. Furthermore, there is no negative friction on the remaining piles.

Pre-consolidation

The design of the drain network and the depth of overburden was adapted to each situation depending on the final load and the allowable pre-consolidation time. The final load is between 1 t/m^2 and 20 t/m^2, the depth of the vertical drains is 32 m at a square grid varying from 1 to 1.37 m. The pre-consolidation time was from four to nine months and the overburden depth was between 8.5 and 16 m. A total of 53 000 drains representing a total length of more than 1 600 000 meters were installed in less than three and a half months by means of two specially designed machines working on two shifts. More than 750 000 m^3 of fill was then put into place to preload the site.
Soil consolidation was checked by means of a monitoring system composed of settlement plates, pore pressure sensors and slope stability sensors (extensometers and inclinometers). This monitoring system is still in place and will be used until the middle of the year 2001.
A first area has already been released for construction of the civil works. The observed consolidation in this area caused a settlement of more than 1.3 m under 8.5 m of overburden placed for four months with drains on a 1.37 m grid. The settlement at the moment in the oil tanks area where the load is highest is more than 2 m under 11.5 m overburden, after four months at a 1 m grid.

Above, the Port-Saïd soil consolidation site carried out by the use of prefabricated drains combined with an overburden consisting of temporary fill.

Menard Soltraitement used the controlled modulus columns (CMC) technique for the Suez site.

Columns with controlled modulus

On the Suez site, the soil consists of a 6 to 7 m thick mediocre layer followed by about 3 m of compacted sand and then an alternation of sand and clay layers down to a depth of 30 m.
The basic solution selected by EDF consisted of boring 80 cm diameter, 35 m deep piles. Menard Soltraitement then proposed a technical solution for the foundation of the two 45 m diameter, 19 m high oil tanks based on the use of CMC (Controlled Modulus Columns).
These CMCs pass through the weak upper layer and are embedded in the load bearing layer. A distribution mattress composed of an approximately 40 cm thick layer of good material was then placed on these columns, and the underside of the oil tanks was placed directly on this layer. Menard Soltraitement determined the optimum grid, depth and diameter of the columns using a Finite Element Method Analysis. A total of more than 1 800 CMCs with a diameter of 42 cm and a total length of about 15 000 meters were constructed in a month and a half using a specially designed machine. The total saving is high considering the reduction in the foundation depth and elimination of beams over the pile caps.

Participants

Client : *EDF International.*
Contract Manager: *EDF CNET.*
Main Contractor: *SAEI/ORASCOM JV.*
Specialized Contractor: *Menard Soltraitement.*

Consolidation principle

The compression of sandy soils under a given load (for example a building) takes place as soon as this load is applied.
The result is a settlement called an "immediate settlement" that can be assumed to be elastic for all practical purposes.
However, buildings founded on clay soils settle over a long period at a gradually decreasing rate until they stabilize. This long term settlement of clay soils under constant load is called "consolidation settlement". This phenomenon is explained by the fact that the pore pressure of water in the soil must decrease before the soil can settle. Since clay soils are only very slightly permeable, this water can only be evacuated very slowly.

Renovation

Penang bridge

The stay cables for Penang bridge needed to be partially renovated, since the bridge carries much heavier road traffic than when it was inaugurated in 1985.

At the moment, Penang bridge is the only link between the island of Penang and the Malaysian peninsula. It now carries 52 000 vehicles per day, which is much more than when it was inaugurated in 1985, and traffic is still increasing. This increase is due to recent developments in manufacturing and commercial activity on the island and in the hinterland. Faced with this phenomenon, the bridge concession company, the Penang Bridge Sdn Bhd (PBSB), appointed Freyssinet PSC Malaysia to perform a contract to renovate the bridge stay cables on August 9 1999. All the works were done by Freyssinet PSC (M) Sdn Bhd with the assistance of Freyssinet International in France and Freyssinet APTO in Kuala Lumpur. Freyssinet PSC (M) Sdn Bhd worked with the assistance of EEG Simecsol as the consulting engineer and WS Atkins as the independent inspection organization. All works were performed without any interruption to traffic during the construction period (ten months).

Investigation, design and construction

Due to the lack of any reliable information about the condition of the bridge, the first phase of the works consisted of investigation (coring and measurements of stress relaxation in the concrete) and design (complex three-dimensional model). The works began after the Chinese new year, on February 15 2000, with the preparation phase that consisted of installing temporary works access platforms and scaffolding erected to the top of the four East and West towers. The investigation activities showed that the concrete strength in the deck was lower than expected. A new works program was then submitted to PBSB in June 2000 and was approved by both parties in September 2000. This program included the supply and placement of four permanent double bearings between the existing deck and pylon crossbeam, and eight rubber bearings between the deck and the towers acting as a longitudinal restraint for the deck. It also included the installation and tensioning of sixteen temporary stay cables, the removal of existing E2 and M2 front and rear stay cables, the coring in the deck and the towers to extract the original stay cable anchors composed of bars fully injected with cement grout. This last operation has proved to be very tricky due to the length and diameter of the cores. The works were completed by the placement of twelve Freyssinet stay cables and their associated components, thus by removal of the temporary stay cables and finally by the load transfer to the permanent upgraded structure. All works were completed on December 21 2000.

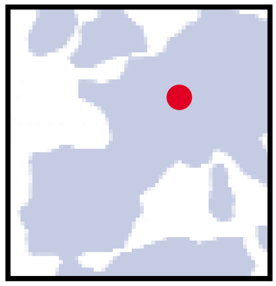
Participants

Client and Contract manager: *Penang Bridge Sdn Bhd (PBSB).*
Design office: *EEG Simecsol.*
Inspection office: *W. S. Atkins.*
Main contractor: *Freyssinet PSC (M) Sdn Bhd.*

Main volumes

- Monolithic reinforced concrete cores through deck and pylons: diameters 325 mm and 470 mm, length varying from 4000 mm to 5300 mm
- Steel works for temporary stay cable anchorages: 25 t.
- 15.7 mm temporary stay cables: 15 t.
- 15.7 mm permanent stay cables (unbonded strands in galvanized tubes): 23 t.
- Twin bearings permanently couple with silicone paste, capacity of 2 x 6 000 kN: 4 assemblies.

Locks



Restoration of the Rhine-Rhone canal

It was decided to carry out a restoration program to repair degradation to the canal between the Rhone and the Rhine built a century and a half ago.

The Rhone-to-Rhine canal passes across Franche-Comté and South Alsace between Dole and Mulhouse, following the Doubs for more than 220 km. It was built at the initiative of Charles de Saulces de Freycinet, then Public Works Minister, in the 19th century, with a total difference in elevation of 160 m and includes 41 locks between Mulhouse and Belfort, and 75 locks from Belfort to the Saône. It was a major trading route until the middle of the XXth century, but is now used mainly for tourism. 2800 boats used it last year, and many cyclists traveled along its tow tracks forming part of the cycle route from Nantes to Budapest. A restoration program entitled "Future of the area between the Saône and Rhine" was decided upon to repair degradation to the canal and its facilities. This restoration and improvement operation is scheduled to take place during the period when the canal is not used for navigation, and in particular includes mechanization of gates, construction of new control stations, plantations and signs.

Cleaning and stripping

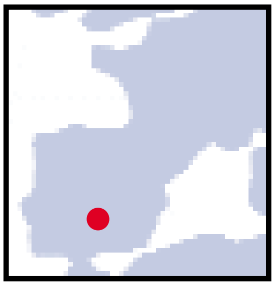
Since the beginning of October, Freyssinet has been working on thirteen locks distributed along the length of the canal, including a flat entry lock. The works consist of cleaning lock chambers with an average width of 5.2 m and an average depth of 5.5 m, repairing stonework and replacing gates.
The VNF (Voies navigables de France) company constructed the cofferdams necessary before lock chambers could be emptied and old wooden doors could be disassembled. In each lock, Freyssinet cleans the stonework by high pressure water stripping, repoints the stonework and replaces stones when necessary. New prefabricated concrete walls are placed for some chambers in which the old side walls have collapsed during emptying, and some of them are clad with cut stone.

Mechanization of gates

At the same time, new steel lock gates with a unit weight of 3.6 t are installed with a crane. On average, the Freyssinet teams place four gates in a single day, and then need 6 days to make all adjustments and do the waterproofing works. These gates are fitted with a remote controlled hydraulic mechanism that will eventually be automated. Consequently, grooves were constructed in the lock capping through which hoses and different equipment can pass. Apart from the lock chambers, Freyssinet is also restoring 190 m of stone facing on canal embankments upstream from the town of Dole. To respect the historic importance of this canal, all works done were designed to achieve a global architectural consistency. "A memorable site" commented one of VNF's supervisors.

Participants

Client and Contract manager: *VNF.*
Main contractor: *Freyssinet France.*
Co-contractor for the gates: *Métalform.*



Historic monuments

Renovated churches

Freyssinet is continuing its historic monuments renovation activity and is now working on two very ancient churches.

< *Restoration of Santa Maria de la Asunción Church*

The Santa Maria de la Asunción parish church is located in the old district of the town of Alcala del Rio (near Seville in Andalusia) and is surrounded by place del Calvario and Padre Ruiz Paez, Padre Aguilar and Hermanos Marchante streets. Its bell tower is an example of religious art in the Mudéjar period (XIIth to XVIth century art influenced by Islam) and consequently is architecturally very important.

Freyssinet is doing the rehabilitation works for this historic monument. Foundations inside the church are strengthened by a reinforced concrete slab. The 0.60 m load bearing walls, affected by water infiltration by capillarity, are drained using the Electro-Osmosis-Foresis TRABE system. Vertical and horizontal cladding is chipped and the masonry is rebuilt. The arches consisting of 9 cm thick double hollow bricks are reinforced and marble and ceramic tiles are installed. The bells are disassembled and cleaned before being reassembled. The clock mechanism is replaced and metallic reinforcing straps are installed around the bell tower at two different levels on the outside (at 15 m and 18 m). Like on the inside, the external masonry is repaired and the external cladding is made waterproof. Finally, concrete protections are built for the staircase portal and a lightning arrester is installed on the bell tower.

Renovation of Santa Maria La Mayor church in Linares >

Santa Maria La Mayor church in the small town of Linares (Jaen) is unique among all buildings that have survived Spain's history, as a result of events that occurred in the region during the second half of the XVIth century. There is a remarkable contrast between the Gothic part with three naves with five spans each, and the Renaissance part composed of three transepts with semi-circular arches decorated with coffers on the intrados and terminating in wall ribs.

The renovation works done by Freyssinet SA include two main packages, firstly underpinning of the foundations, and secondly waterproofing of the transept roof.

The works began by improving the ground by bentonite and cement grouting. A drainage system was then constructed to prevent incoming moisture and water flows. Freyssinet also made a grout curtain in a crypt, made foundation underpinning by grouting and installed a siphon. Internal and external cladding were cleaned, and all floor slabs in the monument were repaired. Architraves in the gothic nave and wall buttresses were reinforced before protecting, polishing and varnishing the altar.

Mobile Scaffolding System

Award for Construction Automation

Pacific Construction Co. Ltd was rewarded for its works on viaducts carrying an expressway in Taiwan.

Pacific Construction Co. Ltd received the prize for excellence in Construction Automation for their MSS Mobile Scaffolidng System used for construction of C301 viaducts. These structures form part of the construction project to build a second expressway in Taiwan and include more than 50 spans.
The committee emphasized four important points about the method of construction.
Firstly, labor saving. Productivity improved by 26.5% due to the high degree of automation of the equipment.
Secondly, innovation. The MSS is unique in Taiwan. It uses a single bracket that is self launched without the need for a crane.
Thirdly, the environment. The superstructures were built without the need for access from the ground, minimizing the impact on the environment.
Fourthly, technology transfer. Freyssinet carried out the design work for the Mobile Scaffolding System, and also supervised fabrication, technical assistance on site and technology transfer for the main contractor.

Participants

Client: *Taiwan Area National Expressway Engineering Bureau.*
Contract manager: *Pacific Construction Co. Ltd.*
Consulting engineer: *China Engineering Consultants Inc.*
Specialized contractor for design of equipment, construction methods and prestressing: *Freyssinet Taiwan Engineering.*

Silos

Construction of cement factory

New cement factory with large capacity silos is now under construction in the Suez region.

Freyssinet Egypt, which had already worked on the extension of the Suez cement factory between May 1997 and June 1998, is now participating in the construction of a cement factory close to El Soukhna (Suez). The works include the construction of four 86 m high, 20 m diameter raw materials storage silos, with a unit capacity of 16 000 m^3; four 78 m high, 20 m diameter cement silos with a unit capacity of 20 000 t; and four 64 m high, 16 m diameter cement silos with a unit capacity of 10 000 t. A total of 5 600 anchors, 800 t of cables and 10 650 m of ducts will be constructed.
The works started with the construction of two production lines, and Freyssinet Egypt started a third and fourth production line while the second line was being terminated. The works started in October 1997 and will be completed by the end of 2001.

Participants

Client: *the Polysius/Orascom Construction for industries Consortium.*
Contract manager: *Arab Consultant Engineer (ACE).*
Design office for prestressing: *EEG Simecsol.*
Specialized contractor: *Freyssinet Egypt.*

Santa Maria La Mayor Church.
Freyssinet SA worked
on the complete restoration
of this historic monument located
in the heart of Linares (Spain).