Freyssinet
MAGAZINE
MAY/AUGUST 2002 - No. 214

Hong Kong

The East Rail extension project

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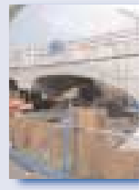

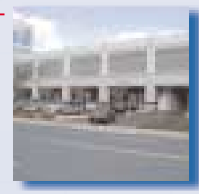

Freyssinet Magazine, 1 bis, rue du Petit-Clamart 78148 Vélizy Cedex – France. Tel.: 01 46 01 84 21. Fax: 01 46 01 86 86. Internet: www.freyssinet.com
Publication manager: Claude Lascols. **Project leader**: Stéphane Tourneur. **Contributed to this issue**: Isabelle Angot, Pierre Bost, Jean-Pierre Buys, Laure Céleste, Carlos Correa, Walter del Curto, Khalil Doghri, Jean-Philippe Fuzier, Tan Gee Hoi, Roger Lacroix, Philippe Liausu, John Marchese, Fernand de Melo, Sylviane Mullenberg, François Prongué, John Ritchie, Jean-Michel Romagny, Taffy Vadron. **Layout**: Grafik Tribu. **Translation**: Netword. **Editorial secretariat**: Nathalie Laville. **Photos**: Jean-Pierre Buys, Claude Cieutat, Francis Vigouroux, stt, photo-library Freyssinet and subsidiaries. **Cover page**: The East Rail extension project, Hong Kong. Photo Jean-Pierre Buys. **Photo-engraving**: Trameway/Grafik Tribu. **Printing**: SIO.

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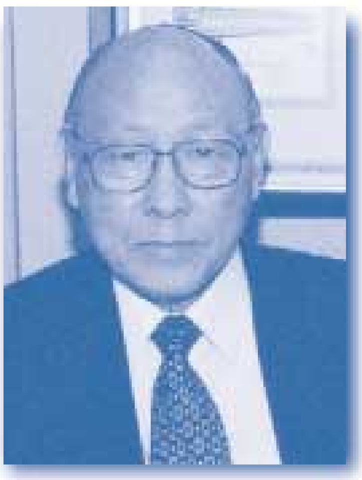
Points of view

Precast concrete and railway bridges in Japan

Precasting would appear to be the unavoidable choice for most railway structures under construction throughout the world. Now that the East Rail project in Hong Kong is advancing quickly and a few months before the *fib* 2002 conference organized in Osaka in Japan, Professor Misao Sugawara shares his view of precasting and its application to railway bridges in Japan with us.



Professor Misao Sugawara, Member of the Board of Japanese National Railways from 1980 to 1983, Executive Director of the Kyokuto Kogen Concrete Shinko Co., Ltd.

"I began my research work on prestressing in the 1950s as a research worker at the Japanese Railways Technical Research Institute. I worked on the design and construction of many prestressed railway structures and participated in the expansion of this technique. Precasting is not always an economic solution, particularly for the construction of small structures that are frequent in Japan. However, I believe that precasting will expand for projects with short construction times and in urban areas in which protection of the environment is an overriding concern."

When was precasting first used in Japan?

Historically, the Kogen railway bridge about 10 meters long was the first precast structure. It was built in 1953 to link the Oriental Concrete Company to the Japanese National Railway network, and was composed of beams cast on the banks and assembled above the river. However in Japan, the use of precast has been systematically adopted for work built by cantilever construction in the 1960s, for railway and road structures.

The first major use of precast segments was in 1960 for access spans to the Arakawa railway bridge on the Sohbu line. This method reduced construction times by one third compared with a solution using cast in situ segments. Other bridges were built later using this construction method, including bridges on the Sakamoto line in the Nara department and the Yoneshirogawa bridge in the Akita department. In 1970, the precast segmental bridge construction method was used for the Kakogawa bridge carrying the Shinkansen high speed railway line. Consequently, we are about 10 years behind France, where the first precast segmental bridge, Luzancy Bridge, was built in 1946, followed by five structures on the Marne River. I recently had an opportunity to visit the bridges on the Marne River and I saw that they had not deteriorated in any way.

What are the main structures concerned and how have they aged?

As already mentioned, the first large structures are now about forty years old. Precasting has often been used on the Tohoku Shinkansen railway line for segments close to the town of Ohmiya, to reduce construction times and to enable the work to be completed in 1981. During this time, the first railway bridges such as the Kogen Bridge became disused because the Oriental Concrete Company moved elsewhere. They have been dismantled and inspected. On the Kogen Bridge that I will present at the *fib* (International Concrete Federation - Fédération Internationale du Béton) conference in Osaka in October 2002, we found no deterioration to the concrete, or even to joints between elements.

What were the main characteristics of these precasting bridges?

The reason why we developed precasting is related to the large number of projects that were undertaken in the 1960s. Firstly, there was the extension of the Shinkansen high speed train, and the development of motorways, the 1964 Olympic Games, etc. We chose to standardize construction methods by choosing precasting to save time and money.

The choice of external prestressing for bridges, recommended by the Japan Highway Public Corporation, has contributed to the development of precasting.

At the time, the various persons involved in construction reached a general consensus to study the feasibility of precasting.
In the beginning, segments were precast and joints were cast in situ. Joints could be as much as 50 cm thick. Subsequently, following the development of epoxy resins, match cast segments were developed. Prestressing was done using internal cables with the main difficulty of keeping the ducts continuous between segments.

The Kogen Bridge was built in 1953 in Japan and is the first railway structure made of prestressed concrete. It is composed of beams cast on the bank and assembled above an arm of the Tama River.

What are the advantages and restraint of precasting in the construction of railway bridges?

I think that there are three factors that influence the choice of a construction method. They are the cost, construction time and quality assurance. There is absolutely no doubt that precasting is the best solution for construction time and for quality assurance. However, costs vary as a function of the environment and the topography.
In Japan, when several small nearby segments were made, each main contractor traditionally installed his own concrete batching plant. Nowadays, the trend is to set up common precasting areas shared between contractors and saving time and money. Japan is now faced with a space problem on flat ground since the entire centre part of the country is covered by mountains. Therefore, we need to extend our railway network through mountains, by constructing tunnels and small viaducts. Precasting is no longer an economically attractive technique under these circumstances, since it is difficult for us to store the elements.
Concerning the environment, precasting has an advantage in urban areas since it creates less inconvenience and nuisance than in situ casting.

What construction systems are compatible with Precasting?

Precasting has been used for about fifty years and technical progress has participated in its development. We have thus made progress in the field of epoxy resins which harden quickly, particularly with “Show Bond”, “PRX” and other plastic materials and also in precasting techniques such as segments with match-cast joints. Experience has also led us to prefer spans composed of an odd number of segments so that the bending moment is at the center of a segment rather than at the joints between segments.
Precasting can be used with all construction methods and can also be combined with in situ casting. It is equally suitable for girder bridges, cable stayed bridges, extradossed bridges and all other types of structure. The Bangkok Expressway is one recent example, although is admittedly not a railway bridge, that is largely built using precast segments to save time, and also because it is an urban structure.

What is the future of prefabrication in Japan?

Relief in this country will play an essential role in the future of precasting. We will need to build increasingly in a mountainous environment using a "tunnel, viaduct, tunnel" system, and will consequently be faced with element transport and storage problems. Precasting technique is not well adapted to this configuration, since we lose all the economic advantages of the technique. Precasting has a promising future for sites built on plains.
However, fast growth in precasting has occurred during recent years. One of the reasons is due to the decision made by the Japan Highway Corporation (Motorways Ministry) to prefer to use external tendons for bridges to reduce the cross sectional area of the segments, which makes it easier to make ducts continuous between segments.
The other current trend is the use of ungrouted cables but provided with perfect individual protection and insensitive to corrosion, such as Freyssinet’s COHESTRAND™ cable. In any case, precasting will expand considerably in the future due to standardization, regardless of the technique used.

South Africa

Retaining wall for open cut mine

The Boschmanskrans opencast mine, 20 km from the city of Witbank in the State of Mpumalanga, now has a tip wall for a run-of-mine crusher and grizzly, starting from a retaining wall. The maximum height of the wall is 27 m, it occupies an area of 1,570 m², and is based on the TerraTrel® technology. The bottom tier is composed of TerraTrel® elements specially designed to give a better distribution of the reinforcing strips. The benefits of this configuration include the large number of horizontal joints, better overall stiffness and settlement without any bulging.

Homage

Mohammed Helmy Amin El-Sharkawy

Mohammed Helmy Amin El-Sharkawy passed away on March 21 2002, after participating in many civil engineering works in Egypt and the Middle East throughout his life. He graduated from Ain Shams University of Civil Engineering in 1952, and spent his life promoting prestressing throughout the Arab World. Apart from the huge Aswan dam, he constructed the first prestressed structures in Egypt including an oil mazout tank in 1955. He was appointed Vice Chairman of the Arab Consulting Engineer company in 1965 and was made responsible for developing activities in Egypt, Kuwait, Qatar, Yemen, Algeria, Morocco and Mauritania. At the same time, he worked in close cooperation with the RATP (Paris Transport Authority) for the construction of the Cairo and Alexandria metros, and worked with Freyssinet International on several occasions. In the 1970s, he became representative of Freyssinet International in Egypt before being appointed Chairman of Freyssinet Egypt. Mohammed Helmy Amin El-Sharkawy was Member of about ten professional associations and received many distinctions including the 1st Order of the Arab Republic of Egypt and the Soviet Union "Red Flag" in 1964, for construction of the Aswan High Dam Project. Everyone who worked with him appreciated his professionalism, knowledge and honesty. He leaves a large number of structures behind him in the Arab World that will forever be the symbols of his expertise. We extend our profound sympathy to his wife and his loved ones.

United Kingdom

The Turner Bridge

Reinforced Earth Company and Freyssinet have pooled their experience to renovate a bridge. Reinforced Earth Company Ltd devised the innovative bridge strengthening scheme for the Turner Bridge (over the Tongue river in Bolton) using a precast concrete arch. Freyssinet Ltd then designed a 30 t TechSpan® arch and then slid it underneath the existing bridge, thus making the original girders redundant. The void between the two structures was firstly filled with foamed concrete and then clad with bricks. This construction method avoided the need to divert traffic and created substantial savings for the Client.

France

Shock treatment for concrete

The apartment building in Firminy in the Loire department (France) was built by the famous architect Le Corbusier in 1960. It is a tall building comprising 450 dwellings, a primary school and a theatre on the roof, and is listed as a historic monument. The Firminy low rental housing office and the DRAC (Direction Régionale de l'Aménagement et de la Construction – Regional Directorate for Development and Construction) have initiated a renovation programme and have appointed Freyssinet to repair the concrete façade. This work includes remedial action to remove damaged concrete and then reconstitute the steel cover, and preventive action in the most sensitive areas (structure nodes) by the use of a sacrificial cathodic protection using anodes. The repair of 31,000 m² of the building façades is being supervised by a Monuments de France architect to respect the designer's intentions.

United States

Dynamic Compaction in California

Menard Soltraitement has been working on soil improvement for the construction of a public school in Thermal (Palm Spring), within a seismic area, using the Dynamic Compaction technique. The purpose of this operation is to prevent liquefaction of the soil in the case of an earthquake. The area to be treated, in other words the main building and a few annexes, covers 40,000 m^2 (or 2,080 impressions) for a treatment depth of 12 m. A crane with a 30 m jib carrying a 25 t mass was used. A second crane with a capacity of 15 t compacted the backfill in the impressions. The work took about three and a half months.

Turkey

A school amphitheatre

Reinforced Earth Construction Company (REAS), Freyssinet's Turkish subsidiary, has presented an innovative idea for improving the court forming part of the construction of a new primary school complex; the construction of an amphitheatre using the Reinforced Earth® technology. The Ankara Governorship very much appreciated this concept, which created a highly functional and aesthetic area, and granted the contract to REAS. The Reinforced Earth® technology was applied to the construction of the tiers composed of half panels and to the 8 m high retaining walls that close the amphitheatre. The construction was completed within one month.

Australia

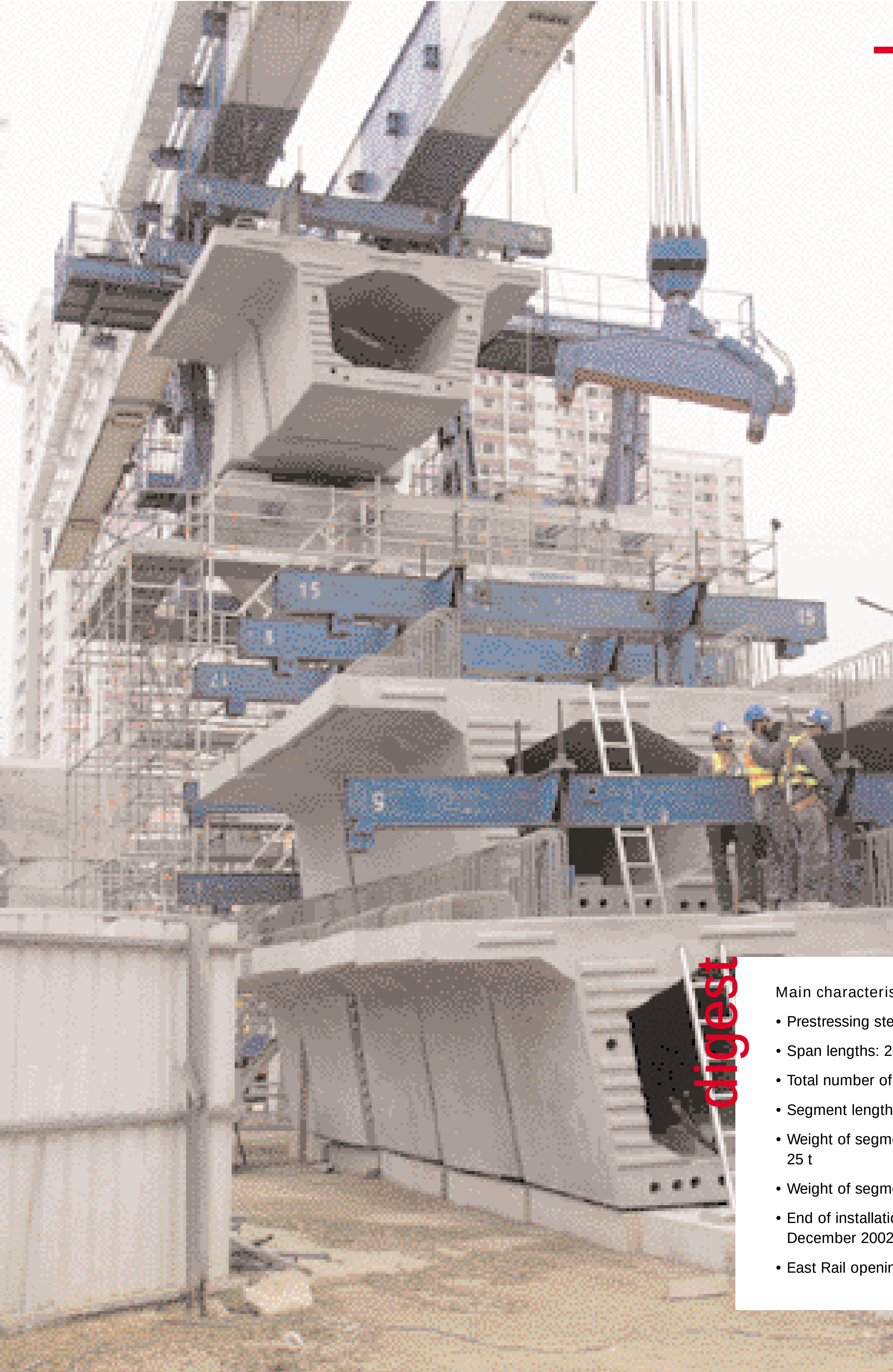
Reinforced Earth® walls for the RAAF

Reinforced Earth Company has designed and supplied almost 7,200 m^2 of Reinforced Earth® walls for the Australian Air Force (RAAF) Base in Townsville in Queensland, Australia. The project includes the construction of 22 structures with concrete facing that form various "Gun Missile Barriers" and "Traverses" to protect aircraft in the event of a nearby explosion. They are between 6 m and 8 m high, and up to 60 m long. The Air Force facility is located on a site that was largely swampland. Therefore, the foundations in the area were highly problematic with expectations of very high differential settlements during and after construction of the structures. Reinforced Earth Company completed this difficult project on time and without the slightest incident.

Argentina

Extension of the La Nación building

Freyssinet is participating in the extension of the La Nación newspaper building in Buenos Aires. The work, done by the Techint S.A.C.I. company, forms part of the development of the Puerto Madero area. It includes the construction of sixteen new storeys for the La Nacion newspaper building, thus increasing the total area of the building to 65,138 m^2. The first phase of the work to be done by Freyssinet applied to reinforcement of the building concrete foundation slab, with the construction of a new raft. The raft consists of a slab prestressed in both directions. The existing foundations comprise beams in both directions which could not be demolished for structural reasons. Therefore, cables had to be passed through while maintaining uniform compression. Holes were formed in the beams so that ducts and 19K15 tendons could be installed. The total steel quantity used is about 50 T, including the use of a hundred and ten 19K15 anchors. Tensioning of the tendons is now being completed, and Freyssinet teams will grout the ducts before the anchors are sealed.



digest

Main characteristics:

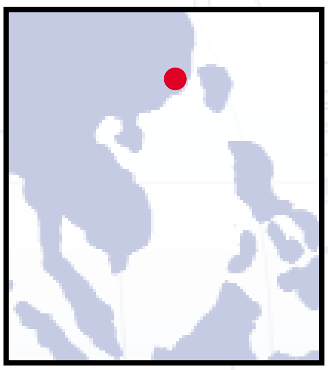
- Prestressing steel quantity: 3,055 t
- Span lengths: 20 to 40 m
- Total number of segments: 4,000
- Segment length: 2.5 m
- Weight of segments in typical parts: 25 t
- Weight of segments on piers: 33.5 t
- End of installation of segments: December 2002
- East Rail opening to the public: 2004

Segments are installed with launching trusses and glued together by epoxy resin.

digest

Precast concrete and railway bridges

The East Rail extension project



Work on the Hong Kong railway network has started; this prestigious project includes the construction of elevated sections that necessitate the installation of 4,000 voussoirs.

MANAGED BY THE KOWLOON CANTON RAIL Corporation the Hong Kong railway network consists of two lines between the South and the North of the province. These two lines are more commonly known as the East Rail and West Rail, based on their geographic locations. The East Rail line that joins Hung Hom to Lo Wu at the far south of Hong Kong close to the province of Shenzhen, is used for the transport of passengers and goods. After electrification in 1983, traffic on it increased considerably, supported by the economic development of the province. The South terminal station was completely renovated in 1998 in order to absorb a continuously increasing passenger flow, and its daily capacity was increased from 180,000 to 250,000 persons. These efforts were a resounding success, as demonstrated when the East Rail network carried a record number of more than 288,500 passengers during a single day on December 26 1998. The continued economic development of Hong Kong and demographic growth during the same year led the Kowloon Canton Rail Corporation to issue a call for bids for the extension of the East and West Railway networks, at the request of the Chinese Government. The work started in 2000. These new infrastructures in a densely populated area like Hong Kong, consisting largely of viaducts for the East Rail project, required a special design including special elements to protect the public from nuisance due to noise.

East Rail: a superelevated railway

The East Rail network extension contracts TCC200 and TCC300 (the East Rail project was broken down into sections) were awarded to the Freyssinet-VSL Group, with Freyssinet being the project leader. The work includes the supply and installation of mechanical and neoprene bearings, the placement of span segments and prestressing work (3,055 T).

The viaducts under construction are composed of two parallel independent decks that separate near the approach to the different stations in the downtown area. They are composed of isostatic spans with lengths varying between 20 and 40 m. The spans are provided with an expansion joint adjacent to each pier. Each section is composed of 2.5 m long segments weighing 25 t except for segments on piers that weigh 33.5 t. A total of 4,000 voussoirs will be placed between now and December 2002. They are put into place using underslung trusses with a crane and on overhead launching truss for construction of high curved spans. Freyssinet's Engineering Department in Velizy modified the overhead launching truss, that had previously been used on another Hong Kong site, and adapted it for the construction of the decks in the East Rail project, particularly when the radii of curvature are small. This overhead launching truss enables fast construction of spans with a maximum length of 42 m and a minimum radius of curvature of 272 m. The transition spans between stations and structures are built using scaffolding or special placement launching truss called Ninive that had already been used previously on a site similar to the Hong Kong site.

Overhead launching truss

Due to the overhead launching truss, the segments stored on the ground under the span to be built are lifted in sequence into their quasi final position using a winch. The overhead launching truss must be fully loaded before the segments are assembled, apart from the last of these segments that leaves a space between the segments necessary for gluing the assembly. This final element is put into place during assembly of the span.

The segments are glued to each other by epoxy resin. Temporary prestressing is then applied using Macalloy bars before the final prestressing is applied by strands so that the span can support itself. The overhead launching truss is then removed and all hangers are released to go on to the next span. This technique has the advantage of being fast (each cycle lasts 4 days) and flexible, since it does not require the permanent use of a crane. The spans are supported on temporary bearings to prevent the final bearings from being damaged by compression caused by falsework movements during a typhoon. They are then lowered onto three bearings placed on each pier; two lateral elastomer bearings to resist the deck load and a central mechanical bearing to resist horizontal forces.

A typhoon-resistant design

Typhoons are frequent along the Chinese Eastern seaboard from June to September (and sometimes until November). Therefore, equipment had to be designed to resist wind forces and the induced vibrations. There are three typhoon alarm levels in Hong Kong, classified as a function of the strength of the wind and the distance of the typhoon from the town. A "level 1" alert is given when the typhoon is less than

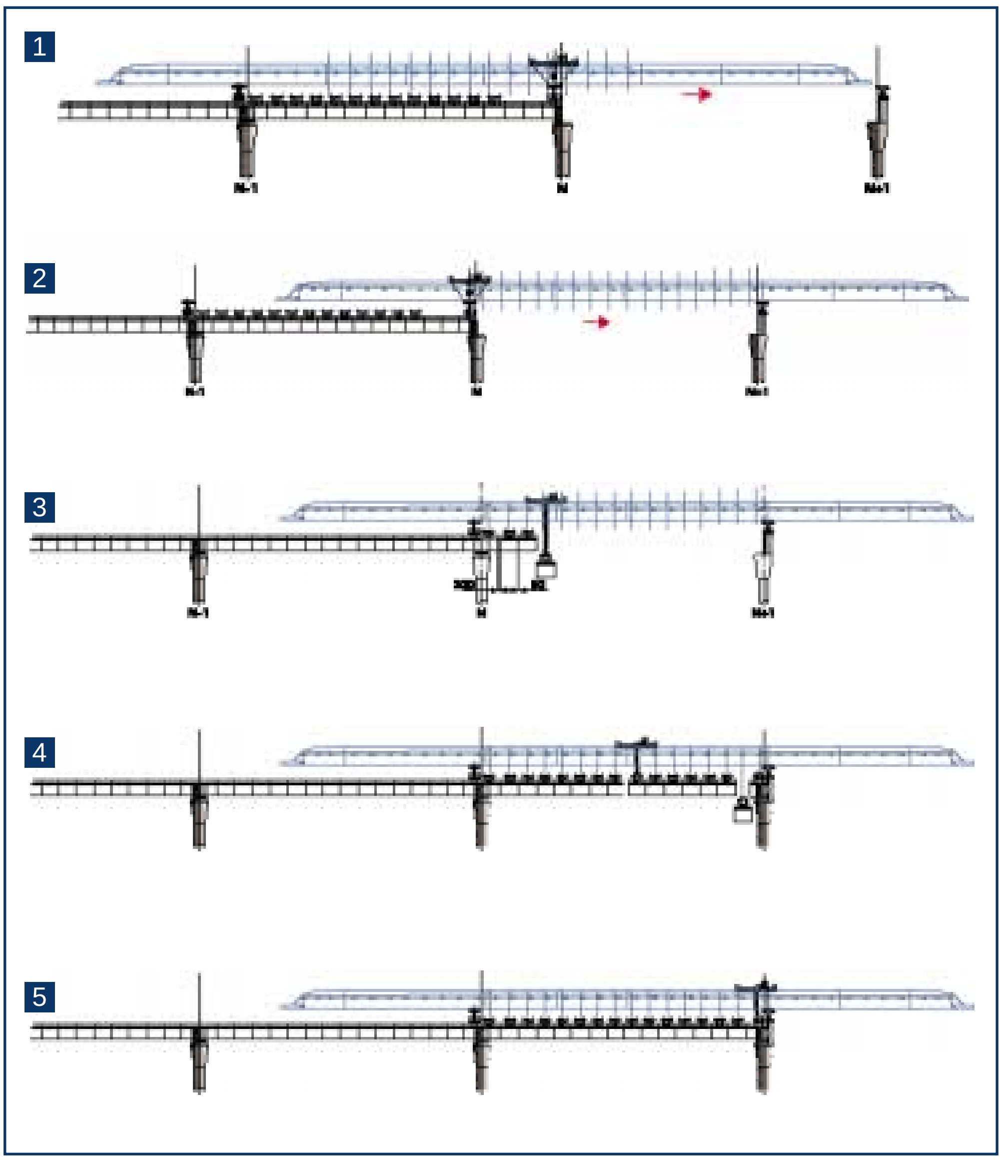
800 km from Hong Kong. A “level 3” alert is triggered when the typhoon is less than 400 km from the town and the wind speed in the port is between 40 and 60 km/h with gusts of up to 110 km/h. Finally, a "level 8" alert is reached when the typhoon is less than 180 km from the town and wind speeds are between 60 and 115 km/h with gusts at 180 km/h. All these factors have to be taken into account in choosing construction methods. The overhead launching truss, like all other placement falsework, is unstable in the case of a typhoon. Therefore, it has to be made secure. The special feature of the Freyssinet overhead launching truss is in its design that provides excellent resistance to typhoons when carrying a suspended span.
If a cyclone warning is received in the region, the structure is secured by a holding down system using bars and cables. The falsework is then fixed to the pier by a 7T15 cable and slings. This arrangement transmits overturning forces due to wind to the pier.

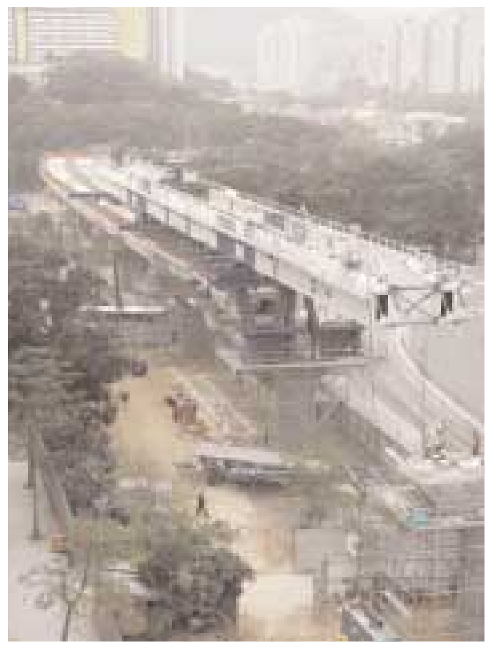
Two special spans

Two sections in the East Rail project will be built using a construction technique other than the use of bottom or overhead launching truss. These sections are long spans crossing a motorway. The site configuration made it impossible to store segments under the structure. Central elements will be placed in cantilever using two cranes. This operation will be done at night and motorway traffic will be interrupted during the work.
All segments in the viaducts must be completed by the end of December 2002. However, Hong Kong inhabitants will have to wait until 2004 before they can use this ultra-modern line.

Participants

Client: *KCRC.*
Contract manager: *Maunsell.*
Main contractor: *Freyssinet (Freyssinet International et Cie and Austress Freyssinet) -VSL group (with Freyssinet project leader).*





Schedule for placement of segments with a overhead launching truss.

1 and 2: Launching of the overhead truss.

3 and 4: Place segments. Tensioning of tendons.

5: Unload the overhead launching truss, preparation for launching the next span.

Soil improvement

The MIN site in Lyons

Menard Soltraitement has just completed consolidation of a 47-hectare platform by Dynamic Compaction.

The town of Lyons is planning to transfer the MIN (Marché d'Intérêt National – National Wholesale Market) installations currently installed in Lyons into the confluence area in Moins Corbas. These installations will be built on a 47-hectare platform within a "food processing centre" concerted development area comprising the MIN development area itself, a food processing centre and a future extension area to the south. Although the precise location of the buildings has not been finalized, it is planned to build large storage buildings with loading and unloading platforms with a load capacity of 60 kPa on slabs on grade, engineering and administration buildings, roads, networks, and a rain water retention pond. Almost the entire area to be occupied by the project was formerly a sand and gravel pit from which thick deposits were removed, the various works will be built on mediocre and heterogeneous fill. The SERL (Société d'Equipement du Rhône et de Lyon - Rhône and Lyons Development Company), appointed by the urban community of Lyons and with the assistance of EEG-Simecsol, has started a first phase of the development work for the site. This phase includes earthworks and prior treatment of the platform by dynamic compaction, which was awarded to the Menard Soltraitement and G.T.S.

Random building layout

The Dynamic Compaction technique (mass treatment) is particularly suitable for a random layout of buildings and gives the best

The project uses a special "rammer" on tires capable of lifting 25 t masses to a height of 25 m.

guarantees of stability while minimizing predicted settlements for all infrastructures, and was a natural choice.
Several preliminary geotechnical surveys were carried out on the site selected for the concerted development area part of the food processing centre, and demonstrated the presence of 9 and 18 m thicknesses of fill in former gravel pits. The fill is predominantly gravelly with a sand-clay matrix, and contains many artificial elements such as demolition materials and various blocks. This fill is underlain by what is left of the globally compact gravel formations, a large sandy-silty formation with good to very good compaction, followed by a deep compact silty-pebbly bed.
Before the soil consolidation work was done, a preliminary earthworks phase was carried out to take stock of the ground to be treated compatible with the final layout of the site and to form an approximately plane working platform on which the ramming equipment can move about. A complementary geotechnical survey was carried out before the beginning of the compaction work, to complete knowledge of the soil to be treated. This investigation included thirty-six cored boreholes to identify the nature of the fill to be treated.

A sensitive area

There are various sensitive structures close to the periphery of the area to be compacted, and particularly including an oil pipeline, a sewer, a gas pipeline, the A46 motorway, etc. All these elements necessitated a preliminary environmental study to define methods of adapting the dynamic compaction technique to respect allowable vibration thresholds for the different structures. This was done by excavating an anti-vibration trench and reducing the unit energy to not exceed a particular velocity of 50 mm/s for the oil pipeline. For other sensitive areas, it was decided to make local use of the stone column technique that consists of improving the soil by using stone columns made using a special tool containing a vibrating rod. Vibrations are monitored throughout the duration of the construction period.

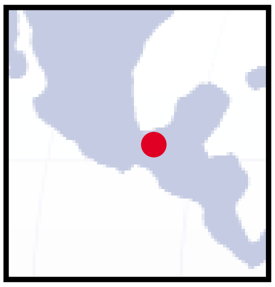
Six ramming workshops

The treatment to be done is applied on a platform covering about 47 hectares. The objective is to compact a thickness of 12 m, which requires very high energy ramming. Therefore, the project made use of large cable drawn shovels on tracked vehicles weighing more

than 100 t and a special tired rammer capable of lifting 25 t masses to a height of 25 m. Six ramming workshops are mobilized simultaneously to respect the extremely short deadlines (12 months). The treatment in each area to be compacted begins with the construction of a test plot to define details of the ramming methods to be used (grid, number of blows per impression, etc.).
Compaction impressions are backfilled using material taken from the working platform which is therefore lowered during the work by 60 to 100 cm. Incompressible materials are also taken away in a few areas and some impressions are filled using a granular backfill from outside the site. Once the treatment has been completed, the platform will be levelled and compacted with a roller using 80 000 m^3 of granular materials stored on the site by the earthworks contractor, to achieve the required unit bearing capacity per unit area.
Ramming is continuously checked in order to improve the compactness of the treated material, to modify compaction parameters if necessary, and to make sure that contractual guarantees are satisfied. This geotechnical monitoring is very important and includes energy measurements, compaction measurements and other in-situ tests.

Six ramming workshops are used to respect a tight schedule.

Incremental launching



Reconstruction of the Pigua I Bridge

Freyssinet de México has restored a major road between the Yucatan peninsula and the rest of the country within a very short time.

THE TOWN OF VILLAHERMOSA IN SOUTH-eastern Mexico has been confronted with serious traffic problems since the two spans of the Pigua I Bridge collapsed in April 2000. The bridge that was adjacent to its twin bridge Pigua II crossed the Carrizal river and was located on a major route between the Yucatan peninsula and the rest of the country. The effects of this accident on industrial, tourism and tertiary activities were quickly felt and the Ministry of Communications and Transport Highways and Bridges Directorate in the Mexican Government decided to build a new bridge. This work was awarded to Freyssinet de México as a main contractor.

An incrementally launched bridge

The first step was to remove the collapsed former deck from the bottom of the Carrizal river, so that it did not hinder the foundation construction work. The selected solution was the construction of a steel bridge composed of fourteen 2.8 m deep segments. A 104 m long assembly platform was built for placement of the steel girders. Once all parts have been assembled, an 18 m long front nose was fixed to the structure so that incremental launching could begin.

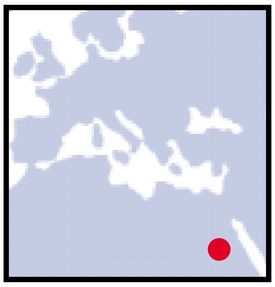
The bridge comprises two 40.5 m end spans and a 65 m central span, giving a total length of 146 m. The superstructure is supported on two abutments and two cast in situ concrete piers founded on 0.6 m and 1.20 m diameter steel piles driven to a depth of 54 m.

Apart from this work, Freyssinet de México also supplied and installed the Tetron CD bearings and the CIPEC WP 400 expansion joints. The main objective of the work was to restore normal traffic as quickly as possible, specifically within five months.

Participants

Client: *Communications and Transport Ministry, Mexican Government.*
Main Contractor: *Freyssinet de México.*
Designer: *Euro Estudios (México).*

Stay cables



The Aswan Bridge

The stay cable work on the bridge over the Nile 11 km to the North of the dam has just been completed, and the bridge will shortly be opened to traffic.

THE NEW BRIDGE BUILT FOR THE GENERAL Authority for Roads and Bridges is 977 m long. The main cable stayed bridge is 500 m long and comprises a 250 m central span and two spans (one 49 m and one 76 m) on each side. It provides 13 m clearance above the river. The deck is suspended from fourteen pairs of Freyssinet stay cables arranged in a central layer and composed of units varying from 66 to 109H15 depending on their location. The stay cables are anchored in two towers at heights varying up to 30 m, and at 7.8 m intervals in the deck. For aesthetic reasons, the anchors are concealed in the tower. The forces that they carry are transmitted using looped prestressing tendons. This particular configuration makes the structure perfectly resistant to cracking.

Prestressing

The bridge deck is a 3.3 m high and 24.5 m wide single cell trapezoidal shaped prestressed concrete caisson that supports two times two traffic lanes. It is supported on main piers at the towers and intermediate piers, all made of prestressed concrete. The thin (220 mm) top slab is supported at its centre by inverted V bracing prestressed using 4F15 tendons. The lower slab is also very thin (200 mm) and is strengthen by 300 mm thick transverse spacers. Two pairs of mobile formwork travellers are used for pouring the segments in cantilever from the towers. The final prestressing supplied by Freyssinet is installed in the deck as the structure progresses and the stay cables are anchored every two segments.

Special mobile formwork travellers

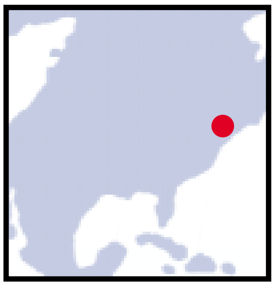
The construction is done symmetrically for the first four segments. The side span segments are then made following a cycle with two days advance on the main span. When the span reaches an intermediate pier, the mobile formwork traveller is used to cast the segment on the pier. This construction cycles continue until the different keyings are made. The mobile formwork travellers used on this site were specially designed and constructed by Freyssinet to not apply excessive forces on the deck during pouring operations. They are supported by beams located under the flanges of the segments. This arrangement leaves the upper surface of the deck free and thus facilitates transfers of materials and equipment necessary for construction.

The deck is supported on two lines of elastomer bearings adjacent to the towers and on two Teflon bearings adjacent to the intermediate piers. The intermediate bearings limit horizontal, longitudinal and transverse displacements. With this equipment, the structure is protected from risks due to earthquakes and wind effects. Furthermore, prestressing bars fix the deck to the intermediate piers to prevent uplift phenomena.

Participants

Client: *General Authority for Roads, Bridges and Land Transportation*
Contract Manager: *Arab Consultant Engineering*
Main Contractor: *General Nile Company for Roads and Bridges*
Superstructure designer: *EEG-Simesol*
Specialized contractor: *Freyssinet*

Improvement



Strengthening of a car park

Freyssinet has strengthened prestressed slabs in a car park in Maryland.

THE BRIDGE ON THE 401 N - WASHINGTON Street in Rockville, Maryland, is a 4-storey above ground car park built in 1975. The floors are made of 216 mm thick cast in situ 2-way post-tensioned lightweight concrete slabs and supported by concrete columns on an approximative 9 m grid. The total prestressed area is 14 270 m^2. The original post-tensioning consists of unbonded 12.7 mm diameter 7-wire strands with an ultimate strength of 1 860 MPa (270 ksi). The strands are greased then 'paper wrapped' inside an asphalt-impregnated kraft paper. The original design, performed by Smislova, Kehnemui and Associates, used a live load of 2.4 kN/m^2 (50 psf) and specified a minimum concrete cover over all reinforcing of 19 mm.

Concrete repair

Over the years, the car park was affected by corrosion of some passive steel and failure of some prestressing tendons. Freyssinet LLC was

awarded the work to repair the concrete in August 2001. The work consisted of:

• repairing concrete damaged resulting from all reinforcing steel oxidation, or removal of this concrete with a pneumatic and hydraulic hammer;
• replacement of strands and surface preparation and placement of air entrained concrete with a minimum 28-day compressive strength of 34 MPa (5000 psi) (the new placed concrete contains a corrosion inhibiter and a glass fibre mesh);
• removal of all deteriorated sections and replacement by 0.5" greased strands through existing paper ducts, while minimizing trenching and damage to the slab. A typical splice between old and new strands is made using monostrand strand couplers. The strand is stressed to an effective fore of 119 kN at the coupler. Freyssinet also made various repairs to concrete walls and columns, particularly including the treatment of rout and cracks by the injection of epoxy resin, replacement of expansion joints and installation of new drain.

The work is done in carefully planned phases, such that not more than a hundred car park spaces will be temporarily unavailable. This solution made it possible to keep the car park accessible, functional and in operation throughout the duration of the works.

Participants

Client: *Wellsford Commercial Properties Trust.*
Project manager: *HBW Group*
Engineer: *SK&A*
Main contractor: *Freyssinet, LLC.*

Handling

A new railway bridge for Arnhem

The old Zijpse Poort Bridge had to be replaced by a more modern bridge to enable extension of the railway network within the Netherlands.

THE NEW BRIDGE (THAT REPRESENTS ONE of the largest railway junction in the Netherlands) located in the centre of the city of Arnhem close to the central station, comprises a cast in place post-tensioned concrete structure, weighing about 5,200 t. The 60 m long, 13 m wide and 8 m high bridge consists of a single arch. It is supported on two abutments at each end and a mushroom-shaped bearing at its centre. A second larger deck with a similar shape and design and built close to the new bridge, will carry additional tracks.

Computer aided lowering

The first phase of the work began in 2000 and was recently completed with the final placement of the deck. Freyssinet Nederland supplied and installed the prestressing for the deck composed of thirty-six 22C15 tendons. The construction method used is innovative. The deck was built superelevated to enable vehicles to pass underneath, and particularly trolley buses. In October 2001, Freyssinet Nederland lowered the deck by 800 mm using jacks before placing it on incremental launching beams. The handling operation was carried out using a computer aided system that enabled continuous control of loads and displacements for each group of jacks from a central control station. Thirty-one 200 t jacks distributed in groups were used to lower the 5,200 t bridge. Railway traffic was interrupted for 70 hours to enable demolition of the old bridge using six cranes.

Incremental launching

The incremental launching beams that support the weight of the structure were placed at the location of the future foundations of the second deck. They were two HEB 800 beams with a striated steel plate in the upper part. Friction is minimized by the use of a thin stainless steel plate fitted onto this plate in combination with elastomer cushions covered with a Teflon layer.
The structure is incrementally launched over a distance of 15 m in steps of 50 cm by means of a system of shoes fixed to the beams and two Freyssinet 200 t incremental launching jacks fixed on each abutment. A third set of jacks was installed at the centre to provide assistance if necessary. The deck was put into the final position in four hours.

Carbon fibre composite cables

The Laroin footbridge

The town of Laroin has just acquired a new cable stayed footbridge to cross the Gave du Pau river. An innovative technical solution that makes use of carbon fibre composite cables.

THE SMALL TOWN OF LAROIN CLOSE TO PAU IN South-Western France is planning to build a watersports base on the site of former sand pits. Inhabitants and tourists will use a cable stayed footbridge to cross over the Gave du Pau to reach the base.

A XXIst century construction

The Laroin footbridge is composed of a single 110 m long and 2.5 m wide span, and is an excellent example of a XXIst century structure. The deck is supported by two planes of four carbon fibre stay cables. They are anchored into 20 m high inverted V towers stabilized at each end by a 19HD15 retaining stay cable. Each leg of the tower is anchored to the abutment foundations by two prestressed concrete plates. An anchor head near the top is used to attach the retaining cables and the carbon stay cables. The deck consists of steel beams at a spacing of 3.2 m. The deck surface is composed of 2.5 m wide 0.10 m thick concrete slabs supported by bridge parts. The stiffness of the assembly is provided by X bracing consisting of angle sections. The handrails are directly fixed onto the structure.

Composite stay cables

The deck is suspended by high performance carbon fibre cables. Each stay cable is composed of two or three bundles of seven composite rods and isolated from the external environment by an HDPE sheath. They are connected to the tower by fixed clevises and to the deck by adjustable clevises. Watertightness in the anchor areas is achieved by a Freyssinet patented stuffing box into which petroleum wax is injected. The mechanical strength of a 6 mm diameter composite rod is exceptional and can resist loads of almost 7 tonnes.

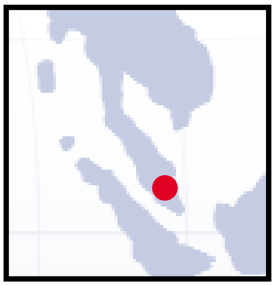
The 19HD15 retaining stay cables are anchored in a foundation made of concrete pinned with anchor rods to a depth of 20 m. Each strand is inserted in an HDPE sheath and anchored individually into a high strength steel anchor block. Besides protection barriers provided by hot galvanizing of strand wires and their HDPE sheath, all interstices between the wires are filled in with petroleum wax. Anchor areas are perfectly watertight due to the placement of glands.

For a cabled structure, the use of composite materials results in a very good ratio between the self-weight and the bearing capacity. Composite materials also have excellent fatigue behaviour for very large stress amplitudes and a good elastic behaviour with a high ultimate strength. The good resistance to aging and insensitivity to corrosion make carbon fibre cables an ideal material for durability of the structure. The Laroin footbridge is a full scale test bench that demonstrates the feasibility of the use of carbon for structures with very long spans.

Participants

Client: *Laroin Townhall.*
Engineer: *DDE of Pyrenees Atlantic*
Main Contractor: *Freyssinet.*

Stay cables



Stay cables for Putrajaya

The new federal government administrative centre in Putrajaya, about 30 kilometres to the South of Kuala Lumpur, is under construction. The cable stayed bridge BR9 is an architectural landmark of the new town, and provides access to the city's main boulevards.

For project designers, the structure was supposed to symbolize the town of Putrajaya. Therefore, they preferred an innovative design and geometry inspired from a sailing boat. The 240m long bridge is supported on two abutments, one at the East and one at the West. A single inverted "Y" shape pylon is inclined at 15 degrees to the vertical, sloping towards the main span. The cable stayed span that crosses a man made lake is 168.5 m long.

A complex project

The stay cables supporting the main span are composed of cables with 13 to 73 strands each. The two planes of front stay cables arranged in thirty pairs are laid out as in a fan arangement, and are anchored in the hollow upper core of the pylon. They are stressed from lower anchors located in the two concrete edge beams of the deck.

The backstays consist of twenty-one pairs, and each stay cable comprises 45 to 125-strand each. They are stressed in a purpose designed backstay anchorage box behind the abutment. This anchorage is formed using a massive reinforcing concrete multi-cell box structure supported on bored piles, all of which are designed to withstrand uplift (tensile) forces. The backstays are unusually configured in that the stays anchored at the highest point of the pylon are anchored in the backstay box closest to the foot of the pylon creating a cross-over effect in all the backstays. Furthermore, for this project, Freyssinet needed to carry out the largest full scale stay cable anchorage fatigue test to date, a 125-strand stay cable anchor.

A hybrid structure

The pylon is a split column structure between its foundation and at the level just below the front stay anchorage. Here it is reinforced concrete with additional strengthing using cast-in steel rolled column sections. For the pylon in the region of the stays, the hollow core structure is formed using steel/concrete composite construction. Due to the incline, the pylon is required to be supported by 3 No. temporary stays during its construction. The deck is cast in situ, made up of a longitudinal post-tensioned central box core and edge beams linked by post-tensioned transverse rib beams. The deck is constructed completely on falsework, which will be removed progressively after the installation of the stay cables, as the lake is yet to be filled. Freyssinet PSC (M) Sdn Bhd has been awarded a subcontract package for specialist services. This includes supply and installation of stay cables, post-tensioning, pot bearings, expansion joint, Macalloy bars and supply of shop drawings. Freyssinet APTO (M) Sdn Bhd through Freyssinet PSC is also providing construction engineering services to the main contractor, i.e., defining the construction sequence, check of structure during construction, monitoring during construction and calculation of casting curves. Completion of the installation of stay cables, construction of the pylon and the deck is planned for July 2002.

Participants

Client: *Putrajaya Holdings Sdn Bhd.*
Main contactor: *Muhibbah Engineering (M) Bhd.*
Consultant: *Perunding Jurutera Satu Sdn Bhd.*
Specialized contractor: *Freyssinet PSC (M) Sdn Bhd.*

Characteristics

Main span: 168.5 m.
Deck width: 7.2 m.
Tower height: 85 m.
Number of cables: 102.
Stay cables: 850 t.
Tendons: 250 t.

Renovation

'Pont dels Anglesos'

There were several disorders on the bridge over the river Ter and a canal, including severe degradation of the concrete due to water infiltration.

THE 270 M LONG AND 7.5 M WIDE STRUCTURE, located at Sant Vicenç Torelló (near Barcelona), consists of five reinforced concrete arches that support the deck on fifteen transverse concrete walls at a spacing of 2.25 m. A sixth span crosses the canal. The abutments are composed of two masonry walls with earth backfill.

Precast elements

The work done by Freyssinet included partial demolition of the structure using a solution in which the original structure was kept without deteriorating it. The spans were rebuilt using precast elements, a cast in situ slab and a cantilever part above the canal span and accesses. Each 5 m wide 0.6 m thick wall was replaced by two 70 cm wide and 40 cm thick columns cast in situ. The new deck, composed of precast concrete beams installed on capitals at the top of the columns, is 11 m wide. Loads are resisted by small precast concrete arches with a span of 2.25 m and a width of 1 m. All precast elements are supplied by Tierra Armada.

'Tailor made'

A total of a hundred and fifty rectangular columns were made, located between transverse precast arches and lintels on the underside of the deck. This work was 'tailor made', since the arches were neither equal nor symmetrical. In two months, Freyssinet teams also made the seventy-five lintels supporting the seven hundred and seventy small longitudinal arches located under the deck. In order to achieve this, it was necessary to design and manufacture two steel moulds for lintels and one for the arches.

The precast lintels equipped with two spare openings for the reinforcement of columns, were assembled to form a portal frame. At each pier, the portal frame consists of 5 m high columns and an 11 m wide lintel with a 3 m projection on each side. The work continued by reinforcing and concreting of the deck, followed by canal end and crossing spans. Multi-directional falsework was used to support the 2 m long and 30 cm thick cantilevers in the latter area, and thus to achieve the width of 11 m.

Participants

Client: *Barcelona General Council. Servei de Vies Locals.*
Contract manager: *Pedelta, SL.*
Main Contractor: *Freyssinet, SA.*

Key figures

Width of the old/new deck: 7.5 m / 11 m

Total area of the old / new deck: 2,025 m² / 2,970 m²

Reconstituted segment length: five 32.5 m span arches

Length of access and canal crossing spans: 107.5 m

Weight of each lintel: 5,800 Kg

Total weight of each arch: 400 Kg

B500S steel in high bond bars: 150 t

Prestressing

An arch over the Brisbane River

Austress Freyssinet is participating in the construction of a new bridge in the Queensland capital. This project required a special construction method.

Brisbane's new footbidge at Southbank provided a long awaited connection between the city's central business district and the leisurely riverside gardens and restaurants of Southbank. The bridge structure consisted of a 100 m span steel-tied arch that is approached from each bank by a series of shorter spans culminating in a total overall length of 450 m.

A prestressed tied arch

Austress Freyssinet installed the post tensioning that was used in the main span to assist in the tied action of the arch. The upstream and downstream chords were 100 m long and consisted of 25C15 and 55C15 tendons respectively that were stressed in 3 separate stages over the course of the construction. Central to the river are the concrete pavilion and viewing deck. The bridge was strengthened by five stay cables each 35 m long ranging in size from 19C15 to 55C15 that were supplied and installed by Austress Freyssinet.

Placement by lifting

Particular to this project is the fact that the 100 m arch was constructed on a land site approximately 5 km downstream. Austress Freyssinet was engaged to provide the expertise and equipment that would be used to launch the arch and raise it approximately 15 m to its final constructed position. As a separate entity the arch weighed almost 400 tonnes. The erection of the arch was programmed over a five-day period which consisted of heavy lifting it from the land base onto two awaiting barges which transported it upstream to second heavy lift stage where it was lifted from the barges and raised into the final constructed position. The equipment consisted of two 180 tonne heavy lift jacks and a hydraulic power pack independently set up at each bridge abutment and coordinated via two-way radio communication and survey readings.

Participants

Client: *Southbank Corporation.*
Main contractor: *John Holland Constructions.*
Consulting engineers: *Ove Arup.*
Specialized contractor: *Austress Freyssinet.*

Repair

Renovation of a building in Ballaigues

Freyssinet Suisse and MTS worked together on the renovation of an industrial building damaged by fire.

At the end of January 2001, building D in the Dentsply Maillefer Instruments plant caught fire. Some columns and slabs in the structure lost up to 60% of their bearing capacity under the effect of heat. The expertise carried out by the Saretec Suisse Company showed that the building stability was not threatened. Therefore, experts chose renovation of the building by strengthening the damaged columns; this solution was considered more economic and faster than demolition and reconstruction.

Removal of concrete

The 45 m long 35 m wide building comprises three floors. The 50 cm thick slabs have a span of 13 m. They are supported by columns on the façade and in the middle of the structure. The upper slab on the flat roof is supported on a steel structure. The structure was propped and the different surfaces were sand blasted after the fire.

The work done by the Freyssinet Group through its MTS and Freyssinet Suisse subsidiaries began by the treatment of partially damaged concrete in the slab supporting the second floor. Degraded areas were removed by water demolition. The concrete was then taken away since there was a risk of chloride contamination due to combustion of PVC reinforcing spacer blocks used when the slab was poured.

Strengthening of columns

The 5 m high and 0.35 m diameter supporting columns had “melted” under the effect of the fire over a thickness of about 10 cm. The teams then removed degraded concrete areas by water demolition and exposed the reinforcement. The strengthening was made by applying a new 45 cm diameter spiral surround placed around the columns and anchored to the floor with epoxy mortar. This arrangement was accompanied by a series of holes drilled in the raft to improve the anchorage of the reinforcement.

Finally, the surfaces of ceilings and walls damaged by the fire were treated by water demolition. All concrete was reconstituted by dry shotcreting, generally followed by fine trowelling.

Participants

Client: *Dentsply Maillefer Instruments S.A.*
Expert: *Saretec Suisse*
Main Contractor: *Freyssinet S.A. and MTS joint venture*

Australia

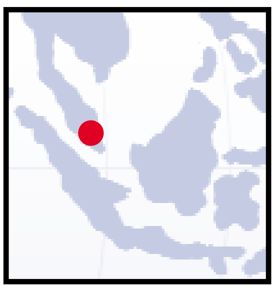
TerraPlus®

TerraPlus® for Brisbane

One of the biggest urban road bypass projects ever done in Australia was completed in Brisbane with the construction of 13,000 m^2 of Reinforced Earth® walls.

The Brisbane Inner City Bypass is a major project that will be one of the most attractive urban road in Australia. The project began in May 2000 and lasted two years. There are 21 different structures of varying types, colours and textures along the route, utilizing of the new 2 x 2 square TerraPlus® panels.
All panels were made by Reinforced Earth Company in close cooperation with Leighton, in its own precast facility in the southern suburbs of Brisbane. Geoff Slavin, the Precast Manager, coordinated the production of 4 000 panels whilst continously attending the site to assist the installation contractor in efficiently building the walls.
Many of the structures incorporated unique finishes. Although some panels were sand blasted on the precast yard, they were all treated with anti-graffiti paint in the factory.
The design of these structures was particularly challenging. The engineering team at the Reinforced Earth Company (RECo) worked in close cooperation with the client's design office to create unique structures with special features that RECo engineers had never encountered in the past. Thus, some walls are provided with voids (so that steel beams can pass through the panel) that are supported by posts located inside the Reinforced Earth® blocks. The final aesthetic effect is impressive, and provides a solution worthy of the technical challenge.

Malaysia



Reinforced Earth®

Urban developments

The Malaysian capital has undertaken work to improve traffic.

The Besraya Highway carries very heavy traffic and leads to Jalan Sg Besi Avenue, one of the main access roads to the centre of Kuala Lumpur. Jalan Istana Avenue joins Jalan Sg Besi to the Federal Highway which also carries very heavy traffic. Vehicles from the Besraya Highway and Jalan Sg Besi Avenue converge at the intersection of these two extremely busy roads, and create enormous traffic jams every day. Therefore, a flyover construction project was developed. Due to land constraint, the exit ramp had to be constructed between a disused monsoon drain and Jalan Sg Besi Avenue. The invert level of the drain is located at about 12 m below that of the bridge. To overcome this constraint, the 6 m high lower-tier Reinforced Earth® wall was constructed like a working platform. The flexible nature of the wall allowed the embankment to be constructed over the varying foundation soil, that also supports the loading from the upper tier.
Traffic was not interrupted along Jalan Sg Besi during construction. The lower tier of the Reinforced Earth® wall was constructed in fifteen days, due to a simple and efficient construction method. The Reinforced Earth personnel worked in close cooperation with the consultant in the planning and the development of a practical solution for the project, and with other contractors to ensure that all deadlines were met. The four 12.5 m high 2 300 m^2 retaining walls were completed in only ten weeks.

Participants

Client: *DBKL (Town Hall).*
Contract Manager: *Maju Holdings.*
Engineer: *Perwaja Structures International.*
Specialized contractor: *Reinforced Earth Company.*

Architectural landmark of Putrajaya, the new administrative capital city of Malaysia, the Putrajaya bridge will provide access to the city's main boulevards.

Photo: Francis Vigouroux