# Soils&Structures

THE FREYSSINET GROUP MAGAZINE

**ACHIEVEMENTS** 240 T OF PRESTRESSING FOR AN UNPRECEDENTED PROJECT IN SWITZERLAND

**COMPANY** FREYSSINET LTD

**HISTORY** FLAT JACKS

## NUVIA
# Nuclear, Freyssinet's third business

Freyssinet NUVIA MENARD Terre Armée

**Sustainable** technology

N° 227 October 2008

# CONTENTS



## 1,000 t of prestressing for the mass transit system

**Thailand.** In Bangkok, Freyssinet Thailand is involved in work on the aerial mass transit system, more familiarly known as the BTS (Bangkok Mass Transit System Extension). The company is notably supplying and installing the prestressing (937 t of steel) of a 5.25 km viaduct built between the districts of Onnut and Bangna and the crossbeams (120 t of steel) of the five stations being built on the route.

## Dynamic compacting in double shifts

**United Arab Emirates.** On the edge of the sea in Bahrain, Ménard is about to complete the dynamic compacting of a 280,000 m² platform on which a residential hotel complex is to be built. Two Liebherr cranes, equipped with 17 t masses, are working in double shifts using mesh varying from 5 x 5 to 10 x 10 m. The free-fall height is 18 m and average production is 750 drops per shift.

## 5 362 m² of prestressed floors in Istanbul

**Turkey.** Bahcesehir, a district situated in the European part of the Turkish capital, saw the launch of a major property development program in 2007, consisting of residential buildings, a shopping center and various facilities. Freysas, the Group's Turkish subsidiary, was involved with the installation of 5,362 m² of prestressed floors between January and May.

## Take-off of a company

**India.** Reinforced Earth's subsidiary in India, which was created in 2006, is involved in the construction of the interchanges and access roads of the new Bangalore international airport. The company designed and supplied the materials and equipment required to build the 40,000 m² of reinforced earth walls for this project.

## Dynamic compacting in hand

**United Arab Emirates**. Prior to the construction of a power station, Ménard carried out a soil improvement project in the emirate of Fujairah at the start of 2008. Dynamic compacting, the technique chosen to improve the bearing capacity of a 36,000 m² sandy platform, was carried out at medium energy (a mass of 15 t released at a height of 10 m) in order to limit the impact of the vibrations on a plant under construction less than 100 m from the site. Seismograph readings were taken continuously over the duration of the work, which was completed at the beginning of April.

## Prestressed floors
# Record area for the Platinium tower

**Poland.** A first of this scale (30,000 m²), developer Atlas Estate was convinced by the prestressed floor solution proposed by Freyssinet Polska for the Platinium tower, under construction in the heart of Warsaw. The work began last February and will be completed in December 2008. In all, the project will have used 206 t of non-adherent sheathed greased strands and some 14,200 F1F15 active anchorages.

## Reinforced earth on the Ajaccio-Bastia section

**France.** Terre Armée has designed a 20 m high reinforced earth retaining wall for the construction of the RN196 by-pass (Ajaccio-Bastia) in Bocognano (Corsica), at the geographical center of the island. The wall will be faced with TerraTrel panels (welded mesh).

## Ballasted blocks in an earthquake zone

**Croatia.** North east of Zagreb, Ménard has installed 4,700 ballasted blocks to support the foundations and slab of the West Gate, soon to be the country's largest shopping center (91,000 m²), in an earthquake zone with very poor foundation soil.

## A festival of stay cables

**South Korea.** Freyssinet and its Korean subsidiary are currently working together on several cable-stayed bridge projects: the Cheong Pong bridge a 442 m mixed structure with a main span of 327 m, fitted with 92 H2000 stay cables, for which Freyssinet Korea is building the pylons, installing the metal deck and supplying and installing the stay cables; the Chundan Sandan bow-string bridge, with a prestressed concrete deck with a 120 m central span, supported by three metal arches by means of H1000 stay cables (see picture); finally, the Gujin arch bridge, which will have H2000 37 unit stay cables with compact sheaths. For all these projects, Freyssinet is providing the associated design, anchorages, sheaths and wax, leasing the special installation equipment and providing technical support. Three other cable-stayed bridge projects are also currently in the design and preparation phase.

## Nuclear prestressing inspections

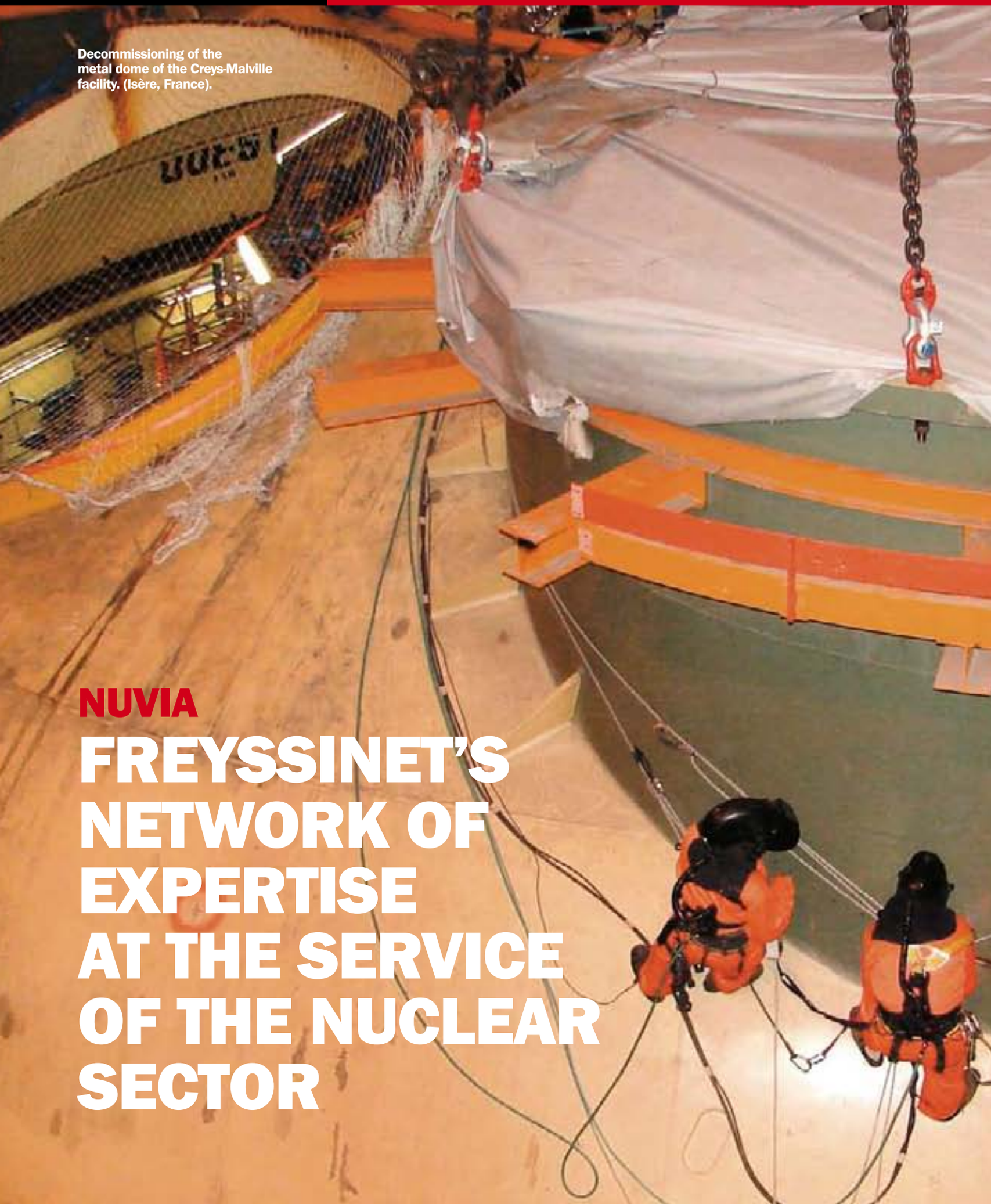
**Spain.** Following a five-month campaign, Freyssinet completed the 7th inspection of the prestressing system of reactor number 1 of the Asco nuclear power plant, near Tarragona, last January. The company supplied and installed the prestressing when the power plant was built between 1977 and 1980. During the work, tests were carried out on 13 cables to check the state of repair and tension of the strands and compare the values with the minimum and maximum design values. The anchorages were examined and grease samples were taken for analysis. The 7th inspection campaign began at the start of July on reactor number 2, while the 6th inspection on the neighboring nuclear power plant of Vandellós is continuing.

## Four new silos

**United States.** In the State of Virginia, RECo recently delivered four new storage silos made of TechSpan arch segments to the US army. A total of 56 structures of this type are now in use.

# Franco-Spanish collaboration

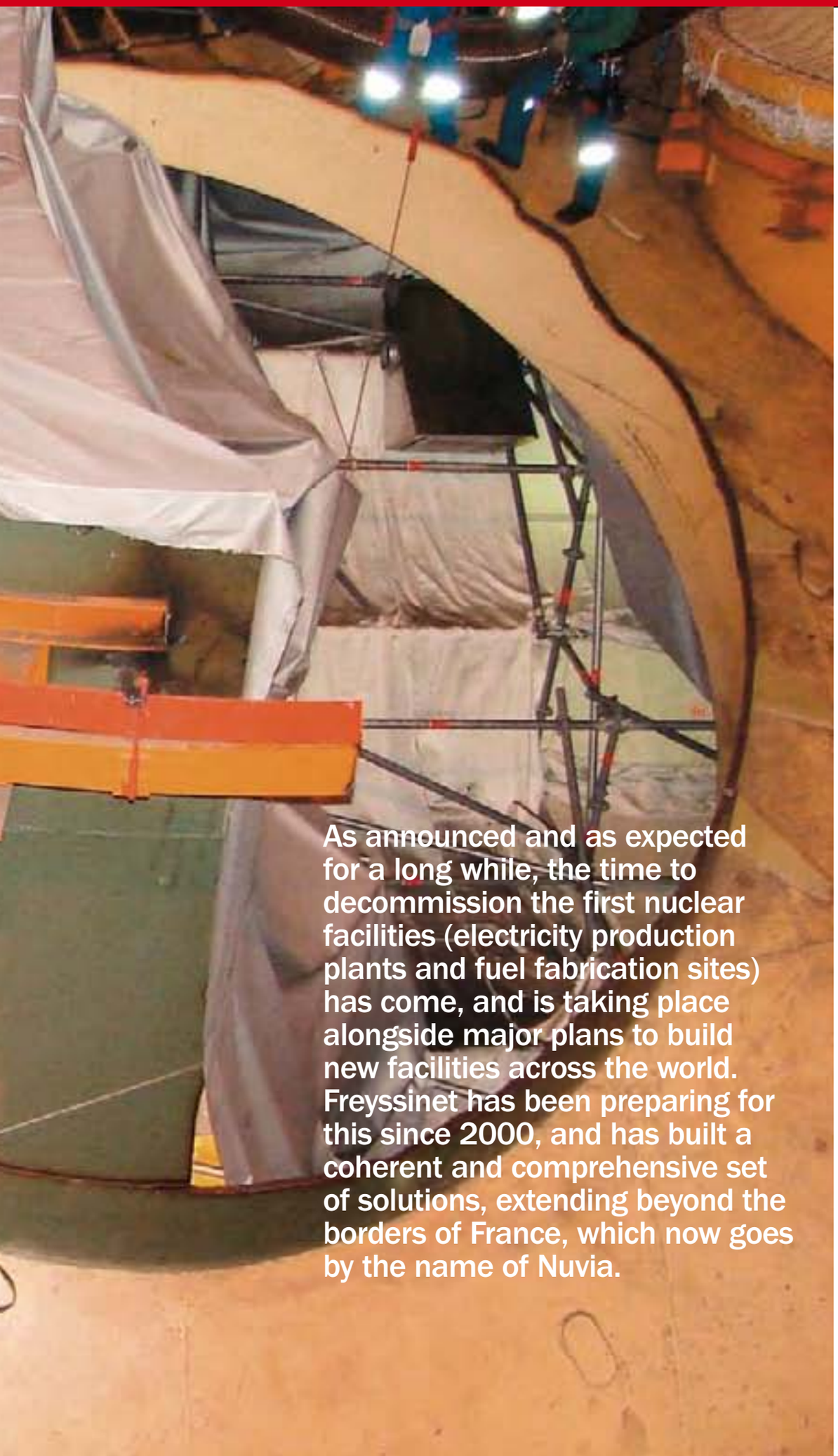
**France.** As sub-contractor to VINCI Construction France, Terre Armée and its sister company Tierra Armada SA have recently been working together to design and prefabricate a 8.38 m high and 46 m long TechSpan arch with a 13.20 m opening destined for the north by-pass of Brive-la-Gaillarde (Corrèze). The 38 segments prefabricated in Madrid were transported to site by Tierra Armada SA. Terre Armée provided technical support with the construction work, which was completed in May.



Decommissioning of the metal dome of the Creys-Malville facility. (Isère, France).

## NUVIA

# FREYSSINET'S NETWORK OF EXPERTISE AT THE SERVICE OF THE NUCLEAR SECTOR



**As announced and as expected for a long while, the time to decommission the first nuclear facilities (electricity production plants and fuel fabrication sites) has come, and is taking place alongside major plans to build new facilities across the world. Freyssinet has been preparing for this since 2000, and has built a coherent and comprehensive set of solutions, extending beyond the borders of France, which now goes by the name of Nuvia.**

While the creation of Nuvia has thrown Freyssinet's nuclear expertise into the spotlight, its existence and growth is down to the same logic as the one that saw the company's growth in the field of stay cables or the emergence of its repair business in the 1970s. As Jérôme Stubler, chairman of Nuvia, points out: "first came the expertise on which the company was built, prestressing, and its associated skills areas: in-depth knowledge of structures, calculation capabilities, a well-established command of design and implementation methods". Then, between 1970 and 1997, Freyssinet was involved in building all the nuclear reactor containment vaults of facilities built in France by EDF – namely 58 units across 19 sites. Designed and installed by Freyssinet, the prestressing cables are used throughout the concrete structure, called the "3rd shell(1)", which encloses the reactor and secures the facility.

### Repair and maintenance

Following this construction period, Freyssinet continued to assist EDF in its new phase, the operation of the facilities, by putting its skills and experience to use in structural repairs and maintenance. This work gave the Freyssinet NTS (now Nuvia TS) teams the opportunity to grow their knowledge of the facili- >>

**JÉRÔME STUBLER, CHAIRMAN OF NUVIA**

*"Decommissioning is the art of clean-up and deconstruction, an operation that can be likened to reverse construction, requiring expertise not unlike construction using prefabricated segments".*

>> ties' operating rules and safety procedures. "This knowledge and the collaboration fostered with EDF gradually enabled the company to expand its services, involving all or part of our specialty fields, from design studies to the execution and management of complex projects, either alone or as part of a consortium with other suppliers", explains Bruno Lancia, director of Nuvia France. "These operations are being stepped up due to our clients refocusing on their core business, and we're able to offer them end-to-end solutions that keep risks and costs under control".

"In this kind of work, which is always a matter of solving problems and working to the limit of machinery and civil engineering, which are the very foundations of Freyssinet's expertise", confirms Jérôme Stubler, "the objective and number 1 constraint is always the same: to ensure the work doesn't disrupt the operation of the facility, while controlling the security and safety requirements of the facilities and the people there. This risk control, a key phrase in the nuclear sector, has also become the major concept around which Freyssinet built its offer when it made the decision to commit to this market in 2000.

### Mobilization

Economic players are aware of the fact that certain electricity production plants and facilities linked to the fuel cycle[2] are reaching the end of their life and will have to be dismantled. For many players, these prospects continue to have an unspecified future and are of no consequence. This isn't the case for Freyssinet, which is carefully following the progress of these future projects. In five years, the company has mobilized and changed size by successively acquiring Salvarem, Mecatiss, Essor, Millennium and then the British Nukem Limited. Together, these complementary areas of expertise cover all the risks associated with nuclear activities >>

BRUNO DUPETY, CHAIRMAN OF FREYSSINET

# "Growing synergies and building group offers"

**At the end of April, Freyssinet announced the creation of a "nuclear" activity, launched under the brand name of Nuvia. Is this a new business area?**

**Bruno Dupety.** – Clearly not. Since the 1970s, Freyssinet has been involved in the construction of 100% of French nuclear power plants and has installed the prestressing of the reactor confinement vaults. As a logical step, the company then became involved in the maintenance and repair of the buildings. These projects which, until now, had been carried out as part of our Structures business, gave the Freyssinet teams the opportunity to further their knowledge of the client and the specific skills required for operations carried out in an environment exposed to radiation. Over time, EDF approached us for other services, using our engineering and design capabilities, this time in the field of waste management and clean-up operations. Our analysis of the growth of the nuclear market in general and its prospects led us to strengthen and expand our skills and focus on development in this sector as a strategic objective. Thus, between 2005 and 2007, we acquired Salvarem, Millennium, Mecatiss, Essor and, finally, the British company Nukem Limited. Freyssinet has acquired expertise in clean-up operations, radiation protection, criticality calculations, fire protection and waste

management. At the same time, our client base has extended to all the operators in this sector who were clients of these companies: Areva, CEA, military, etc. Based on core civil engineering expertise, Freyssinet, in just a few years, has become a source of knowledge and force for proposal for its clients. Today, these complementary skills enable Freyssinet to take part in all stages of a nuclear power plant's life cycle, namely the design and construction of the plant, its maintenance and operation and, finally, its decommissioning. We had to structure and promote this turnkey offer. This was why Nuvia was created, which is both the brand name under which we offer solutions for the nuclear sector and the name of our third specialist business, like soils and structures.

**What made nuclear a strategic challenge for Freyssinet?**

**B. D.** – Constantly rising oil prices, ever-increasing energy demand and the debate on $CO_2$ emissions have led to a renewed appetite for clean, or nuclear, energy. The construction of a new generation of brand new power plants has become a reality with EPR and work is underway in Olkiluoto, Finland and in Flamanville, France, where a second site is in the planning stage. We are also looking to develop new projects in countries seeking to diversify their energy sources. In parallel, the first facilities, commissioned for an operating life of roughly 30 years, are reaching the end of their life cycle. Some will be kept, with a certain amount of work, and others will be decommissioned. Major decommissioning projects have already been launched in the United Kingdom and in France. These are numerous, profitable and targeted operations, although relatively small in scale. In France, for example, decommissioning work involves the CEA site at Fontenay-aux-Roses, the EDF facility at Brennilis in Brittany and the Creys-Malville facility in Isère. These operations require a high level of technical expertise and major R&D investment, which corresponds perfectly to the culture of Freyssinet.
We tackle the work in the same way we tackle the engineering projects we are involved in, without claiming to "build the bridge", but with a view to making an essential and expert contribution.

*"We tackle projects to repair or decommission nuclear facilities in the same way we tackle the engineering projects we are involved in: without claiming to "build the bridge", but with a view to making an essential and expert contribution.*

**What does this business currently represent in terms of the Group's overall business? How is it organized and what are your objectives?**

**B. D.** – In 2007, the 1,700 players (half of whom are engineers and technicians) in the nuclear business realized sales of more than 150 million euros, representing 13% of the Group's overall business. To explain these figures, which don't illustrate the dynamic of the sector, simply note that Salvarem has more than doubled its sales since 2005 and that Essor has virtually quadrupled over the same period. In organizational terms, the Nuvia division comes under the responsibility of Jérôme Stubler, who also heads up the department specializing in prestressing for new power plants. There are two divisions: Nuvia UK, in the United Kingdom, headed up by Keith Colett and Nuvia France in France, headed up by Bruno Lancia, which groups together Nuvia TS (Special Works), Salvarem, Mecatiss, Essor and Millennium. These companies, whose names are well known to clients, have retained their identity, which is now associated with the Nuvia logo. In the future, Nuvia should represent between 20 and 25% of total sales of approximately one billion euros. Our real objectives, however, relate more to the business: by drawing on the expertise and experience of Nuvia UK, which has a waste conditioning plant in Sellafield, we plan to build a plant of the same type in France, which will enable us to offer turnkey solutions covering the whole waste management chain (identification, classification, processing).
We must also work on the commercial and technical synergies that have begun to develop between the companies in order to build group offers, launch R&D programs and promote our solutions and products for export, since one of our objectives is to expand internationally, targeting Eastern European countries in particular.

**Does Sustainable Technology, the motto adopted by the Group in 2007, apply to this new business?**

**B. D.** – The creation of Nuvia is a direct conclusion of an approach that began roughly six years ago, yet integrates perfectly with Freyssinet's position on energy saving and environmental protection techniques. Nuvia is involved in creating energy sources that do not produce greenhouse gases (construction), preventing potential pollution problems (maintenance, repairs) and helping to return sites to their original state (decommissioning). Sustainable Technology, more than ever before, is the key element driving our businesses and our network throughout the world.

>> and the full life cycle of the facilities: personal exposure (radiation protection, criticality), treatment of radioactive elements (sealing), fire procedures (fire protection), durability and resistance of the structure (prestressing, maintenance, repairs) etc. With this expertise, Freyssinet has gained a foothold in all projects within the sector, such as electricity generation or the fuel cycle, and, through the acquisition of Nukem Limited, is doing so at an international level.

### Growth market

Meanwhile, rising oil prices and debates on global warming and the development of new energy sources have become society issues and opened up new prospects for nuclear. In Spring 2008, for example, there were more than 220 nuclear power plant construction projects in the world, notably in China, India, United States, South Africa, the United Kingdom and Russia. Decommissioning business is also growing: in an article published last April, Le Moniteur estimated the value of decommissioning contracts scheduled over the next 15 years in France to be in the region of 150 million euros, with an anticipated growth of 200 to 250 million euros per year thanks >>

## NUVIA TS
## Civil engineering and project management

**EXPERTISE**

Specializing in structural repair and maintenance operations, Nuvia TS, formerly Freyssinet NTS, draws on all the company's civil engineering expertise: reinforcement, repairs, concrete treatment, alterations (openings or opening expansions), handling, decommissionning of metal or concrete structures, installation of paraseismic equipment etc.

**WORKFORCE**

85 employees (including 14 engineers and 40 technicians). The company provides civil engineering project management, design and construction services and specializes in structural decommissioning.

**SOME PROJECTS**

• Sealing and repair work to radioactive waste recovery pipes in the auxiliary buildings of all EDF's nuclear power plants.
• Decommissioning of RM2 on the CEA site at Fontenay-aux-Roses. Project launched in 2007 as part of a consortium with Salvarem. Objective: decommissioning (cutting and handling blocks sent to the storage center) of 14 of the facility's reinforced units previously used for fuel testing (see p. 28).
• Decommissioning of the metal dome of the Creys-Malville power plant.

## SALVAREM
## Process decommissioning and radiation protection

**EXPERTISE**

Salvarem, created in 1979, was France's first private radiation protection company. Its expertise has grown since 1990. Today, it covers radiation protection, clean-up, maintenance, operation, process decommissioning and waste processing, including designs and studies.

**WORKFORCE**

220 employees across three offices: La Hague, l'Île-de-France and Pierrelatte.

**SOME SERVICES**

• Studies and decommissioning of the process A and process B extraction batteries of room 60 on the Marcoule Areva NC site (finally shut down in 1997, this facility, built in the 1950s, housed the graphite/gas fuel dissolution process).
• Decommissioning of RM2, as part of a consortium with Nuvia TS (see p. 28).
• Maintenance and clean-up work, partly carried out remotely, on areas 3 and 4 of the Areva La Hague facility (part replacement of steam generators).
• Operation of waste sites at La Hague. Recategorization (reclassification of waste from one category* to another) and cutting (to optimize storage container filling during the conditioning phase).

** Radioactive waste is classified according to four categories, depending on its radioactive intensity:*
*- very low-level waste (VLLW);*
*- low-level waste (LLW),such as gloves, overboots and protective masks from industrial production or maintenance operations (90% of waste stored in specialist centers);*
*- medium-level waste, such as some parts from the decommissioning of production equipment, measurement appliances, etc. (8%);*
*- high-level waste, principally the fission products separated during recycling and reprocessing operations (2%).*

# MILLENNIUM
## Engineering studies

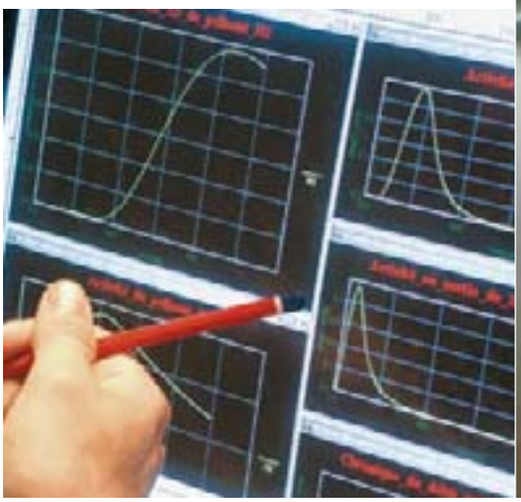
**EXPERTISE**
The Millennium design office specializes in nuclear engineering and provides scientific calculation and measurement services in areas such as criticality* for designing installations (ventilation room, waste packaging site, hospital X-ray rooms etc.) and defining the conditions for safe operations in an ionizing environment.

**WORKFORCE**
80 employees, of whom 70% are engineers.
Locations: Les Ulis, Lyon, Aix-en-Provence, La Hague, Pont-Saint-Esprit.

**CLIENTS**
EDF, Areva, CEA, DCNS, Andra, Autorité de Sûreté Nucléaire, Ganil (Grand Accélérateur national d'ions lourds), etc.

**SOME STUDIES**
• Involved in the Eurodiff decommissioning studies (former uranium enrichment plant) at Pierrelatte.

** Criticality: risk of uncontrolled fission phenomena in fissile materials.*



**BRUNO LANCIA, DIRECTOR OF NUVIA FRANCE**

*"Nuvia, which has a presence throughout the life cycle of a nuclear facility, is the only market player that brings together specialized and technically complementary companies, all leaders in their field, and is therefore able to offer a turnkey decommissioning solution".*

**LUDOVIC MARTIN, DIRECTOR OF SALVAREM**

*"Nuvia gives us greater credibility and enables us to seek out larger contracts by proposing a turnkey offer comprising studies (Millennium), structural decommissioning (Nuvia TS) and process decommissioning (Salvarem)".*

**KEITH COLLETT, DIRECTOR OF NUVIA UK**

*"Our complementary expertise and our desire to build synergies within Nuvia put us in the best position to meet the needs of our clients".*

>> to major projects. “This already major market has gone beyond the borders of France”, points out Jean-Jacques Doublecourt, export director of Nuvia France, “there are 73 power plants (9 of which in France) awaiting decommissioning, and this doesn’t include sites associated with the fuel cycle, which involve harder and more complex operations”. In this context, Freyssinet, a well-known player in the civil engineering sector, had to establish itself as a player in the nuclear sector. This is the mission of Nuvia, which is both a brand name and the name of the Freyssinet Group’s third business division. Together with the names of the companies, who are all leaders in their field and well-known to their clients, the Nuvia logo will symbolize the Group’s global offer to entities in the sector. In-house, the creation of Nuvia splits the business organization into two divisions, under the responsibility of Jérôme Stubler: Nuvia France, headed up by Bruno Lancia (which groups together Nuvia TS, Salvarem, Millennium, Essor and Mecatiss and benefits from the support of the Technical Department managed by Jean Botti for designs and studies for major projects and multi-company projects) and, overseas, Nuvia UK, headed up by Keith Collett.

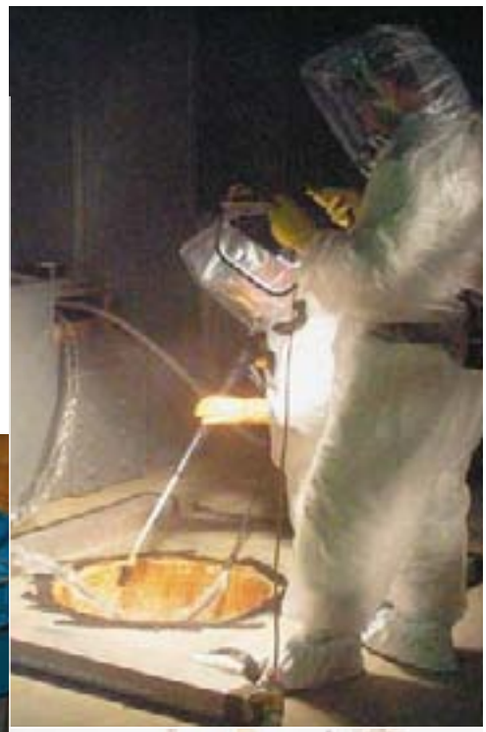
**1.** *Barriers preventing radioactive fuel dispersing into the environment. The first is the metal sheath containing the fuel, the second is the steel vessel enclosing the reactor core, where the coolant recovers the thermal energy produced by the fission process.*
**2.** *The fuel cycle covers all the nuclear fuel preparation and usage stages: mineral extraction, concentration, purification, conversion, enrichment, fuel fabrication, passage to the reactor to exploit the decay heat, reprocessing, uranium and plutonium recycling and waste storage.*

## NUVIA UK
# A lever for synergies and an international foothold

**EXPERTISE**
Representing the history and organization of the British nuclear sector, Nuvia UK was formed in the 1960s, initially as an operator, but at the same time growing its expertise in preliminary studies, design and construction of installations, management of complex decommissioning operations, waste management, soil decontamination, radiation protection etc., through an active innovation policy. Working alongside different regulatory authorities, such as the British Ministry of Defense and Ministry of Industry and Commerce, Nuvia UK benefits from a major international foothold, illustrated notably by its involvement in the project to decommission ex-USSR atomic submarines.

**WORKFORCE**
900 employees, including 400 engineers and scientists, present on the main UKAEA (United Kingdom Atomic Energy Authority) sites: Dounreay, Sellafield, Rishey, Harwell, Winfrith.

**SOME PROJECTS**
• Design, construction and installation of the AWE waste reprocessing plant at Aldermaston.
• Involvement in three decommissioning operations in Dounreay. The DFR fast reactor: design and construction of NaK coolant (sodium-potassium alloy) disposal plant. The PFR prototype fast reactor: design and operation, in conjunction with Areva NP, of the facility used to decommission and dispose of the radioactive liquid metal coolant; involvement in the removal of the steam generation building and the three secondary sodium circuits.
• In Winfrith, design, construction and operation of the facility to recover, treat and encapsulate the sludge from the external tanks of the heavy water reactor.
• Involvement with the ex-USSR nuclear decommissioning program.



# MECATISS
## Fire protection, sealing and biological protection

**EXPERTISE**

For more than 28 years, Mecatiss has been meeting clients' needs with the design of innovative concepts in the areas of fire protection, seals and biological protection. Mecatiss designs, builds, commissions, maintains and provides expertise in systems protecting key installation (power plants, tunnels, factories etc.) security and safety equipment (cables, motors, valves, pumps, sensors etc.), enabling operators to keep control of their installations for several hours in the event of a fire.

**WORKFORCE**

64 people, including 30 managers and technicians and 34 agents attached to each of the French nuclear sites.

**SOME PROJECTS**

• Mecatiss has equipped 100% of French power plants (representing more than 200 km) with passive fire protection (1 hr 30 mins fire protection for cableways), following the fire action plan launched by EDF.

• Mecatiss installed the protection system of fire zones in French, Chinese, Russian and US facilities...

• After the promulgation of new European regulations, Mecatiss, according to these new standards, certified all its products and processes to fire resistance periods of 2, 3 and 4 hours. Mecatiss was the first to obtain its initial certificates and its first contracts.

# ESSOR
## The services

**EXPERTISE**

Essor was established in 1996 as a service provider and works in four areas: nuclear logistics, decontamination, conventional and radiological risk prevention and facilities management and operation.

**WORKFORCE**

240 agents, including approximately 60 attached to the Cruas-Meysse, Tricastin, and Saint-Alban CNPE in the Rhône valley and, from 2008, the Dampierre power plant on the Loire.

**SOME SERVICES**

• Endorsed by the State (the only Nuvia company to have been so), Essor provides radiation protection consultancy, inspection and measurement services.

• Essor installs biological protection systems, provides assistance to personnel, installs contained airlocks, etc., during maintenance or repair work carried out in so-called power plant "hot spots".

**BERNARD MARQUEZ, DIRECTOR OF MECATISS**

*"Our aim is to accompany the alignment of facilities in China with French standards and to take 30% of the accessible market share".*

**GILLES GRÉGOIRE, DIRECTOR OF ESSOR**

*"In Essor's business, the human factor is 95% the success and 100% the difficulty as we have an average of twenty business profiles and some half a dozen different study levels."*

**ERIC LEJEUNE, DIRECTOR OF MILLENNIUM**

*"Freyssinet's desire to expand abroad is a major challenge for Millennium. We have already embarked on this by conducting studies for Nuvia UK".*

# Key link in Budapest's major ring road

**Like other eastern European countries that have recently joined the European Union, Hungary is continuing with the overall regeneration of its infrastructures. The M0 motorway, built around the capital, will link the five main routes connecting the country. The Megyeri bridge, which crosses the Danube at Szentendre, north of Budapest, will serve as the link for this vital route at the end of 2008. The structure's metal deck is supported by 88 stay cables supplied and installed by Freyssinet** **(see also p. 18).**

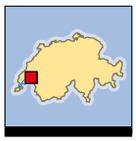
# A cost-compacting technique

**In Saint-Fons, south of Lyon (Rhône), immediately adjoining the A7, the main north-south European trade route, the company Em2c owns 40,000 m² of land which is ideally situated for the construction of a logistics platform, provided the construction costs can be contained. On land consisting of different types of contaminated backfill, and taking into account a large amount of spoil, Ménard is helping with a dynamic compacting solution to allow for the installation of shallow foundations (see also p. 30).**



STRUCTURES/**EPFL LEARNING CENTER**

# 240 t of prestressing for an unprecedented project



**On the site of the Learning Center of the École Polytechnique Fédérale de Lausanne (Switzerland), the creation of two flat arches is made possible by a massive amount of prestressing installed by Freyssinet SA.**

IN BOTH FORM AND IN FUNCTION, the Learning Center project implemented by the École Polytechnique Fédérale de Lausanne (EPFL) is an extraordinary and important project. Important, because it augurs new designs and the "US-style" campus, which will enable the establishment to gain prestige vis-à-vis the German language École Polytechnique in Zurich. Extraordinary, and far removed from traditional designs, because this building, designed for the knowledge and learning resources of the future (not as yet established), will house libraries, media libraries, a café etc. and "its contents will ultimately be used in the manner imposed by its users", sums up Patrick Lacour, member of the EPFL Graduates Association. Visually, imagine a 35,000 m² structure facing Lake Leman, reduced to two fine, curved lines: the floor and the roof (the façades are entirely glazed). Crossed diagonally by two arches delimiting a small and a large shell (respective areas of 2,100 and 6,300 m²), the building is opened up vertically by a number of atria and light wells. According to the designers, Japanese architects Kazuyo Sejima and Ryue Nishisawa (from the firm Sanaa), these simple lines aim to "build an experience or create an atmosphere". The structure is undoubtedly complex in terms of construction too, since the counter-curves and large off-center openings of the atria generate major bending moments that prevent the structure from working as a thin shell. The solution involved optimizing forms, designing groundbreaking form-

work, forming special concrete and developing a "hybrid static system", where some shells act as tied arches, while others bear on these arches while retaining their function as a shell.

### A base with a varied thickness

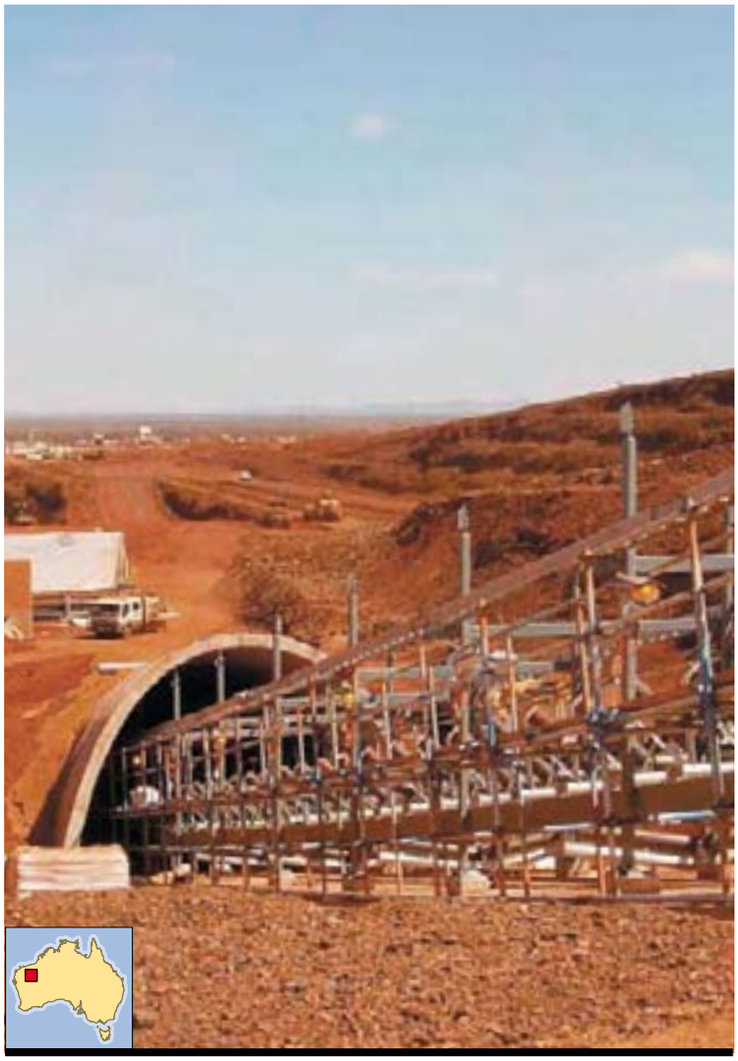
"The arches acting as such exert horizontal pressure on the car park cover slab, which automatically becomes a base with a thickness that, depending on the place, varies from 40 to 80 cm", explains François Prongué, Freyssinet SA technical director. "These stresses are taken up, at the level of the slab, by 11 tied arches, representing 21 bundles (6 for the small shell and 15 for the large shell) of 5 to 14 prestressing cables functioning as tie-rods". The volume and nature of the prestressing is impressive: in total, it represents 240 t of steel and employs units normally used for engineering structures: 73 31T15 cables (5,500 m) and 36 19T15 cables (1,800 m). After building the small shell, which was concreted in approximately fifteen hours in one go last April, work on the large shell was in full swing in May. "This is an unprecedented project in Switzerland", highlights François Prongué, "since the teams are working side by side on a vast area the size of four football pitches". 28 days after the concreting of the large shell, which was scheduled for July, Freyssinet will take part in the straightening work. First of all, some sixty jacks will be installed on Megasteel stays supplied by Hebetec, the Group's Swiss specialist lifting and handling subsidiary, and the cables will be gradually tensioned in line with the straightening work to prevent any sudden change of stress in the structure. Even if designing and installing the prestressing in such tight deadlines was not, in itself, a challenge for Freyssinet, "everything about this project is exciting", believes François Prongué, "because everything is extraordinary". ■

### THOSE INVOLVED

- **Contracting authority:** École Polytechnique Fédérale de Lausanne.
- **Prime contractor:** Sanaa Ltd (Japan).
- **General contractor:** Losinger SA.
- **Specialist contractor:** Freyssinet SA.

SOILS/**CLOUDBREAK IRON MINE**

# A three-phase tunnel



A PROJECT COMPLETED LAST FEBRUARY once again illustrates RECo's leadership in the supply of complex concrete arch tunnels for the country's public transport and mining infrastructures. In three phases over a year and a half, the company was involved in the construction of the recovery tunnel of the Fortescue Mining Group iron mine at Cloudbreak (Western Australia), one of the country's most important mining sites. The structure consists of TechSpan arches with a span of 6.70 m. This 315 m long structure is one of the largest ever built by RECo and crosses a 40 m high massive iron ore deposit. In June 2007, the company won a 160 m extension contract, "which was more difficult to design due to being situated on a steep slope", explains RECo's Gary Power.

Finally, in 2007, a new 77 m extension was commissioned to create an emergency tunnel. At the end of 2007, RECo also built one of the reinforced earth tunnel head walls faced with TerraMet panels. ■

STRUCTURES/**MEGYERI BRIDGE**

# 88 stay cables over the Danube

**In Budapest, Freyssinet's Major Projects Department and Hungarian subsidiary Pannon Freyssinet teamed up to help build the largest cable-stayed bridge in Hungary. This eighth bridge over the Danube at Budapest, will be the capital's first cable-stayed bridge.**

THE 1,862 M LONG MEGYERI BRIDGE IS A KEY LINK IN THE M0 PROJECT, Budapest's new ring road which will link up the Hungarian motorways around the capital. Located to the north of the city, the structure successfully crosses the flood zones on the left bank of the Danube, then the river itself, the river island of Szentendre, the secondary river channel and, finally, further flood zones on the right bank. "We are working on the main bridge over the Danube, and are supplying and installing the 88 stay cables. The structure will be complete at the end of 2008", explains Maté Borbas, managing director of Pannon Freyssinet.

The structure has two 145.50 m approach spans either side of the 300 m central span. The 37 m wide deck will accommodate four traffic lanes and the side strips provided for future expansions. "We are installing latest-generation HD2000 stay cables on the structure", continues Maté Borbas. "At the top, they are anchored to two A-shaped 100 m high pylons and fixed to the deck at 12 m intervals". A total of 88 stay cables, representing 460 t of greased sheathed strands and 176 anchorages, will be installed by the teams of Freyssinet's Major Projects Department and the Hungarian subsidiary.

The stay cables are installed simulta-

**The metal segments of the deck, brought to the site by water, are installed either side of the pylons. Their load (170 t) is taken up by a stay device on the barge before being transferred to the two stay cables that the Freyssinet teams install in one day following a rigorously prepared schedule.**


neously on either side of the pylons, in line with the installation of the metal segments. These segments, weighing 170 t, are assembled in the south of the Hungarian capital before being transported by barge to the site, where they are lifted to their final position using a crane and then welded. "Our work begins when the welding work is 70% completed. We hoist two cables simultaneously, all in less than a day. There isn't a minute to lose during this very delicate phase, which involves meticulous planning", explains Daniel Clapisson, the Freyssinet site manager. The stay cables are made up of bundles of parallel cables, with a number of strands ranging from 31 to 61. With pale gray outer sheaths, the cables measure 55 to 163 m and are fitted with IED (Internal Elastomeric Damper), IHD (Internal Hydraulic Damper) or IRD (Internal Radial Damper), depending on their length.

## THOSE INVOLVED

- **Contracting authority:** Nemzeti Infrastruktúra Fejlesztó Zrt. (National Infrastructural Development Corporation).
- **General contractor:** M0 Északi Dunahíd Konzorcium (Hídépító Zrt.-strabag Zrt).
- **Specialist contractor:** Pannon Freyssinet Kft.

STRUCTURES/GREEN SQUARE NORTH TOWER

# Production target of 33,000 m² of prestressed floors achieved


**The Group's Australian subsidiary installed the prestressed floors of a hotel with high environmental credentials built in Brisbane in the State of Queensland.**

THE AUSTRESS FREYSSINET QUEENSLAND BUILDING DEPARTMENT recently completed the installation of the prestressing of the Green Square North Tower in Brisbane for Leighton Contractors Pty Ltd. This luxury hotel, with strong ambitions to be the first in Queensland to obtain six stars, and its developer, Leighton Holdings Pty Ltd, have applied for the hotel's certification by the Australian Green Building Council, which involves meeting complex and rigorous environmental requirements at all stages of design and construction.

Before work started, the developer's project manager, Tony Joslin, held important meetings with both Rod Price, director of Pryme Pty Ltd, the company responsible for the formwork, and Mica Simovic, the Austress Freyssinet building director. These meetings were held to optimize the design of the floors, their construction and plan the work.

### 4D software to control the project

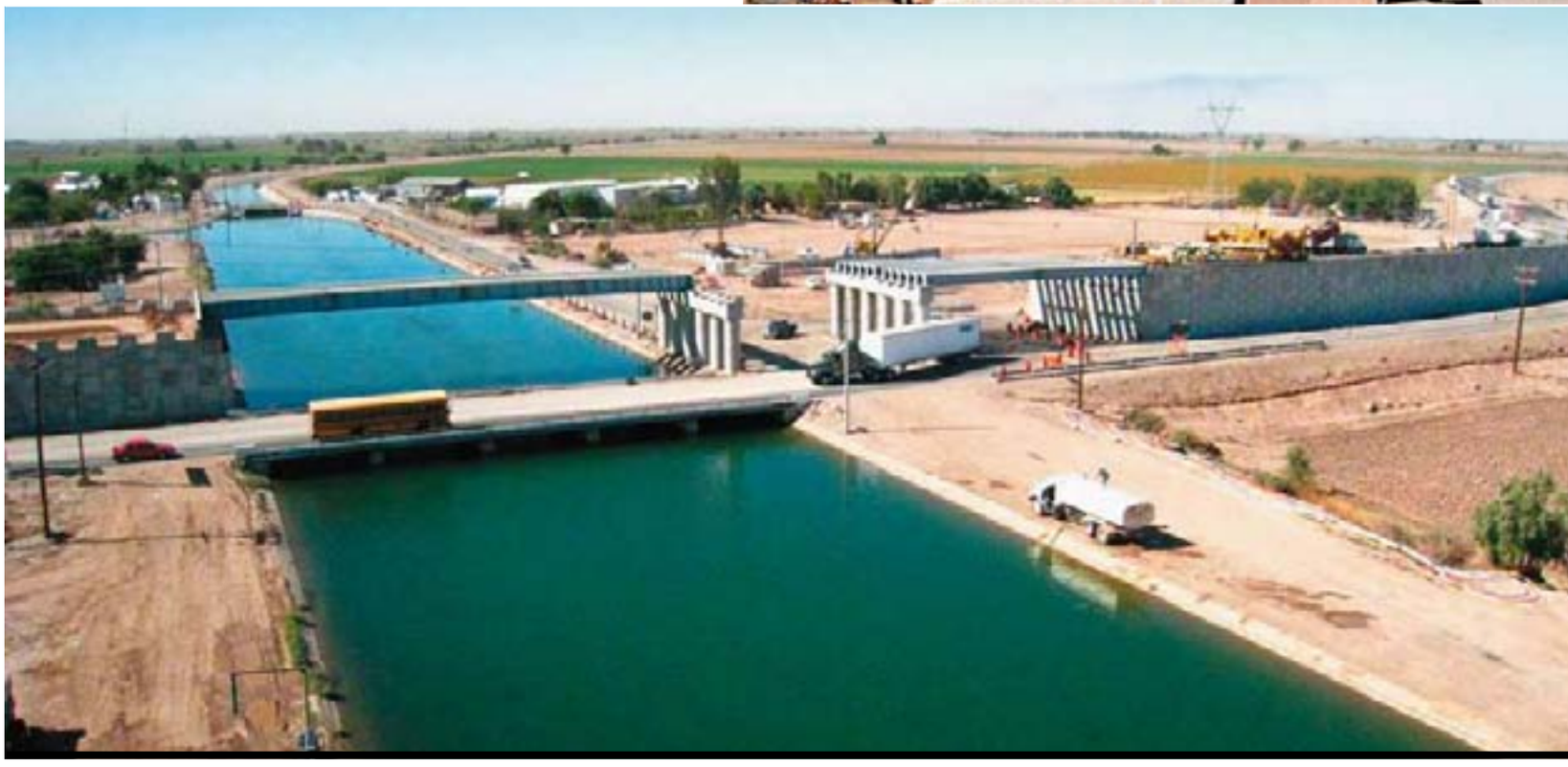
"We were in charge of designing and building 12 prestressed slabs for floors 2 to 13 and building the lower floors, representing an area of more than 33,000 m², and installing 200 t of strands", explains Benoît Lecinq, managing director of the subsidiary. For this work, where meeting deadlines was key to obtaining the certification, a four-dimensional development software was used for the first time.

This innovative tool allowed us to visualize all key stages of the construction process and the time assigned to each stage. By dividing all the structural work on a floor by floor and hour by hour basis, the software gave us valuable help in understanding and executing the structural work, which was supervised on site by project engineer Nathan Power and team manager Mat Keary. Using this software and data from the study and design phase, the Austress Freyssinet structures team was able to meet its production objective of one floor per week, representing three concrete casting operations, each approximately 650 m². Freyssinet's involvement from the design stage ensured a high production rate was achieved and safety, precision and quality requirements were met. ■

SOILS/**SONOYTA-MEXICALI ROAD**

# 70,000 m² of reinforced earth walls for 16 structures

**At the gateway to the State of Baja California (Mexico), Tierra Armada de México is involved in a major road modernization project.**



IN THE FAR NORTH WEST OF MEXICO, bordering the United States, modernization work has begun on the Sonoyta-Mexicali road (approximately 250 km), particularly on the San Luís Río Colorado-Mexicali section (approximately 70 km). The expansion of the roadway from 13.50 m to 24 m involved major earth and drainage works, the installation of hydraulic and asphalt surfacing, signage works, the construction of six crossings (called Algodones I, Hermosillo, Algodones II, Monterrey, Aeropuerto, Puebla) and 22 level crossings. "This section will see improvements over a total of 53 km", points out Luis Rojas, managing director of Freyssinet's Mexican subsidiary Tierra Armada de México, "and we're involved with work on 16 structures". The company began work in 2005, during which 24,174 m² of reinforced earth walls were built. 21,694 m² and 19,427 m² were built, respectively, over 2006 and 2007.

"The final walls will be finished at the end of 2008", confirms Luis Rojas. On its completion, the modernization of this section will ease traffic congestion and secure this road link, which is used by 17,000 vehicles every day and on which most traffic to or from Baja California travels. ■

## THOSE INVOLVED

- **Contracting authority:** SCT Centro Baja California.
- **General contractor:** Alta Ingeniería 2000 Construcciones y Puentes de Chihuahua Constructora Gusa.
- **Specialist contractor:** Tierra Armada de México.

STRUCTURES/**AL ABDALI BUILDING COMPLEX**

# Prestressed floors for a 250,000 m² project

**Active in Jordan since the 1980s, Freyssinet has just created a local subsidiary and won a very large floor prestressing contract in Amman.**

IN JORDAN, THE NAME FREYSSINET IS ASSOCIATED with many prestigious engineering structures such as the bridges of the airport and Amman university, Wadi Mujib and the Jerash interchange. In 2004, the Group added prestressed floors for buildings to its range of traditional engineering, materials supply and prestressing installation services.

"This technique enables us to build large spans with a smaller slab thickness and make significant savings in terms of materials used and hours worked. The sector quickly got to grips with benefits of the technique and has used it for numerous projects such as the Mecca Mall shopping center (for the Al Kurdi Group) and the Abu Taweela Plaza (with Al Wajih Contracting), both carried out in Amman", explains Khalid Rabadi, managing director of the newly created Jordan subsidiary (see below).

Finally, Freyssinet, on behalf of Al Masar-MID JV (Oger is the client's principal project manager), embarked upon a new project to design and install the floor prestressing of an immense building complex situated on Boulevard Al Abdali, in the new area under development in the center of Amman. The project, which is currently underway, represents a total area of 250,000 m² and includes underground car parks and 10 residential and commercial buildings. "To begin with, the design planned for the use of reinforced concrete for the structures", explains Khalid Rabadi. "We proposed an alternative prestressed concrete solution for building the floors, explaining to the client that it would do away with the need for certain structural elements that are essential when using reinforced concrete, such as prefabricated slabs or beams". Using prestressed flooring also simplifies the construction cycles, reduces construction times and does away with the need for the imposing cranes and storage areas

**Fewer materials and equipment, greater simplicity and efficiency in production cycles etc., prestressed floors show off their advantages on a very large-scale project for which the use of reinforced concrete was initially planned.**

required when using prefabricated elements. "When compared with the cost of a traditional reinforced concrete solution, the choice of floor prestressing represents savings of 20% for the client", points out Khalid Rabadi. For this project, which is the country's largest prestressing project, 1,200 t of strands will be installed over two years. "At the peak of activity, we are using up to 30 people", says Khalid Rabadi, "as well as two site foremen, two works managers, one site manager and one project manager".

### A new address in the Middle East

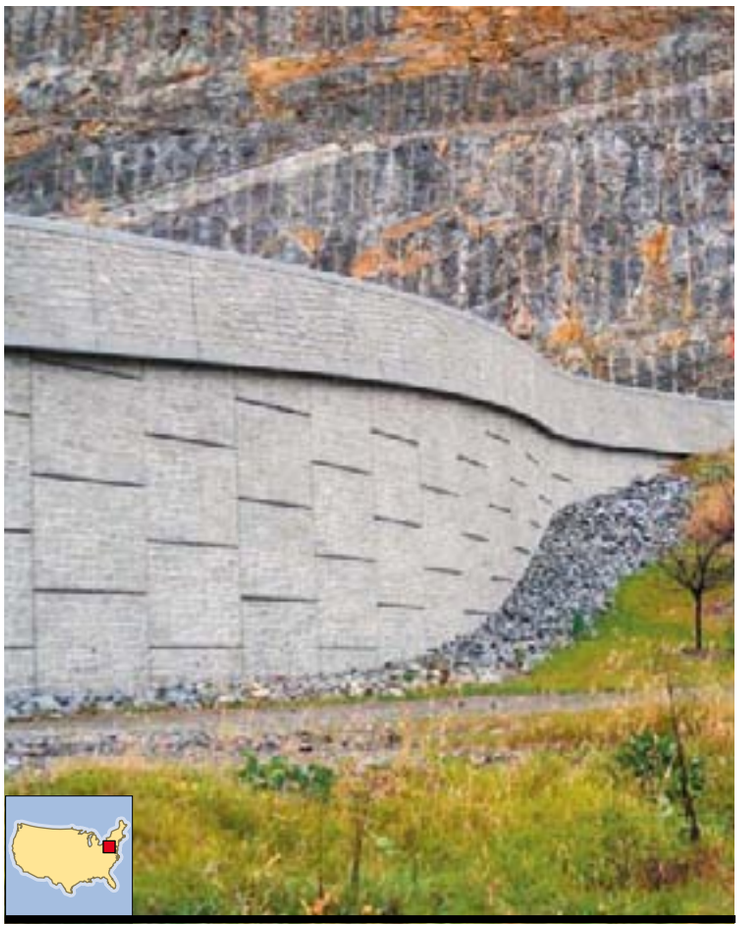
Jordan has experienced very rapid growth and a construction boom, particularly in Amman, located on the Dead Sea and in the Aquaba free trade area. To accompany this growth and continue to provide local, high-quality services to its clients, Freyssinet created a new subsidiary in Jordan, Freyssinet Jordan Ltd. The subsidiary, which has been operational since March 2008, is part of the Group's Middle East network and employs a full-time, qualified and local workforce. It will offer a wide range of the Freyssinet Group services, notably reinforced earth retaining walls and the soil improvement services of its Ménard branch. ■

SOILS/**ARCHITECTURAL FACINGS**

# Reinforced earth in the town and reinforced earth in the country

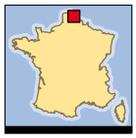
ON THE OTHER SIDE OF THE ATLANTIC, TWO RETAINING WALL PROJECTS, in which subsidiary Reinforced Earth has recently been involved, confirm the preference of US clients for architectural facings and the adaptability of reinforced earth. In Pennsylvania, a road improvement project was launched in February 2007, which included the creation of 1 540 m² of reinforced walls and the installation of 300 m of prefabricated safety barriers in the Cumberland valley. "For this project, we designed and supplied the materials and construction equipment and we created the 1.50 x 3 m architectural facings with a pattern inspired by the natural stone facing of a neighboring mill so as to ensure the structures integrated seamlessly into the surrounding mountainous landscape", explains Sherif Aziz at Reinforced Earth.

Radical change of environment with the second project. This time, the project involved the design of 22,300 m² of reinforced earth retaining walls (1.50 x 3 m panels) and 4,500 m² of TerraTrel welded mesh wall facing for the urban section of the 175 highway at Dayton (State of Ohio). Four different treatments were used on this occasion and work began in Spring 2008. ■



STRUCTURES/**EGLISE DU SACRE-CŒUR IN LILLE**

# Baptism of Foreva



**The reinforced concrete clock tower of the Église du Sacré-Cœur, in Lille (France), built after the Great War, was repaired in eight months using the range of Foreva products developed by Freyssinet.**

SEVERAL HUNDRED METERS FROM THE CITADEL, the Sacré-Cœur, in Lille, is one of a number of churches built in the modernist era in the neogothic style. Another unique feature: the structure was built in two stages: the body of the church, built in stone and brick in the aftermath of the 1870 war, followed by the clock tower, built in reinforced concrete after the First World War. The 82 m high clock together had resisted a century's worth of bad weather, until the beginning of 2004. A cross at the pinnacle fell just as people were leaving mass, requiring the structure to be urgently made safe and a number of repairs to be carried out, since the delicate ornaments were extremely weathered and spalling was revealed at various points on the concrete reinforcements.

### Like-for-like restoration

More than three years later, having raised the necessary funds, the monument has undergone a true like-for-like restoration, a project that was scheduled and entrusted by the town to a co-contracting consortium made up of the northern office of Freyssinet France (for the reinforced concrete) and MCCM, a local masonry company qualified

for historic monument work (for the stone and brickwork). "The project was split into two stages to minimize scaffolding costs, which would be up to 100 m high", explains Arnaud Beseme, Freyssinet France site manager: the simultaneous intervention of both companies on the mixed concrete/stone part, situated at a height of between 32 and 50 m, then, after adapting the scaffolding, work on the clock tower (developed area of approximately 600 m²) by Freyssinet and on the bottom section by MCCM". Work for both companies began with the removal of all the damaged parts, followed by sandblasting to ensure the adherence of the repair materials, which were selected after undergoing adherence tests. The parts were not all repaired the same way due to their different states of deterioration. Out of the 108 ornamental brackets on the clock tower, only 30 were repaired in-situ. All the others were entirely recreated by off-site molding work, before being embedded in-situ. The most damaged small sculptures, ornamental column heads and pillars received the same treatment. The parapet moldings were repaired in-situ using special formwork and the gargoyles, louver slats and the decorative beading around the edge of the openings were repaired by hand. "The common theme", points out Arnaud Beseme, "is that all these repairs were carried out using products from the Foreva range developed by Freyssinet (see opposite): Foreva M110 fiber repair micro-mortar, Parexlanko Lancorep fin 730 and Parexlanko Clavexpress 700 micro-concrete. The clock tower was then given a double protective coating of Foreva Relastic 300, a flexible coating specially formulated to protect concrete against environmental stresses. The coating was pale gray for this project to meet the requirements of the French buildings' architect". The work, which began in August 2007, was carried out mainly during the winter and was completed last March. "This wasn't exactly a first", comments Arnaud Beseme, "since the eight journeymen, the site manager, Mohamed Drici, and the works manager, Aldo Vici, carried out similar work on the Saint-Quentin Église Saint-Martin in 2004. "It was, however, the first time work was carried out at a height on a structure with so many moldings and sculptures and using Foreva products". ■

## A product/ expertise solution

**Specializing in the repair, protection and reinforcement of concrete, metal or wood structures, Freyssinet is also an expert in the products it designs and installs. To better align its expertise and the products meeting its specifications, Freyssinet grouped the products under the Foreva brand name in 2007. The range of Foreva products comprises repair solutions for concrete, waterproof coatings, the corrosion protection of reinforcements, cathodic protection etc.**

STRUCTURES/**KINCARDINE BRIDGE**

# Once, twice, three times for prestressing

IN SCOTLAND, 40 KM NORTH EAST OF EDINBURGH, the construction of the Kincardine bridge over the Forth river will soon be complete. "This 1.2 km long structure has 26 spans installed by launching and weighs more than 32,000 t. This is the second longest launched bridge in the world, and Freyssinet Ltd supplied and installed the prestressing", comments Ian Campell at Freyssinet Ltd. The system used to construct the spans stands out through the use of "partial" prestressing, consisting entirely of replaceable external strands (19C15 and 37C15). "The strands aren't tensioned in the freshly cast segment, but straight after the segment has left the casting bench, on the barge transporting it across the estuary", points out Ian Campbell.

For Freyssinet Ltd, the start of the launching work, in January 2007, marked the start of its two-stage involvement in the project. Firstly, the "centered" temporary prestressing had to be installed: 94 m long rectilinear cables making up both spans. After the launching, the teams then installed the continuity prestressing using 140 m cables. The carefully prepared installation of the "partial" prestressing of the spans (45 m long) took place in an average of 8 days instead of the 10 forecast in the initial contract. Designed and built by a consortium made up of VINCI Construction Grands Projets and Morgan Est, the Kincardine bridge project is a flagship sustainable development project: the site is surrounded by new conservation areas that are home to numerous animal species and on the site, recycled materials were used in abundance. ■

SOLS/**PYRMONT POINT PARK**

# A firmly implanted park

**In Sydney's Pyrmont district (Australia), Austress Freyssinet created 400 jet-grouted columns to consolidate a dyke in preparation for creating a new green space.**

NEXT TO THE OCEAN, BETWEEN THE JOHNSTON AND JONES BAYS, to the west of Sydney, the Pyrmont Point park is one of the major urban development projects currently underway in the Australian city. Covering a 1.8 ha area, this green space is being created on land that used to be owned by the marine police, acquired by the city in July 2005. When planning the space, landscape architects prioritized the use of certain materials such as sandstone for the walls and paths, wood beams and even ramps with a maritime design to remind future park-goers of the district's port and industrial history. A promenade and a deck-clad panoramic viewpoint built on the edge of the park will offer an unrestricted view across the two bays.

### "Fixing" the soil

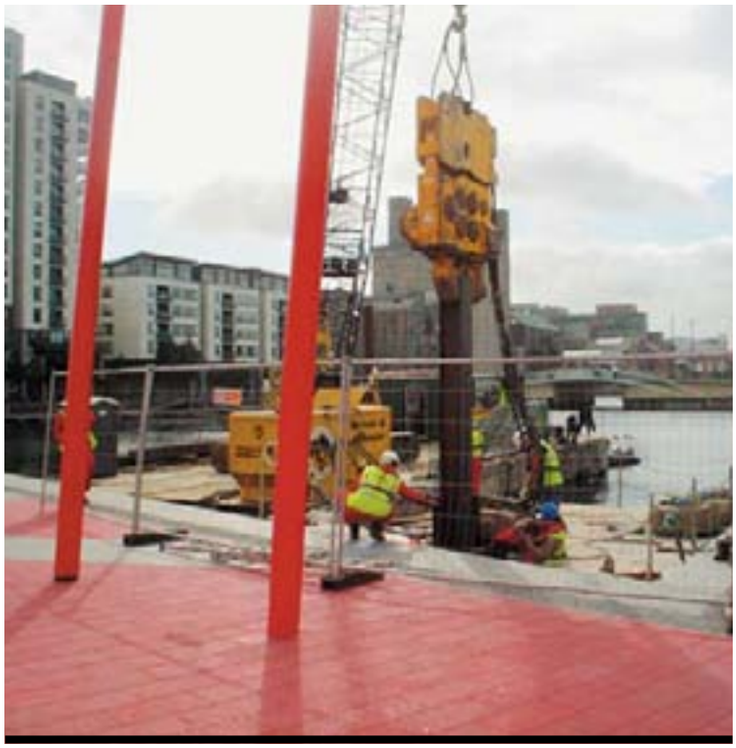
"Before beginning the work, we had to stabilize the soil", explains Paul McBarron, managing director of Austress Menard. The company, which specializes in geo-technical work, was involved in strengthening the existing dyke, on which the new park would sit, by creating jet-grouted columns. "With this process, a specialization of Austress Menard that we use frequently, we "fixed" the soil behind the dyke to prevent any movement or rotation of the structure and to increase its general stability and security". A series of adjacent columns, arranged over three rows, was then created at the back of the dyke to lock certain zones. 400 jet-grouted columns, with diameters of between 800 mm and 1,700 mm, were installed in just two months. "The 1,700 mm columns are the largest ever installed as a waterside backfill material", points out Paul McBarron, "a fine illustration of our soil strengthening expertise". The project was actually completed ahead of schedule and under budget. ■

STRUCTURES/**REHABILITATION OF THE GRAND CANAL BASIN DOCK**

# The mark of a specialist

THE GRAND CANAL BASIN DOCK was built 200 years ago in the heart of Dublin (Ireland), at the confluence of the Liffey and the Grand Canal. The commercial and residential regeneration of the district recently saw the dock's renovation on the agenda, and its transformation into a leisure area.

The structure's rehabilitation was first of all necessary, particularly the side adjacent to the canal. Initially, the plan was to install a sheet pile cofferdam 4 m from the structure in order to drain the area and reinforce it with shotcrete. "This solution was finally abandoned", explains Gerry Cluney, general manager of Makers Freyssinet (see p. 32) "in favor of our solution. This had the dual advantage of limiting the cost of the work, thanks to the use of light resources (innovative underwater formwork and micro-concrete) and preventing any risk of collapse by removing the hydrostatic pressure".



In all, the use of underwater formwork, installed at a depth of 4 m over a length of 240 m, enabled us to dredge 2,000 m $^3$ of sediment at the level of the wall and install 200 m$^3$ of micro-concrete to consolidate the structure.

"During dredging, we dealt pretty well with undesirable objects: two cars, three safes and rifles and ammunition", continues an amused contracts manager Mervyn Miller. 600 m² of brickwork structures were also repaired and restored above and below the waterline. So as not to disrupt the dock users, the work was carried out from work boats and a pontoon equipped with two 20 t cranes, 25 t diggers, a drop hammer and a sonar surveillance system. ■

SOILS/**A1 MOTORWAY**

# Foundations for backfill

IN POLAND, THE CONSTRUCTION OF THE A1 (582 km) is one of the country's flagship construction projects. The A1, the country's only north-south motorway route, will, by 2010, link the town of Gdansk on the Baltic and the Czech Republic, as far as Katowice, crossing the A2 and A4 east-west motorways. In its southern section, between the towns of Swierkalny and Gorzycki, the route crosses an area of clay and loam soil which couldn't bear the weight of the motorway backfill without being consolidated beforehand. "The principal design office therefore decided to carry out work to limit the settlement of the land under the heaviest areas of backfill and improve the stability of the shoulders, and this work was entrusted to us", says Jakub Saloni, responsible for the Ménard activity in Poland. The design office more specifically proposed the installation of a ballasted block solution, which is known to be effective in Poland, over a 70,000 m² area divided into five parts.

Given the substantial thickness of the soft soil layer, which can be as much as 8 m in places, the design office recommended a shoulder stabilization solution, to be implemented in several stages. In another area (40,000 m²), the presence of gritty backfill material, with a loose consistency, up to a depth of 5 to 9 m, led the design office to opt for another technique, dynamic compacting, which is just as familiar to Ménard. "To consolidate the 10 m high motorway backfill, the compacting teams used a 15 t mass released at a height of 20 m", explains Jakub Saloni. The work was completed at the end of summer 2008. At the peak of activity, the project involved 20 Ménard employees working in four teams. ■

**THOSE INVOLVED**

- **Contracting authority:** Polish Roads Directorate.
- **Prime contractor:** Jacobs.
- **General contractor:** Alpine.


NUCLEAR/**DECOMMISSIONING OF RM2**

# Nuvia's synergies at work

**Joining forces for the first time for a major project, the teams of Nuvia TS and Salvarem benefited from the support of other Nuvia companies and used the decommissioning of the CEA RM2 site at Fontenay-aux-Roses as an opportunity to share their expertise and build local synergies.**

FREYSSINET'S NUCLEAR COMPANIES did not wait until Nuvia was created to bid together for major projects. On the site of the CEA (Commissariat à l'Énergie Atomique) at Fontenay-aux-Roses (Hauts-de-Seine), Freyssinet NTS (now Nuvia TS) and Salvarem, as part of a consortium with STMI (subsidiary of Areva), won the contract in September 2006 to decommission the RM2 laboratory on completion of studies headed up by Jean-Jacques Aman (Salvarem) and Hervé Ridoux (Nuvia TS), involving engineering teams and designers from both companies. Essentially comprising 14 reinforced units with an average volume of 120 $m^3$, the RM2 is an installation built at the end of the 1950s and used for research on spent fuel until 1982. It comprises a lower gallery where active waste is collected and evacuated and an upper level with a mechanical-handling tunnel and slab-raising system, above which, outside the contamination zone, is a technical gallery. The structure is built of barium concrete, an extremely dense material, and its shells and floors have a remarkable thickness of 1.50 m, which is required to mitigate the ionizing radiation in the work zones. "This facility was the subject of a first clean-up campaign in the 1990s", explains Nicolas Box, Nuvia project manager. "This time, our mission is to carry out further decontamination and the decommissioning of the reinforced enclosures and their equipment (shells, floors, sheaths and tanks) so as to release the building from any nuclear constraints and enable the CEA to re-assign it to new activities".

Having received the installation plans and radiological mapping dating back to the 1990s, the consortium's mission began with radiological inspections and the creation of up-to-date mapping data, carried out by STMI, which was essential for creating the decommissioning scenario, a document describing the following for each stage of the work: the area in question, the protective measures, the materials used etc., and must be submitted to the client (the CEA). "This principle of anticipation and validation is a constant for this type of work", points out Nicolas Box, "and following the acceptance of the overall decommissioning scenario, all the implementation studies are submitted to the client together with a technical note". The project is currently in its initial phase: 80% of the implementation studies and 90% of the preparatory work (creation of areas for the temporary storage of waste, installation of an acoustic screen, installation of a new DNF [final filtration level] etc.), are now complete.

### Working from the top down

After switching over the ventilation system to the new DNF, a job that is currently subject to the validation of the Nuclear Safety Authority, the decommissioning work can really begin. This will take place logically, starting with the technical gallery, and the decontamination phases (dedusting, cleaning with special foam, scaling and planing where necessary) and dismantling phases (cutting of blocks with wallboard or diamond wire saws, Brokk demolition, a remote-controlled mini-excavator equipped with a rockbreaker) will be sequenced from the top down.

The work should be completed in 2011, and generate 780 t of waste, representing 50 t of non-hazardous industrial waste, 7,000 t of VLLW (very low-level waste) and 130 t of low-level waste. The consortium will take charge of the radiological categorization and conditioning of the waste. "This is the first time our two companies have worked together on a project of this size", points out Nicolas Box. "For the project, we benefited from the assistance, where required, of our colleagues at Nuvia UK (formally Nukem Ltd) and Millennium. We also decided to use this project as an opportunity for the mutual exchange of expertise by implementing a work-mentoring process". This joint project also gave us the opportunity to bring together the Salvarem, NTS and Millennium teams based in Île-de-France in the same building. This proximity and the synergies have already enabled Nuvia to secure contracts for further projects combing these different skills. ■

**THOSE INVOLVED**

- **Contracting authority and project manager:** CEA.
- **Works:** consortium STMI (agent)-Nuvia TS-Salvarem

STRUCTURES/**HOMELEIGH WATER TOWER**

# Heavy-weight lifting

**To build a water tower in East London (South Africa) without using extremely high scaffolding, a contractor called upon the heavy-lifting expertise of local subsidiary Freyssinet Posten.**

THE CONSTRUCTION MARKET IS IN FULL SWING IN SOUTH AFRICA A contractor all but paid the price when, after being hired to build a water tower in the Homeleigh district, in East London, it failed to get hold of scaffolding. To honor its commitments, it therefore decided to build the structure (20 m diameter, 8 m high, 640 t) on the ground and asked Freyssinet Posten to lift it more than 25 m.

"We're the specialists in this technique, and have already used it on several occasions across the world. We needed a week to prepare and five days to carry out the work", explains Mike Mollentze, managing director of Freyssinet Posten. The operation required highly specialist equipment: lifting jacks, high-resistance steel cables and sophisticated control instruments (laser distance measurement, electrical sensors reading the pressure in the jacks, other sensors measuring the jack extension, multi-channel data recorder, specialist software for processing and displaying the data ensuring that engineers could control the lifting operation in complete safety).

### Lifting 25 m at a speed of 1 m/hr

After the equipment was in place, lifting was carried out in six stages. First of all, 12 steel threads were threaded through vertical sheaths installed in the tank and connected to the lifting platform, at the top of the shaft. The structure was then gradually removed from the mold and hoisted 30 mm. This stage ensured the behavior of the tank and the structure could be inspected before continuing with the lifting itself. "The tank was then hoisted at a speed of 1 m/hr, in 200 mm cycles, corresponding to the stroke of the jacks", explains Mike Mollentze.

Once in its final position, the tank was then secured to the shaft using Freyssibar prestressing bars and the lower bracing was concreted. The suspension cables were kept tensioned until the concrete on the bracing had reached the desired hardness. "Freyssinet has shown it can meet challenges for its clients with this project. The operation took place without problems, despite the wind squalls that forced us to take endless precautions", concludes Mike Mollentze. ■

SOILS/**ROCHE-LA-MOLIERE AND SAINT-FONS PLATFORMS**

# Dynamic compacting shows off its advantages

**The presence of backfill can hinder the development of old industrial sites. In the Lyon region, the dynamic compacting solution proposed by Ménard offered a two-in-one technical and financial solution.**

AT ROCHE-LA-MOLIERE, NOT FAR FROM SAINT-ÉTIENNE (Loire), the site of a former opencast quarry which was filled, to significant thicknesses, some twenty years ago was chosen for the construction of a TNT package delivery premises. "The thickness of the backfill, more than 10 m in places, and the possible presence of spots deeper than 25 m, rendered the shallow foundation solution unfeasible. Foundations on stone weren't feasible from a financial viewpoint, given the depth to reach and the presence of plurimetric blocks", explains Gilian Erbeja, works manager at the Ménard Rhône-Alpes office. Ménard solved the problem posed by this backfill by proposing the treatment of the soil with dynamic compacting.

The fine analysis of the energy to use as a function of the admissible settlement stresses of the building and the distribution of the deep stresses served to validate the process and, during March 2008, an area of at least 15,000 m² was treated, consisting principally of materials from mining activities, over an average thickness of 12 m under the building.

### Cost savings

"This project once again demonstrates the relevance of the soil-structure interaction analysis and the substantial cost savings the client can make in terms of the structural foundations", concludes Marc Lacazedieu, managing director of Ménard. In Saint-Fons (Rhône), yet again in an urban area adjoining a chemical complex classified as sensitive, Ménard rolled out its historic technique for the company Em2c. Driven by the wish to optimize the costs associated with the structural foundations and limit the amount of very likely contaminated spoil, Em2c was convinced by the alternative proposed by Ménard instead of the deep pile foundations solution. "Over an average thickness of 7 m of different types of backfill, we treated an area with dynamic compacting equivalent to six football pitches on which a logistics platform and industrial buildings are to be built", explains Stéphane Brulé, manager of the Ménard Rhône-Alpes office. A study and the monitoring of the vibrations generated by ramming, carried out throughout the site, enabled us to treat the soil just 10 m from the neighboring buildings.

"Here, dynamic compacting has demonstrated its use when faced with a problem of contaminated heterogeneous backfill, since it enables you to site structures on shallow foundations and reduce the amount of spoil, and hence the costs linked to the environmental treatment of the soil", adds Stéphane Brulé. ■

# RADIATION PROTECTION, A MULTIFACETED REGULATORY OBLIGATION

In the nuclear sector, exposure to ionizing radiation must be controlled so it doesn't exceed the regulatory limits (see box). This control lies in expertise in radiation protection, one of Nuvia's core businesses, whose facets aren't always the same depending on whether it takes place in an electricity production plant, fuel cycle or waste treatment facilities or whether it involves maintenance or decommissioning operations. Except for the studies, which take place by means of calculations (an area of radiation protection in which Millennium and Nuvia UK specialize within Nuvia), the fundamental tool of the "radiation protector" is the radiation meter.

This is used to measure the radiation in an area and, with additionnal accessories, its contamination, or rather the presence of radioactive elements in the form of dust deposits or in suspension in the air. "These readings, along with others (measurement of oxygen levels, explosimetry, fire protection tests etc.), form the basis of our work, which is to protect against all risks and is split into two main areas", explains Cédric Beauvieux, Essor's methods manager.

The first area covers the regulatory inspections and mapping of the premises. This involves carrying out measurements for the operator inside the facilities and recording the contamination and radiation readings on schematic representations (mapping), notably to identify and flag the "orange" zones, where the dose rate exceeds 2 mGy/hr. "These periodic inspections are carried out monthly, based on a well-defined schedule, but don't constitute the bulk of our work, which is better represented by the shutdowns of the units for maintenance", continues Cédric Beauvieux.

### Ensuring compliance of the site environment

In the second area, the radiation protectors carry out monitoring and provide advice and help to teams carrying out servicing and maintenance work. As the interface between the client and these suppliers, the protectors must ensure that the site environment is compliant and that the lead radiation protection barriers and personal and group protection markers measuring contamination in real-time are installed and operational.

"At Salvarem, we provide the same type of service both for maintenance teams working during the unit shutdowns of the EDF power plants, and for the decontamination and decommissioning work carried out on behalf of the CEA or Areva", explains Ludovic Martin, director of Salvarem. In application of the 2003 decree on integrated radiation protection, our works consists in evaluating, protecting, monitoring and controlling. The work remains the same, in contexts and with radiation and contamination risks that may differ.

This is particularly the case with decommissioning, clean-up, maintenance and operation work on fuel reprocessing plants, where workers handle a very large range of radioactive elements and are exposed to an alpha contamination risk that doesn't exist in electricity production plants". ■

## Radioactivity and "effective dose" limits

**When a person is exposed to radiation from a radioactive source, the energy absorbed by the tissue it passes through can cause biological damage. This risk depends on the radiation characteristics and the sensitivity of the irradiated organs. Based on the "dose", the quantity of energy received, measured in gray (Gy), we therefore calculate an "effective dose", measured in Sievert (Sv), which enables us to evaluate the risk of damage to the body as a whole or to an organ.**

**In France, the annual effective dose limits for the whole body were fixed by the decree of 31 March 2003. For workers (excluding pregnant women), this is 20 mSv. The effective dose for the general public is limited to 1 mSv. By way of a comparison, the average individual effective dose due to natural radioactivity in France is 2.4 mSv per year.**

# UNITED KINGDOM SIX YEARS OF RECORD GROWTH

**Soon to celebrate 60 years of operation, Freyssinet Ltd. bases its growth on the technical expertise that benefits Freyssinet throughout the world and harnesses this expertise in its repair business and in niche markets.**

## FREYSSINET LTD

Freyssinet's history in the United Kingdom begins, more than fifty years ago, in March 1950, with the birth of PSC Equipment Ltd, which becomes PSC Freyssinet Ltd in 1979 and then Freyssinet Ltd in 1998. Today, this entity is made up of three companies: Freyssinet UK, Reinforced Earth Company Ltd (RECo) and Corrosion Control Services Ltd (CCSL), all three based in Telford, north west of Birmingham, where 170 people are employed including 30 managers and engineers and 45 marketing, administration and accounts employees.

Over the last six years, Freyssinet Ltd. has experienced record growth, doubling its sales through acquisitions and an organic growth "in line with the performance of the Group as a whole", points out Patrick Nagle, the managing director. Although 10 to 15% of the division's sales are realized outside the country, the key to its development lies in the strategy applied in the United Kingdom. "We focus on work with high added value and niche markets, where there is less pressure from competition", continues Patrick Nagle. In practice, Freyssinet Ltd can draw from the vast technical expertise of each of its companies in its core business: prestressing design and methods and structural repairs for Freyssinet UK; design of reinforced earth solutions and supply of materials for RECo; cathodic protection for CCSL. Most often, these entities work as subcontractors for contractors, but all three evidently aim to increase the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## Makers Freyssinet, total expertise in repairs

**In October 2007, Freyssinet Ltd acquired the north infrastructure division of Makers UK Ltd, one of the United Kingdom's largest structural repair specialists, which has been providing a wide range of expert solutions for more than 25 years: electrochemical treatment of structures by resin injection, hydrodemolition, shotcreting, carbon fiber reinforcement, for a portfolio of clients including general councils, water agencies, municipal councils and private clients. Named Makers Freyssinet, the company continues to operate from its Cumbernauld head office, near Glasgow, and its offices in Belfast, Perth and Dublin. Its 2008 order book points to very positive growth...**

**1.** From January 2006 to February 2008, Freyssinet installed the prestressing of three new LNG tanks on the Isle of Grain (south east England).

**2.** On the M6 motorway, Reinforced Earth designed 39 retaining structures and bridge abutments in reinforced earth, over a total area of 23,000 m².

**3.** The company was actively involved in repairs to the South Hook jetty (Wales) and dispatched teams specializing in cathodic protection and shotcreting.

**4.** The roof of the famous Millennium Stadium in Cardiff was completely cable-stayed by the Freyssinet teams.

share of work carried out directly for clients. Their services cover a wide spectrum: cable-stayed bridges and cabled structures, prestressing of liquefied natural gas (LNG) tanks, reinforced earth bridge walls and abutments, TechSpan arches etc., with an outstanding niche area, prestressed flooring, which now represents 30% of Freyssinet UK's sales.

### Niche areas

With development and infrastructure networks reaching maturity, the new work market has dropped off over the last decade. This is why Freyssinet UK chose to redeploy its offer and focus on structural repairs. "It was both difficult and time-consuming to establish a reputation due to the extremely competitive nature of the British repairs market", explains Paul Bottomley, managing director of Freyssinet UK, "but, notably through the acquisition in 2007 of Makers, a Scottish company specializing in this sector (see box on p. 32), we have been getting known and recognized over the last two years". RECo and CCSL have a presence on target markets. RECo's core business in the United Kingdom is the design and supply of materials for bridge abutments and retaining walls of road structures and the company stands out through ongoing efforts to expand its range of solutions. "To continue its development, the company is aiming to expand geographically, and is notably targeting northern European countries", points out Jonathan Cross, director of RECo. CCSL specializes in the design and on-site installation of cathodic protection systems, particularly for bridges and marine structures. CCSL, the only British company specializing in cathodic protection in the United Kingdom, is not resting on its laurels and is using the Freyssinet network to promote its expertise in numerous other countries.

### Noteworthy synergies

"We're always looking for opportunities for our entities and subsidiaries to work together", insists Patrick Nagle. This is the case for Freyssinet UK and Nuvia UK (formerly Nukem Ltd), specialist in the nuclear sector (see Dossier), whose volume of business is significant in the United Kingdom. The approach is the same with Advitam, which specializes in the inspection and monitoring of buildings and structures. Yet the opportunities for synergies are not lacking with other companies of the VINCI group and are being developed with British companies VINCI PLC, Ringway and Norwest Holst and with VINCI Construction Grands Projets and VINCI Energies. "Furthermore", points out Patrick Nagle, "the inclusion of the cathodic protection techniques developed by CCSL in the portfolio of Freyssinet solutions was a key element to the growth of our repairs business".

### A planned growth

"Freyssinet Ltd reflects the image of the Group: we share the same culture, the same philosophy and the same strategy", sums up Patrick Nagle, "substantial technical resources, honest employees sharing the same values and driven by the same desire to push back barriers and diversify our business through innovation and R&D". Similarly, we favor a local foothold and the growth of local markets, and our companies are managed by local people, in line with the Group principle "one person, one product, one territory". Finally, Freyssinet Ltd highlights its environmental commitment by focusing increasingly on sustainable technology in its business.

For the next three years, the accent will remain on structural repairs and gaining a foothold in local markets, that one or two sites in the south of England could strengthen. The flagship values, illustrating technical excellence, will remain cable-stayed bridges, prestressing of LNG tanks and nuclear containment vaults. In terms of business, the London Olympics are also generating interesting projects, such as the supply of retaining walls for RECo and various projects for Freyssinet in the construction of the Olympic village.

Finally, so as not to overlook the part played by people in the dynamic of integration and growth of recent years, a training program has been scheduled for all staff between now and 2010. ■

**KEY DATA**

- **2007 turnover:** 28 M€.
- **Workforce:** 170 employees.

**From left to right: Patrick Nagle, managing director of Freyssinet Ltd, Paul Bottomley, managing director of Freyssinet UK, Jonathan Cross, director of RECo, David Dudeney, managing director of CCSL.**

# THE FLAT JACK: A SOURCE OF POWER

**In Freyssinet's business, mechanics is an indispensable tool, but the power of the machines requires complete control. Combining these qualities, the flat jack is ideal for all kinds of applications.**

As is often the case with great inventions, flat jacks first emerged over the course of a project. In 1938, when the Beni-Bahdel dam in Algeria was under construction, the client decided to increase the capacity of the structure. To raise the dam by 7 m while retaining the structure, the system of arches and buttresses, Eugène Freyssinet was called upon to design a system to bear the loads on the abutments rendered "active" by an unprecedented system of extremely powerful jacks with a negligible thickness.

The jacks took the form of a collapsible casing made up of two steel half-sections and an annular edge, equipped with two flexible pipes, one of which allowed for the injection of pressurized liquid, which "opens" the jack. These same flat jacks are used to tension the tie-rods, each 1,000 t, providing the link between the existing part and the raised part of the dam. This was a major first, both for prestressing and for prestressed tie-rods in the ground. Since its invention, the flat jack has been used in many applications, "in particular for applying or transmitting a force and simultaneously controlling the corresponding deformation", explains Pierre Boitel, Freyssinet research & development director. ■

The Montreal Olympic velodrome.

## Stripping and straightening

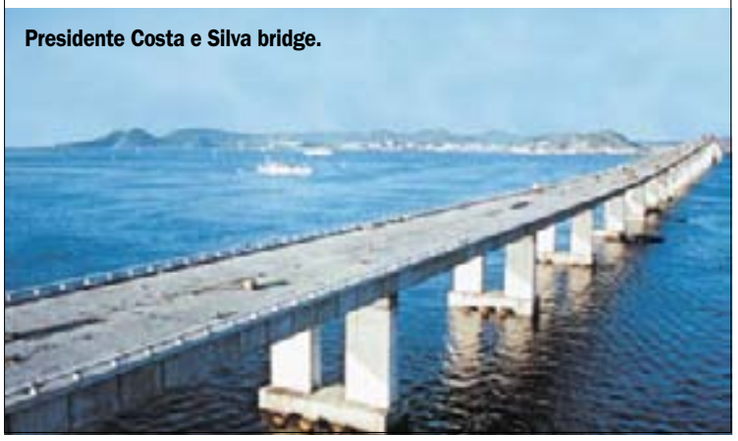
**1945** Very soon, Eugène Freyssinet uses flat jacks to strip structures. The method allows for the stability of the structure to be verified at the time of stripping and ensures the operation is completely safe as the formwork is still load-bearing. The method was notably used in the construction of various bridges over the Marne shortly after the Second World War.

**1975** A system of 226 flat jacks supported by the principal abutments and deploying a force of 22,000 t is used to strip the shell of the impressive Montreal Olympic velodrome. After the operation, the flat jacks were incorporated permanently into the structure in order to control delayed deformation.

## Measuring stresses and prestressing

**1974** In Brazil, on the Presidente Costa e Silva bridge which links the cities of Rio de Janeiro and Niterói crossing the Guanabara bay, flat jacks are used to measure the residual stresses in the structure. Coupled to a system of strain gauges, they are installed in concrete recesses and pressurized to restore the structural deformation before the recesses were created.

**2000** As part of the repair work following the fire in the Mont Blanc tunnel in 1999, a 2,900 m road section is prestressed using flat jacks.



Presidente Costa e Silva bridge.

## Reducing creep deformation

**1945** As a major specialist in concrete bridges, Eugène Freyssinet is notably responsible for building the Luzancy bridge (Seine-et-Marne). To reduce the effects of creep deformation, he installs flat jacks between the abutments and the deck.

**1962** With its 304 m span, the Gladesville bridge in Sydney (Australia), is one of the longest concrete arch bridges in the world. To prevent the arches from undergoing deformation following shrinkage and thermal expansion differences, Freyssinet equipped the structure with several groups of compensating flat jacks controlled by a sophisticated system of hydraulic circuits. Each group comprises 56 flat jacks, capable of exerting a pressure of 65 MN. Providing a 100 mm stroke, the jacks are arranged in stacks of four.

## Maintenance work

**1990** In parallel to the vast raft of work undertaken to build the fourth Brussels-Midi station (Belgium), destined to receive high-speed trains, 3,000 flat jacks are installed under the adjacent, principally brickwork, buildings to prevent any problems due to differential compressions.

## Transfer of loads

Works to the Louvre in 2003

**1975** When restoring York Cathedral (United Kingdom), Freyssinet uses braces and flat jacks to support a number of cracked walls and compensate for the possible compression of the foundations of these supports. "When we create new bearings, the load must be transferred slowly, in three or four months", indicates Pierre Boitel, "and flat jacks are perfect for this application".

**1987** Following the compaction of underwater soil, seven bridges on the Ekofisk oil platform, on the North sea, have to be raised by 6.50 m. The operation involves taking up the 70,000 t load of the structure. The operation is a success thanks to some one hundred high-pressure flat jacks inserted into special bearings. Its success makes this the event of the year.

**2003** In Paris, some one hundred flat jacks are installed in the temporary foundations of the Denon façade of the Louvre museum to underpin the pillars.

**2008** In Vélizy (France), Freyssinet installs a system of flat jacks to strengthen the floors of a branded shopping center and increase their bearing capacity from 500 to 1 000 kg/m².

## Lifting

**1964** One of the most spectacular applications and, without doubt, one of the most famous, is the use of flat jacks to move the Abou-Simbel temples in Egypt. The temples, located not far from the border with Sudan, risked being engulfed by the construction of the Assouan high dam. From 1958, an international press campaign alerts public opinion. The funds raised enable work to begin under the auspices of Unesco. Flat jacks are used to strip the structures and allow them to be transferred to an artificial cliff above the waterline.

**Today** Practical, small, light and adaptable, flat jacks are the perfect solution for replacing bearings, which requires the transfer rather than lifting of loads.

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