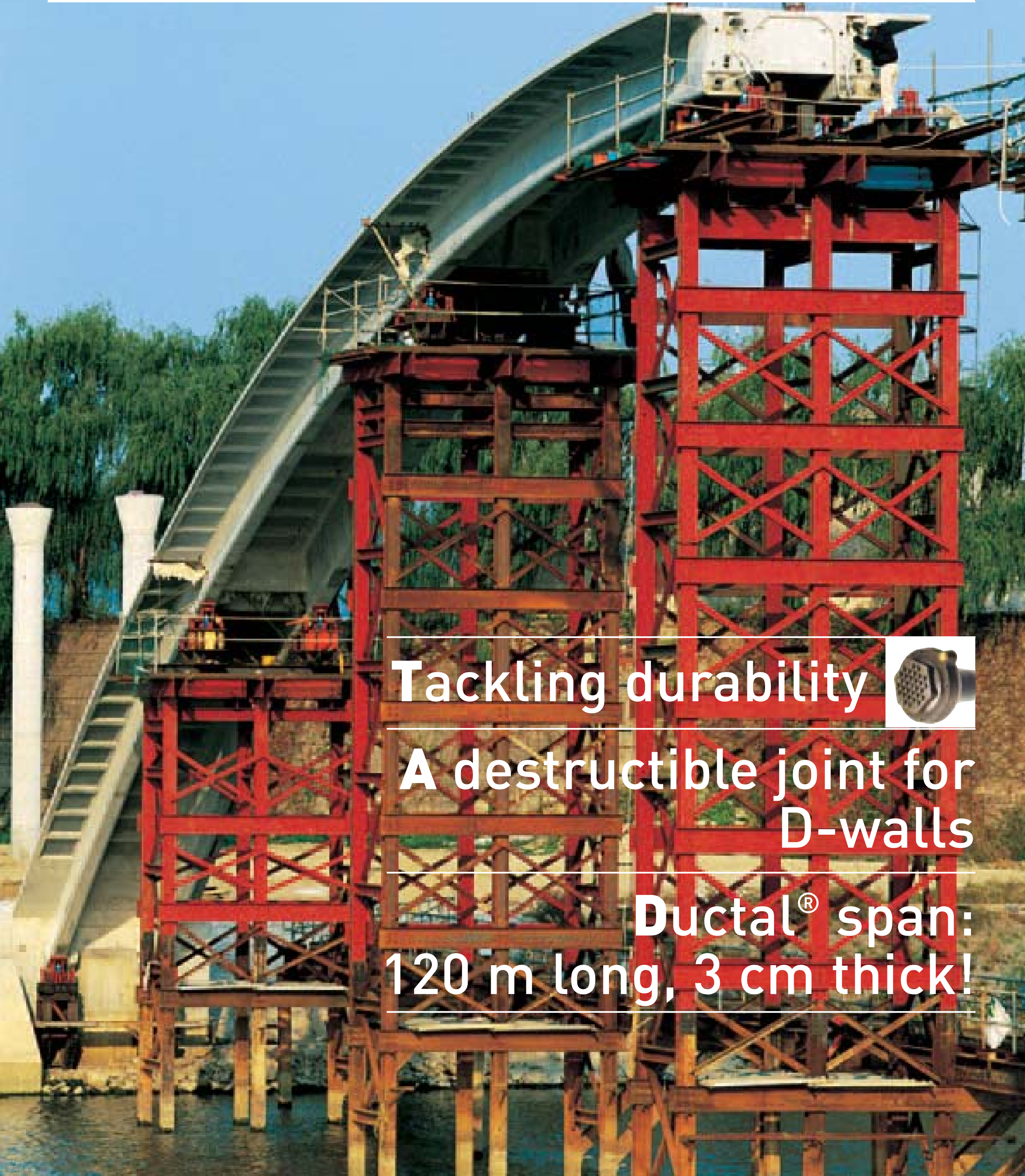
VSL NEWS intrafor

THE VSL-INTRAFOR MAGAZINE • ISSUE ONE - 2002



## Tackling durability

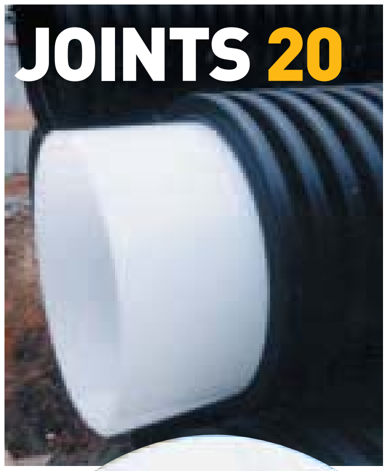
## A destructible joint for D-walls

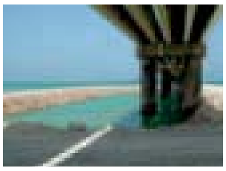
## Ductal® span: 120 m long, 3 cm thick!

# highlights









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*Cover photo: Medway crossing, UK*

# EDITORIAL

BY JEAN-PHILIPPE TRIN

## Quality makes the difference

One year after the VSL-Intrafor alliance began, we are expecting sales to grow more than 8% in 2002, compared with 2001. Our order book for foundations and projects using VSL techniques has risen to a record level, equivalent to over nine months of activity.

We are stepping up our development programmes, especially those focused on new products like Ductal® and new customer services. We are also pursuing our Total Quality Policy in the design and execution of projects, including during the essential phases of preparation, testing and inspection. This policy supports our commitment to superior service for our customers. And it is a way to show that we are different. All the teams in the VSL-Intrafor network share this conviction and are ready to work with and for their customers to create the best technical solutions.

Recently delivered projects and others in progress illustrate this commitment. The deep foundations for the high-speed rail line at Groenehart, in Holland; the large diaphragm walls for a Dublin expressway; the complex construction of post-tensioned viaducts on the West Rail project in Hong Kong and the M5-project foundations for the Sydney Airport are typical of our capacity to innovate and to achieve our prime objective of superior quality.

## Ireland
# A spectacular start



→ **This urban highway,** built as a joint venture with Mowlem (U.K.) for the Dublin Port Authority, is connecting the port area to the airport. Intrafor's portion of the overall civil engineering works amounts to more than 120 million euros. In this included are 13 million earmarked for the project's diaphragm walls and piles with completion scheduled for July 2002. The construction of 60,000 m$^2$ of diaphragm walls (with thicknesses of up to 1.5 m and depths reaching 35 metres) and 200 piles to serve as lighter supporting structures. The project requires a total staff of 60, with 10 expatriate personnel and the use of 4 wall assembly workshops. The foundation work for this exceptionally large project lies on the critical path, especially as regards the 55-m diameter, 35-m deep shaft for the tunnelling machine. Moreover, the soils on site prove to be either very hard (anchorage of the walls down to the limestone) or very loose (backfill produced from waste), which asks for very detailed investigations and adaptation of the equipment. This initial and sizeable contract for Intrafor in Ireland also constitutes a valuable reference for the U.K. market; similar joint ventures are expected. ■ ***Contact: daniel.clert@fr.vsl-intrafor.com***

## Vibroflotation in Hong Kong
# Openings for Intrafor

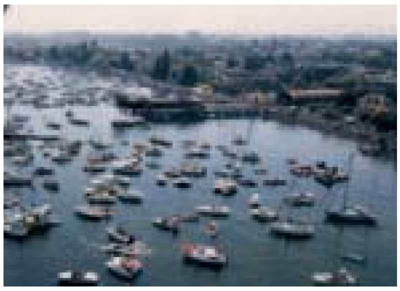
→ **Intrafor Hong Kong is successfully broadening** and diversifying its scope of works for ground improvement projects. In 2001, its biggest ever contract was secured for ground improvement using the vibroflotation method, worth a total of HKD 120 million. This project is part of the reclamation of Penny's Bay, site of Hong Kong's upcoming Disneyland theme park. Intrafor participates in improving the 32 million cubic metres of sand placed by the main contractor HAM/HK Construction JV. In early November 2001, a second contract was signed, this time with China State as the main contractor, to improve an additional 2.6 million cubic metres. ■ ***Contact: c.yue@hk.vsl-intrafor.com***

## VSoL in Vietnam
# Walls on the rise

→ **After earning an initial reference** last year on the Met Bridge Project, the VSoL system is gaining momentum in Vietnam, with more than 9,000 m$^2$ of orders placed during 2001. VSoL was selected for the Phomoi Bridge Project located in the northern province of Lao Cai, a top priority for the nation's Ministry of Transport & Communications (MOTC) in 2001. With a maximum height of 11 m and a total wall area of 5,200 m$^2$, it is the highest MSE wall built to date in Vietnam and has been highly appreciated by MOTC.
■ ***Contact: lpe.vslvn@fpt.vn***

## Heavy lifting

# New record: 45,000 spectators!



**There were this many people on hand to watch the VSL crew** during the launch of this 17th-century galley, 55 m in length and weighing 140 tonnes. It was built over the past 6 years within the scope of an innovative training project for the unemployed. The launching operation combined Friderici SA, Special Transports and VSL Heavy Lifting. The event was broadcast live by Swiss Television. VSL used four of its SMU-70 strand jacking units. ■
*Contact: rruprecht@vsl-schweiz.ch*



## Displacement joints

# VSL well-positioned in Chile

**Since the first displacement joint was introduced** in June 1998, more than 3.5 km of various sizes and types of Cetec joints (distributed by CTT Stronghold) have been installed in Chile. This strong level of growth has resulted from VSL's focused efforts on the Chilean market, where before only one major supplier had been present. To further develop this market, a special displacement joint has been created in order to accommodate seismically-induced transversal movements in addition to longitudinal movements. Such joints have already been installed in the field, as competition for the standard steel dentate-shaped joint, thereby generating considerable time and material savings for the contractor. VSL in Chile supplies the material and provides full installation services.
■ *Contact: aavend@vslchile.cl*

## Monitoring

# Targeting packages

**Monitoring is hailed as a promising activity** for Group development. Jean-Baptiste Domage has been named Monitoring Development Manager for the group. Beginning January 2nd, 2002, he has set out to improve the technologies employed throughout the network and to prepare "package solutions" for use by VSL-Intrafor's operating units. ■ *Contact: jbdomage@vsl-schweiz.ch*

## Tackling durability

# Optimism from optimisati

Hans Rudolf Ganz

**Owner, designer, main contractor and sub-contractor share the same concern: ensuring durability of their structures. Problems like disintegration of concrete and corrosion of steels may shorten the service life of concrete structures. VSL's dedication to constant improvements for higher quality has led to better performing anchorages, optimised grouting and effective inspection and monitoring systems. Hans-Rudolf Ganz, Technical/R&D director, comments on VSL's approach.**



**What is new with the newest VSL post-tensioning system, the Composite System CS 2000?**
We have made the components lighter. A traditional anchorage is a cylindrical steel block. We have streamlined its shape, cutting away up to 50% of the material in certain cases. The lighter weight is a plus for the people installing these anchorages. We have also made the anchorage more compact to deal with the problem of the space that the anchorage and local reinforcement take up in structures. The design engineer does not have to provide as much space for this anchorage, and the detailed plans of the structure are simpler.
The CS 2000 is one-third the length of a traditional anchorage!

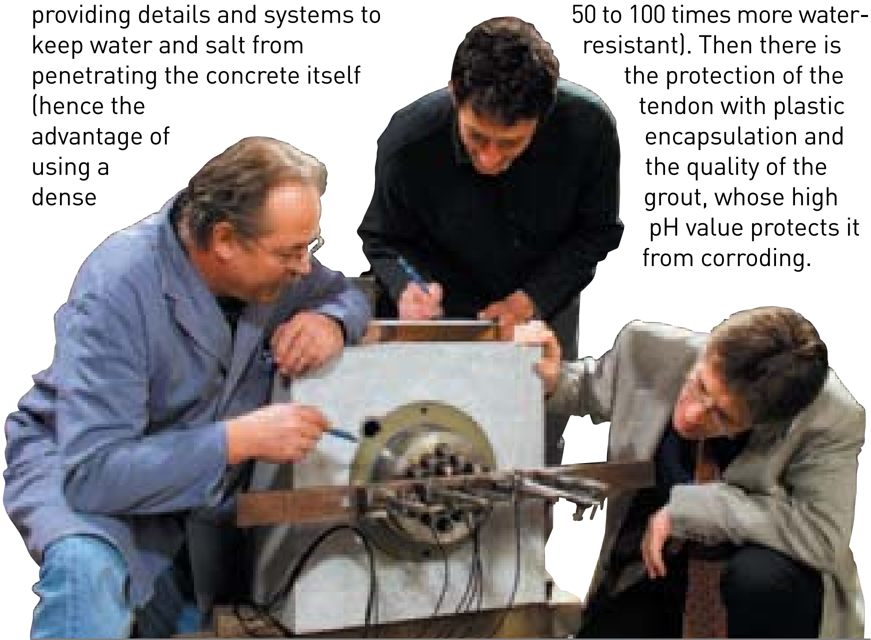
**What are the benefits for the client?**
The main one is in the corrosion protection and durability of the system. The encapsulation of the tendon in plastics keeps water and de-icing salts from getting to the cable. Then there is the system's performance! It exceeds the usual fatigue requirements set in today's standards. It is very resistant to large load variations – for example, on railway lines. The CS 2000 eliminates steel-to-steel contact between the strand and the anchorage. In addition, the anchorage is a combination of steel and high-performance mortar, allowing a more gradual transfer of the force into the structure.

**Hadn't you already created this watertight envelope?**
We had already introduced robust and leaktight plastic ducts PT-PLUS® for bonded post tensioning. The plastic duct enhances tendon durability because

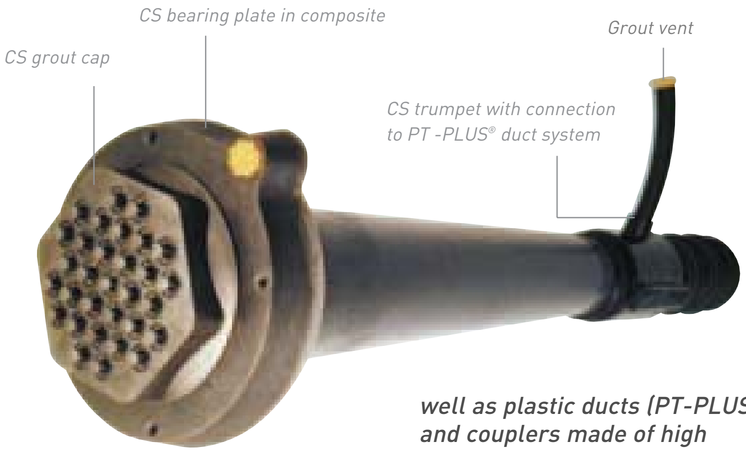
on

it provides a complete encapsulation of the tendon with a durable material which does not corrode like the traditional metal ducts. We were the first to propose such a watertight envelope. Today, this plastic duct is combined with the CS 2000 to provide a complete system. Its connections do away with the rather crude solution of using adhesive tape as the final bit of waterproofing. The duct can be cut and the anchorage placed anywhere one wants: the connection is always perfect. So here is the first system on the market where everything fits together. It is an all-in-one kit with standard connections that eliminates any need for on-site improvisation.

**But the structure itself can deteriorate before tendon durability becomes critical?**
That's why designers need to specify several layers of protection for the structure. These include providing details and systems to keep water and salt from penetrating the concrete itself (hence the advantage of using a dense concrete like Ductal®, which is 50 to 100 times more water-resistant). Then there is the protection of the tendon with plastic encapsulation and the quality of the grout, whose high pH value protects it from corroding.


Hans Tschaggelart, technician for all system tests, Adrian Gnaegi, VSL Systems manager and H.R. Ganz, studying the new CS 2000 system.

## Complete encapsulation for tendons




*The Composite System 2000 (CS 2000) concept was introduced in 1999. The continuous improvement of CS 2000 makes it the best state-of-the-art bonded post-tensioning system, either external or internal, in terms of durability. The system features complete encapsulation for the tendons as well as plastic ducts (PT-PLUS®) and couplers made of high corrosion resistant materials. With plastic ducts, the fatigue strength of tendons is considerably increased. At the anchorage level, damaging steel-to-steel contacts, other than the wedge gripping on the strand, are eliminated. In addition to greater durability, the CS 2000 offers a strand-duct friction coefficient that is about 30% lower than the usual one with metal ducts.*

**Is there any way to check the quality of the tendon protection?**
Yes, the electrical testing of the tendons (EIT) has been confirmed in practice to make sure they are well insulated and thus completely sealed. This EIT testing for multi-strand tendons was brought to the market by VSL, and it has proven itself over the last few years.

**You have just spent two years doing research to improve your grout for post-tensioning tendons. How have you made it better?**
A lot of people look at grouting simply as a matter of mixing cement and water and pumping it into a duct. However, many clients and engineers have begun to realise how complex the grouting of a post-tensioning tendon is. The big problem with the grouts used by the profession in the past was that they ▶

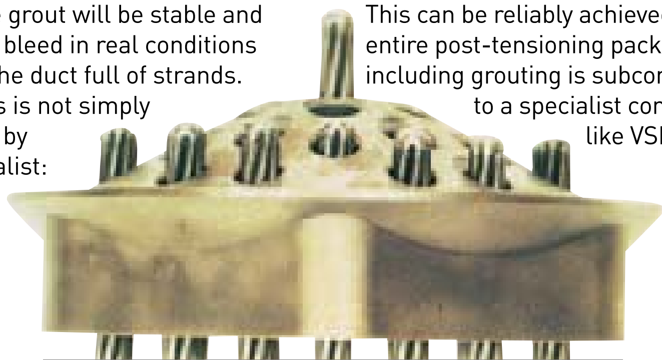
*Extralong CS trumpets on Medway bridge deck*



contained too much water and therefore were not sufficiently stable. However, tests used in the past were not able to identify such unstable grout. Voids could form. Our experience with high-performance concretes enabled us to create grouts using very little water: only about 30% of the cement weight, or just a little more than needed to make it set. Traditionally, 50% more water was added to make the mixture fluid. We have also developed a plasticizer that works well with the different cements in use around the world. There are enormous differences between cements, and some types are incompatible with some admixtures. We have also defined the procedures for optimising the amount of admixture for a given cement.

**In short, a scientific approach to draw up standard marriage contracts between cements and additives... And what are you offering as the dowry?**

The assurance for the client that the two constituents -cement and admixture- will be compatible and that the grout will be stable and will not bleed in real conditions inside the duct full of strands. And this is not simply a claim by a specialist: our procedures demonstrate the superior performance. We are determined to offer a reliable technology and to be the quality benchmark. This approach assumes, of course, that the right materials are used and that there are specially trained people. This can be reliably achieved if the entire post-tensioning package including grouting is subcontracted to a specialist company like VSL.



*Streamlined shaped anchorages*

### How is this technique communicated inside VSL?

We are running technical training centres on grouting with our specialists, some with 20 years or more of experience in the group. They teach labour on site and the new specialists.

### What is your annual research budget?

Two million euros a year, or 1% of sales. That's more than the usual outlay for research in the building and civil works sector.

### What's new in the field of cable stays?

The SSI 2000 cable stay system developed over the last few years is a big step forward in providing a more compact anchorage. We have improved the deviator, which protects the anchorage from flexural effects induced by cable vibrations. This deviator can be replaced with a proprietary anti-vibration damper, if needed. And unlike our competitors, we have opted for individual encapsulation of each strand in the anchorage. This limits damage if any one of them is compromised or damaged, i.e. we offer improved redundancy of the protection system. We have also developed an automatic cable-stressing system that is unique in the profession. It ensures that the exact specified force, neither more nor less, is uniformly applied to each strand. And it provides a complete stressing record upon completion of the stressing operations.

### And what are you planning to develop with Intrafor?

An offering of packages that will supply technical solutions to improve the foundation/ superstructure interface in projects – for example, for underground car parks, combining Intrafor foundations with VSL post-tensioned floors and rafts that will generate savings for us and the client.

### What are you going to be working on in the future?

Monitoring of structures, repair and strengthening of structures, applications of post-tensioned ultra-high strength concrete...

## Medway Crossing in the UK: 1st contract for the CS2000 system

*Medway Crossing, in the UK, is the first known use of purely external PT with balanced-cantilever construction. It is also the first contract for the CS2000 system (640 anchorages), and the first time VSL's optimised grout will be used in the UK. The client had specified greased and sheathed strands. However, a combination of the CS 2000 system with bare strands and VSL optimised grout ultimately satisfied its requirements.*

*The scheme involves widening 17 km of the A2/M2 in Kent. The work consists in constructing a new motorway bridge over the River Medway between the existing M2 and the new Channel Tunnel rail link bridge. The design and construct contract was awarded in November 1999 to a joint venture of Costain Civil Engineering Ltd, Skanska Civil Engineering International and John Mowlem & Company Ltd (CSM).VSL are the specialist subcontractor for the PT works. The VSL scope of work from February 2001 to April 2002 is for the supply and installation of all post-tensioning materials, including grout, for the new multi-span, balanced-cantilever bridge (953 m long) with approach spans using only external 6-19 strands.*
*VSL was established in the UK in January 2000. Since then, several large projects, including the Medway Crossing and the cable-stayed Taney Bridge in Dublin, have been awarded to this young Profit Centre.*

*640 units of CS 2000 anchorages to be installed*

# Post-tensioned technique

**VSL's construction systems/methods and related engineering, with post-tensioning as a core business, have earned a well-deserved reputation for their quality and reliability for almost half a century.**

## POST-TENSIONING (PT)

To artificially create compression forces in order to reinforce a structure during its construction and/or service life: tendons with anchorages are incorporated in the structure and stressed with jacks. PT rather than reinforced concrete allows better use of materials and longer spans, though it does require more complex calculations, more resistant materials and careful execution of the work. Stay cables are a technology derived from concrete post-tensioning: stay cables must support the bridge deck as well as withstand fatigue load while the structure is in use. VSL is a leader in both technologies.

**Anchorages.** They transfer the prestressing force to the concrete. VSL's anchorages are based on the very reliable self-locking wedge system. The CS2000 anchorage has a composite bearing plate (metal and high-performance concrete) which makes it lighter and more durable.

**Grout.** An optimized mix of cement, water and admixtures that is injected into the ducts to provide corrosion protection and bond between the prestressing steel and concrete members. Grouting is critical to a structure's durability. VSL works continually to improve it and has developed the high performance VSL-HPI Grout™.

**Ducts.** They provide protection for the strands. VSL developed the PT-PLUS™ system of plastic ducts and couplers with the possibility of having electrically isolated tendons (EIT).

## PT IN BUILDINGS

**Transfer plate.** PT very effectively reduces the reinforcement for passive bending and shear as well as the volume of concrete. Can be constructed in several layers.

**Slab post-tensioning.** The advantages are the smallest possible floor-to-floor height, the largest possible column-free space, and quickest possible floor cycle.

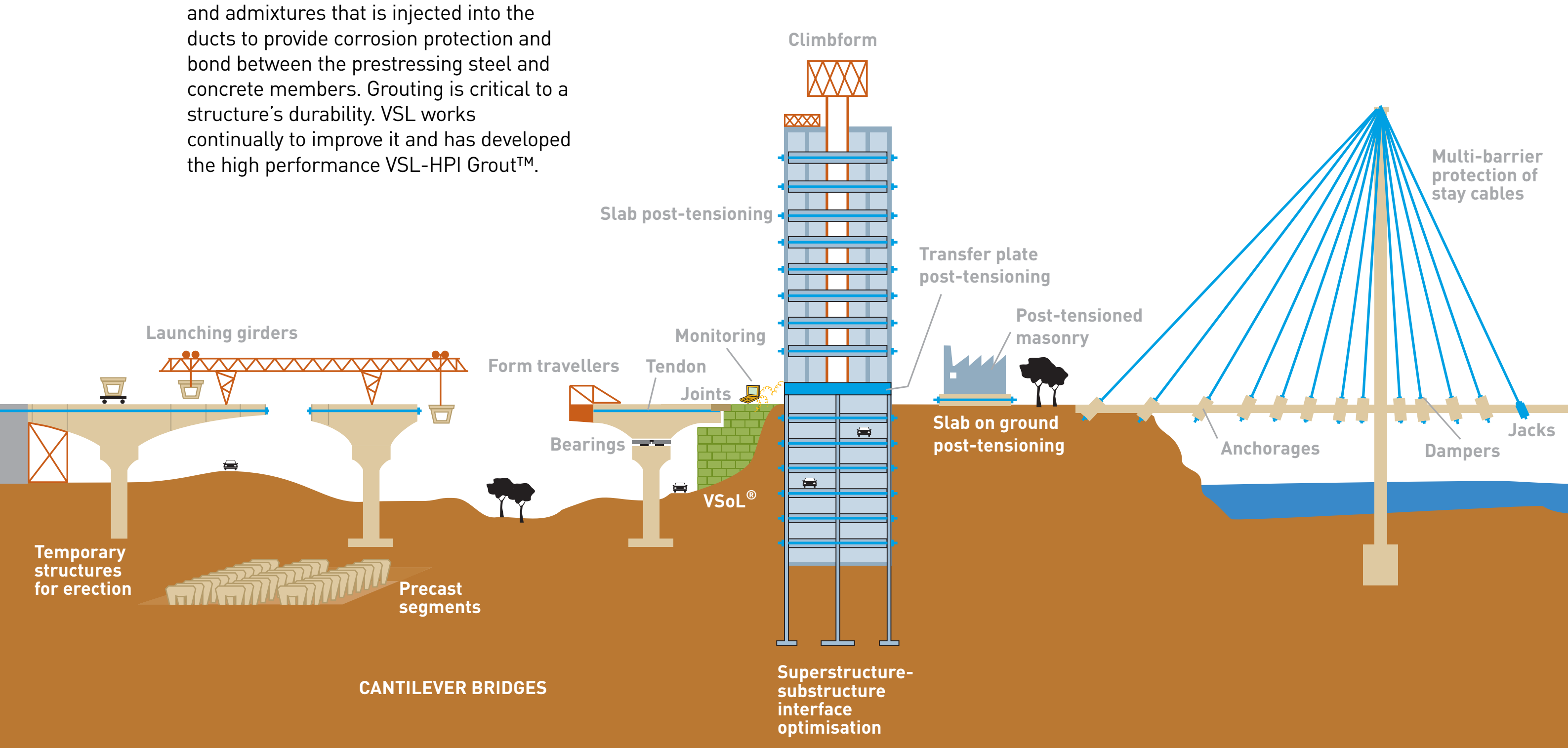
**Slab-on-ground.** Used for warehouses, container terminals, recreational slabs, etc. PT reduces the need for joints, which cuts future maintenance costs. Provides a thinner, crack-free slab.

**Post-tensioned masonry.** PT allows higher walls with greater stability and the possibility of strengthening existing structures, e.g. in seismic areas.

## PT IN BRIDGES

**Segmental bridges.** To brake down the deck of a bridge into segments of similar size and geometry to enable mechanized construction. External post-tensioning suits this method well, as it reduces construction time and allows easy inspection of tendons. VSL executes segment production and erection for precast solutions, as well as cast in place deck construction, providing optimization of the permanent work design and engineering and supply of all the temporary equipment and installations. The Bar and Slab PT systems allow vertical web and transverse deck stressing.

**Incrementally launched bridges.** This method is well suited for bridges over congested areas and waterways. The need for centrical prestressing during construction can be achieved with a combination of permanent and temporary PT. VSL provides all the temporary equipment for casting and launching.



# s and services in the field

**Cable stayed bridges.** In this particularly aesthetic type of bridge, stressed strands support the deck. VSL's SSI 2000 system provides full individual encapsulation for each strand from wedge to wedge, and strands are stressed individually with a fully automated system. Full prefabrication avoids site assembly on the critical path. The very compact anchorages permit easy installation, even in confined spaces. Friction dampers are usually placed at deck level to prevent stay vibrations, on both new and existing bridges.

## PT IN SPECIAL STRUCTURES

**Tanks, water towers, silos, and shells.** PT applications include circumferential and vertical post-tensioning of walls as well as suspension of tank shells. VSL's development of the "Flower Anchorage" allows reducing the concrete dimensions.

## MONITORING AND REPAIR

**Monitoring.** Periodic inspection, detailed investigation, material testing, permanent monitoring installation for post-tensioned structures, stay cables, and soil assessment.

**Structural repairs.** After damage analysis and determination of procedures, remedial works such as crack injection, jacketing repairs, replacement works, repairs to fire-damaged structures and waterproofing, shotcreting and pressure grouting, internal and external PT, glued and/or bolted steel and FRP plates, anti-carbonation treatment and concrete surface repairs.

## GEOTECHNICS

**Ground anchors.** They stabilise the ground or anchor a structure to the ground. They can be both strand and bar anchors. VSL has developed an electrical resistance measurement system to check anchor integrity.

**Micropiles.** for alternating tensile and compressive loadings.

**VSoL® retained earth.** Reinforcement of backfill using welded wire mesh or polymeric strips combined with lightweight precast concrete facing panels.

## PACKAGES

A combination of services that includes feasibility studies, construction engineering, equipment supply and operation.

**Climbform.** VSL's self-climbing, modular system for construction of vertical walls. It gives complete flexibility in structural design of the walls and selection of finishes.

**Special formwork systems.** Large table forms for fast track construction. Mivan, an easy to assemble modular aluminium formwork for efficient assembly by hand.

**Erection and launching equipment.** Gantries and frames for all lifting, lowering and placing applications.

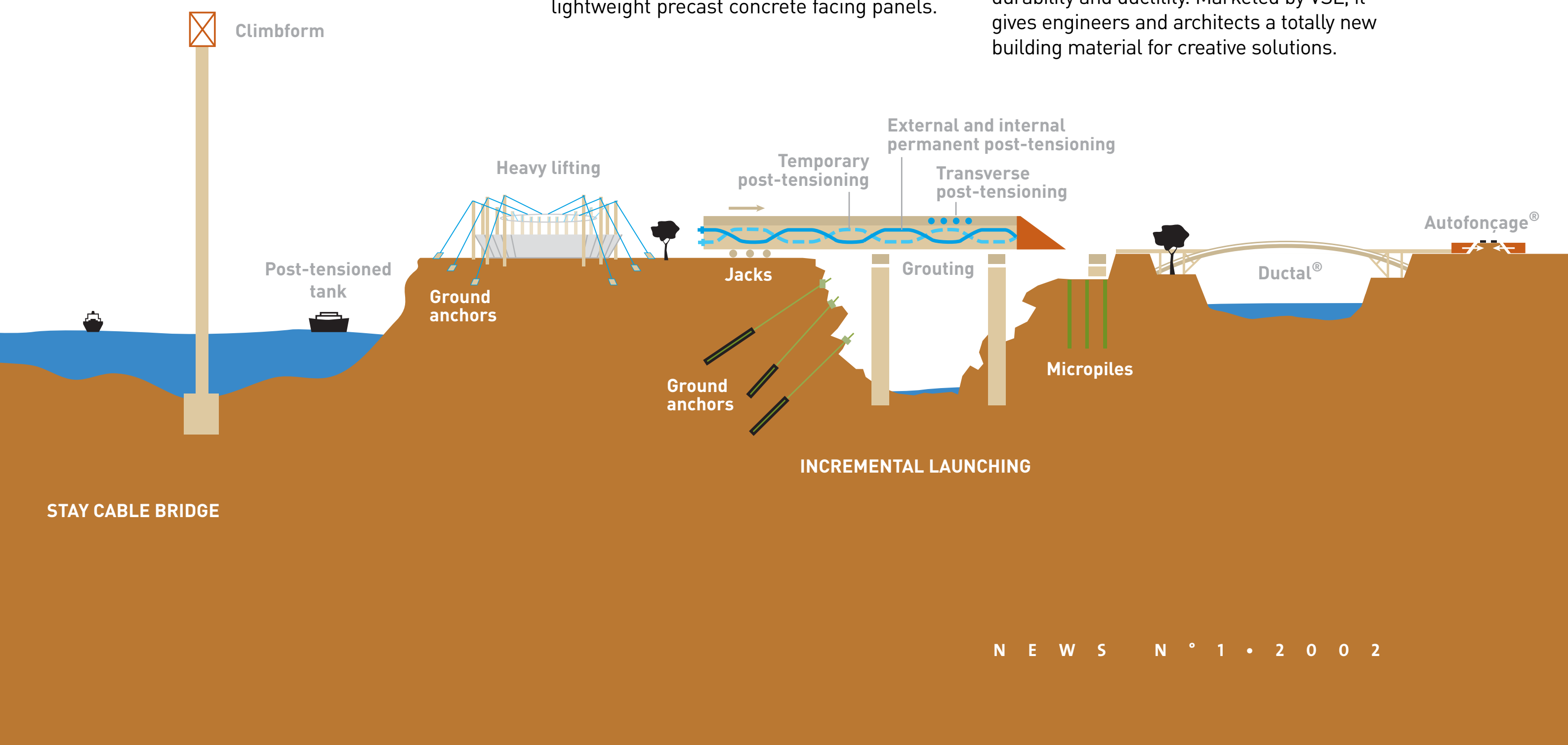
**Bearings and Joints.** Manufactured to any customized requirements. Services include design, testing, supply and installation.

**Heavy lifting.** The most effective tailor-made solution, with VSL's strand lifting system at the core, for projects where cranes cannot be used.

**Autofonçage®.** Pulling a precast concrete underpass through a railway or road-embankment with a minimum interruption of the traffic flow.

**Ductal®.** A new ultra high performance concrete with a unique combination of superior properties such as high strength, durability and ductility. Marketed by VSL, it gives engineers and architects a totally new building material for creative solutions.





**Hong Kong**

# Completion of the West-Rail contracts



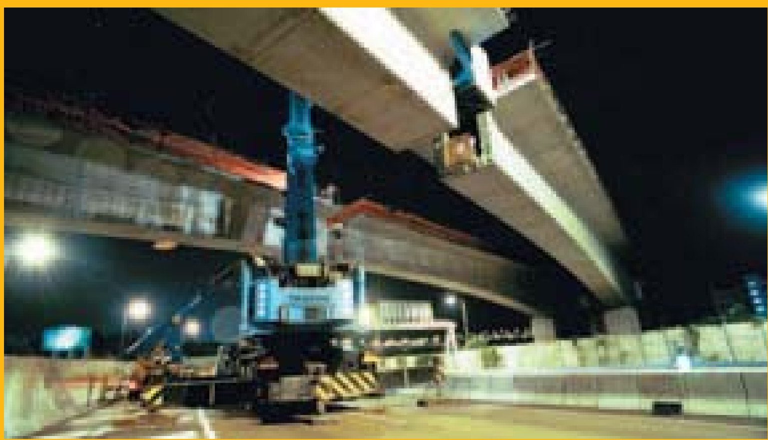
→ **The final segments have been erected** for the CC201, CC211 and CC213 contracts on Hong Kong's West-Rail Rail Link. This line represents an entirely new piece of infrastructure and extends about 30 km westward into the New Territories, from Kowloon to Tun Mun. Beginning with a series of tunnels, the line then continues onto a 12-km dual viaduct that encompasses three separate contracts. In August of 1999, VSL Hong Kong was successful in winning the erection works for both the CC201 and CC211 contracts with Maeda-Chun Wo Joint Venture, a previous client from the Hung Hom Bypass project.

Subsequent negotiations enabled VSL to secure the remaining West-Rail erection works on the CC213 contract with HK ACE Joint Venture. The permanent project structures within VSL's scope of works have called for the erection of 658 pre-cast segmental box girder bridge spans consisting of some 9,400 segments and 3,500 tonnes of internal post-tensioning, along with the supply of all bearings and movement joints. The total value of VSL work on this project amounts to € 44 million. With a peak staff requirement of over 60 and a construction workforce of 200 people, the West-Rail Link owes its success to VSL's experience drawn from similar projects throughout the region. Segmental erection projects, such as the Second Crossing and KL-Ampang (Malaysia), NS4, NS7 and BTS (Thailand), Pakse Bridge (Laos), C310 (Taiwan) and Hung Hom (Hong Kong), have served to generate a highly experienced and skilled staff. In conjunction with the existing VSL Hong Kong team, members of the methods staff from TPMP, Technical Center designers and a handful of others from within the VSL Group, a solid and talented project organisation could be assembled.

■ *Contact: sgrogan@vsl-hk.com*

# 13 erection fronts at a time!

*VSL's approach on erection centred around three concepts, all designed, developed and executed by VSL.*



*For the bulk of the work under-slung "Type II" **launching girders** have been planned as the 1st method. These girders feature a pair of 85-m long plate girders supporting the spans under the segment wings. Each launching girder weighs some 250 tonnes including brackets and 8 sets were used. Segments were moved along the top chords by means of chain-driven trolleys equipped with both vertical and horizontal alignment jacks. Launching of the girders was performed by a second, heavy-duty chain drive attached to the girder's bottom chord.*

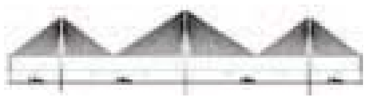
*The 2nd and 3rd methods consisted of **heavy-duty shoring and scaffolding systems** for multiple parallel spans and **crane erection** for the longer balanced cantilever spans over waterways and highways. These spans have accounted for 20% of the overall works.*

*Once the first girder had been commissioned in late May 2000, work proceeded simultaneously on up to 13 fronts. The many difficult road and river crossings entailed numerous late night and 24-hour shifts with road detours requiring crews to man intersections as far as 5 km from the work front. In some instances, a 5-hour road shutdown meant 3 hours for diverting all road traffic and 2 hours for erecting the segments.*

*At peak production, 16 spans (or 550 m of bridge deck) were being erected each week. Though for the Type II girders, a 3.5-day average turnaround was originally planned, many of them were completed within only 2 days. The girders will be reused on the upcoming East-Rail Project.*

## NOTE PAD

***Crossing the Yangtze.*** *When completed, the Yiling-Yangtze River Cable-Stayed Bridge in central Yichang (Hubei province) will add another reference for VSL's cable-stayed bridge projects in China.The bridge will span 988 metres. VSL's scope of works includes supply of the SSI 2000 stay cable system, erection equipment, stay cable engineering, site management and site supervision.*



***Hi-tech slab.*** *For the Hi-Tech City in Hyderabad (Andra Pradesh), VSL India performed the counter-check on the post-tensioned slab design. The flat plate measures 64,000 m$^2$, with a thickness of 300 mm. VSL supplied all post-tensioned materials, grouting equipment and technical assistance.*

***Foundations for youth.*** *For the design and construction of foundations and pile caps on the extension of a youth centre in Wong Tai Sin, Intrafor Hong Kong proposed its PIP piling system, a method, similar to the continuous flight auger which is suitable for low-rise buildings and is the only authorized friction pile-driving method in Hong Kong.*

***An aesthetically pleasing wall.*** *Originally designed as a multi-span elevated structure, the 16.5-m high VSoL wall (1,700-m$^2$) of Cyber Port Southern Access Road project in Hong Kong was an alternative proposed to Leighton Contractors (Asia) Ltd and was selected for its considerable scheduling simplification and cost savings while providing an aesthetically pleasing and streamlined solution. An arch cast in situ has served to overcome the soft ground constraint and adds an interesting architectural feature.*

## Dubai

# Major PT contracts for Bur Juman Project

→ **Structural works for the Bur Juman Centre Expansion Project**, the largest ongoing building site in Dubai, were awarded to Skanska Cementation International Ltd. in early 2001 on the basis of an alternative post-tensioning scheme developed for Skanska by VSL-Middle East. These works include: 4 levels of underground car park (85,000 m² of post-tensioning), 5 levels of retail/podium space including a cinema complex (58,000 m² of post-tensioning) and a 24-storey office tower. Two separate contracts (car park and retail space) were put out for tender and awarded to VSL-Middle East in February 2001 and May 2001, respectively. VSL's scope of works encompasses design and installation of all post-tensioning. Project completion is slated for April 2002; by then, over 1,300 tonnes of post-tensioning will have been installed. ■ ***Contact: cpetrel@vsl-schweiz.ch***



## China

# First application of the SSI 2000 system

→ **In Chongqing, one of China's oldest cities**, VSL China has successfully completed a cable-stayed bridge (the Masangxi Bridge) over the rather turbulent Yangtze River. By introducing the "VSL Stay Cable System SSI 2000", Masangxi has become the first bridge project to implement this new system. The client awarded VSL the entire scope of works throughout the stay cable contract, and the SSI 2000 system has allowed saving both on materials and on valuable installation time in comparison with the pre-formed parallel wire system. In particular, the dead-end and live-end SSI 2000 anchorage assembly is more compact and proves much simpler to install. Moreover, the deviator has been designed to directly clamp onto the strand bundle at the anchorage zone, thereby enabling a more efficient transfer of the cable lateral force onto the guide pipe and deck structure. The bridge is 718 m long, consisting of 2 x 179 m side spans and 360 m main span. One interesting design feature is stay pair No. Zero: this cable pair was the last one constructed directly underneath the two pylons and served to lift the bridge deck into a floating mode while the mid-span was being closed towards the end of October 2001. ■ ***Contact: t-t.tran@hk.vsl-intrafor.com***

## Australia

# Cooks River Tunnel completed in Sydney

→ **VSL-IP (Intrafor) has finished the foundations** of the 550 m-long tunnel under the Cooks River near the Sydney International Airport, as part of the M5 East Highway, the latest link in Sydney's ringroad network. The works comprised construction of the tunnel side walls, 354 m long on each side, using the diaphragm-walling method, as well as bored piles built down the centre line of the tunnel. Building work was performed at ground level through the use of three separate cofferdams placed in the river itself, thereby allowing construction to proceed under dry conditions. The highway was opened to traffic in December 2001. ■ *Contact: bcavill@vslsyd.aust.com*

## Australia

# Climbform "Lite"

→ **Meriton Apartments,** Sydney's largest developer of apartment buildings, awarded VSL a series of design and construction contracts for three projects: 80,000 m$^2$ of PT suspended slabs. VSL also won the bid for the design, supply and erection supervision of 2 climbforms. A "Deckform" and climbform "Lite" have proved to be the most suitable VSL system for the small lift and stair shaft so typical of residential high-rises. ■ *Contact: amccotter@vslsyd.aust.com*

## Hong Kong

# 590 control points

→ **Foundation Techniques Ltd.**, a member of the VSL-Intrafor network, has been supplying geotechnical monitoring instrumentation for the KCRC East-Rail Extension Project (TCC200/300). In all, 293 deformation monitoring points and 297 utility monitoring points are needed. Tilt-plate and vertical inclinometers have been installed on existing structures or temporary works. Surface-mounted crack gauges have been changes in crack width underneath the construction site. Standpipe piezometers and observation wells serve to monitor the fluctuation of water levels. Measurement frequency varies between twice a day for the standpipe piezometers to three times a week for crack gauges. ■ *Contact: c.yue@hk.vsl-intrafor.com*


## Chile
# A VSoL environmentally sensitive solution

→ **As part of a major Chilean road development programme,** 28,000 m$^2$ of VSoL walls were used in the project to upgrade the trunk road connecting Santiago with Valparaiso and the port city of Vina del Mar. The original road alignment crossed a historical park. In order to minimize the amount of land lost in this environmentally-sensitive area, VSL worked with the main contractor (ACS-Sacyr S.A.) to develop and implement a VSoL solution for channelling of the river and compressing the construction schedule. At the same time, it proved to be the most viable for the available foundation soils given the seismic and hydraulic loadings onto the structure.

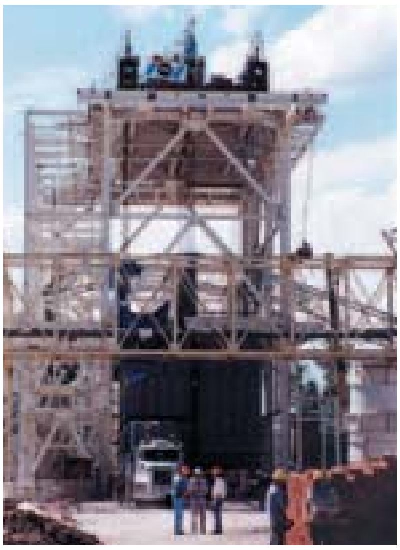
***Contact: vcabello@vslchile.cl***

## USA
# PT on Broadway Bridge

→ **The Broadway Bridge,** which spans the Intracoastal Waterway, serves as the primary access route into Daytona Beach, Florida. The main superstructure comprises 13 spans (approx. 820 m in total length). The longitudinal post-tensioning systems applied on the project are VSL CS5-12, CS5-19 and CS5-31. Each anchoring tendon features a 0.5"-diameter strand. The transverse systems within the bridge deck consist of VSL's SA6-4 Anchorage and VSL "PT Plus™" duct.

***Contact: jcrigler@structural.net***

## Argentina
# Boiler lifting



→ **In San Miguel de Tucumán,** for a power station involved setting up two new boilers. Sade-Skanska awarded VSL-Argentina the contract for lifting these boilers (850 tonnes each), at an elevation of 18 metres, with a maximum allowable tolerance of 10 mm at any one time.

***Contact: vslargen@correo.com.ar***

## USA
# Clearance to vessels

**→ VSL holds an $ 8.5-million subcontract** for the I-895 connector road, part of the final segment of Richmond's beltway (Virginia), which has required some unique design elements since the vertical clearance for cargo vessels must exceed 44 metres. VSL supplied six 3-horse form traveller headings to the project, as well as post-tensioning components and installation. ■ ***Contact: jcrigler@structural.net***

## Czech Republic
# First VSoL

**→ For the Kralupy-Vranany section of the Czech Railways track,** the VSoL retained earth system was chosen over the traditional concrete gravity wall and other alternative gabion wall designs. Polymeric frictional ties using coated steel loops provide for electrically-insulated connections. Total surface area: 2,000 m$^2$.
■ ***Contact: psmisek@vsl.cz***

## Spain
# Fishing out a viaduct


**→ As part of the new highway project** between Granada and the coast, the Lanjarón viaduct has given rise to a critical engineering challenge. A 90-m deep valley had to be spanned without any intermediate pier in order to preserve the vestiges of an 11th-century bridge. The structure chosen was a bowstring formed by two parallel trusses with a single 114-m span and a weight of 504 tonnes. CTT Stronghold (VSL Spain), backed by the heavy lifting expertise of VSL Switzerland, was awarded the contract for the launching works.
The structure was first loaded with a counterweight and then moved with the help of two VSL SLU-70 units. From this advanced position, the cables could be installed from the bridge extremity to the towers while the concrete structures were installed at the other side of the valley. As with a fishing line, one extremity of the bridge was hoisted from the opposite abutment and pulled across the valley.
The structure was supported on one abutment by temporary bearings that allowed rotation and longitudinal displacement along sliding tracks. At the other extremity, a "virtual support" created by two 31-strand cables linked the free end of the bridge to a system of two towers. The vertical reaction needed to balance the weight of the bridge was thus generated by the main cables' vertical component.
The lifting work turned out to be extremely challenging due to: a wind speed at times surpassing 120 km/hr, very strong forces generated in both the tensile members and towers as a result of the main cable's small angle, and the main cable horizontal component exceeding the friction (two jacks were installed at the back of the bridge to help balance the system). The bridge was ultimately positioned with pinpoint precision.
■ ***Contact: jmartinez@vslsp.com***

**The Netherlands**

# Groenehart: innovative clamping



→ **Within the scope of the North-South high-speed European rail link** and on the heels of its successful efforts for France's high-speed network, Intrafor is taking part in building the Dutch section of the new link: the Groenehart Tunnel is to be bored over a length of 7,150 m and an extraordinary diameter of nearly 15 m. The project also calls for two access ramps 700 and 750 m long as well as three emergency shafts. The exceptional nature of these works is owed both to an inhospitable geological site (clay, peat, sand, surface-level or rising water table) and to the dimension and depth of the tunnelling machine.
To enable the tunnelling machine to enter and exit the ground, Intrafor-VSL conducted a series of temporary foundation work, soil treatment, lowering of the groundwater surface and "clamping" of submerged concrete. In addition to producing 1.50-m and 1.20-m thick walls with depths of nearly 50 metres, an innovative approach was employed to clamp the submerged concrete. Both the elevation of such concrete and the sheer magnitude of the sustained forces involved made the use of more conventional processes (pile-driving, micropiles, piles, VC Piles, etc.) highly uncertain or at times impossible. Intrafor-VSL has thereby developed a new solution that combines foundation barrettes with the intermediate force-transmission elements used in the VC Piles process. These elements, anchored into the concrete cast in situ within the barrettes, actually allow transmitting the support forces to the barrette itself once the "box" has been drained by the submerged concrete (forces resulting from applied pressurization). Transmission of this 4,050-kN force to the anchorage floor occurs through friction. In the special case of the Groenehart Tunnel, the intermediate elements are also anchored to the definitive base slab. Some one hundred anchorages of this type have been installed at both the tunnel's entrance shaft and the deepest extremity of the access hatch. This innovative technique will be reused under even more difficult conditions for the tunnel's exit structures.

■ ***Contact: christian.besson@vsl-intrafor.com***

*Assembly of Tunnel boring machine in the shaft.*

## Hong Kong

# 120 m deep foundations for Package 7

→ **In a joint venture with a foundations specialist**, Intrafor signed for Harbour Vantage Management Ltd one of the three biggest deep-foundations contracts out to tender in Hong Kong: the design and construction of the foundations for a 100-storey tower block topping out to 500 m high. The works include 240 barrettes to a depth of more than 110 m, a 1.5 m thick, 76 m diameter circular diaphragm wall to a depth of 75 m, and an 8 m thick foundation raft.
The project has several outstanding features, including excavation down to a 120-m depth of 110,000 $m^3$ of diaphragm wall and barrettes in 12 months with a new BC40 cutter.
The expected turnover for Intrafor should be 23 million euros.
■ *Contact: khalil.ibrahim@hk.vsl-intrafor.com*

## Australia

# Reducing weight

→ **For a 350-metre bridge, for the Collins Street Extension Project** in Melbourne, VSL has forwarded the option of using post-tensioned beams as a cost-effective alternative, thereby reducing the weight of beams by 20% to 25%.
VSL's scope of works includes the design and supply of 108 precast post-tensioned beams, and 620 lineal metres of precast reinforced soffit slab units. ■
*Contact: jjoubran@vslmelb.aust.com*

## Morocco

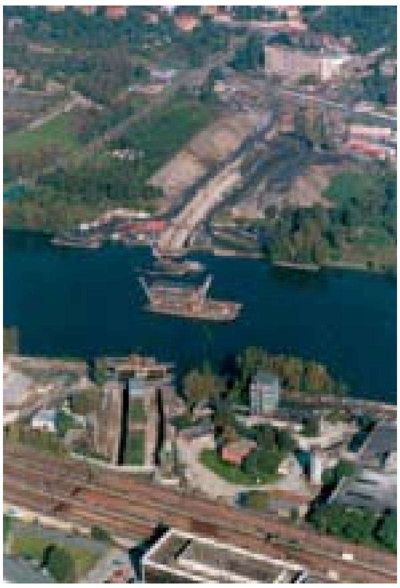
# Beam removal

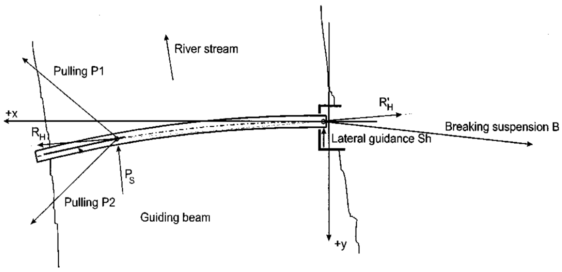
→ **The 3.5-km long Laayoune wharf** on Morocco's coast, used for the transhipment of phosphate, is now the focus of a major renovation effort. The damaged concrete beams are replaced with a watertight metallic box girder.
VSL France has been assigned to head up the engineering and supply of beam-removal equipment installed on a launching girder fitted with hydraulic jacks.
VSL is also responsible for launching the substitution metallic box girders, in all a project extending through the end of 2002 and worth over € 2 million.
■ *Contact: k.doghri@intrafor.fr*

## Czech Republic

# Unusual launching

→ **For the extension project of the underground line in Prague** that crosses the Vltava River, a unique technique was developed to build the two tunnels. The first 168-m long, 6700-tonne concrete tunnel was constructed in dry dock along the riverbank. Once the ends were sealed and its weight had been balanced, the structure was flooded for subsequent launching into the trench dug into the riverbed. VSL was responsible for the design, supply and execution of the tunnel





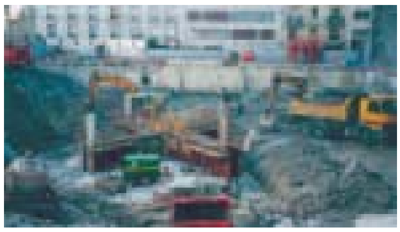

launching. The mechanism developed comprises two 4-strand pulling cables, two tandem pulling units (TPU 40), a moveable pulling-cable fixing point, one 7-strand breaking hydraulic coiler and a cable suspension of the tunnel-pontoon connection. The operation lasted a total of 9 hours. The movement had to be controlled within 250 mm, with the ultimate placement of the structure achieving an accuracy of 20 mm. Launching of the second tunnel is slated for June 2002.
■ *Contact: psevcik@vsl.cz*

## Reunion Island
# Travelling high



→ **This structure crossing high above the Bras de la Plaine** ravine (Reunion Island) is a 350-m long raised-arch bridge with a single span of 280 metres in length. The single central span is the longest of its type and features a composite deck made of steel and high grade concrete (B60). The Bouygues TP / DTP Terrassement joint venture signed a contract with VSL France for PT works: to prestress the deck and remove the two travelling forms at the end of 2001. The link between the concrete structure (both lower and upper decks) and the metallic (diagonal) structure was prestressed inside the metallic structure. As such, 163 tonnes of cement slurry-grouted cantilever prestressing and 58 tonnes of external prestressing were required, as were 16 tonnes of prestressing in the metallic diagonal members grouted using petroleum wax (to ensure ease of disassembly). Four SMU 71/555 jacks were used to remove the 300-tonne travelling form all at once, allowing for quick dismantling of the metallic structure with the help of heavy equipment to prevent against the risk of cyclones. VSL's involvement in the project lasted a full year and amounted to over a million euros worth of work. ■ *Contact: jean-claude.peslier@fr.vsl-intrafor.com*

## France
# Fast grouting



→ **The work performed by Bouygues Bâtiment** for a building at 148, rue de l'Université in Paris involved Intrafor for the installation of a peripheral diaphragm wall (surface area: 3,525 m$^2$) and piles carried out in 70 days instead of the 95 scheduled, for a contract worth slightly more than € 1.5 million. ■ *Contact: christian.lemonze@fr.vsl-intrafor.com*

# France

## Lafayette's organisation

→ **Intrafor grouted sealant and drove foundation micropiles** into a transfer floor as part of a renovation project worth over € 1.2 million for a corporate building located on rue Lafayette in Paris. Successful execution of this

highly-complex project, from both an organisational and scheduling standpoint, necessitated installing the micropiles within the existing cellar space in order to create 4 or 5 basement levels and then reconstructing an entire office building while preserving the facades. ■ *Contact: christian.lemonze@fr.vsl-intrafor.com*

# France

## Keeping up a palace



→ **Intrafor-VSL France carried out foundation works** for the Méditerranée Palace in Nice (on the French Riviera) by use of the diaphragm wall technique. The project was organised around the constraint of maintaining both the building's existing facade (a landmark for its art deco style) and the structural support system, which resulted in extremely limited access to the work site. The soils encountered were composed of alluvia in the upper layers and of limestone blocks further below the surface, with the anchorage being fastened into the gypsum. ■ *Contact: christian.carail@fr.vsl-intrafor.com*

# France

## Replacing the Eiffel viaduct

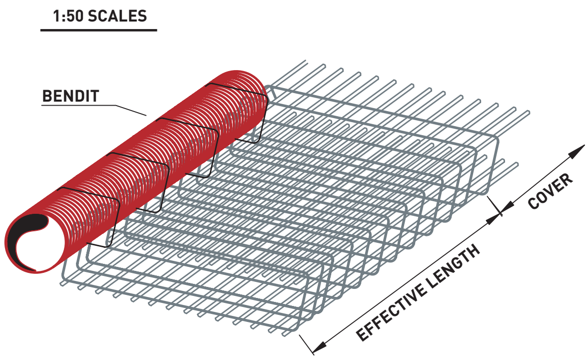
→ **The 162-m long Bezons metallic viaduct**, designed by the architect Eiffel (of Eiffel Tower fame) in 1900, needed repair. VSL conducted the launching of metallic beams to enable building the replacement bridge alongside the deficient structure, in order to minimize traffic interruptions. The former metallic

deck (weighing 1,000 tonnes) was slid sideways a distance of 13 m and the abutment and pile anchorage blocks were repositioned; ultimately, the new 2,500-tonne structure could be set into place.In all, rail traffic inter-ruptions lasted less than 15 days. ■ *Contact: patrick.travers@fr.vsl-intrafor.com*

## Destructible joints

# A new jointing process for diaphragm walls

**This brand new DSEI system ensures the continuity of panels for structures over 40 m in depth, including constructing shafts with diameters of less than 15 m. A patent has recently been filed.**




*Installation on ground surface*

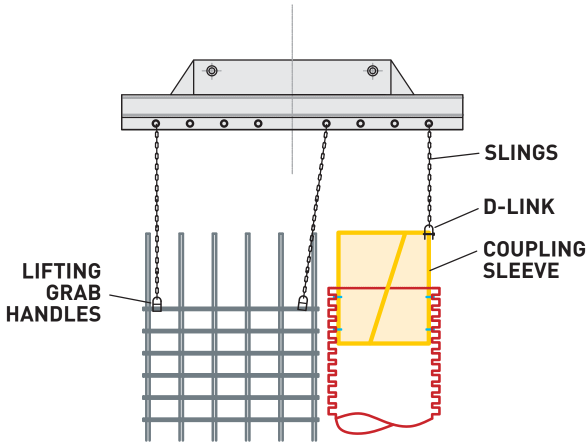


This brand new system upgrades the potential offered by other types of joints on the market under the strictest safety conditions.

### Conventional joints: nightwork expected

In all, three conventional processes are available for joint-based solutions between wall panels. The circular metallic tube joint boasts the longest track record. It should be kept in mind that following excavation (which typically occurs in the presence of sludge) of a diaphragm wall panel, a vertical formwork element (tube joints) is installed at each panel end. This element is then removed upon completion of the concreting and stiffening stages, thereby leaving two "void" imprints at the two ends. When excavating adjacent panels, the boring tool is guided by these imprints, which are to be cleaned and concreted during the concreting of adjacent panels. The difficulties encountered with this method pertain to: protection of tube joints when concreting the primary panels; the need to extract the tubes at a specific point in time (and in some instances at night); trajectory deviations of the boring tool; and depth, which accentuates these phenomena and generates increasingly-heavy systems (whose weight is also dependent upon wall thickness). Beyond a depth of 30 to 35 metres, the circular metallic tube joint proves less reliable.

A second, more recent process has led to three advances: ease of continuity from one panel to the next, introduction of waterproofing joints, and separation of the concreting operation from formwork removal. According to




*Lifting of a cage-tube assembly*

this process, the circular joint has been replaced by a plane joint with a shape suited to the configurations discussed above, whereby the formwork is removed upon excavation of the panels adjacent to those receiving the joints. This type of process however remains vulnerable at greater depths for the same reasons as the circular tube joint, with the lower stiffness serving to accentuate the phenomenon. Doubts over its effectiveness also get raised whenever the wall panels form an angle of more than a few degrees, which is the case for small-diameter shafts.

With the advent of toothed rotary excavation tools that make it possible to grind into the concrete, a third solution has come to the fore. This technique calls for completing the primary panels that frame a secondary panel, whose unit length slightly exceeds the length of the boring tool. During excavation of the secondary panel, this tool then "bites" the concrete at the end of the two framing primary panels. While not subject to any apparent depth limitation, this process is nonetheless confronted with the potential problem of panel deviation and twisting, in addition to sludge pollution concerns caused by the concrete used in the primary panels.

None of these three methods is entirely satisfactory as regards the creation of small-diameter (less than 15 m) shafts in sites with large depths. This assessment has led to the development of the "DSEI" destructible joint method.

## DSEI: extracted upon excavation

This process combines the advantages of the circular tube joints and formwork, without the hindrance of weight and hence of depth. In the case of the "Butard" shaft described above, the DSEI joint is circular, in a high-density polyethylene and set in place with reinforcement cages at the bottom of the excavation pit (45 m). It is to be "extracted" upon excavation of the adjacent panel, after being destroyed and broken up into pieces by a special tool during the boring operation and after serving to guide the cutter in its downward stroke, all the while ensuring perfect continuity from one panel to the next.

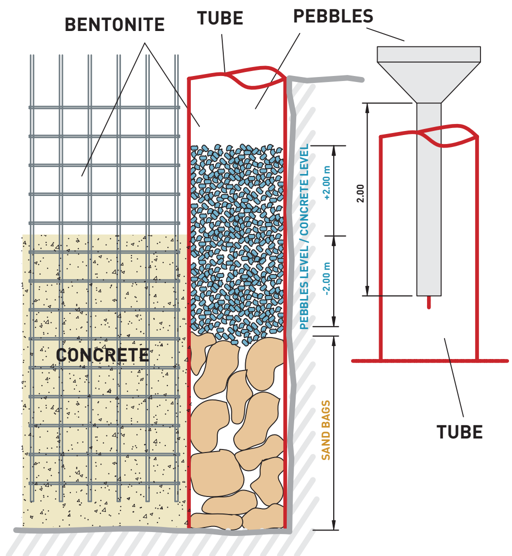
## Specific panelling plan

This works programme consists of constructing a circular peripheral diaphragm wall with an inner diameter of 11.60 m, a thickness of 1.02 m, a depth of 46.35 m and a surface area of slightly less than 2,000 m². The panelling plan calls for an assembly of two primary panels, two sequential panels and two secondary panels.

Standard phasing in the construction of a primary panel comprises the following:
- fabrication of guide walls and a drill hole 5 metres deep,
- cutter-driven boring with continuous vertical alignment tracking and any necessary adjustments, plus grit removal,
- joint equipment assembly of the reinforcement cages and DSEI tube joints.

The reinforcement cages, composed of a number of "mini cages", are installed by means of 11-m high elements. The uniqueness of this set-up lies in introducing the "mini cages" on a






*Concreting*

given horizontal level at the same time as the one or two open joint elements fastened to the panel's end cage(s). The DSEI tube joints are then connected to one another by sleeves riveted to the tubes. Waterproofing the base of both tubes in their definitive position completes this phase.
- concreting of the panel.

The fundamental distinction here pertains to the fact that the concrete is introduced simultaneously with the filling of the two DSEI tube joints by 10/20-grade gravel. It is continuously being verified that the level of tube-filling slightly surpasses the level of concrete in the trench cut. An easy-to-apply concrete has been specially used for this step. The boring operation on a secondary or sequential panel is carried out (beyond the drill hole) using a cutter. During excavation of the passage(s) along the DSEI joints, the teeth of the cutter partially break the high-density polyethylene tube. The broken pieces, less dense than the bentonitic sludge, then make their way to the surface, thereby avoiding obstruction of the cutter's suction pumps. Once the panel has been entirely excavated, the remaining polyethylene tube pieces are dislodged and evacuated by an appropriate system, which is mounted onto a cable-powered bucket that navigates vertically along the joints. After verification that the tube has been fully "extracted", final adjustment and cleaning of the panel bottom is accomplished using a cable-powered bucket.

## A deeply-embedded future

The DSEI joint technique, which provides considerable advantages (particularly for very deeply-embedded structures), has been successfully implemented on the "Butard" shaft, the first of two structures Intrafor has been commissioned to construct. The second application on the "Bois de l'Etat" shaft, featuring a smaller diameter (7.60 m) and greater depth (55 m), promises to be just as successful. ■

**Destructible joints on site: tl**

# Four options in one shaft

*The 46.5-m deep "Butard" shaft completed in six weeks during 2001 along with the 55 m "Bois de l'Etat" shaft, a five-week job, showcase Intrafor's reactivity thanks to a series of highly-innovative design options. At stake: over € 3.35 million in contract work.*

*The "Socatop" project, undertaken for the highway developer Cofiroute, consists of building two road tunnels for the A86 ringroad skirting Paris to the west. The consortium engaged Intrafor to construct two 1-m thick ventilation shafts using the diaphragm wall technique. Four design options proved critical to winning this award:*

***1) A cutter for large depths***
*Given the depth requirements on the diaphragm walls, the very low vertical tolerances (0.5% vertical clearance) and a site located in a fragile environment with difficult access, only the earth cutter is capable of performing with acceptable results. A new cutter carrier (LB 882) allowed reaching depths of up to 60 m (as opposed to 43 m for the previous model). Its inclinometric control system provides a continuous indication of the deviation between the tool's theoretical and actual positions (in both x and y terms). Twelve jacks placed on the cutter serve to correct any misalignments.*

***2) Destructible tube joints***
*Ground water beyond a depth of 30 m complicated the jointing operation between panels. Moreover, since the effectiveness of sheet-pile at such depths is uncertain (potential risk of clamping), the use of HDPE destructible tube joints was decided; in light of this method's innovative nature, a patent was filed. The basic principle consists of fastening an HDPE tube with a diameter equal to the wall thickness (i.e. 1 metre) to the reinforcement cage. In so doing, the tube serves as a formwork for the panel end. When boring the adjacent panel, the action of the cutter destroys this formwork over its half-circumference, with the remaining portion being removed by means of a conventional debris-removal bucket.*

***3) Vertical storage capacity***
*Due to the site's access constraints (especially at "Bois de l'Etat") and the sizable quantity of bentonite needed to be stored*

# with two innovations design

(800 m³), a number of three-unit interlocking containers were produced for the project, each featuring a "tripled" effective capacity of 100 m³; by virtue of stacking these containers three high, the surface area devoted to storage could be scaled back.

**4) Fluid concrete mixes**
Both the considerable depth of the diaphragm wall and the large opening of the panels made it necessary to carry out concreting batches exceeding 340 m³.Given a 60 m³/hr production rate, concreting runs of approximately 6 hours were required. Furthermore, the concrete located at the base gets submitted to high pressure levels by the end of the concreting phase. In order to alleviate such pressure build-up, various concrete mix designs were experimented and a high-flow concrete design featuring a minimum slump of 21 ultimately selected.

Intrafor was lauded by Socatop project management for its performance in terms of: design (extremely reactive), methodology (successful innovation), quality, safety and schedule compliance. Similar structural works for this same project are currently under review. ■ **Contact: pierre.congiu@fr.vsl-intrafor.com**

Assembly of a primary panel (two DSEI tube joints)

Located in an environmentally-sensitive zone, the site is particularly difficult to access.

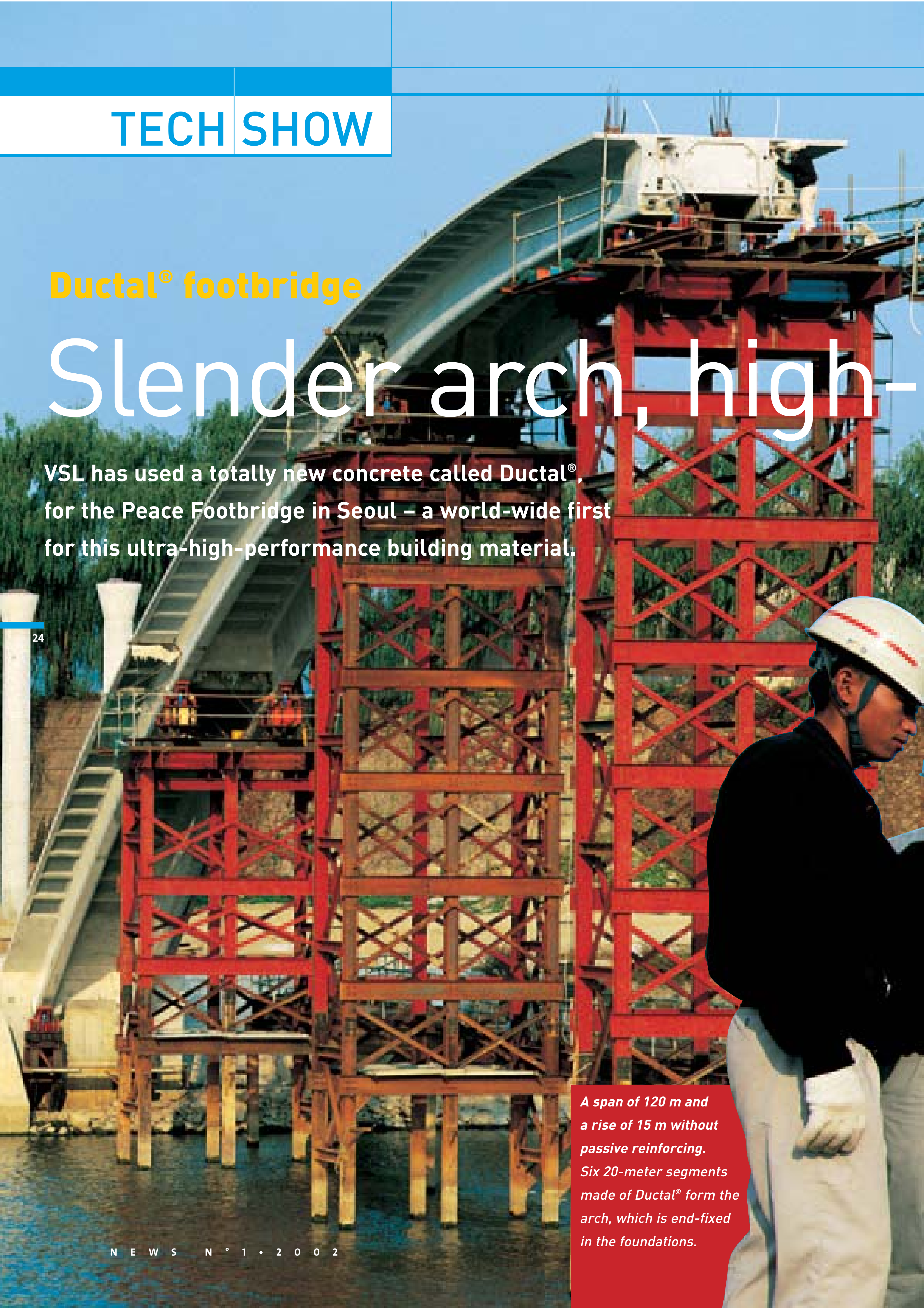
The upper part of the "Butard" shaft is excavated while being protected by a 1.02-m thick diaphragm wall.

The first project with the destructible joints

## Ductal® footbridge

# Slender arch, high-

VSL has used a totally new concrete called Ductal®, for the Peace Footbridge in Seoul – a world-wide first for this ultra-high-performance building material.



*A span of 120 m and a rise of 15 m without passive reinforcing. Six 20-meter segments made of Ductal® form the arch, which is end-fixed in the foundations.*

# tech leap

***Sleek proportions.***
*A tautly bowed arch and thin, shaped deck, thanks to ductility that has greater capacity to deform and support flexural and tensile loads, even after initial cracking.*

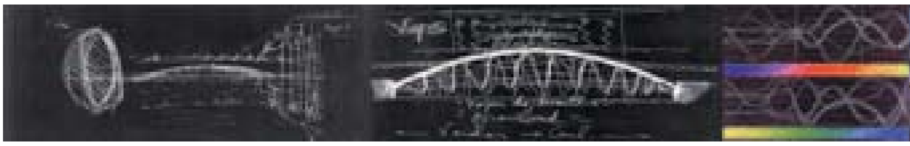
***Safe and fast.***
*Elimination of passive reinforcing and reduction of size improve segment erection conditions, which provides greater safety and speed.*

***Cross section with two longitudinal ribs at both ends.*** *Longitudinal prestressing is achieved with two 6-12 and four 6-9 tendons, and transversal prestressing by one or two 5-1 tendons at every rib.*

## New structures

# Pioneers of the Ductal® grammar

**Rudy Ricciotti, the Frenchman who designed this exceptional bridge for the city of Seoul, is the first architect to design a full-size structure using Ductal®. He talks about the new material in this exclusive interview.**



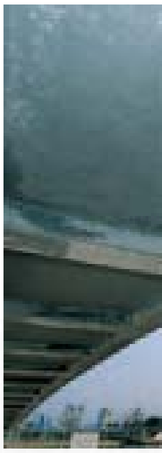


**Why did you choose Ductal® as the building material?**
It was a deliberate choice to work with a new French technology that I am very proud of. It is a fascinating material that is not yet widely marketed.

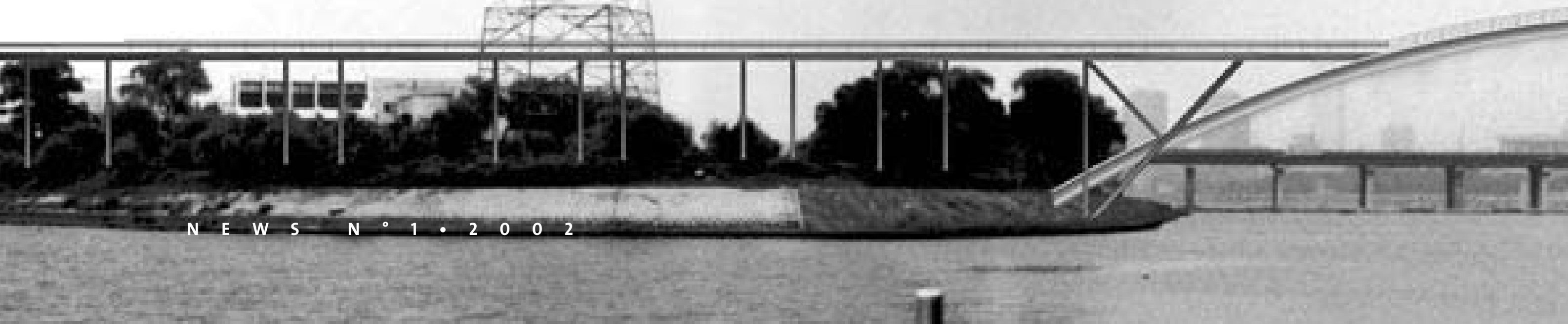
**Why is it "fascinating"?**
It is going to lead to radical changes and improvements, just as concrete did in comparison with stone and post-tensioned concrete did in comparison with reinforced concrete. It's a revolution of the same magnitude. Imagine the reaction of a cathedral builder in the 18th century, who had to rely on keystones, if he were shown reinforced concrete! We are changing the grammar. We are breaking the sound barrier.

**How is Ductal® revolutionary?**
The architect and the engineer are coming back to the arch, to work involving compression, meaning complex forces that until now required large sections. Ductal® is a baroque, anticlassical, paradoxical material. It is able to withstand very strong compression, yet it is very ductile. Its expression is dense, like the words of a poet. Its character is ambiguous, with a capacity for compression and flexion, though it is neither a metal nor concrete. There is no overstatement. Ambivalence, simplicity, discretion despite its obvious appeal – a dual nature that creates the eroticism of this material. Building with it demands a lot of skill and know-how. I have great admiration for the engineers who use it!

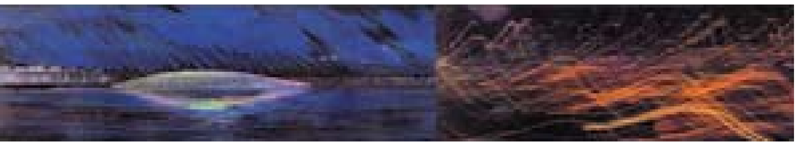
**What were the technical difficulties at the site?**
We are working at a scale that the eye has not yet memorised. It takes a lot of nerve! When the first airplanes were being built, it took raving lunatics to design the engine. It took a chain of people all sharing the same idea to deal with the risk. VSL is the only company I know of at the present time that is capable of post-tensioning with Ductal®. Even knowing the values, it's a real challenge! Ductal® does not dilate like concrete. For example, imagine what happens with a 3-cm-thick deck when the mechanical behaviour is not right because of a badly poured segment!



**What is the future for building with Ductal®?**
I've got my fingers crossed. It would be great for building. I'm sure the story is just beginning...



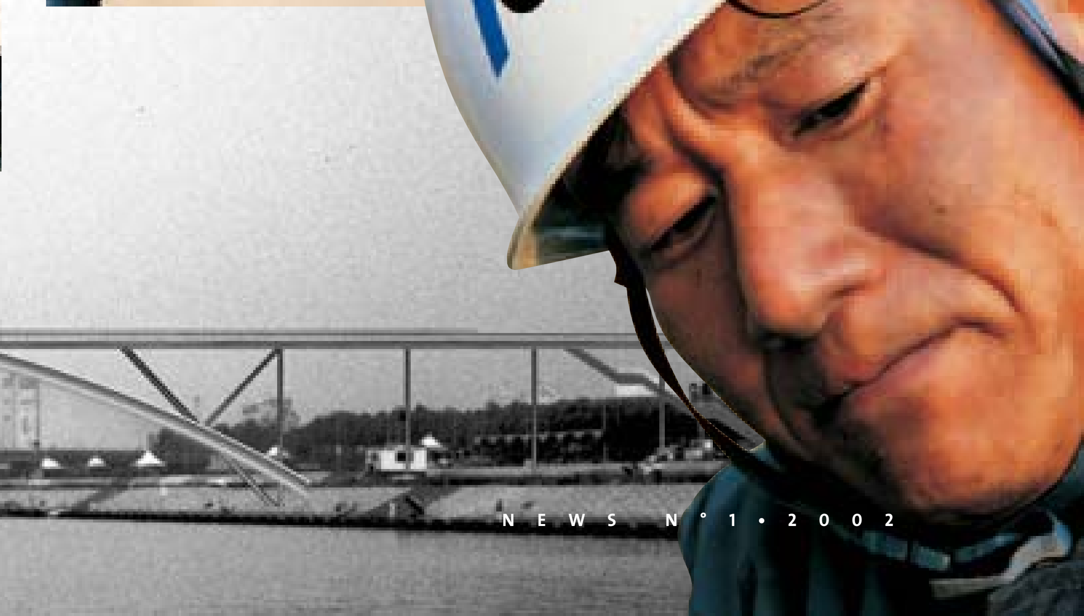
***A deck 3cm thick instead of 12.*** *Ductal® UHPC provides mechanical strength. It has compression strength of more than 200 MPa, as opposed to 20 to 50 MPa for ordinary concrete. Durability properties are those of an impermeable material.*



© Yann Kersalé

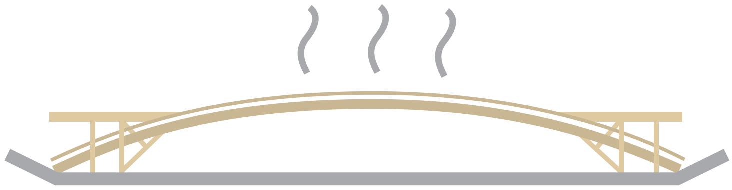
***Prestressed ribs.*** *The deck slab is stiffened by ribs every 122.5cm.*
*The prestressed ribs constitute a straight face in which the anchor heads of the transverse prestressing are placed.*

***Accurate formwork needed.*** *Ductal has the ability to replicate the micro and nano-texture of the mould. The result is solutions of high-quality surface aspect and beauty.*



**Home made**

# VSL's Ductal® bridge



**1) Prepare your mould**
Avoid sharp angles and add keys to facilitate opening. Soften the mould if necessary with a polystyrene lining so as not to block shrinkage of the Ductal®.
To end up with perfect surfaces, avoid trapping bubbles; if necessary add burlap under the cover of horizontal moulds to help bubbles escape.

**2) Prepare your batch of Ductal®**
Select only the best ingredients and measure them carefully.
Mix them all together for at least 15 minutes. Pour into the mould and cover.

*Tip: You might want to add colour to the mix to give your segments a personal touch.*

**3) Steam the segments**
After the mixture has hardened for at least one day (use a maturometer for accurate timing), remove the segment from the mould and steam it at 90° C for 48 hours. Set it aside. Repeat the operation until you have all the segments you need.

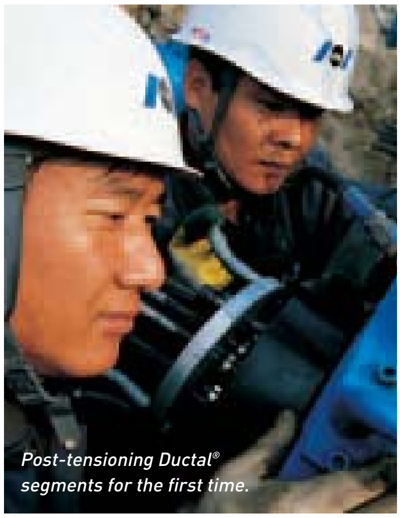
**4) Erect the segments**
Erect them one by one using previously installed formwork as support and prestress with the appropriate VSL system. If needed, install a Vibration Control System (TMD) for more smoothness.

**5) Enjoy!**
Sit back and savour the creativeness of your 100% original, state-of-the-art structure.

**Ingredients:** premix, fibres, superplasticizers and a little water.
**Utensils:** a high shear mixer; accurate scales; a vibrator system to blend in the fibres evenly; a soft mould with smooth angles; a maturometer; a VSL prestressing system; the right kind of partnerships.

# VSL Korea for the Peace Footbridge

To commemorate the 100th anniversary of diplomatic ties between Korea and France, the City of Seoul and France's Year 2000 Committee agreed to build a symbolic structure in the South Korean capital. French architect Rudy Ricciotti came up with the concept for the footbridge, and Bouygues developed the detailed design. The main contractor in the project is Dongyang.



*Post-tensioning Ductal® segments for the first time.*

VSL Korea's scope of work in the joint venture with Bouygues TP is production and installation of six 20-meter Ductal® segments, including post-tensioning, and installation of Tuned Mass Dampers (TMD) for vibration control. Ductal® segment erection and the post-tensioning had been completed at year-end 2001. The TMD installation will be finished by the end of March 2002.

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JOINING FORCES FOR YOUR PROJECTS

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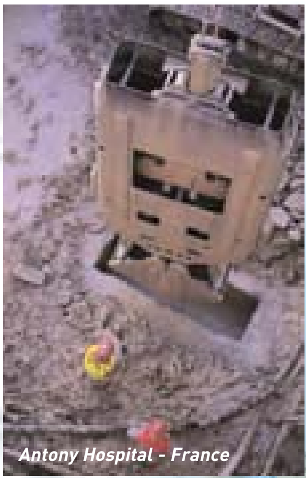
# Joining forces for your projects

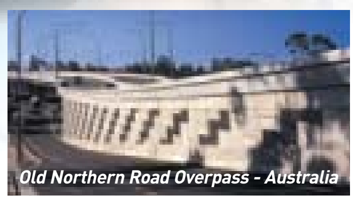

Groene Hart Tunnel - Netherlands


Kisosansen Bridge - Japan


Antony Hospital - France


Manhattan Heights - Hong Kong

- Post –Tensioning
- Deep foundations
- Stay cables
- Soil improvement
- Heavy lifting
- Climb form and formworks
- Retained earth
- Superstructure erection
- Diaphragm walls
- Special construction methods
- Grouting
- Ground anchors
- Repair & strengthening
- Vibroflotation
- Dewatering


Old Northern Road Overpass - Australia


Sydney Southern Railway - Australia


Pakse Bridge - Laos

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