Repairs and strengthening
Diversification strategies
Mega Tower in Hong Kong
FACTS&TRENDS

New generation of composite decks  
Stone columns in Disneyland

COVER STORY

DEVELOPING BY DIVERSIFYING
VSL India: Drawing confidence step by step  
Chile: Footbridges  
Morocco: Offshore works  
Hong Kong: Earth walls  
Philippines: Formwork  
Japan: Ductal®

SITE INSIGHTS

Mexico: Full construction of the Puente de la Unidad  
Reina Sofia Centro de Arte: a Ductal® first  
Hong Kong: foundation works on the Spur Line  
XXL roof lifting for Airbus in France

SPECIAL REPORT

REPAIRS & STRENGTHENING
Far more complex than new construction  
Upgrading deficient -but occupied- structures, a growing segment of the construction industry.  
VSL is a leader provider in the US.

SYSTEMS

Predicting friction for 15 years  
VSL designed a new generation of mechanical friction dampers.

TECH SHOW

High-tech foundations for primitive arts  
A closer look at this highly-prestigious job located in the heart of Paris.
Advanced technologies
with local expertise

We have been continuously improving our products and expanding our technical expertise for more than 40 years. In our post-tensioning activity, we have done this by conducting ambitious and focused R&D programmes in stay-cable systems (SSI 2000), automatic stressing equipment (AMS), high-performance grout (HPI) and anchorages (CS 2000). To enhance our capabilities in foundations, we have developed specific products like destructible joints for deep diaphragm walls, and high-tech friction barrettes implemented with a new cutter in Hong Kong.

Our goal is to offer the construction industry a wide and diversified range of advanced technologies throughout our network, relying on local experts who are ready to assist our clients swiftly and efficiently. Our newly created subsidiary in India is a typical example of our diversification strategy. In the space of just four years, we have supplied not only post-tensioning for civil works, but also nuclear applications, building solutions, retained earth and soil anchors as well as precasting and erection services. All the staff is local. Its members have been trained in Singapore, Hong Kong and Europe, and they have the full support of all our specialists. India is on the move and now helping other subsidiaries with new best practices. Our entire network will benefit from these improvements, since at VSL-Intrafor, expertise is a client-oriented value to be shared.

Jean-Philippe Trin
Since receiving official French government approval, the compact VSL CS 2000 system has been used in several bridge construction projects in France. They include the Saint-Lô bypass anchors (19T15) and the A29 motorway from Amiens to Neufchâtel: 31 bridges, 1,016 anchors (12T15). Significant savings in transportation, handling and installation of the anchors have been observed. VSL France will also carry out the post-tensioning works on 76 bridges on the A28 motorway.

Contact: alain.stamm@fr.vsl-intrafor.com

New generation of composite decks

Composite highway bridge decks with steel truss girders and post-tensioned precast concrete deck elements have been proposed recently in Switzerland for the Dättwil Highway Bridge. The steel truss girders are erected first, then the precast deck elements are placed on top of the girders. The segments are post-tensioned longitudinally after the joints between the segments have been sealed with epoxy resin. The first time this system was used, inserts in the precast concrete elements were welded to the steel truss girders. To facilitate the connection, a new detail using shear studs or keys attached to the steel girders was designed. These studs or keys fit into a continuous recess in the bottom of the precast deck elements. Once the assembly is completed, this recess is filled with a high-performance grout to achieve a monolithic connection between the steel girders and precast concrete deck. VSL has been contacted to design and supply such a high-performance grout for prototype testing of this connection. Test results are very promising.

Contact: svildaer@vsl-europe.com

Iran
Market revival

The Iranian construction market is currently enjoying a revival, as reflected by the number of projects recently awarded to VSL, from ground anchors to bearings and joints. Since 2000, VSL has provided strand ground anchors for two dam projects in Iran: the Masjed-e-Soleiman HEP extension project (approximately 200 permanent anchors) and the Karkheh HEP dam (74 temporary anchors).

Contact: deccleston@vsl-schweiz.ch

Spain
Imaginative slab start

In April 2003, CTT Stronghold (VSL in Spain) completed a contract for the design, supply and installation of post-tensioning at the new logistics centre of Imaginarium, one of Spain’s largest toy companies. The original solution for the 5,700-m² storage area included precast elements and columns at 6.30-m intervals. CTT’s alternative design eliminated 70% of the columns and increased the span to 12.60 m. Despite the longer span, VSL was still able to reduce the slab thickness to 32 cm at midspan with drop panels of 64 cm. Acieroid, VSL Chile and VSL Argentina, participated in the project. It is the first use in Spain of the bonded 0.5” monostrand system with plastic sheathing to provide full encapsulation.

Contact: jlima@vslsp.com

CS 2000
Now French

Since receiving official French government approval, the compact VSL CS 2000 system has been used in several bridge construction projects in France. They include the Saint-Lô bypass 364 anchors (19T15) and the A29 motorway from Amiens to Neufchâtel: 31 bridges, 1,016 anchors (12T15). Significant savings in transportation, handling and installation of the anchors have been observed. VSL France will also carry out the post-tensioning works on 76 bridges on the A28 motorway.

Contact: alain.stamm@fr.vsl-intrafor.com
Monitoring

Single-strand load cell

→ Owing to the rapidly growing use of the SSI 2000 stay cable system, VSL has now developed a compact load cell. The SSI 2000 Hc160 monitors the load on a single strand within a stay cable. This new equipment fits over any strand and sits on the anchor head of the stay cable between adjacent strands, making it easy to install and replace. Since any variation of the total stay cable force or elongation will cause a change in the monitored individual strand, a single Hc160 load cell offers an economical way to have a good indication of the total force in the stay cable.

Contact: bdomage@vsl-schweiz.ch

Hong Kong

Stone columns in Disneyland

→ In its first stone column project in Hong Kong, Intrafor HK, working in a joint venture, has successfully completed 100,000 m of stone columns at Penny’s Bay, the location of the future Disneyland HK. The project team installed 78,000 m³ of stones and delivered 7,500 columns of 1 m diameter in February 2003, using the dry bottom feed method to a maximum depth of 19 m. Meanwhile, 600,000 m³ of reclaimed sand was compacted above the head of the stone columns. Some 42 million m³ of reclaimed sand had already been compacted with this method on another part of the site.

Contact: jean-christophe.gillard@hk.vsl-intrafor.com

Repairs

Refined solutions

→ Arnold De Silva has been appointed Asia Representative of Structural Preservation Systems in Singapore. While SPS is developing VSL in the US, a strong ongoing partnership is now leading SPS and VSL to launch a repair and strengthening activity in Asia. Offers include structural health diagnosis, concrete repair, strengthening and protection against deterioration in petrochemical plants.

Contact: a_desilva@vsl-sg.com

PRESS REVIEW

Spreading high-tech

VSL-Intrafor has been featured in several magazines since the beginning of the year. One is the Singapore Engineer, a magazine covering engineering disciplines and advanced design and construction solutions. Its 1st issue for 2003 published a cover story on the durability of post-tensioned concrete structures, in which VSL’s R&D project on effective grouting of post-tensioned tendons is very positively highlighted. VSL was also on the cover of Concrete International in conjunction with the use of the innovative VSLABTM post-tensioning system in the Baltimore Washington International Airport Parking Garage Project. An article titled “High-Tech in Projects” in the French BTP Magazine describes the Spider project and the Damper Cable System (DCS) developed by VSL and Jarret for seismic protection. In its second issue of 2003, Bridges & Engineering shows VSL’s new mechanical friction dampers for cables in a feature article stating “Friction factor, a new generation of friction dampers designed to address maintenance problems with the existing”.

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Contact: jean-christophe.gillard@hk.vsl-intrafor.com
Developing by diversification

VSL-Intrafor is growing by developing new capabilities from its core businesses of post-tensioning and deep foundations. This diversification strategy enables the company to better serve its clients while balancing its activities. Here are some illustrations.

VSL India: Drawing confidence step by step

VSL India was created in January 1999. Within 4 months, the first contract was the prestressing for the Dabhol LNG Tank. Within 2 years, the company is the leading specialized contractor for post-tensioned buildings. Retained earth projects have also been launched and are growing larger. Activity is diversified and profitable, clients are happy. Muthuganesan Rajamani – just call him Ganesh – comments on this successful strategy.

What did VSL have to cope with at start?
VSL entered the Indian market at our competitors had already established in India. We had to cross many hurdles, like getting our system approved from various agencies. We identified the obstacles and made a step-by-step approach in getting our system accepted by our clients, we wanted to win over their confidence.

What do you believe in about approaching clients?
As a specialized contractor, our approach was to understand the client’s requirement and provide solutions accordingly. We treated every query according to its merit and worked out an economical solution which would benefit both VSL and the client. Our basic strategy is that if our client wins we win. We try to be costwise less expensive with better technical solutions. Securing contracts also depends very much in India on personal interaction and emotional quotient with the clients.

How do you interact with clients?
Clients need to feel that I’m able to match the price and that I’m very keen, responsive, that I show interest whether I’m going to get the job or not. They give me early notice. Not only do I execute our

VSL India’s growth (in million €)

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Post-tensioning for a residential building at Pune.

Muthuganesan Rajamani, VSL India Manager.
job, but also I help them out in their own job. It can range from getting quotations to arranging meetings with key people and carry out catalogues. I also like to sit and chat with them, outside office hours, to exchange ideas on what is happening, to give them a glimpse of a few things. Clients also need more orientation towards the value added engineering and execution packages. They often think they can do it but 95% of them end up in trouble. As VSL has experienced many clients and jobs, we develop packages and we educate our potential clients to these new techniques.

**How about your own team’s experience?**
We have developed multi-skilled teams. Every year, VSL recruits 6 to 10 young and energetic engineers and has them trained. The expat supervisors train the local foreman and supervisors. We also conduct periodical appraisal for our engineers and supervisors.

A major feature of VSL India is our age group: most of our work force is under 40. People sometimes complain that we are too young, but keep in mind that post-tensioning is a specialized work. Don’t look at age, look at what they do! Also, for me, marketing is done by everyone in the company. Even our drivers can work on site, and can speak about what the company does!

**How do you encourage new ideas?**
Oh yes, we make good use of them! Particularly as we are backed up by a well-established brand name in the world market of post-tensioning. I believe in knowledge sharing among staff, and on having informal meetings. More group discussion brings high energy into the workplace. On site we encourage ideas from our engineers and workers. For example in our Dabhol site, a supervisor came up with an idea for placing the duct and we adopted it and saved a lot in manpower.

**VSoL® panels at Kanchipuram**

Recently VSL India was awarded with three major projects in the national highway development scheme. Package RC2 is leading these projects giving first ever VSoL® panels in India that are supporting 24.6m ramps for Rail Over Bridge along the stretch of NH46 at Kanchipuram, covering 13,200 sqm of facing area to a height of 11.75m. The structure was designed based on the acceptance of the locally available fill material, seismic condition and full containment crash barrier.
How do you take advantage of the VSL network?
By working in various countries, VSL has gained a lot of experience. VSL India has benefited a lot from this. We have used the reference of the jobs done by other VSL companies. If we have any clarification in our jobs, we approach those profit centers which have done similar work. I also like to bring in a top VSL specialist from the VSL Technical Center in Singapore, when necessary. Clients like that kind of response, they know I can call in anyone from anywhere!

“As a consultant, I give a lot of importance to adherence to technical provisions. I need to feel fully confident. I found VSL to follow the books on site and to be meticulous on that. They are also very prompt to bring in engineers from abroad to solve some issues. VSL is a late entry but a leader now in the Indian PT market...”

says Mr Umesh Joshi, from Y.S. Sane Associate, a leading consultant in Mumbai for building construction.

Madhuban chowk in New Delhi

VSL India has been awarded a contract to supply and fabricate 1040 permanent ground anchors (40 t) for the underpass project in Maduban chowk at New Delhi India. The anchors are proposed to keep the base raft slab of the underpass spanning between diaphragm walls on either sides in positioning against the uplift pressure. VSL has successfully completed the test anchors (performance test, creep test and pull-out test up to 3 times capacity of anchors) as per FIB standards, which was a requirement set for awarding the job.
You started with post-tensioning for LNG tanks, then for buildings, then for bridges. You are now growing fast with VSoL® projects. What will be your next step?

To produce our own components, because we usually need 10 weeks to get them through customs. We are also building a factory for bearings, in which we will do our own assembly and testing. Testing can also be provided to our clients. We are targeting 5 major contracts for bearings, approximately 3 million US dollars.

Why did you pick up that activity?

Every year I sit and think: how can I diversify? I did a 6 months survey for bearings, our price is in the middle range, VSL has a good name... So I volunteered to one of my clients for supplying bearings. Development is: Always room for improvement. Diversification is: Let’s release one of the client’s headaches!

LNG terminals at Dahej and Hazira, Gujarat

After the successful completion of the post-tensioning works for 2 LNG terminals at Dahej, VSL India has now secured with Technigaz a contract for the 3rd LNG terminal in India, at Hazira. Since 1999, VSL India now has 7 references for tanks, 2 still is under progress and ahead of schedule. Scope of work included the supply of post-tensioning materials, specialist equipment and all installation work for the post-tensioning tendons.
FOOTBRIDGES IN CHILE

Route 5, Santiago Talca section. Chile is modernizing the country’s highways network. In tough commercial competition with the strong local precast constructors, VSL in Chile has obtained 3 contracts for full construction of the footbridges. The construction process (post-tensioned steel girder as formwork) has been one of the keys of the commercial success. The construction cycle for one complete footbridge is 1.5 months. Since the beginning of this new activity, VSL in Chile has constructed 42 footbridges and has just signed a new contract for 25 more.

OFFSHORE WORKS IN MOROCCO

Laayoun Wharf. The Somagec company, VSL France’s Moroccan partner in the “Laayoun Wharf” project, has been signed to a new works contract: the disassembly and replacement of the pumping platform located at the end of the wharf at a distance of 1,750 m off the coast. This 22-month job will start up in September 2003 as regards VSL France’s contribution. VSL France is currently replacing the southern slab of the Laayoun Wharf over a length of 1,750 m, three-fourths of which extends into the sea, removing 330-ton prestressed concrete double beams built in 1968.

Building up new capabilities to offer a broader range of customer-oriented services through an efficient network of 40 subsidiaries.
FORMWORK IN THE PHILIPPINES

C5/Ortigas Avenue Extension Interchange in Metro Manila.
For a 696-m long flyover over the existing Ortigas flyover, VSL Philippines, Inc. is precasting and supplying 112 AASHTO precast girders and is using the VSL launching truss. VSL introduced the main contractor to pre-cast planks as a composite deck slab formwork, offering an alternative to the conventional forming, and received the contract: the pre-casting and installation of 3,864 PC planks including the left turn section of the interchange. Installation is to be completed end of June 2003. On this project, VSL also won its first contract in the Philippines for 1,150 m² of MSE wall.

EARTH WALLS IN HONG KONG

Castle Peak Road Improvement.
VSL Hong Kong was awarded Phases 1 and 2 to upgrade a winding, two-lane highway along the coast. When the project was originally announced early in 2002, it consisted mainly of bridges to span the wide gaps below the road. VSL worked with the main contractors to develop an alternative scheme in which the bridges would be replaced by reinforced earth walls wherever this was possible.

VSoL® solutions proved to be an efficient diversification activity for VSL-Intrafor in Hong Kong in the last few years.

DUCTAL® IN JAPAN

Sakata Mirai Bridge. A major Japanese precasting company, Maeta, awarded Taisei and VSL Japan the design and construction of the Sakata Mirai Footbridge. Compared to the Ductal® footbridge that VSL built in Korea, which has a single arch span, the Sakata Mirai Footbridge is a single, 51-m-long span with a hollow beam. Prefabricated and Ductal®-FM elements were assembled by external prestressing. This is the first application of the UHP concrete Ductal® in Japan. Because of its special features and added value, this new material represents a major technological leap forward, allowing attractive structures and buildings to be constructed.
In 2002, the joint venture Grupo Garza Ponce–VSL Mexico was awarded the contract to construct the 300-meter-long cable-stayed bridge across the Santa Catarina River at Monterrey Nuevo Leon in northern Mexico. VSL Mexico’s scope in the 50-50 joint venture includes project management, complete technical and methods support and part of the production management. VSL Mexico has also supplied and installed the 300 t of post-tensioning and the 440 t of stays, using the SSI 2000 system. The bridge has a single, 60-degree-inclined, post-stressed pylon on the south side of the crossing. The whole structure is 160 m high. On the north side, 13 pairs of stays support the main deck, which is designed to carry four lanes of traffic. The pylon is being erected over an important highway. Once the pylon is completed, this highway will pass through it. The deck is composed of a 185-m-long concrete transition span receiving two future access ramps and a 150-m-long composite (structural steel and concrete) structure connecting to the north viaduct. Production peaked 10 months after work started on the Puente de la Unidad, with 220 workers and 30 staff working round-the-clock shifts on five simultaneous fronts: pylon, stays, in-situ transition span, main span and end span. Completion is scheduled for September 2003. Contact: arossetto@vslmex.com.mx

VSL provided the innovative VSLAB™ post-tensioning system for the Baltimore Washington International (BWI) Airport Parking Garage Project (325,000 m² of parking space). The feature that set it apart from other garages was the VSLAB™ post-tensioning system, which provides total encapsulation of the strands, minimising lifecycle maintenance costs. Contact: bgallagher@structural.net

VSL recently completed the launching of the 1,200 t steel superstructure on the 600-m-long Perdigao viaduct near Beira. The steelwork was pulled on special free-sliding bearings. Two steel/concrete decks with 12 spans were built by assembling precast concrete slabs on a pair of previously launched steel girders. VSL Portugal was in charge of the design and execution of the launching method. Contact: ralmeida@vslsistemas.pt
USA
Flat plates in latest flats

For this contemporary, state-of-the-art apartment facility located in Arlington, Virginia, VSL provided a two-way post-tensioned slab system with unbonded tendons. A flat plate design was selected to avoid column drop panels and maximise floor-to-ceiling clearance.

Contact: bgallagher@structural.net

Portugal
Circular threading

For the LNG tanks project at Sines, VSL was awarded the full contract for the supply and installation of 1,300 t of post-tensioning strands, using the latest technologies under very stringent safety requirements: 80 horizontal circular tensioned tendons (6-22) in four buttresses and 124 vertical U-shaped tendons (6-12) with a 1-m radius at the bottom. This required performing special threading and tensioning operations from the top.

Contact: ralmeida@vslsistemas.pt

Chile
Chuquicamata: VSoL® to extremes

VSL is constructing two walls in the new crusher at the world’s largest open-pit copper mine, Codelco Chile Chuquicamata Division, in northern Chile, at an altitude of 2,400 m. One wall is 35 m high! It will support truck loads up to 600 t, under seismic conditions up to 0.3 g at the wall base and will serve for 25 years. VSL designed the wall, supplied the materials and supervised the installation.

Contact: aavend@vslchile.cl

NOTE PAD

Columbian bridge - VSL has just completed in June 2003 the installation of stay cables on the Peldar cable-stayed bridge in Envigado, Colombia. VSL is also providing 1 600 m² of retained earth walls, forms for the inclined pylon, POT-bearings and joints, PT bars and post-tensioning, design and supply of the steel saddle, and monitoring for the stay cables.

First VSL-HPI grout mix - It was used for the first time in the UK on the Medway Bridge. The owner had specified a ready-mix grout. VSL offered a 270 t of VSL-HPI mix to grout 26,820 m of tendon ducts.

Extradosed bridge - VSL China was awarded the supply and installation contract for the Xiamen Yinghu Bridge, in Fujian Province. This is the first extradosed cable-stayed bridge in Mainland China.

More Plus® than ever - For the Milano-Bologna PT-rail line, VSL in Italy has been awarded 2 supply contracts for PT-PLUS® corrugated plastic duct. The first order – the largest ever for PT-PLUS® – was for 600,000 m for the 22 km Modena viaduct. The other, for 150,000 m, was for the Po River and Piacenza River bridges.

Above water - In the upgrade project at Waitakere Hospital, near Auckland, New Zealand, the conforming design was a reinforced concrete rib beam and slab that required excavation below the water table. VSL provided a 300-mm-thick flat slab located above the water table.
The structure of the new buildings for the Spanish Centro de Arte Reina Sofia project, designed by Jean Nouvel and Julio Medem is steel columns with hollow diaphragms at each floor level, with 32 cm minimal internal diameter, not allowing the positioning of rebars: a classical reinforced concrete solution could not be used. Ductal®-AF [anti-fire Ductal®] was cast inside the steel tube because of its exceptional mechanical characteristics and fire resistance.

The cable-stayed bridge over the Amsterdam-Rhine Canal at the Papendorpse Polder, near Utrecht, is well over 300 m long and 37 m wide. The main span over the canal is 151 m long. The longitudinal axis of the bridge has a 4 m-wide gap, making it look as if there are two separate bridges. This is not the case, however: the two by two steel longitudinal girders are joined by 1 m-deep cross girders. Due to these impressive dimensions, the steel components of both pylon and bridge deck were welded into the largest possible parts and then ferried by pontoon to the construction site, where they were placed in position by crane or floating derricks. The pylon base stands on a concrete footing, pile-driven underneath, and is connected to it by 87 (Ø36mm - FeP1230) pre-stressed rods. The two pendulums in the western land abutment, which absorb the vertical reaction of the bridge deck, are also connected to the foundations by rods of this kind. The deck, supported by the cables, consists of four parts (52 m-long and 37 m-wide) with a weight of more than 200 tonnes each. The strongest cable supporting the deck is made up of 120 strands, setting a new record for the VSL system.

Contact: wichertjes@vsl-benelux.nl

Contact: jmartinez@vslsp.com

Spain
Reina Sofia: a Ductal® first

Contact: jmartinez@vslsp.com

Netherlands
120 strands in one stay!
Czech Republic
Preparing for champions

→ The new Sazka Stadium in Prague, where the 2004 World Ice Hockey Championship will be held, has to be built fast. The contract was awarded to Skanska CZ Co. Post-tensioning was used in both parts, the big arena and the small arena, due to the complicated layout and large spans. VSL supplied and installed approx. 100 tonnes of post-tensioning. [Contact: psmisek@vsl.cz]

Egypt
Two-way tensioning

→ Two tanks are being constructed in the Damietta LNG Tank project at a liquefaction plant in the Damietta free zone in northern Egypt. VSL is supplying the materials for the vertical and horizontal post-tensioning of the 800-mm-thick concrete walls as well as the equipment and technical assistance for the installation of the post-tensioning. Completion in November 2003. [Contact: cpetrel@vsl-schweiz.ch]

Germany
Bridge shift

→ The road bridge over the Meglitze River near Schwedt, at the Polish-German border, is being replaced. To minimise the disruption of the border traffic, the 680-ton steel truss of the old bridge was shifted 12 m onto previously built abutments parallel to the bridge axis. VSL Germany conducted all the operations. Traffic interruption across the river was only three days. [Contact: vsl-syst@t-online.de]

Dubai
Skywalk lift

→ “Yet another jewel in Dubai’s crown” read a headline in the Gulf News on the day after this spectacular lift. Dubbed the longest footbridge in the world, it now links the two towers of the Marriott Executive Apartments at the 19th floor and houses the Skywalk Cafe. This 280-t section was lifted 60 m in less than a day and joined to two cantilevers, forming a total span of 73 m. [Contact: djunker@vsl-schweiz.ch]

Stays in China
Strand-by-strand cable replacement

→ Damage was caused to four stay cables on the Ching Chau Min Jian cable-stayed bridge in Fuzhou, P.R.C, due to the collision of a barge close to the main span during a typhoon. VSL checked four stay cables, carried out by a lift-off test on each strand. One 300 m-long stay was to be replaced. Since there was no longer a construction crane at the site, all VSL’s equipment for the operation had to be lightweight. To control the force transfer during the cable replacement, VSL used the strand by strand replacement technique. Some installed strands were replaced one by one with temporary longer strands. Then the other strands were de-tensioned and removed. Finally a new stay cable was installed. The whole operation took only two weeks. [Contact: yves.bournand@vsl-intrafor.com]
Hong Kong
Giant Climbform for Pacific Forum

On the 38-storey Pacific Forum development project in Wanchai, VSL-Intrafor is supplying and installing 360 t of post-tensioning for the floors as well as renting and supervising a VSL Climbform for the core wall. The PT floors, mainly one-way flat slabs spanning up to 16.0 m, are typically 350 mm thick, with 4.0 m x 4.0 m x 500 mm drop panels and 500-mm-deep partial perimeter band beams. The large amount of pre-stressing required the use of the S6-5 flat slab tendons for the first time in Hong Kong. The Climbform for the core wall, the biggest Climbform ever, has the outer dimensions of the core shaft and consists of five cells, 35.00 m x 15.90 m. The VSL Climbform was chosen due to the local support, quick response to queries, short lead time and the unique flexibility of the Climbform, which allows modifications to the system to allow for dimensional changes in the core wall while construction is in progress.

Contact: christian.venetz@hk.vsl-intrafor.com

China
First launching girders

Phase 2 of the Humin Road Project includes a viaduct in downtown Shanghai. Because of the tight construction schedule, lots 1 and 3 are to be constructed with precast segmental concrete decks erected with the span-by-span method using launching girders, for the first time in Shanghai. For Lot 1, VSL will supply an underslung launching girder to erect the approach ramps, and for Lot 3, six casting cells and two overhead launching girders.

Contact: dどroniou@vsl-hk.com

Australia
Floating anchors

For the Lake Narracan Upgrade Project site in Victoria, VSL developed a system to float the anchors, including a 6-55 one, from the fabrication area to the workforce, along the Latrobe River. As main contractor, VSL’s scope of work included installing strand anchors, increasing the size of the concrete piers, concrete and rock drilling and upgrading pedestrian access on structure.

Contact: jjoubran@vslmelb.aust.com
**Hong Kong**

D-Walls, piles and decks on the Spur Line

> The Spur Line is part of the East Rail extension in Hong Kong linking the Sheung Shui station to the Chinese border. The Kowloon Canton Railway Corporation (KCRC) has divided this project into three major contracts: the tunnel and station (LDB201), the viaduct (LCC202), and the terminus (LCC300). VSL-Intrafor Hong Kong is working on all three contracts, providing post-tensioning, erection and foundation works. For LDB201, Dragages [main contractor], a diaphragm walling at the Kwu Tung station is under construction using Intrafor’s BC40 cutter and is expected to finish in early August 2003. Installation of other diaphragm walls, grouting, jet grouting and sheet piling will continue until early 2004. Ground freezing for cross passages is expected to be carried out in year 2005.

For LCC300 with the Balfour Beatty/Lam JV as main contractor, the contract is for the construction of 326 large-diameter bored piles for the Lok Ma Chau Terminus. Piles are of various diameters (1.2 m, 1.8 m, 2.1 m and 2.4 m) and will be founded into rock at around 35 m below ground level. Completion is planned for December 2003. On the East Rail Extension of the Lok Ma Chau Spur Line, for LCC202, VSL will construct an elevated precast twin-deck segmental viaduct with 91 spans (35 m to 45 m long) for the main contractor, Maeda. Total deck length is approximately 3,500 m. Scope of works includes segment handling and on-site transportation, erection, supply and installation of post-tensioning, bearings and joints.

Contact: khalil.ibrahim@hk.vsl-intrafor.com

**Singapore**

Incremental flyover

> The Land Transport Authority (LTA) of Singapore undertook the construction of two twin flyovers at the Tampines Expressway (TPE)/ Sengkang East Road Interchange and TPE/Sengkang East Drive. Since the flyovers were to be constructed over an existing expressway, the incrementally launched method (ILM) was adopted so as not to interfere with or endanger with expressway traffic. VSL’s scope included the design of all temporary works, preparation of the casting yard, casting the segments, launching, post-tensioning, bridge bearings and expansion joints. Completion in September 2003.

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**NOTE PAD**

Taste for the forest - For the Moorebank Ave Interchange on the M5 Motorway in Sydney, VSL-Intrafor supplied 2 permanent VSoL® wall structures and offered a full range of architectural facing elements. The client selected a forest finish, a design used extensively on earlier sections of the M5 East project.

First segmental bridge - VSL constructed the Creve Coeur Lake Memorial Bridge near St. Louis: this cast-in-place segmental bridge, constructed by the balanced cantilever method with form travelers, represents the first major concrete segmental bridge project of the Missouri DOT.

Crossing the Yangtze - The stay cables for the North Channel Bridge, part of the Runyang Yangtze River Crossing linking Yangzhou to Zhenjiang, China, are in a semi-harp fan arrangement. They were installed using the VSL stay-cable strand-by-strand method, with a total of 720 t of non-galvanised, greased, 15.2mmØ strand.

PIP piles - Intrafor HK is designing and constructing the foundation for the extension of the Toi Shan School in Ma On Shan, using 50 PIP (Packed-In-Place) piles, 610 mm in diameter and 40 m deep. The PIP method is suitable to low-rise buildings and is almost the only recognised approved friction pile method in Hong Kong.

Slabs for distribution - VSL in Australia has started work on the second distribution facility at the Austrak Business Park, near Melbourne, Victoria: 36,000 m² warehouse with 160 mm-thick slabs and 15,000 m² of 210 mm-thick post-tensioned external pavement slabs.
**France**

XXL roof for upcoming Airbus

➔ Early 2003, VSL France successfully carried out the spectacular lifting of the roof on the S70 assembly workshop for the upcoming Airbus jumbo jet model A380. This 250-m long, 115-m wide structure with a weight of 7,500 t was assembled on the ground and raised as a single block to reach a culminating height of 46 m. The client’s main requirement was to hoist the roof at a rate of 2 m/hour with constant deflection, while respecting an elevation offset tolerance (to remain less than 50 mm). Lifting could thereby be driven by an automated program.

VSL France utilized a total of 28 SLU 330 jacks (330-350 t each), 16 hydraulic pumps and a remote-controlled system plus a Bravo lifting control system featuring displacement sensors at every lifting point [16].

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**France**

Difficult ground for high-profile project

➔ After ten years, Intrafor has returned to the “Cité Internationale” complex in Lyon with two new contracts: support structures for the parking garages for a planned 3,000-seat auditorium and additional office space. The architect for this high-profile project is Renzo Piano. The two excavations are enclosed by anchored diaphragm walls. Capitalizing on their experience in this area, Intrafor teams are well aware of the unstable and highly-difficult ground conditions: Rhone River alluvia, coarse clastic material. The two sets of anchoring rods that tie the diaphragm wall also necessitate considerable technical competence, as the second set is to be carried out in the presence of a high water load, by making use of an airlock. In addition, the project entails installing a studded shotcrete wall on one side along with the set-up and nearly 3-year monitoring of a pumping system to allow lowering the water table inside the enclosure.

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In March 2003, Intrafor has executed 965 permanent anchors on a sheet pile curtain within the soil of the Var River, near Saint-Laurent-du-Var. The soil composed of coarse alluvia, sands and boulders becomes unstable when employing conventional boring methods. This necessitated special roto-percussion tools with diameters of between 120 and 146 mm using both a sunken tool and a tube embedded into the grouting. An average hourly rate of one 16-m anchor bored and installed was achieved.

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The Dublin Port Tunnel provided the opportunity for the Intrafor/Mowlem-Piling consortium to execute the entire series of special foundation work as part of a major European infrastructure project. Over 50,000 m² of diaphragm walls have been completed (1,200 to 1,500 mm wall thickness). A work crew of fifty and no less than four D-wall excavation grabs and one cutter assembly were mobilized simultaneously, and three slurry treatment plants were used. In continuity with the diaphragm walls, a series of tangent piles 1,200 mm in diameter over a linear distance of 55 m were stayed throughout the preliminary phase prior to constructing the concrete structure. These 16 m-long piles are anchored into the bedrock. Additionally, a soil nailed wall (0 to 12 m-high, 850 m-long) provides for the provisional support of the black clays slopes. The studs (8 to 11 m-long) are drilled with air-percussion with a daily rate higher than 200 linear meters: i.e more than 100 m² of shotcrete are sprayed at the same time. Also 56 high-capacity (2,445-kN) rock anchors were placed at the toe of the wall and 210 units of rock bolts were drilled into the underlying rock. These works were performed inside the TBM returning shaft.

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France
1,000 anchors in the river

Ireland
Dublin Port Tunnel delivered

Tight frame – VSL in Chile has been awarded the construction of a 7 km-long viaduct, for the metro of Santiago project, including the supply of 3 launching girders, framework, post-tensioning and bearings, to be delivered in Sept. 2004.

Piles on fast track – For the high-speed rail link Paris-Strasbourg, Intrafor in a consortium is driving 276 piles associated with 9 civil engineering structures: 4,100 m of boring, amounting to 2,600 m³ of concrete for piles reaching depths of 25 m.

Highest wall – At the Collahuasi Copper mine in the desert near the border to Bolivia, VSL in Chile is building a 2,400m² VSOL® wall at a record-breaking altitude: 4,500 m.

Jet Grouting columns – Floodings in northern France in the winter 2002 have led to modify a series of locks over the coming years. Intrafor has widened an initial lock at Saint-Valery-sur-Somme and built a screen using the “Jet Grouting” technique to shore-up and water-tighten a dockwall.

Flexible screen – In Mauritius, the Midlands dam has now been flooded. For this dam, Intrafor constructed a 30,000-m² diaphragm wall: a flexible concrete screen to a depth of 14 metres, anchored to the rock.

Airlock boring – Due to a leak under the foundation raft of a caisson for the immersed tunnel underneath the Warnow River in Rostock, Germany, caused by damage to the temporary joint during installation, Intrafor grouted the raft under very low pressure (120 kPa) using a low number of borings of small diameter (56 mm) and a sealed airlock.
Far more complex than

Upgrading deficient but occupied structures is a challenging and growing segment of the construction industry. In the United States, VSL is a leading provider of structural strengthening solutions.

Case 1 External post-tensioning of athletic arena
VSL strengthened a university athletic facility utilizing a unique application of post-tensioning that provided a structurally elegant and aesthetically pleasing resolution.
The strengthening solution consisted of 4 hoops of 15.2 mm-10 strand, external multistrand tendons. Each hoop has tendons that were anchored and stressed at 90-degree intervals circumferentially around the dome. The tendons were fully encapsulated in high-performance, co-extruded HDPE ducts and grouted to ensure long-lasting durability.

Structural strengthening is the process of upgrading the structural system of an existing structure to improve performance under existing loading or increase the strength of the existing structural components to carry additional loads. A challenging aspect to this process is that...
deficient structures are occupied and functioning, therefore, the strengthening systems must be tailored to serve the intended use of the structure without interfering with its occupants or function. As a result of the higher load demands, existing structures may need to be reassessed and may require strengthening to meet heavier service loads. Structural strengthening may also become necessary due to code changes, seismic upgrade, deficiencies that develop due to environmental effects such as corrosion, changes in use that increase service loads, or deficiencies within the structure caused by errors in design or construction. The structural upgrade of concrete structures can be achieved using one of many different upgrading methods such as external or internal post-tensioning systems, span shortening, externally bonded steel, fiber reinforced polymer composites (FRP), section enlargement, or a combination of these techniques.

**External force**

External post-tensioning techniques utilized by VSL have been effectively used to increase the flexural and shear capacity of both reinforced and prestressed concrete members. With this type of upgrading, active external forces are applied to the structural member by means of post-tensioned steel cables or rods to resist new loads. Due to the minimal additional weight of the repair system, this technique is effective and economical, and has been employed with great success to correct excessive deflections and cracking in beams and slabs, parking structures and cantilevered members. The post-tensioning forces are delivered by means of standard prestressing tendons or high-strength steel bars, usually located outside the original section. The tendons are connected to the structure at anchor points, typically located at the ends of the member. End-anchors can be made of steel fixtures bolted to the structural member or using reinforced concrete blocks that are cast in place. The desired uplift force is provided by changing the profile of the post-tensioning element using deviation blocks, fastened at the high or low points of the structural element. Prior to stressing, all existing cracks are epoxy-injected and spalls patched, to ensure that prestressing forces are distributed uniformly across the section of the member.

**Additional support**

Span shortening is accomplished by installing additional supports underneath existing members to reduce the span length. To achieve this, structural steel members and cast-in-place reinforced concrete members are used. Connections can be easily designed using bolts and adhesive anchors. Span shortening method may result in loss of space, and headroom may be reduced.

**Bonded composites**

Fiber reinforced polymer (FRP) systems are paper-thin fabric sheets that are bonded to concrete members with epoxy adhesive to significantly increase their load carrying capacity. Usually carbon-
Far more complex than new construction...

Based, these systems can be used to increase the shear and flexural capacity of beams, slabs, and joists and can be used to increase the shear and axial load capacity of columns. An important characteristic of FRPs for structural repair applications is their non-corrosive properties, speed and ease of installation, lower cost, and aesthetics.

**Bonded steel elements**

In this method, steel elements are mechanically (anchors) or chemically (glued) to the concrete surface to achieve composite behavior. The steel elements can be steel plates, channels, angles, or built-up members. Steel elements attached to the sides or bottom of a structural member can improve its shear or flexural strength. A jacket made of steel plates can increase the shear and axial capacity of columns. The exposed steel elements must be protected with a suitable system immediately following installation. Regardless of the corrosion protection system specified, its long-term durability properties and maintenance requirements must be fully considered.

**Enlarged section**

This method of strengthening involves the placement of additional “bonded” reinforced concrete to an existing structural member in the form of an overlay or a jacket. With section enlargement, columns, beams, slabs, and walls can be enlarged to increase their load-carrying capacity or stiffness. Enlargement as thin as 50-70 mm for slabs, and 75-125 mm for beams and columns can be used to increase the capacity of the structural members.

**Best solution?**

Structural strengthening is a “scientific art form” with conventional cement-based materials, as well as new techniques and materials. A variety of expertise including technical (engineering), constructability (construction methods), aesthetics (architectural), and economics each play a role. Many opportunities exist for engineers, contractors, and material suppliers who can work together to supply their perspectives to an upgrade project. This explains the trend of design/build-type teams for delivering cost-effective solutions to owners. It should be recognized that strengthening assessment and design is far more complex than new construction. The degree to which the upgrade system and the existing structural elements share the loads must be evaluated and properly addressed in the upgrade design, detailing, and implementation methods.

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**Case 4 Innovative cement silo upgrade**

VSL achieved an innovative and cost-effective solution for the upgrade of six cement storage silos in Boston, Mass. with FRP rods. The use of near-surface mounted FRP rods supplemented the existing steel, and offered the durability benefits of the FRP composites while maintaining constructability and cost-efficiency. The rods were mounted in both the vertical and circumferential directions. Fiber optic sensors were attached to the FRP rods prior to installation and used to monitor strains in the composite bars while loading the silo. Over 16,000 meters of FRP rod was installed.

**Case 5 Post-tensioning Upgrade of Structural Beams**

Concrete encased external post-tensioning was effectively used to increase the flexural and shear capacity of the structural beams in a casino parking structure. Due to a change in loading conditions, the girder was found to be deficient in flexure and shear. Deviation of the standard prestressing strand was achieved by utilizing four transverse beams adjoining to the beam from both sides at approximately one third the span from each end. The cables were bundled together between the adjoining beams and were splayed toward the ends of the beam.
Cable dampers development

Promising friction for 15 years

Installation of dampers at bridge deck level on stay cables is the most common counter-measure for improving the structural damping of cables and reducing vibration. VSL designed a new generation of mechanical friction dampers to address maintenance problems with the existing products.

Until recently the most common solution was to install hydraulic or viscous dampers on the stay cables. The aesthetic aspects of these types of dampers, the way they react on temperature and the frequency on cable vibration could however be open to criticism. All these dampers may be subject to small, non-critical vibrations and they will very quickly have to support a high level of cycles. Consequently they may experience rapid deterioration and require frequent maintenance operations. With Professor I. Kovacs, who first developed the concept for cables, VSL is now introducing a second generation of these friction dampers for use on suspended structures.

The damper connects a specified point of the cable with the bridge structure and it consists of 2 parts. The first is a steel collar that is rigidly fixed to the cable and moves as the cable moves. This collar is equipped with 4 hard friction “partner” components. The second part is two spring blade half-ring pairs that are rigidly fixed to the bridge structure. Four soft friction “partner” components which are pressed against the hard friction partners are held by the spring blade rings. When the cable vibrates, friction force and damping reactions are produced between the soft and the hard friction partners, to counteract the cable movement. The flexibility of the spring blade rings allows the soft friction partners to follow the longitudinal movement of the cable.

For aesthetic reasons, the damper is generally placed near the anchorage. The vibration amplitude at the damper point of the cable is then not more than 1 mm or 2 mm. Any play or flexibility in the unit would lead to a loss of the efficiency. Some damper designs are not compatible with these small cable amplitudes and have to be placed at a greater distance from the anchorage. The new damper works in any direction of cable motion. At small amplitudes of cable movement, the friction parts are designed to stick and hence prevent the damper from coming into play. Dampers are adjusted so that they begin sliding as soon as a predefined amplitude is reached.

Long term performance has been assessed: a total of 120 VSL friction dampers have been installed on the stay cables of the Uddevalla Bridge (Sweden ) in 2000. After two years of service, 25% of the dampers were investigated to check their conditions. During this period of two years, since the opening of the bridge to the car traffic, the bridge has been subjected to varying wind speeds and no cable vibration has been observed. This maintenance operation confirmed the ease with which each element of the unit could be examined and replaced, if necessary. The performance that was measured after the first two years has lead to a predicted period of more than 15 years before replacement of the friction partners would be required.
Mega Tower project in Hong Kong

Highest of technology for highest building

As a member of the contracted joint venture, Intrafor has participated in building the renowned Union Square Mega Tower, a prestigious skyscraper among the highest in the world. A unique and challenging foundation job.

In 2007, Hong Kong’s Mega Tower will rise 480 meters above the inlet of the sea that separates the city of Kowloon from Hong Kong Island. This structure has been designed by the architect Kohn Pederson Fox, with Sun Hung Kai Properties Limited acting as the developer: this venture represents the seventh and last component within the overall Kowloon Station Airport Railway project. Intrafor, as part of the selected consortium, was awarded the contract for foundation work with a total budget allocation of 650 million Hong Kong dollars. The works program started up in January 2002 and was forecasted to run through May 2003.

Tough rocks

The contract schedule called for completion of the foundation work by May 2003 in acknowledgement of two major constraints typical of Hong Kong building conditions: speed of construction and respect for the environment. As opposed to the competing solutions that entail boring large-diameter piles anchored into the rock (a method very commonly encountered in Hong Kong) or the use of driven H-piles, the solution proposed by the joint venture consisted of a diaphragm wall in combination with floating friction barrettes that lie flush with the rock; the “shaft grouting” technique has been adopted to enhance the performance of these units. No less than 40,000 m³ of soil investigation boreholes and 5 test barrettes loaded up to 4,500 t (i.e. 2.5 times the working load) were carried out, in conjunction with the monitoring of adjoining structures and buildings including real-time data recovery, in order to prepare for the actual works.

The daily rate of 135 m³ of excavated volume required

- 2 hydrofraises
- 1 BC 40 cutter
- 3 bentonite recycling plants
- 1 bentonite mixing plant
- 1 slurry mixing plant
- 1 wastewater treatment plant
- 4 cable-operated grabs
- 6 to 12 lightweight drilling rigs
- 2 SM 400 drilling rigs
- 1 grouting unit for cracking the “Manchettes”
- 3 grouting stations
- 32 grouting hose reels.

The joint venture mobilized no less than 130 staff in order to provide 400,000 man-hours on the worksite, including the preparation and prefabrication zones.
The works performed included a circular wall 1.5 m thick and 75 m in diameter, along with 240 barrettes. The circular wall will serve for the excavation of a 25-m deep basement. The overall capacity of the 76-m deep diaphragm wall has to be enhanced using the shaft grouting technique given that it's a load-bearing element.

The 240 Barrettes (87 with a cross-sectional area of 2800 x 1500 and 143 of 2800 x 1000) were excavated to an average depth of 83 m and a maximum depth of 104 m. The concrete has been poured up to 24 m below ground level and topped with lean concrete. The load-bearing capacity of these units, enhanced by the shaft grouting, gets cumulated with the capacity of the diaphragm wall in order to support the building.

An extremely haphazard substratum featuring semi-vertical dips and extending to depths of over 105 meters.

It thus proved necessary to set a total of 130,000 m³ of concrete within a very short time frame of 11 months and, even more constraining, using just a 6,500 m² work platform with little maneuverability, engendering a high risk of work stoppage. Among the measures adopted to incorporate these conditions, a series guide walls were included in the working platform and fitted with a cover capable of resisting the loads of heavy equipment, making it possible to avoid traffic encumbrance in between two successive foundation operations. The supply networks handling water, air, bentonite, electricity and slurry were undergrounded beforehand and routed between the various structures.

A truck every 3mn

Material storage and equipment stowage on the platform was forbidden. Other design features included: subassemblies repaired off site, packing lists prepared in advance to allow for instantaneous unloading, prefabrication work performed outside, compactness of the bentonite and slurry mixing and recycling plants reengineered and optimized. These measures enabled, under appropriate safety conditions, attaining 100,000 truck entrances/exits on the platform, at a pace of 40 per hour.

Testing/controls implemented before and after the works

- 40,000 slump tests conducted with a 99.9% success rate
- 128,000 m of KODEN excavation profiles to establish excavation geometry prior to concreting
- 150,000 m of sonic testing
- 400 confirmations, via core sampling, that the bottom had been accurately located
- 2 pumping tests
- 4 full scale static load tests, on the working barrettes.

Five test barrettes loaded up to 4,500 tons (i.e. 2.5 times the working load) by means of a 575-m³ of steel, in order to validate the enhanced load-bearing capacity of the barrettes.
VSL-Intrafor has recently completed the deep foundation works for the new Museum of Primitive Arts in Paris. This showcase project is designed by Jean Nouvel who is also overseeing project construction. The works are taking place along the Seine River, just steps from the Eiffel Tower.
1 **Excavation of a barrette:**
Over its underground portion, the museum project has necessitated the installation of diaphragm walls and deep foundations within a building context particularly sensitive to environmental issues.

2 **Bored pile, performed under bentonite.**
Intrafor installed 29 pre-bored H-column piles.

3 **Application of temporary guide casing for the pre-bored H column.**

-Alain Saleh, supervisor and Laurent Cayet, site manager
4 Welding of the reinforcement cage on the H column.

6 Placement of the pre-bored H column into the excavation.
5 The pre-bored H column and its reinforcement cage is lifted prior to installation in the excavation filled with fresh concrete.

7 Installation of the pre-bored H column in fresh concrete.

8 The noise-nuisance generated by the worksite is measured and limited according to very strict regulations, in conjunction with real-time measurement data-transmission.
KEEPING THE DECIBELS LOW

The foundation job for Paris’s new Museum of Primitive Arts was split into two distinct contracts. The first set of works comprised 18,000 m² of diaphragm wall (116 panels in all), 70 piles, 30 anchors and 12,000 m³ of excavation. The second contract, in which Intrafor has been subcontracted to stabilize both the diaphragm wall and the excavations, was concluded in July; these works entailed setting up anchors on the Seine River side as well as a girder on the side along the rue de l’Université.

This effort has encompassed the installation of 140 foundations, including 29 pre-bored H-columns, 86 piles, 14 barrettes and 76 temporary anchors. The Northern retaining wall is held in place by two tiers of anchors (56) applied at 1.30 m and 3.10 m from the top of the wall, and with a load-bearing capacity of 470 kN.

Laying the girder designed to resist diaphragm wall horizontal thrust during the temporary phase necessitated constructing, as of the excavation phase, a portion of the Museum’s permanent ground floor slab. This structure has been cast on a series of 29 pre-bored metallic piles and sits atop the diaphragm wall built as part of the scope of works for the first contract. The other foundation elements consist of 86 piles and 14 bored barrettes, all performed from an intermediate platform located at a depth of 4 m below street level. Pile diameters vary between 0.6 m and 1.5 m, while barrette thickness ranges from 0.62 m to 1.02 m.

Foundation works have been completed since March. Delivery of the subgrade excavation and acceptance of both the piles and barrettes took place during July. Each component of this overall works program has been subjected to a strict inspection of noise emissions and vibrations in order to minimize the noise nuisance generated by the worksite for neighboring residents as well as to avoid any risk of degradation to adjacent buildings. An automated and permanent noise/vibration monitoring system was installed at several locations throughout the site, in conjunction with real-time measurement data transmission. This system triggers an alarm whenever site-produced noise exceeds established thresholds.

Diaphragm wall and pre-bored H columns for support of the future slab. A portion of the Museum’s ground floor has been cast on the bored piles and sits atop the diaphragm wall.
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