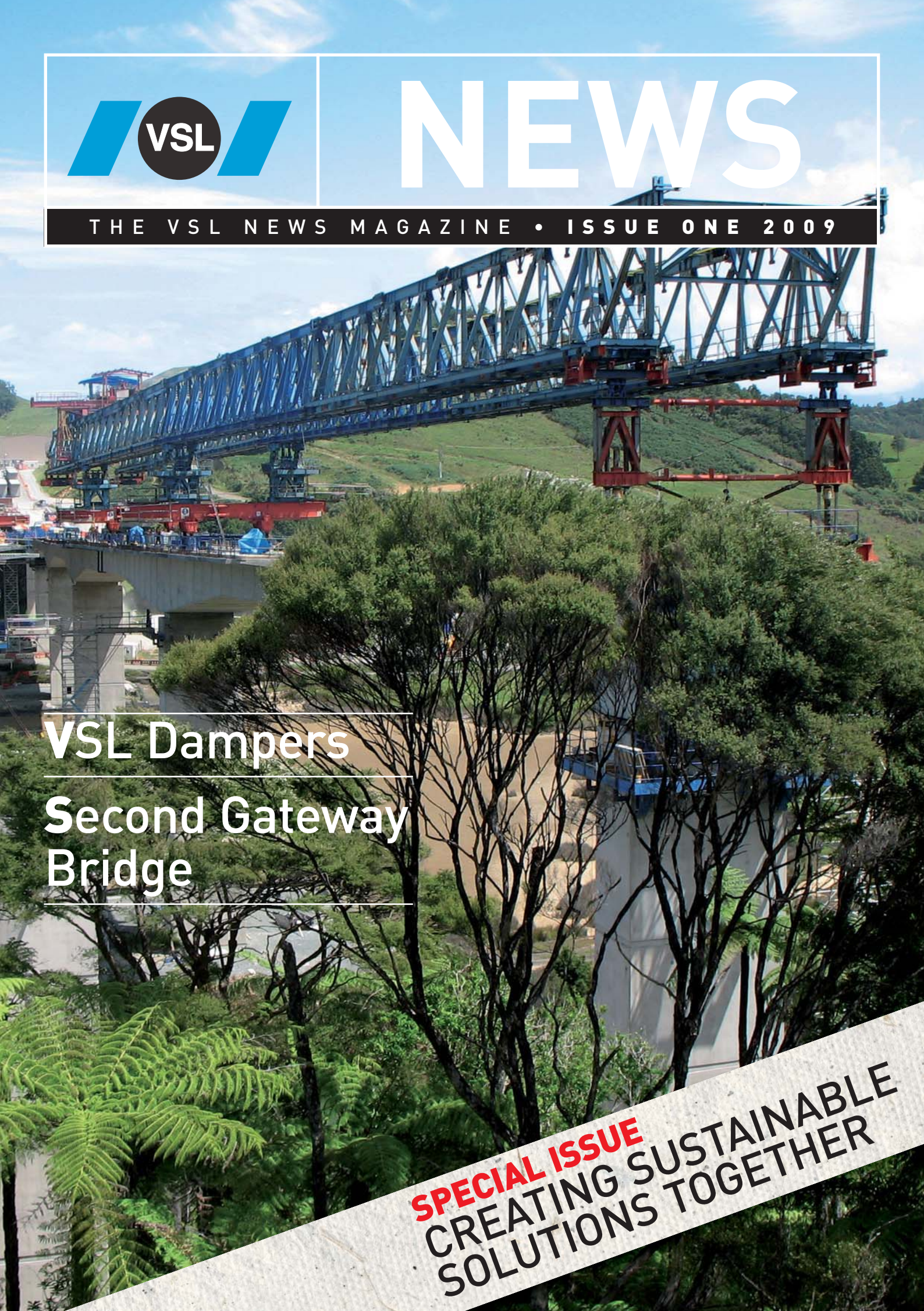

NEWS

THE VSL NEWS MAGAZINE • ISSUE ONE 2009

VSL Dampers

Second Gateway Bridge

SPECIAL ISSUE
CREATING SUSTAINABLE SOLUTIONS TOGETHER

highlights

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Cover photo: Environmental friendly construction techniques on the Alpurts Waivera viaduct

EDITORIAL

Key partner for sustainability

In this current worldwide turmoil, it is more that ever important to run our business according to safe and sound rules in terms of management of projects, contracting, execution of works, cost effectiveness and quality.

However, performing to our clients' total satisfaction also means today showing ourselves at the cutting edge of sustainable development. First of all, to acknowledge our world citizenship and our will to preserve our environment, whatever it is for each of us worldwide. Secondly, to enhance VSL's position as a key partner in construction, providing solutions to be seen as pragmatic, specific, efficient – and durable.

This means not only complying with environmental standards, not only having sustainable development as a structural element of our business plan but also having sustainable development issues leading us to change the way we do business. We want to build up even better solutions and address our client's challenges with a different approach. Sustainability is one of the clues.

Jean-Philippe Trin, CEO

Russia
Repeat business

→ **VSL has participated on another project** with main contractor Mostostroy 6 and subcontractor Mostootriad 75, following on from the success of Okhta Bridge 1. A modern cable-stayed arch bridge has replaced a 1948 wooden crossing. The name remains the same: the Lazarevskiy Bridge over the Malaya Nevka, or Small Neva River. The bridge has a 27m-high slanted arch and features the VSL SSI 2000 Stay Cable system. Installation of the 10 stays began towards the end of the harsh Russian winter in February 2009 and took just two weeks as the bridge opening was scheduled for 20th March. Work began with the 83m longest cable and finished with the 21.5m shortest one. Design and supervision has been carried out by Stroyproekt. ■

Contact: christophe.petrel@vsl.com

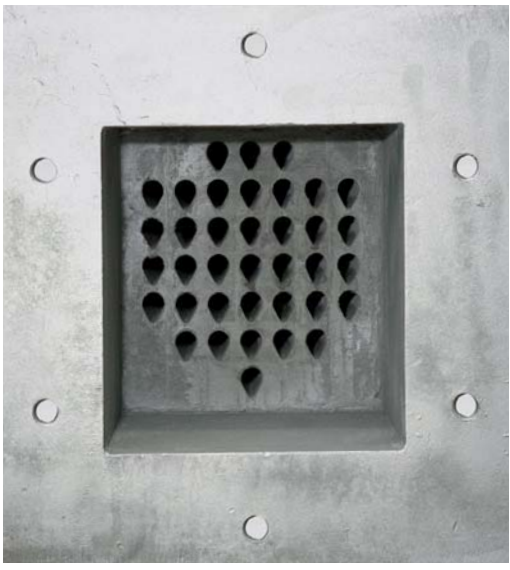
Post-tensioned slabs
Extended portfolio

→ **CTT-Stronghold is extending its portfolio** for slab post-tensioning with several major airport and bus terminal projects on the Iberian Peninsula. It is currently involved in schemes for Murcia Airport, Gibraltar Airport and the new Madrid central bus station. VSL's Bondtech® bonded monostrand post-tensioning system has been the solution of choice this year for many of the region's transport facilities. The new projects all require an easily-installed system to meet specific requirements in terms of openings for stairs, elevators and other services. Allowance also has to be made for additional openings that may be required once the terminals are in use. Achieving the demanding construction schedules of these types of projects requires monthly production rates of between 15,000m^2 and 20,000m^2. ■

Contact: posso@vslsp.com

VSL saddle
Workshop facility in Hong Kong

→ **VSL Hong Kong has recently established a workshop facility** for manufacturing its new generation of saddles, which improve load transfer from cable to pylon in the SSI 2000 Stay Cable System. After a few months of trials, the facility has been tested, inspected and is now in production.



The particular geometry of the VSL Saddle

The saddle is rectangular in shape and made of Grade S355 steel. Manufacturing requires precision assembly and sophisticated techniques for injecting the high-strength Ductal® mortar used in the saddle. A twin drum mixer has been developed for the Ductal® to ensure compliance with stringent quality requirements. VSL Hong Kong has already produced eight S6-37 saddles and 28 of the S6-31 model for India's Moolchand Bridge, Delhi Metro and Mumbai Metro projects. ■ *Contact: henrypc.chan@vsl-intrafor.com*

Offshore

Lift and lower on Emeraude

→ **VSL has played a key role in the installation of an offshore oil platform in Congo-Brazzaville,** working on the lowering of the substructure and lifting of the platform itself. The Heavy Lifting project started in 2008 with the delivery of equipment that included 16 SLU and SMU 580 units as well as high-capacity hydraulic pumps and a laser height control system.
VSL provided 8,800t lifting/lowering capacity to meet the strict offshore safety requirement for 100% redundancy. The equipment was installed onshore in the shipyard in Casablanca, Morocco, where the structure was fabricated. The platform was then transported by sea to Pointe Noire on the coast of Congo. The VSL-HL team carried out its work on a continuous schedule in two shifts, first to lower the substructure to the seabed and then to lift the platform into position. Lifting of the 4,000t Emeraude project took place successfully in difficult offshore conditions in February. ■
Contact: peter.siegfried@vsl.com

Power station

40 lifting units together

→ **An environmentally-friendly coal-fired power station** with a twin 335MW output is quickly taking shape on Bulgaria's Maritza-I plains at Lake Galabovo. VSL was entrusted with the heavy lifting works which included a steel drum, gas flue ducts as well as front and side walls with weights up to 600t. The most demanding lift for each block was the pressure vessel, which was assembled and lifted in several steps to the full height. Each had a total weight of about 1,900t. At times, all the overlapping operations required the use of more than 40 lifting units together with the necessary pumps and controls. Various types of lifting units were used, ranging from 10t to 330t capacity.
The jacking platform was about 100m above ground. ■ *Contact: rolf.oesch@vsl.com*

NOTE PAD

21 access bridges. *VSL Middle East has been appointed by contractor Alor to supply and install the post-tensioning for 21 access bridges in what is set to become one of the world's largest waterfront cities, the Al Raha Beach development. Some 1,900t of PT strands have already been installed. Most of the bridges feature the enhanced corrosion protection of VSL's PT-Plus® ducting. VSL's work also includes provision of bearings and high-tensile threaded bars.*

Full service slab. *Successful application of post-tensioned slab-on-grade technology in a Czech Republic hangar has led to use of the same technique for Aviation Service's capacity expansion at Ruzyne Airport. The project features a 58m by 31m joint-free concrete slab, designed to handle the 22.5t point loads of Gulfstream V aircraft. The main contractor is Konstruktiva Konsit and VSL CZ supplied a full-service package including slab design in co-operation with VSL Spain and Helika.*

ASQPE certification

→ In March 2009, VSL France was awarded the ASQPE (Association for the Qualification of Prestressing and Equipments for Building and Civil Works) certification to introduce prestressing processes involving post-tensioning. VSL thus becomes the first company to enjoy such recognition both in France and throughout Europe. Certification was only issued once compliance with all applicable European and French standards had been satisfied through audits conducted by independent bodies. ■

Creating sustainable so

Sustainability addresses social and cultural issues, economic constraints and the need to maintain or improve the quality of the environment. Sustainability means meeting the needs of today without compromising the ability of future generations to meet their own. This approach is no longer a novelty: such concepts are being integrated into nearly all aspects of life today.

Within VSL, sustainable construction means changing the way we do business: providing ever

lutions together

safer methods of construction and ways of using fewer scarce resources and less energy, while causing less pollution and producing less waste. We aim to produce schemes that ultimately require less maintenance and are easier to recycle, yet still achieve the required level of specification. Many of VSL's systems and technologies are already contributing significantly to these aims. VSL however does not limit the effort to construction techniques but also strives to improve on many aspects of its activities for the benefit of all. Overview.

CONSTRUCTION

Sustainable solutions and construction with VSL

In the construction industry, sustainability focuses on economic and environmental aspects: the life cycle cost of structures, environmental-friendly construction materials, energy efficiency and resource consumption, as well as construction and demolition waste management. Increasing importance is also being given to the efficient, effective and responsible operation of businesses and buildings, including decommissioning and de-construction. In particular, the replacement of key infrastructure such as bridges and roads is becoming increasingly difficult due to issues such as traffic disruption, site access and congestion and public nuisance. The construction industry therefore has to find ways of building that minimise the impacts throughout construction, the structure's life and its eventual decommissioning or replacement. Typically, this involves guaranteeing a long design life, and generally providing durability with low maintenance requirements. Such issues are all being addressed by VSL.

CO_2 footprint with materials for PT

CO_2 emissions for concrete are mainly due to cement production (Portland clinker) as the CO_2 emissions for other constituents are marginal:

Global average	0.85t CO_2 / tonne cement
Low	0.65t CO_2 / tonne cement
High	0.92t CO_2 / tonne cement

However, some allowance should be made for concrete mixing. This adds about 15% to the CO_2 total and so a value of 1t CO_2 / tonne cement is suggested for consideration in any assessment. Concrete reabsorbs CO_2 during its life due to carbonation, with major absorption at the time of demolition when the concrete is crushed.

CO_2 emissions can also be attributed to the reinforcing and prestressing steel:

Global average	0.59t CO_2 / tonne steel
Low	0.15t CO_2 / tonne steel
High	1.08t CO_2 / tonne steel

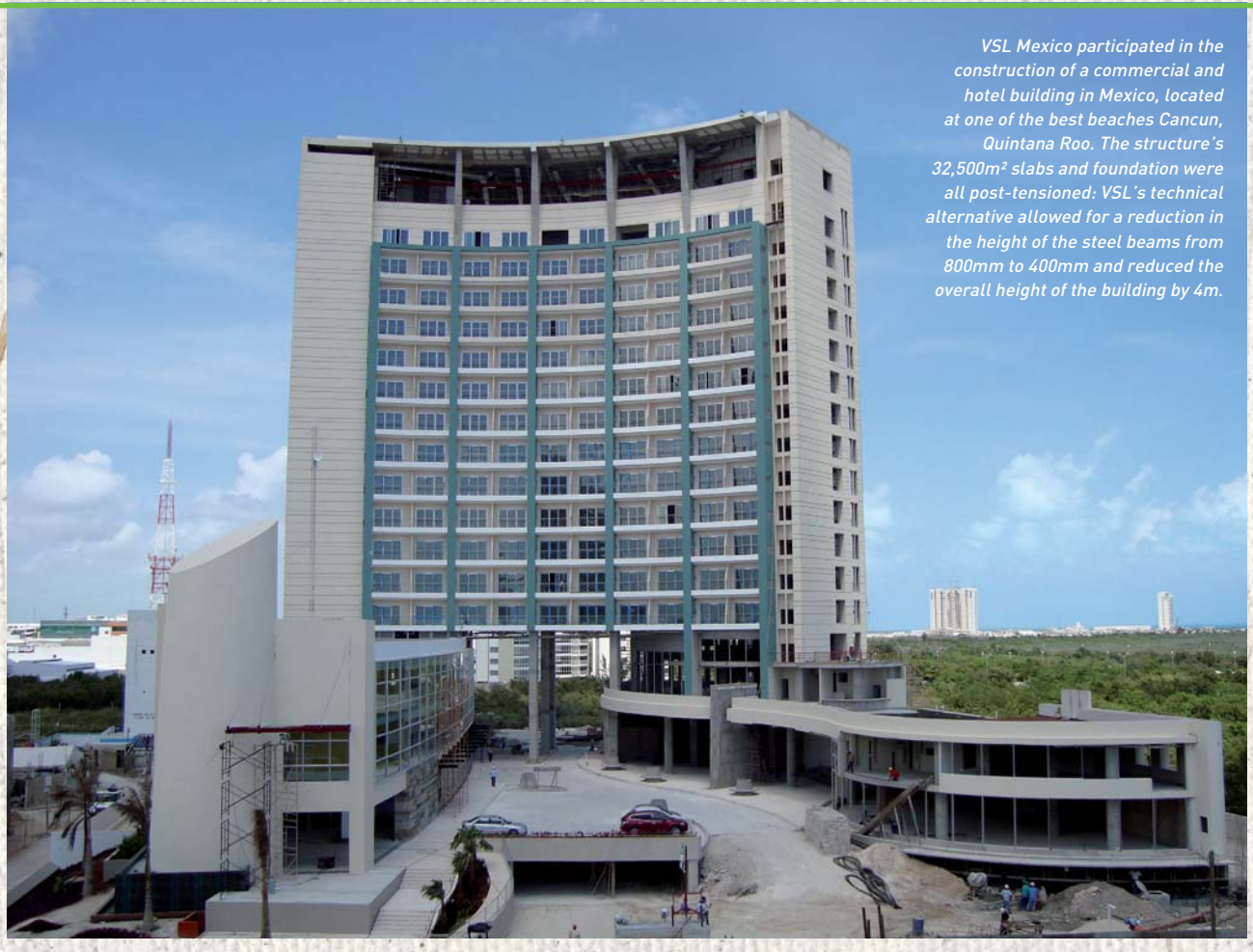
These values apply to the manufacture of bars and rods in an electric arc furnace. Production methods of rod for reinforcing and prestressing steel have similarities and so in a first approximation, the CO_2 emissions for both steels are taken as equal. Structural steel sections produced in a blast furnace have a global average of 1.97t CO_2 / tonne steel.

DESIGN PT as an environmental friendly solution

PT instead of reinforced concrete

The emission of greenhouse gases, specifically CO_2, is the most common way of measuring the environmental impact relating to the energy use for an activity. However, the constant and rapid changes within the construction industry and the nature of the projects add to the complexity. Greenhouse gases are emitted during the production, transportation and assembling of materials but one also has to take into account the construction method, operation, maintenance and eventual demolition of the structures. The energy consumed during construction of an office building represents only between 5% and 15% of the total energy used during a 100 year design life.

As an example, consider a typical office building. Various features of post-tensioning - VSL's core business - help reduce CO_2 emissions of projects when compared with the same building constructed in ordinary reinforced concrete or composite steel-concrete. Optimised post-tensioned structural cross-sections allow thinner floors and slabs giving more slender structures that result in immediate reductions in concrete volume of the order of up to 25%. More slender floor construction also results in savings in building heights of 5% or more, which brings with it savings in curtain wall costs, mechanical and electrical installation costs and in general fit-out costs. There can also be reductions in the visual impact of a building. In addition, the use of high-strength prestressing steel, rather than only reinforcing steel, can lead to a reduction of the total tonnage of steel to be installed by up to 65%. Slender floors also reduce the foundation requirements. Maintenance needs are often reduced and design life extended. And buildings with post-tensioned floors generally provide more usable space and offer increased flexibility in use. Overall, post-tensioned structures have a



VSL Mexico participated in the construction of a commercial and hotel building in Mexico, located at one of the best beaches Cancun, Quintana Roo. The structure's 32,500m² slabs and foundation were all post-tensioned: VSL's technical alternative allowed for a reduction in the height of the steel beams from 800mm to 400mm and reduced the overall height of the building by 4m.

significantly reduced environmental impact when compared with more traditional construction methods.

PT to reduce greenhouse gases

In a typical office building, floors with VSL post-tensioning systems require less material, using it more efficiently. The savings in concrete and steel are of the order of 25% and 55% respectively, resulting in an overall reduction in the carbon footprint of between 25% and 30% for post-tensioned floors. In office buildings, floors and foundations represent about 50% of the cost of the structure, accounting for roughly 50% of the materials and up to 75% in the case of car parks. As a consequence, post-tensioned floors achieve a significant reduction of about 15% in the CO_2 emissions for the total building construction. In long span floors with increased floor thickness, it is possible to introduce void formers and thus reduce the concrete volume and CO_2 emissions by an additional 20%. Hence, VSL post-tensioned floors can reduce the emission of greenhouse gases for typical office buildings by 15% to 25%.

PT offers significant reductions

Materials and quantities	RC (kg CO_2/m^2)	PC (kg CO_2/m^2)
Concrete (300 kg cement / m^3)	105.1	84.0
Reinforcing steel	24.8	8.3
PT steel	0	3.0
Total CO_2 emission	129.9	95.3

The overall reduction of CO_2 emission can achieve up to 27%!

RC: Reinforced concrete *PC: Post-tensioned concrete*

CONSTRUCTION Save natural resources during execution

Optimise design with reusable equipment

Contributions to sustainable construction and to more environmentally-friendly execution of work have been part of the VSL Technical Centres' objectives for a long time, as is clearly visible when looking at the broad range of VSL's activities in engineering for bridge and viaduct construction. The main scope of engineering works covers – among other aspects – the design and detailing of major erection equipment such as launching gantries, lifting frames, and form travellers. VSL's Technical Centres assist other parts of VSL around the world in saving thousands of tonnes of steel in new fabrication of erection

equipment through optimised design and, in particular, the reuse of existing equipment.

For example, a single gantry has erected about 2,700 segments on four projects. It proved to be a sound investment for VSL Malaysia to take back the Second Link gantry used on the Mekong River crossing after two years duty on the Pakse Bridge in Laos. The gantry was immediately reused for the Bayan Baru Viaduct, followed by the Subang Kelana Link Project in Kuala Lumpur. Reuse of the erection gantry saved an estimated 1,100t in new steel fabrication for the last three projects.

Another example is the VSL underslung type-II gantry that was first commissioned for the construction of the West Rail Project in Hong Kong in 1999, where eight gantries were used to erect 8,050 segments. By early 2009, this family of gantries has been deployed to eight other projects around the world, including three other viaducts in Hong Kong, two in Australia, one in China, one in Thailand and one in South Africa, successfully erecting about 18,000 segments overall. Estimated savings in new steel fabrication for erection gantries have been in excess of 5,140t.

Bangalore - Hosur Elevated Expressway

Two overhead gantries were commissioned for the Deep Bay Link Project in Hong Kong in 2004 for the erection of precast segmental viaducts weighing up to 910t per span. Following on from this project, the twin gantries were assigned to two different parts of the world, with one erecting bridge decks span-by-span on the Suvarnabhumi Airport Rail Link in Thailand, while the other was adapted to execute free cantilever construction of the Alpurt Waiwera and New Market Viaducts in New Zealand. To date, about 4,500 segments have been erected by the two gantries. The savings in new steel fabrication of erection gantries for the last three projects amounts to about 2,000t. Other savings in new steel fabrication in precast segmental construction projects are obtained by reusing lifting frames, as seen on the Lai Chi Kok Viaduct when the lifting frames from the Shenzen Western Corridor and the West Tsing Yi Viaducts projects were reused.

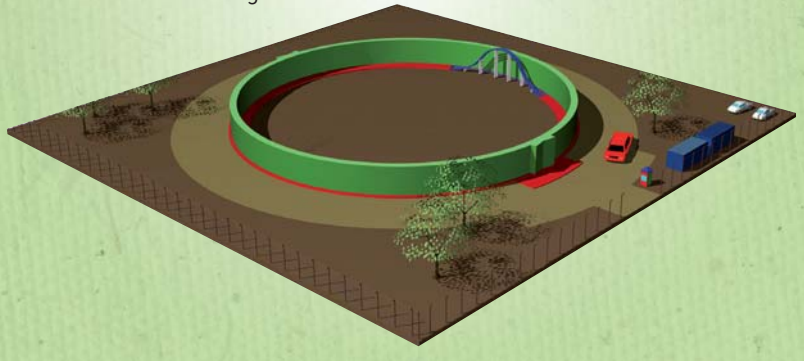
VSL's Technical Centre in Singapore has also developed reusable erection equipment for methods other than precast segmental construction:

Segregation of waste materials: Recycling roll-out in Abu Dhabi

VSL Middle East is cooperating with the main contractor on the Al Zeina Project in Abu Dhabi to recycle materials by putting waste paper into dedicated bins, disposing of waste ducting in a designated area and implementing similar actions in its own premises. An objective for 2009 is to ensure segregation of all waste materials in the warehouse including steel, timber and plastic.

Anticipate waste generated by business: Nuclear mock-up conversion in France

VSL has built a 3m-high full-scale mock-up of a nuclear containment vessel to demonstrate the efficiency of VSL post-tensioning solutions for the latest reactor designs. The construction of the mock-up in central France was completed in 2007, with tests and client presentations ongoing throughout 2008. As part of VSL's own policy requirements, plans were made prior to construction of the mock-up to avoid the need for demolition, thanks to an innovative initiative that provides both environmental and social benefits. An agreement was signed with the local community prior to construction, whereby once the mock-up tests had been completed, the structure was given to the local community for use as much needed rainwater storage tank.



One of the overhead gantries commisioned for the Deep Link Bay project before being adapted and assigned to other projects.

- The development of the VSL modular form traveller for free cantilever bridge in-situ construction allows relatively simple and straightforward recycling for similar bridge geometries. The VSL modular form traveller can be adapted to complex geometry and other constraints, as for the construction of decks for cable-stayed bridges such as the Bai Chai Bridge in Vietnam.
- Lifting frames for steel segment erection of cable-stayed bridges can be reused, as in the case of the Industrial Ring Road Bridge followed by the Southern Outer Bangkok Ring Road, both in Thailand.
- Adaptation was carried out of a precast I-beam erection gantry for the Nan River, Pamok, Ramindra Bridge and the Thalingchan Bridges, in Thailand. One gantry was also sent to the Cebu Viaduct and subsequently the C-5 Ortigas Bridge in the Philippines.
- Reuse has also been possible for miscellaneous temporary steelworks, such as the launching nose for the Kemana Bridge in Malaysia, an incrementally launched bridge and pier cross-head support beams for Deep Bay Link in Hong Kong.

Reduce energy consumption on worksites: Fuel savings in India

VSL India procured three launching gantries to construct a 9km-long elevated highway project in Bangalore. The gantries were equipped with 180KVA generators for the power supply of the winch and other operations. These 180KVA generators are required for the winching and launching operations only. However, these operations take up only about 25-30% of the total operating time, and usually, these generators are the only ones provided with the equipment. VSL procured a second smaller generator of 30 KVA to work the rest of the time when the larger generators are not required. The fuel consumption of a 180KVA generator is about 15-16 litres per hour compared to 4-5 litres per hour for a 30KVA one. By providing a 30KVA generator to all three gantries, the project saved about 120,000 litres of fuel and the cost of production was reduced considerably. There was also a saving in relation to maintenance of the generators, and in particular from less wear on the large ones.

LIFE CYCLE Enhance durability

Three levels of protection for tendons

In addition to the savings in material, time and energy, VSL post-tensioning systems provide a whole range of advantages that offer improved serviceability and help reduce maintenance costs. Reducing extensive maintenance and repair work is becoming an increasingly important issue because of the high costs involved. The protection of structures against corrosion is a critical challenge for project owners and becomes even more vital for post-tensioned structures and post-tensioning cables subjected to aggressive environments. VSL has developed solutions that improve durability and give owners greater peace of mind. Various solutions provide increasing levels of corrosion protection to suit the particular environment and structural details. An approach with three Protection Levels (PL) has recently been proposed by the International Federation of Structural Concrete (fib).
Protection Level 1 involves placing the tendon in a metal duct with a void filling material to provide a high degree of corrosion protection in cases where there is a fairly low exposure to an aggressive environment. The HPI® high-performance grout developed by VSL provides additional protection and has been specifically designed to improve the corrosion protection of anchorages and cables.
Protection Level 2 consists of PL 1 plus a corrosion-proof envelope over the full tendon length, creating a leak-tight barrier. The VSL PT-Plus® plastic duct (see box page 17) for post-tensioning cables

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TRUST

Foster a trusting relationship with its clients, based on consideration, transparency and innovation.

Innovation: PT observer

In today's competitive business environment, it is of utmost importance to provide clients with new ideas and so VSL initiated the Innovation Awards in 2008. Among the many interesting topics and proposals was the winning initiative, a new development called the PT-Observer. Recording stressing results and producing contractual documents for clients and consultants is a necessary and time-consuming process, requiring various levels of checking to avoid transcription errors. For instance, on the Al Zeina project in Abu Dhabi there are approximately 27,000 post-tensioning tendons, which equates to more than 200,000 quality records or pieces of paper, requiring more than three years of one engineer's time for processing alone, excluding checking time.

PT Observer is able to record and exchange complex formulae such as those used during tendon installation, stressing (calculating and verifying elongations) or grouting.
Once fully launched, the new system shall be able to use electronic tagging of components as the basis for meeting the challenge of ensuring quality and efficiency for all the post-tensioning materials as well as for the design and supply chain. It shall enable location tracking for logistics and quality control and the use of material characteristics for calculation. Distributed databases and websites can be used to exchange information while tablet PCs and rugged personal digital assistants allow the capture of information at source. This avoids the need for double-entry of data and eliminates transcription errors.

The main benefit of PT-Observer is a reduction in administrative labour and cost, but it also improves the quality of works and ensures traceability and easy reuse of information. ■

Listening to clients: Client survey

Indicators and follow-up actions are regularly undertaken by VSL to make sure that clients' expectations are met.
An international survey has been organised recently in 20 countries and involving 2,500 clients and consultants about the quality of services provided and client needs for future developments.
The answers showed consistency among the countries where VSL operates. Reputation and experience, based on a strong technical know-how and expertise, are noted amongst VSL's key strengths. It was also established that VSL provides good quality products and excellent technical back-up on projects.
Clients also suggested improvements. Although well interconnected internally, VSL's network is not always perceived as transparent, since clients operating in several countries might have to deal with different representatives according to VSL local offices. The strength provided by this decentralised organisation based on local subsidiaries with strong internal networking to address all types of demands needs some kind of adjustment and trust from clients. ■

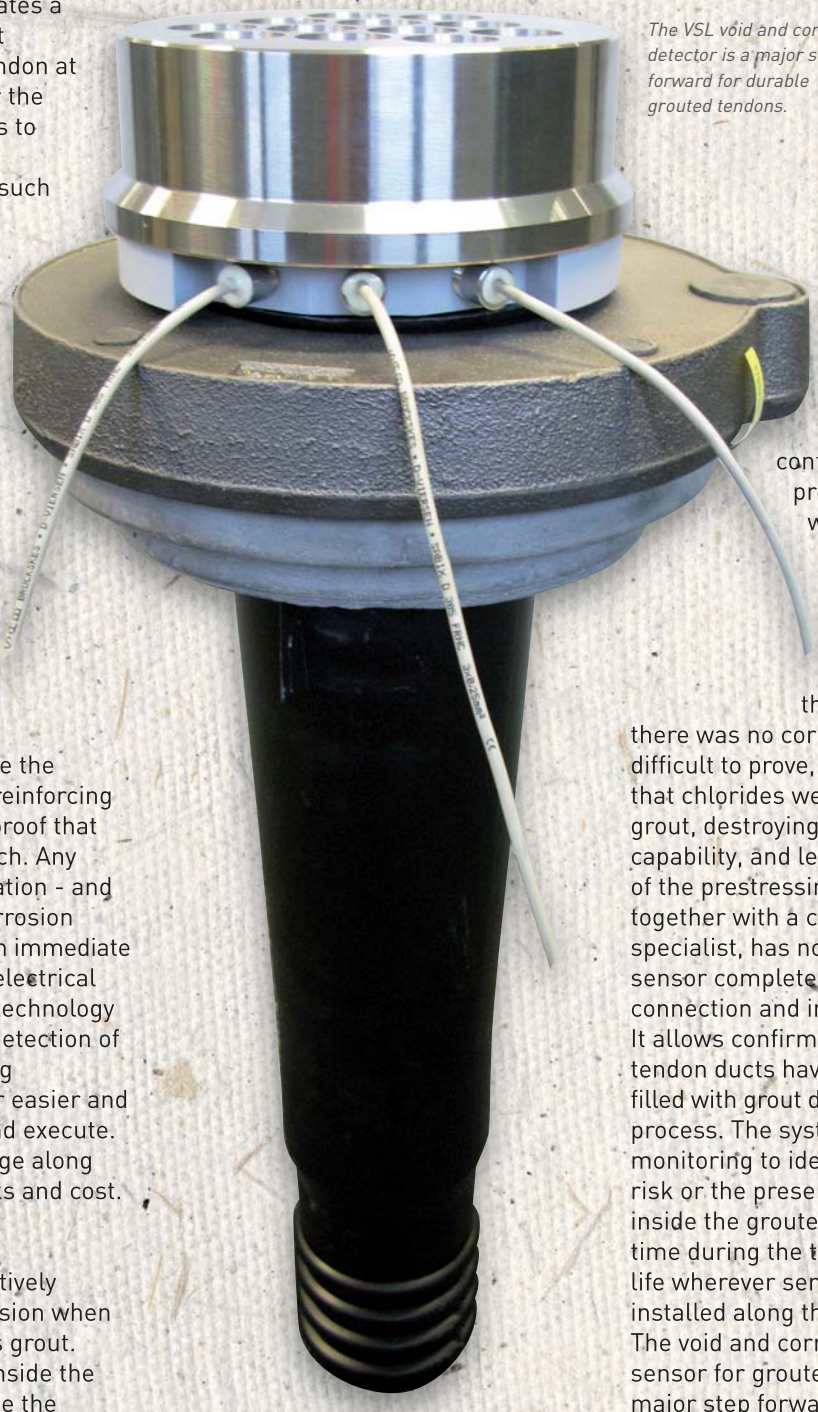
Certifying in 2009: Commitment to the highest quality

An important part of VSL's reputation rests on the company's quality and safety performance and increasingly on environmental performance, too.
Simply put, clients employ VSL because they trust that VSL will do a good job. To help demonstrate VSL's capability in terms of Quality-Safety-Environment, there is now a commitment to a comprehensive certification programme encompassing ISO9001, ISO14001 and OHSAS18001. This commitment builds on efforts that started in the mid-1990s, initially focused on quality. To date the following progress has been made:

	Business Units Certified	Turnover covered
Quality (ISO9001)	18	66 %
Environment (ISO14001)	4	23 %
Occupation Health & Safety (OHSAS18001)	7	26 %
Fully certified	3	22 %

VSL plans to add 24 new certifications in 2009, as well as taking the fairly unusual step of certifying the group head office and regional management activities. ■

fulfils this requirement and has become a standard in many countries. The duct creates a complete and leak-tight encapsulation of the tendon at the anchorage and over the free length of the cables to prevent any ingress of aggressive substances such as chlorides.
Protection Level 3 consists of PL 2 plus the capability to monitor and inspect the integrity of the tendon or tendon encapsulation at any time during its design life. VSL electrically-isolated tendons (EIT) allow ongoing monitoring of the tendon encapsulation.
A high electrical resistance between the prestressing steel inside the encapsulation and the reinforcing steel outside provides proof that there has been no breach. Any breach in the encapsulation - and therefore risk to the corrosion protection - results in an immediate and significant drop in electrical resistance. EIT tendon technology therefore allows early detection of any deficiencies, making maintenance and repair easier and cheaper to both plan and execute. It prevents major damage along with the associated risks and cost.



The VSL void and corrosion detector is a major step forward for durable grouted tendons.

Detecting voids

Prestressing steel is actively protected against corrosion when covered in cementitious grout. Corrosion of the steel inside the grout can only start once the alkaline environment created by the grout has been destroyed, for example by the presence of a sufficiently large amount of chlorides. Humidity and water alone cannot cause corrosion. The situation is however significantly different if the prestressing steel is not fully encased in cementitious grout, where voids in the grout leave the prestressing steel locally exposed and unprotected. Until recently it was quite difficult to detect such voids inside the duct of a tendon cast into a concrete structure. Once installed and grouted, it was also very difficult to confirm that the prestressing steel was well protected by the cementitious grout throughout the design life of the tendon, or that there was no corrosion. It was also difficult to prove, non-destructively, that chlorides were present in the grout, destroying its protective capability, and leading to corrosion of the prestressing steel. VSL, together with a corrosion specialist, has now developed a sensor complete with practical connection and installation details. It allows confirmation that the tendon ducts have been completely filled with grout during the injection process. The system also allows monitoring to identify corrosion risk or the presence of corrosion inside the grouted tendon at any time during the tendon's design life wherever sensors have been installed along the tendon's length. The void and corrosion detection sensor for grouted tendons is a major step forward in the quality control and monitoring of post-tensioning tendons. It can be used to confirm to owners that the grouting of the tendons has been done in full compliance with the specification, achieving complete filling of the tendon duct. It also confirms that the prestressing

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Continuous upgrades to lead our business sectors in terms of occupational health and safety

Awards: Safety stars

VSL Singapore is amongst the first batch of local enterprises to be awarded with the bizSAFE STAR certificate by achieving the highest level in the bizSAFE programme. The bizSAFE programme was initiated by the Singapore Workplace Safety & Health Council, which aims to get enterprises to improve safety by implementing comprehensive risk management systems. There are five different levels to achieve in the programme, the highest being STAR. Hong Kong Construction, which was the main contractor on Hong Kong's Tai Kok Tsui project, awarded VSL's team with an award for the best site safety in December 2008. VSL was in charge of the prestressed transfer plate.

Safety days: What could go wrong?

VSL's top priority is the health and safety of its workforce and everyone else potentially affected by the activities. VSL routinely goes well beyond local requirements and expectations in respect of health and safety and takes an approach that meets international standards. It is recognised as being 'safe', with highly-positive client feedback. The first group-wide safety days within VSL were held at the start of 2009. The main theme of this year was "risk identification and risk control" with the aim of improving safety standards by recognising what could go wrong and taking appropriate preventive actions. Every VSL location arranged specific activities, spread over a week. Initiatives included risk assessment exercises, site inspections, tool-box talks and feedback sessions. A key part of the safety days promotion was the provision of supporting material that could be referred both then and in the future.

SKILLS

Encouraging development of employees' skills and cultural diversity

VSL Academy: Expanding in Dubai

More than 300 engineers and supervisors have received first stage training at the VSL Academy since its very successful launch in 2008. The first VSL students will return in June 2009 to start on the second stage of training in advanced post-tensioning techniques. The VSL Academy, which is based in Bangkok, has been such a success that it has been unable to accept all applicants. A satellite was created in Dubai in 2008 to be an exact copy of the Bangkok Academy. The training courses are conducted by highly-experienced staff and alternate between theoretical classes and practical hands-on training in all types of post-tensioning activities. Each student has to pass an exam to be certified for the particular stage and needs to record at least one year's experience before being admitted to the next stage. Overall, the VSL Academy provides specific training spread over three stages, all in accordance with international recommendations for qualification and training of personnel in specialist post-tensioning companies.

Major Equipment Operation Permit: Extended scope

Major equipment is usually unique to a project and is therefore considered as a prototype. In 2006, VSL implemented the Major Equipment Operation Permit (MEOP) system in relation to the use of major equipment on special projects. This is aimed at ensuring the correct set-up of equipment and operating systems as well as the competence of management and operators while confirming the adoption of best practice. It gives an overall assurance that risk is being managed. The system requires a document review and on-site audit of a project, prior to issuing a permit for the major equipment to be operated by an experienced team consisting of senior personnel from the operations, technical and Quality-Safety-Environment teams. The permit involves a follow-up at least every six months thereafter. The scheme initially focused on the launching gantries used in segmental bridge construction and has since been expanded to cover form travellers, lifting frames and heavy lifting.

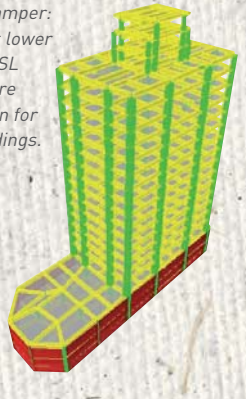
Managing excellence: New training scope for PMX/GMX

VSL launched its PMX programme in 2006 to help develop the capability of experienced Project Managers to take on major projects and manage the operational side of the business. After 3 successful years running the programme, and using the experience gained, an initiative aimed at senior managers in all areas of VSL was launched. The new programme, called GMX, builds on the PMX course with a focus on corporate issues, rather than project specific. GMX is designed to develop the skills of VSL Managers, in particular leadership and personal development; to prepare high potential staff for future management positions; to improve VSL's management capability, particularly in risk management and communication; to strengthen the VSL network; and, to reinforce the VSL Culture. GMX will be launched in 2009 and will run alongside the existing PMX programme as part of VSL's overall staff development plan.

steel is not corroding or at risk of corroding at any time during the design life of the tendon, ensuring that the tendon strength has not been compromised by corrosion.

Increased structural stability
Using VSL Gensui Dampers combined with post-tensioned floors makes the whole structure - from the foundations to the top - lighter than traditional methods, while providing a more ductile and resilient structure for the control of vibrations. With its optimised design, the VSL Gensui Damper works effectively in dissipating energy in structures subject to vibrations arising from any external source, such as pedestrians walking on a floor, cars on a bridge, wind or earthquake. The damper dissipates part of the energy input while the structure itself only has to cater for the balance of the total forces generated by the vibrations. Damper stiffness and location need to be well matched to the structure displacements for optimum performance and efficiency.

Installing the dampers allows the engineers to design the structure for lesser effects, resulting in reduced element sizes in the lateral load-resisting members and the most effective use of the materials required for construction. Use of post-tensioned floors provides a further reduction in the total weight of the superstructure, and consequently in the base shear and over-turning moment. This means that the foundations are reduced as well. The VSL Gensui Dampers require only limited maintenance due to their simplicity and very high durability. All these benefits lead to significant cost savings and, more importantly, the dampers contribute to safer structures at lower overall cost.



The VSL Gensui Damper: safer structures at lower overall cost. The VSL Gensui Dampers are an efficient solution for most types of buildings.

Protecting internal tendons with VSL PT-PLUS®

Encapsulating internal post-tensioned tendons with VSL PT-PLUS® plastic ducts, for example in segmental bridges, has several advantages over the use of traditional metal ducts:

- The VSL PT-PLUS® plastic ducts remain intact even under application of large strand pressures and tendon elongations during stressing.
- The VSL PT-PLUS® plastic ducts offer significantly higher fatigue strength and remain intact across large active cracks even at low temperatures.
- VSL PT-PLUS® plastic ducts reduce friction losses during stressing but provide sufficient bond for fully-bonded tendon design.

In addition, the VSL segmental duct coupler represents a major development in the provision of fully-encapsulated post-tensioning tendons in precast segmental construction. Monitoring can be used. Tendons are protected effectively in the critical sections across joints, even in very harsh climates or exposure conditions, including situations where de-icing salts are in use. The VSL segmental duct coupler has excellent performance and its compact design permits detailing of precast segmental structures identical to those using traditional construction methods with metal ducts. Fully-encapsulated tendons are expected to achieve a design life of 100 years or more, even in harsh environments.

VSL's PT-PLUS® for protection of tendons

High strength for high protection
Ductal® is a material with unmatched strength and flexibility that has been developed jointly by Bouygues-TP and Lafarge and is marketed by VSL for specific uses. It generates a 20-fold increase compared with conventional concrete properties. Ductal® is a very dense material, and thus has much greater durability than conventional concrete, with virtually no maintenance needs. It comes in a wide palette of colours and can be used with precision in a range of potential shapes. Ductal® is almost impermeable and therefore provides excellent protection to other structural elements or materials beneath. Examples are

Why not cycle to work?

VSL Singapore's "Cycle to work" promotion has been successful so far with on average eight staff members regularly travelling to work by bicycle. All would otherwise use cars, and it is estimated that about 50 car trips totalling 400km are saved each week. This translates into more than 5t of CO_2 saved per year. An added benefit from this activity is increased fitness, with VSL now holding regular family cycle days and entering teams into races such as the 40km OCBC Cycle Singapore in February 2009, in support of the Singapore Children's Society. An ocean is made of water drops, and each drop counts.

Ductal® linings of 30mm thickness to protect ordinary concrete exposed to sea or other water. These Ductal® linings can be applied both for new construction and for repair of existing structures, such as linings for pile caps or tunnels. A pedestrian bridge built from Ductal® in Korea in 2001 was a world first. It was designed with unique shapes and required less concrete than its conventional equivalent and absolutely no passive reinforcement.

VSL staff Personal footprint
VSL is also encouraging staff in all locations to work together to promote Sustainable Development and achieve beneficial results. As one of many examples, a Sustainable Development Committee has been launched in Singapore. Initiatives have included energy-use audits and an overall review of the environmental impact of VSL activities, with plans being put in place for better management of them. One of the many results of the committee's activities is the active encouragement of staff members to cycle to work or come by public transport, as well as to embrace all the opportunities to save energy in normal day-to-day office life (see box).

Small efforts, big savings:
To increase staff awareness, VSL launched the "Go green" initiative in 2008, giving advice on minimising waste and reducing the environmental impact of such common business activities as using paper, water use, lighting, use of office equipment, driving and purchasing. Environmental champions have been nominated worldwide to identify good practices.

Today, sustainable development issues are of utmost importance to all partners in the field of construction. Everyone should be addressing these issues in a responsible manner. As for VSL, sustainable development offers a tremendous opportunity to move forward. Challenges ahead are to share this attitude throughout the VSL network, day after day, and to deliver high-performance energy-efficient and environmentally friendly solutions for clients. For both concerns, this means changing the way to do business. ■

Launching gantries for deck erection above the forest

COMMUNITIES

Participation in the economic and social life of regions where VSL operates

Earth summit in Rio: Commitment to Agenda 21

VSL in Spain has become a signatory to the commitment to Agenda 21 Barcelona. Agenda 21 is a comprehensive plan of action to be taken globally, nationally and locally by national and international organisations and institutions, cities and local governments in every area in which humans have impact on the environment. Being a signatory to the commitment means endorsing and accepting a joint responsibility to achieve the objectives that have been identified as important for the coming years.

Free help: Services to the elderly

VSL Singapore has made agreements with various organizations in Singapore to provide structural repair and strengthening services free of charge to homes and facilities for the elderly. VSL will regularly inspect facilities and propose solutions to repair or strengthen where defects are found.

Carbon reduction charter: Green Partnership

VSL in Hong Kong and its entities Intrafor, and their sister company, FT Laboratories have signed the Hong Kong Government Environmental Protection Department's Carbon Reduction Charter. This encourages organisations to contribute to reducing the electricity used by Hong Kong's buildings, which currently account for 89% of consumption there.

Fund raising: Fun and funding

VSL staff and key clients took part in the 4th Giant Steps Autism Sailing Regatta in Sydney. The VSL yachts were very successful in an event that brought together some of Australia's leading financial and construction companies in support of children with autism. The event raised more than AU$90,000 (€50,000).

Company scheme: Lucky pocket

VSL-Intrafor Hong Kong provided financial support to the St James Settlement organisation in Hong Kong, which assists families in need. In a scheme that will be repeated annually, the company doubled any 'Lai See' money contributed by staff. Lai See is the traditional 'lucky pocket' envelope distributed at Chinese New Year.

Czech Republic

Three deck erection techniques

→ **VSL works on Bridge 204 across the Berounka River Valley,** which forms part of the extension to Prague's outer ring road. Three deck erection techniques are in use for the 1.6km bridge. The 46m and 49m spans designed by Pontex are installed on conventional shoring and using overhead movable scaffolding. The substantial part of the bridge designed by Novak & Partner is erected by the balanced cantilever method, with a maximum span of 114m. VSL introduced several improvements to speed up construction in cooperation with the client Bögl a Krysl, including an alternative design for the balanced cantilever section and use of coiled tendon prefabrication. Post-tensioning of 1,350t of strands is scheduled for completion by the end of 2009. ■ *Contact: psmisek@vsl.cz*

Hungary

Extradosed support

Designer: Pont-Terv Zrt., visualization: A.D.U. Építész Iroda Kft

→ **VSL has been awarded stay cable works** for a 370m-long bridge in southern Hungary. The bridge over the Tisza River will be part of the M43 motorway, soon to become a major route towards Romania and Bulgaria. VSL will supply main contractor Hidepito with the 190t of strands required to support the 180m centre span of the extradosed bridge, together with SSI 2000 DR6-37 anchorages and the newly-designed V6-37 saddles. Integration of the saddles into the two 30m-high pylons was carried out by structural engineer Pont–Terv from Budapest and VSL will provide technical support for the construction. Completion of the M43 extension is scheduled for the end of 2012. ■ *Contact: christophe.petrel@vsl.com*

Switzerland

Flood protection

→ **The Swiss city of Thun in the Berner Oberland** is to be protected more effectively by means of a 1.2km flood deviation tunnel that features solutions from VSL. The tunnel has an internal diameter of 5.4m and the single-shell lining is made up of 300mm-thick segments. One ring is 1.2m long and comprises five elements and a keystone. Tensile stresses can occur and so a post-tensioned solution was adopted. VSL proposed the use of its Z anchorage, which gave the benefit of continuous forces around the ring while minimising the number of stressing pockets. Another proposal that was accepted involved the use of PT-Plus® 59 plastic ducting and monostrands to limit frictional losses. VSL successfully installed and stressed the tendons and grouted the box-outs in just three months. ■ *Contact: christophe.candolfi@vsl.com*

Switzerland

Safeguarding the Rhone

→ **VSL (Switzerland) has built a new 30,000 m³ retention tank** designed to safeguard the Rhone River in case of accidental pollution from a nearby chemical site. The main dimensions of this new tank are 107.3m by 79.2m with wall heights ranging from 3m to 3.5m. The client opted for waterproof construction, with stringent requirements on the maximum crack size, from 0.05mm to 0.2mm. Post-tensioning proved to be the most effective and economic of four alternatives studied and also allowed for 380t reduction in passive reinforcement. The risk of cracking was primarily related to temperature rises in the concrete and tests showed that post-tensioning should take place between 48 and 72 hours after concreting. Post-tensioning involved 6-7 units and PT-Plus 59. Approximately 160t of post-tensioned steel were installed and the anchorages were of type EC6-7. The post-tensioning works scheduled for merely 6 months were completed 3 weeks ahead of time. ■ *Contact: christophe.candolfi@vsl.com*

USA

Engineering endeavour

→ **VSL Washington DC personnel and equipment** played a key role in the successful placement of a new 46m-long, 1,256t lift span on an Amtrak-owned rail bridge over the Thames River in Connecticut. The task was an extremely time-sensitive component of a four-day shutdown and was described by Amtrak as one of the largest engineering endeavours in company history. VSL was selected because of its ability to respond quickly and provide technical assistance. Four 526t strand lifting units were attached to the tops of steel columns on the barge carrying the span. Before reaching the bridge, the lift span was raised 9m. The barge then centred the new span ready for final positioning. In total, 10 hours of the 36-hour process involved lifting and lowering the span. ■ *Contact: hross@vsl.net*

NOTE PAD

Military load. *VSL Technical Centre Europe has provided support to designer EstKONZULT for 7,000m² of new outdoor parking in the old centre of Tallinn, Estonia. The structural analysis included the loading from the annual military show that is held there. A two-way unbonded VSL S6-1 system was chosen for the flat slab design. VSL CZ supplied post-tensioning works in cooperation with MAPRI Projekt.*

Deck repair. *Span coupling, replacement of support devices, sealing work, joints and asphalt mixes make up the primary set of repair works performed in record time on a viaduct of the A13 highway, France. This type of single-span viaduct using prestressed beams supports the heavily traveled motorway. In all, 190 jacks, servo-controlled by the VSL Verso® system were necessary.*

Widen a bridge. *The Pont de l'Hérault, in France, is a masonry structure composed of 6 arches overlying a 16-m opening. VSL widened the existing pavement by building a footbridge and rehabilitating the superstructures. Prefabricated elements were introduced at each bank of the new deck slab. The footbridge rests on a series of metal brackets anchored by tie rods set in regions of excess slab thickness.*

Free Zone flooring. *VSL has provided all post-tensioning materials and equipment as well as specialist supervision for more than 80,000m² of slabs in two 100m-high towers at the Downtown Jebel Ali development in Dubai. The 27 floors and roof of each building have a post-tensioned floor system, with tendons up to 70m long. The slab thickness varies from 220 to 300mm.*

Dubai

Palm access

→ **The Trunk Spine Bridge Project** is a primary access to Nakheel's Palm Jebel Ali, connecting the trunk and spine areas of the development. The twin cast-in-situ bridges constructed by Taisei are divided with seven construction joints on both the north and south structures. Post-tensioning plays a significant role allowing the design to be flexible and to accommodate longer spans. VSL supplied the materials and supervised the complete post-tensioning works as well as provided 504 anchorage sets of type Ec 6–31, 600t of strand and 17,000m of galvanised ducting. The six-month programme was completed on time in March 2009. ■ *Contact: a.dodds@vslme.ae*

Abu Dhabi

Leaning tower

→ **A spectacular new building is starting to rise** on the Abu Dhabi skyline, the Adnec Capital Gate Tower. It will, at 14 degrees from the vertical, be one of the world's most inclined towers and has been recommended by the engineer for inclusion in the Guinness Book of Records. The Adnec Capital Gate Tower is a prestigious 35-floor mixed-use development encompassing hotel and commercial facilities, with a total built area of 50,000m². Main contractor for the scheme is Al Habtoor Engineering, with RMJM as the structural consultant. The tower's inclination led to VSL being requested to supply and install vertical strand post-tensioning within the concrete cores, in addition to supplying and stressing some 50t of 65mm-diameter bars at the core-to-foundation interface. ■ *Contact: sburke@vslme.ae*

Abu Dhabi

Sea wall for the mangroves

→ **Intrafor Hong Kong (Dubai Branch)** has successfully completed the construction of 164m of sea wall at Abu Dhabi's first 'eco-resort', the Angsana Resort & Spa in Eastern Mangroves. Intrafor constructed 2,624m² of 1.2m-thick and 16m-deep diaphragm wall using a new mechanical grab of its own design and manufacture. The new equipment worked very successfully, excavating through the Crystalline Gypsum and Calcareous Mudstone layers, which had estimated unconfined compressive strengths of between 8MPa and 14.5MPa. The project is part of a major investment by Abu Dhabi's Tourism Development & Investment Company to transform 140,000m² of land in the capital's Eastern Mangroves district. ■ *Contact: keith@intrafor.ae*

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South Africa

World Cup records

→ **VSL Heavy Lifting is helping key client Pfeifer** to install the cable-net roof for the new Moses Mabhida Stadium in Durban, South Africa. The work for the 2010 World Cup stadium involves two Heavy Lifting records. The roof's main element, a central Y-shaped arch, had to be suspended during its segmental erection while cantilevering from both abutments. The stays for the temporary suspension towers are up to 163m long and have a remarkable 92 strands each in SSI 2000 DS 6-109 anchorages. The next step will be the lifting and tensioning of 50 fully-locked cables, requiring the simultaneous operation of a record-breaking 100 strand lifting units in a complex stressing procedure. ■ *Contact: wolfgang.schroeppel@vsl.com*

Saudi Arabia

Jamarat's final segment

→ **March saw the erection of the 5028th and final segment** of the four-storey Jamarat Bridge, which will be used by pilgrims during the annual Hajj pilgrimage in Makkah for the ritual 'stoning of the devil'. Construction of the huge bridge began in 2006 to replace a two-storey structure. Work took place at full speed, stopping only during Hajj periods, when pilgrims could safely use the completed floors. The 4-level structure encompasses an area of roughly 600m by 100m. Each level comprises 116 arched cantilevers, built from between nine and 14 precast segments weighing between 24t and 60t. VSL provided post-tensioning material and equipment as well as construction engineering and technical assistance for geometrical control and post-tensioning activities throughout the three year project. ■ *Contact: christophe.petrel@vsl.com*

NOTE PAD

Fairway freeway. *The Saadiyat Link road is one of the UAE's largest civil infrastructure projects and VSL has been contracted for the supply and supervision of PT works, including provision of materials, equipment and services for the installation of 1,800t of strands for seven bridges with a total deck length of 1.6km.*

Terminal control. *VSL India in conjunction with VSL Heavy Lifting is installing the 720,000m² roof structure of Delhi International Airport's new third terminal. Simultaneous operation of 12 to 16 lifting jacks is used for the 13m lift of each of the six blocks that make up the roof. The structure is then slid into position. The project uses SLU 70/300 units for lifting and SLU 10/200 units for sliding, controlled by the Bravo system.*

Bartley Road lifts. *VSL is carrying out girder installation for Hock Lian Seng Infrastructures as part of Singapore's Bartley Road extension. Lifting frames are used to install 72 precast box girders weighing up to 57t on three spans that cross existing roads as part of a new 1.9km viaduct. VSL's scope of work also includes application of segment epoxy glue and provision of temporary stress bars for the precast segments.*

Australia
Hale street alliance

→ **VSL Australia is working with the Hale Street Link Alliance of Bouygues TP,** Macmahon, Seymour Whyte, Hyder and Brisbane City Council to deliver the Hale Street Link Bridge over the Brisbane River. The signature structure comprises twin 274m-long balanced cantilever cast-in-situ bridges each with a main span of 117m. The cantilevers with their challenging 8% grades are being built using two pairs of VSL Module Form Travellers (MFT) modified by VSL TCAA to accommodate the exceptionally high gradients and enable concurrent operation on adjacent piers, with only 700mm separation between the wing tips of the adjoining structures. VSL brings to the project skilled key operational staff and supervision, method engineering for the temporary works and post-tensioning using PT-Plus ducting. The project includes the upgrade of the intersection of Hale Street and Coronation Drive, with associated viaduct, road, footbridge and cycleway works. ■ *Contact: dmarchand@vsl-australia.com.au*

Australia
Elevated upgrade

→ **Upgrading of Melbourne's Westgate Freeway,** which began in 2008, involves construction of several elevated roadways to improve traffic flow. These upgrade works were carried out by the West Gate Freeway Alliance, whose members include state road authority VicRoads and Thiess/Baulderstone Hornibrook. VSL won a sub-alliance contract to supply 68 precast bridge columns and cross-heads as well as associated post-tensioning works. The precast columns consist of match-cast segments, erected on top of each other and stressed together with the cross-head by vertical VSL Stressbars.
The 268 match-cast column segments and 68 cross-head segments manufactured in VSL Australia's Thomastown Precast Yard. The precast bridge column and cross-head system was adopted for this project as it allowed faster construction time and required less on-site labour, materials and equipment than cast in-situ concrete systems. This precast system has contributed to reducing the overall project construction period by several months, while minimising traffic disruption. In general, a complete column and cross-head could be erected and stressed in one to two days. ■ *Contact: ccheong@vsl-australia.com.au*

Australia
Ductal® noise protection

→ **VSL Australia has completed a 316m-long wall protection** solution for the Southern Link Upgrade Alliance, in Melbourne. The 99 colour-matched precast Ductal® panels were installed on a parapet of the Monash Freeway to protect new noise walls.
The outstanding durability and the ease of installation of the Ductal® panels led to their selection as an ideal and economical alternative to the proposed concept for in-situ concrete reinforced with stainless steel. VSL designed special formwork to meet state standards and the contractor's installation programme. Panels were colour-matched and cast to the architect's colour requirements, all panels were delivered on time and they were successfully installed in a confined working environment. ■ *Contact: info@ductal.vsl.com*

Brunei

Rapid repair

→ **Repair works to the Sungai Damuan Bridge** in Brunei Darussalam have been completed four months ahead of schedule. The bridge was built 30 to 40 years ago and is supported by two abutments, four piers with cross-beams and 12 550mm-diameter columns. VSL carried out a structural assessment in 2007 in which cracks and concrete spalls were observed on the substructure. As part of the assessment VSL then produced a recommended rehabilitation strategy. The scope of VSL's work included implementing the structural repairs without disrupting traffic. The task involved excavation, replacement of reinforcement and recasting of the deteriorated sections with high strength grout. Propping was used to provide temporary support to allow removal of the poor concrete to an average depth of 100mm. The columns stand in tidal waters and so work could only be carried out during the four hours of low tide. Crack repairs on the reinforced concrete cross-beams and on the deck slab soffit used the nipple injection method. ■ *Contact: vsl@brunet.bn*

Australia

Bypassing Ballina

→ **As part of the improvements to the Pacific Highway,** a 15km section around Ballina will be upgraded and will bypass the town. VSL Australia has been subcontracted to carry out superstructure work on the bridge over Emigrant Creek South, including concreting, reinforcing and stressing as well as temporary works. The bridge comprises a single 70m main span and two 35m back spans which end on the abutments. A propping system counters the out-of-balance forces on the deck to accommodate a cycle based on being one segment out of balance. Superstructure construction starts from the piers at the river banks to minimise environmental impact at this key fishing village. VSL has gone to extreme lengths to ensure that all potential impacts are accounted for. Client for the project is the Roads & Traffic Authority NSW. The Main Contractor is Ballina Bypass Alliance and the engineering is by Maunsell and SMEC. ■ *Contact: jmckenzie@vsl-australia.com.au*

Australia

Tanks on time

→ **VSL is reponsible for the design, the supply and installation** of all post-tensioning components of two new water reservoirs on the outskirts of Gungahlin. VSL's scope includes precasting and delivery of 90 individual tank panels. All panels contain both horizontal circumferential tendons and vertical tendons with cast-in dead-end anchorages. Casting is scheduled to take nine weeks, with the yard producing six panels a week for Elmgrove and four for Kinlyside. Use of a 50Mpa mix allows removal from the moulds 40 hours after concrete is placed. ■ *Contact: dtrayner@vsl-australia.com.au*

France

Jacking a school

→ **VSL, in a design and build contract in a consortium** restored the Blaise Pascal school in Forbach that had experienced ground subsidence. The survey revealed a longitudinal slope of 1.6% and transverse slope of 0.9% on some columns, for a 1.35m elevation difference. VSL proposed retaining the existing structure instead of demolition then reconstruction. The jacking of three zones was performed independently. The operations consisted of introducing a longitudinal and transverse rotation before proceeding with a uniform lift.

A group of jacks positioned underneath each building column within specially-created jacking recesses was used. Once the zone lifted to the desired level, the concreting of new base plates allowed raising the foundation block. In addition to monitoring displacements and pressures, the VeRSO® automated system to accommodate non-homogeneous elevation differences was used. A total of 170 jacks (50- to 100-ton capacity) and a crew of up to 12 were deployed for a 10-week period to complete these operations. The column with the greatest offset (1,350mm) required 14 jacking runs. ■ *Contact: fabrice.loubere@vsl-france.fr*

Singapore

Complex connections

→ **Complex use of temporary props and tendons** is required to carry out the construction of Singapore's Marina Bay Sands Hotel Tower. The waterfront hotel has three 55-storey towers, which each feature vertical and sloping shear walls, connected only at the 23rd level. A two-storey steel bridge links all the towers at rooftop level. Tower construction is challenging, especially because of the cantilevering of the sloping walls before they meet the vertical ones. Temporary props are required between the walls during construction. There are also temporary tendons to reinforce the sloping walls and to reduce forces on the props. Construction of the first tower required three temporary props and twelve 6-19 tendons on each wall. The second tower requires only one prop and ten tendons. Analysis found the maximum prop force to be 800t for each tower. The tendons are stressed in stages and removed once the walls are connected. ■ *Contact: nthorburn@vsl-sg.com*

Vietnam

Tallest landmark for Hanoi

→ **VSL Vietnam has been awarded the supply and installation** of 1,000t of strand for the post-tensioned slabs and beams of a 70-storey office building, the Keangnam Hanoi Landmark Tower. On completion it will be the tallest building in Vietnam and will have one of the world's largest floor areas in a single building, with 579,000m² in total. The development also includes two 47-storey residential towers, car parks and podiums. The VSL S6-4 system is used for the 300mm-thick post-tensioned slabs that typically span 13m. Use of four construction joints within the 4,000m² typical floor layout helped achieve the target fast-track cycle of five days. VSL started on site in February 2009 and is due to complete work by the end of 2010 in time for the celebration of Hanoi's 1,000th anniversary. ■ *Contact : lan.tranduc@vsl.com*

Taiwan

Taipei sight

→ **A landmark cable-stayed bridge over the Dan-shui River** is a key feature of a new ring road that is being built along the banks of Taipei's two rivers to alleviate traffic congestion. The stay cable subcontract was awarded to VSL Taiwan in 2007 and installation began in January 2009. There is a single 135.75m-high pylon with a 200m-long span at either side. Two hollow reinforced concrete columns make up the pylon. The engineer specified the use of

vacuum-assisted grouting to all the pylon looping tendons in what is Taiwan's first use of the technique. Each side of the pylon has 13 pairs of stay cables. The project uses the VSL SSI 2000 system and anchorage samples were subjected to fatigue tests of two million cycles in France between October 2007 and January 2009, in line with PTI recommendations. Stay cable installation work is expected to be completed by about August this year. ■ *Contact: lchou@vsl-tw.com*

India

Flat-out slabs

→ **The latest information technology building project** by Indian real estate giant DLF has used a post-tensioned flat slab system designed and installed by VSL. DLF chose the system as it proved economical and allowed the large 10.2m spans to use a relatively-thin 225mm slab design. Construction speed was another key advantage offered by use of post-tensioned flat slabs. The project was carried out in two phases, with the first 75,000m^2 completed in 12 months. The second phase has an area of 130,000m^2 and took 15 months. VSL is also working for DLF in Pune and Chennai, where more than 1,000,000m^2 of post-tensioned slabs have been installed. ■

Contact: m.phillips@vslindia.com

Singapore

Second Sentosa link

→ **VSL Singapore recently erected the final segment** of a new 380m-long bridge to increase traffic capacity between Singapore and the island of Sentosa's new resorts. The existing seven span 'Chinese-arch' bridge is being joined by a single-cell concrete box girder deck structure. An alternative design by VSL's TCAA helped Main Contractor McConnell Dowell to secure the project with a scheme that could meet the tight construction schedule. VSL's scope also included the precasting and erection of the balanced cantilever deck segments using a 300t barge crane and installation of internal and external post-tensioning. The project is on target to be completed within the 16-month design and build period thanks to features such as highly-standardised segmentation and detailing, an innovative prestressed pile solution and material savings of up to 50% of the conforming quantities for concrete, reinforcement and foundations. ■

Contact: nthorburn@vsl-sg.com

NOTE PAD

Bangalore highway. *VSL India began work on construction of 4.2km of elevated superstructure for Navayuga Bengalooru Tollway Private Limited's build, operate and transfer scheme on the NH-4 highway. The structure is of precast segmental box construction with 1,421 segments across 120 spans and includes 1,625t of post-tensioning. VSL is using a VSL Overhead Launching Gantry to achieve a two-day cycle time per span for completion by the end of 2009.*

Twin delivery. *Work has been completed on Dubai's Ras Al Khor Crossing Corridor. One of the contracts involved a series of elevated viaducts above Doha Road where VSL's work included installation of more than 92km of duct pipes, pushing 2,025t of strand with a total length of more than 1,830km and stressing 1,766 anchor blocks. The other was for construction of a major grade-separated interchange where the PT work included installation of more than 49km of duct pipes, pushing of 1,975t of strand and stressing 1,834 anchor blocks.*

Cable renewal. *VSL in Dallas has won a significant contract to supply material, equipment and technical assistance for replacement of the stay cables on the 25-year-old Luling Bridge. The bridge was constructed prior to a requirement for redundancy in case of cable loss and so the strategy had to involve erection of temporary stays. VSL's scope includes a bespoke solution that uses heavy lifting equipment for the de-tensioning, with replacement of the cables by its SSI 2000 system.*

Spain

VSL on seven viaducts

→ **CTT Stronghold (VSL Spain) has successfully completed work** for the new section of high speed railway linking Ourense and Lalin. Work on seven viaducts involved installation of 1520t of strand and 132 Pot bearings with capacities up to 2,200t. The Deza viaduct has a total length of 926m, made up of 17 spans. The main contractor is UTE AVE Lalin – made up of Dragados and Vías y Construcciones - and the designer is EIPSA. Two viaducts have also recently been completed by CTT Stronghold for the AP-53 highway. The Barbantino viaduct is the most significant structure and has a total length of 804m. The Main Contractor is Constructora San José and the viaducts were built in situ with cantilevers and three pairs of form travellers. The work involved installation of 384 anchorage units and 827t of strands and CTT also supplied 30 pot bearings. ■ *Contact: gislas@vslsp.com*

Ireland

Spanish expertise in Dublin

→ **CTT Stronghold (VSL Spain) has successfully transported** and installed a 1,500t bow string arch in Dublin. The operation used VSL's skid system together with three 10-axle hydraulic self-propelled modular transporter (SPMT) platforms. The new 65m-span bridge is part of the upgrading of the M50 motorway over the N7. Temporary supports were removed once the stay cables had been tensioned. The bridge's front end was then supported on the SPMTs while the rear rested on the skid system. The two 60m-long skid lines had skid shoes with 500t-capacity vertical hydraulic jacks. The skid system was powered by two hydraulic push/pull units with a capacity of 56.5t each. A trial move was carried out to prove the equipment's capabilities and bring it into position for final installation, which took just 3.5 hours. ■ *Contact: jmmartinez@vslsp.com*

Mexico

Speedy parking

→ **VSL began work in July 2008 on a nine-storey car park** located in Monterrey, Mexico. Structural design of the building, including its foundations, has been developed entirely by VSL Corporation Mexico. The project uses 36,500m^2 of 570mm-thick post-tensioned slabs with 17m spans. Construction lasted just five and a half months, during which time 150t of post-tensioning were installed and put into service by a dedicated production team. Production reached 8,000m^2 of construction a month. ■ *Contact: ceciliaalto@vslmex.com.mx*

Portugal - Azores

Mountain challenge

→ **Ferrovial is carrying out 95km of construction** and upgrading of the Azores road network on São Miguel Island, in a project that will run until the end of 2011. VSL Portugal and Vigobloco formed a joint venture to offer precast solutions and are supplying 480 beams as well as 40,000m^2 of planks for 19 viaducts and 39 overpasses. VSL worked on the deck design to develop standardised, lightweight precast elements that can be easily transported over the region's mountainous roads. The decks of viaducts spanning between 20m and 40m will be composed of five I-shaped beams to be erected by Ferrovial using an overhead gantry. For overpasses, two types of U-shaped beams were chosen for installation by crane. Vigobloco finished installation of new precasting facilities for delivery of the first beam in April 2009. ■

Contact: pbranquinho@vslsistemas.pt

Spain

Power alternative

→ **A jacking solution developed by CTT Stronghold (VSL Spain)** has enabled installation of a series of 45m-long bridge beams where overhead power lines precluded the use of cranes. The 120m-long double bridge on the B-40 motorway at Tarrasa required the jacking of six 325t prefabricated concrete beams. CTT's operation involved jacking the beams using four climbing jacks each of 90t capacity. Each jacking manoeuvre was executed in three hours. The structure has three 40m spans, each of which required two of the beams. The work also involved post-tensioning the prefabricated beams. The client for the scheme is the Spanish government's Ministerio de Fomento. Engineering was by Estructural Research and the Main Contractor was Copcisa. ■ *Contact: jmmartinez@vslsp.com*

Chile

Tank tensioned

→ **VSL Chile, in conjunction with the Special Project division of the Region,** has been awarded the supervision and installation of the post-tensioning for tanks at Chile's first LNG plant. Chile has joined a long list of countries that have chosen to invest in their own LNG plant to take advantage of environmental benefits and high availability. The coastal area of Quintero is the site of the first plant, which involves construction of three tanks, starting with one of 14,000m^3 that is due to come into operation in June 2009. The other two 160,000m^3 tanks will become fully operational in 2010. The contract between VSL and EIMISA includes providing and monitoring the installation of all materials and carrying out the threading, stressing and grouting of 1,300t of PT strand. VSL's works are scheduled to take place from August 2009 to April 2010. ■

Contact: mmeier@vslchile.cl

VIBRATION CONTROL

Mitigating vibration with

Two damping systems, the VSL Friction Damper and the VSL Gensui Damper, assist bridge designers to improve vibration control on stay cable structures.

Cable-stayed structures are among VSL's most highly-developed areas of expertise. VSL provides services ranging from design assistance and materials supply to full packages including the installation of stay cables and the building of entire cable-stayed structures.

VSL solutions for vibration control

VSL stay pipes have helical ribs. Their shape and dimensions have been optimised and tested in wind tunnels to mitigate the risk of rain and wind galloping while minimizing wind drag. In addition, increasing the structural damping of the cable with dampers provides a versatile means of controlling cable vibrations. Two solutions - the VSL Friction Damper and the VSL Gensui Damper - cover all needs, from retrofitting existing structures to the design of new projects. In addition to high efficiency, the main features common to both systems are their adaptability, their great durability and their low maintenance costs. The dampers complement each other and allow implementation of the most appropriate solution depending on the characteristics of the stay cables, the types of critical vibrations and the required performance.

VSL Friction Damper on Uddevalla Bridge, Sweden

VSL Friction Damper – designed for performance

The VSL Friction Damper is the most efficient solution for critical cases on long stay cables or where there is a risk of parametric excitation. The VSL Friction Damper has achieved the highest efficiency of a passive damping device ever measured on site or during large scale testing. Its non-linear damping characteristics are particular suitable to prevent cable vibrations independent of the vibration mode. The friction behaviour prevents the damper from being activated at small amplitudes which are considered not to be critical for the cable's performance. Once a certain critical amplitude is exceeded, the damper provides immediately an unrivalled amount of damping preventing the build-up of any large amplitudes and therefore protects the cable extremely efficiently. The activation threshold can be adjusted in line with the characteristics of each cable.

Durability

The VSL Friction Damper is designed not to move under vibration conditions considered non-critical for the structural performance or the user's comfort. and is only activated when required. This in combination with a minimum number of movable parts results in great durability with hardly any wear.

VSL solutions

VSL is carrying out the first project in Korea for main contractor Samsung. VSL's scope is to design, supply and install VSL Friction Dampers and VSL Gensui Dampers on the Incheon Stay Cable Bridge. VSL will supply and install 192 Friction Dampers and 32 Gensui Dampers. The Gensui Damper is provided by SRI Group whereas the Friction Damper by CTT Stronghold (VSL in Spain). Installation of the Gensui Rubber Damper started in March 2009; for the Friction Dampers, the installation work commenced early May 2009. Once the installation completed, in-situ site tests will be carried out.

VSL Gensui Damper - independent of vibration mode and amplitude

The VSL Gensui Damper dissipates energy by deforming a high damping rubber (HDR) pad in shear. The HDR pads have been developed by Sumitomo Rubber Industries and are already in use on more than 40 cable-stayed bridges worldwide. The damper is ideal for cable-stayed bridges with small to medium cable lengths or cables with moderate damping requirements. It can be mounted either internally or externally.

Great simplicity

The damper is composed of several HDR pads, Due to its modular nature it can be easily adjusted to suit any cable even on existing bridges. Its installation can be carried out using light tools and allow retrofitting on bridges even without interrupting traffic. By using shear deformation as dissipating mechanism, the damper does not require any sliding parts. The dampers performance can be tailored by changing the number or type of HDR pads and by varying its distance from the anchorages.

Minimal maintenance

The rubber pads provide a long working life, proven by fatigue and accelerated ageing tests. The damper requires no regular maintenance, allowing it to be installed at the pylon if necessary.

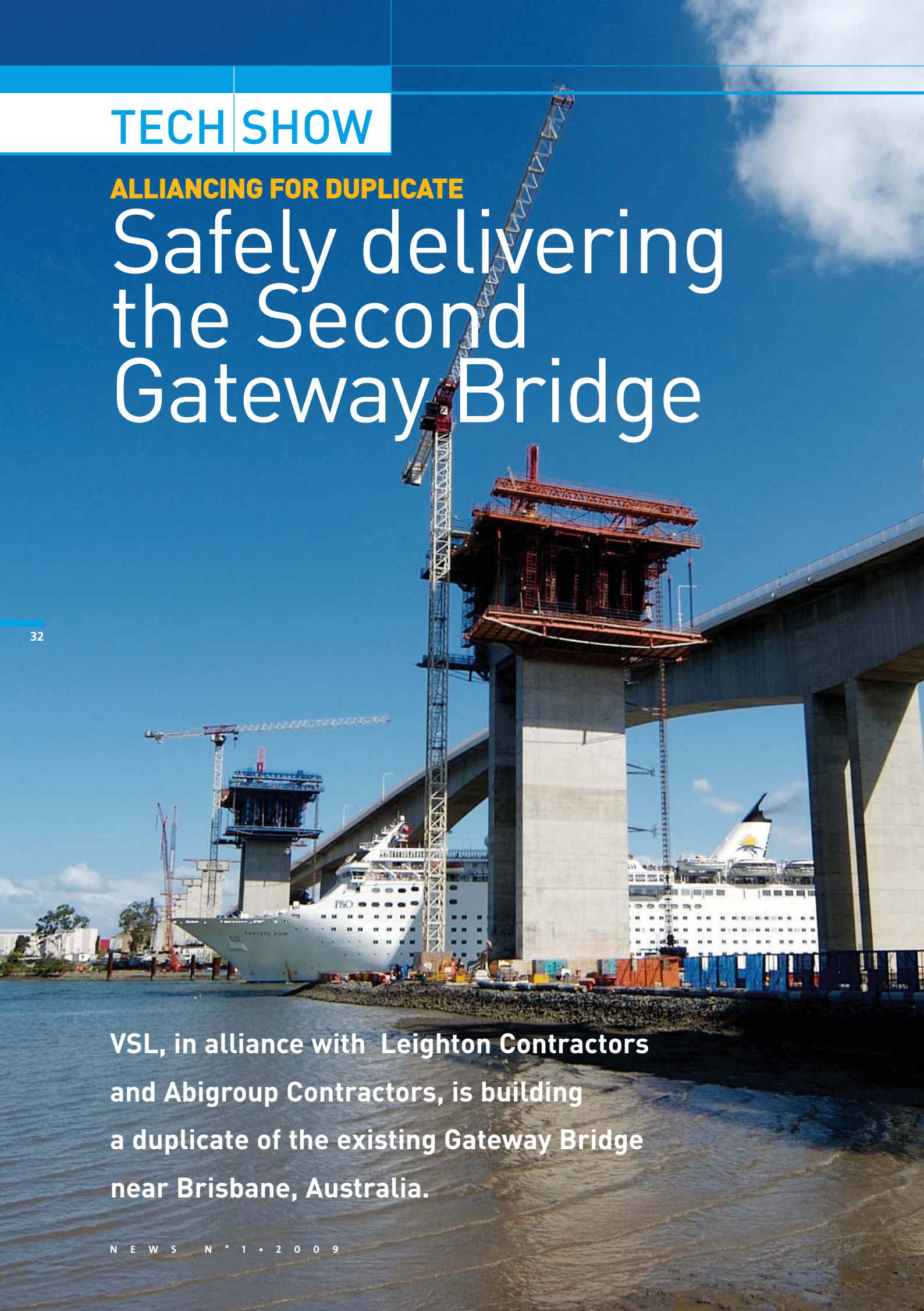
Special applications

Both types of VSL dampers can be installed together on the same cable where highest damping ratios are required for example due to coupling effects between structure and cable. In this case, a VSL Gensui Damper can be installed at the pylon and a VSL Friction Damper at the deck end of the cable. They can frequently be an alternative to the use of stabilising cables (cross ties), where single dampers are not sufficient. The installation of cross ties is relatively complex and results in high maintenance costs while being effective only against in-plane vibrations. VSL's combined damping solution offers a better damping performance with less aesthetic impact. A VSL Friction Damper is located at the deck anchorage and a VSL Gensui Damper at the exit of the pylon guide pipe where maintenance access would be difficult. ■

VSL Gensui Damper on Incheon Bridge, Korea

ALLIANCING FOR DUPLICATE

Safely delivering the Second Gateway Bridge



VSL, in alliance with Leighton Contractors and Abigroup Contractors, is building a duplicate of the existing Gateway Bridge near Brisbane, Australia.

1 ***Back to site...***

The first Gateway Bridge, on the motorway that skirts the suburbs of Brisbane in Queensland, was built in the early 1980s and has a VSL-designed post-tensioned superstructure, twenty years later, VSL is working as full alliance partner on the duplicate bridge, just 50m downstream. The Gateway Upgrade project, worth 1.88 billion AUD, is being delivered by Queensland Motorways with design and construction by the Leighton Abigroup Joint Venture. It comprises 7km of new motorway, 12km of upgrades and the second Gateway Bridge over the Brisbane River. Specification of a 300-year design life for the concrete bridge meant that stringent constraints had to be met in terms of cover, compaction and curing methods for the concrete.

2 ***High volume casting***

The scope of the Gateway Bridge Alliance includes the precast components for 30 other bridges and the roadworks along the 20km-long project, which prompted the Alliance to set up a precasting facility on an 6 hectare site adjacent to the bridge. This allowed the production of the project's high volume of concrete elements: 1,000 super T-beams, 50,000m of octagonal piles, 15,000m² of noise wall panels, 8,000m² of tilt-up panels, 200 deck units and 15km of parapet shells. A separate casting line was established for the 742 match-cast segments of the bridge's approach spans.

3 ***Jump forming the piers***

The 9.2m by 2.3m approach span piers were built using the jump form method, with the pier heads constructed on top once they had reached their final height. The 85t pier head platforms were lifted onto the columns using cranes or heavy lifting jacks. The same method was used to lower the platform back to the ground upon completion. The pier head rebar cage was prefabricated at ground level and raised using cranes, allowing the concrete – up to 230m³ - to be poured in situ.

4 ***Concrete stitches for the approach span***

The 750m-long north and 350m-long south approaches total 15 spans measuring 71m each. A concrete stitch was required between the cast in situ pier head and the following precast segment. The precast segments were lifted to the cantilever either by crawler cranes or using a 165m-long, 800t launching gantry. Two winches mounted on the launching gantry on either side of the piers were used to lift the precast segments from the ground 50m below, with two side-by-side segments forming the full deck width. The lifting sequence was designed so that the spans would never be more than one segment out of balance. Segments are stressed as they are lifted and erected and then stitched longitudinally to produce a continuous structure.

5 ***Complex movement joints***

There are movement joints at three points along the 1.6km bridge. In a highly complex operation, the 12 halving joint segments weighing up to 210t each were precast in two special moulds. Both fabrication and handling were challenging. The joint segments were installed either using the launching gantry or a crawler crane. Once installed, they were held together with support jacks, grout pads and 75mm stress bars. The temporary devices remained in place until the cantilevers had been completed and stitched, the continuity post-tensioning stressed and the sliding bearings grouted in place. They were then released to free the joint movements.

6 ***Crossing the Brisbane River***

The cast-in-situ balanced cantilever construction of the main span started from two 50m-high main piers standing on purpose-built islands in the river. The pier foundations required bored piles of up to 60m depth and 1.8m in diameter. The twin-blade columns were built using the jump form method. Prefabricating the reinforcement cages and lifting them into place helped achieve a seven-day cycle for each 4m jump. Once at full height, the jump forms were converted into falsework for construction of the pier head.

7 ***Speeding construction with prefabricated reinforcement***

The segments are twin cells varying in depth from 15.7m at the pier head to 5.2m at the centre of the 260m-long river span, 60m above the river.

The traveller advances prior to stressing of the longitudinal tendons. Each segment is then stressed with three pairs of 6-19 tendons prior to setting the formwork for the adjoining segment.

Two pairs of custom-made form travellers, weighing 280t each, have been set up on rails on the pier heads to support the formwork for the span segments. The traveller design was constrained by an above-deck height limit for aircraft clearance of 19m and 3m below the soffit for shipping.

This is the first time that an overhead form traveller has installed full height prefabricated web reinforcement cages in excess of 14m-long. Fabricating the web cages has minimised the in-situ work and optimised the cycle times. The A-frames have to be skewed to avoid obstructing the segment webs.

8 ***Work in progress***

Construction of the main span started in March 2009, marking a significant milestone for the overall project. In total, the main span consists of 123 segments of varying sizes and will require about 3,640t of steel for reinforcement and post-tensioning as well as 16,000m³ of concrete. The second Gateway Bridge is due for completion in mid-2010.

HEADQUARTERS
VSL International Ltd.
Scheibenstrasse 70 – Bern
CH-3014 – Switzerland
Phone: +41 58 456 30 00
Fax: +41 58 456 30 95

VSL LOCATIONS

Americas

ARGENTINA
VSL Sistemas Especiales de Construcción Argentina SA
BUENOS AIRES
Phone: +54 11 4326 06 09
Fax: +54 11 4326 26 50

BOLIVIA
Postensados de Bolivia
San Miguel, LA PAZ
Phone: +591 2 27 70 338
Fax: +591 2 27 96 183

CHILE
VSL Sistemas Especiales de Construcción S.A.
SANTIAGO
Phone: +56 2 571 67 00
Fax: +56 2 233 67 39

COLOMBIA
Sistemas Especiales de Construcción Ltda.
BOGOTA
Phone: +57 1 620 96 34
Fax: +57 1 620 58 16

MEXICO
VSL Corporation Mexico S.A de C.V
MEXICO
Phone: +52 55 55 11 20 36
Fax: +52 55 55 11 40 03

PERU
Sistemas Especiales de Construcción Peru S.A.
LIMA
Phone: +51 1 349 38 38
Fax: +51 1 348 28 78

UNITED STATES
VStructural LLC
BALTIMORE, MD
Phone: +1 410 850 7000
Fax: +1 410 850 4111

VENEZUELA
Gestión de Obras y Construcciones C.A.
CARACAS
Phone: +58 212 941 86 75
Fax: +58 212 941 86 75

Africa

EGYPT
Matrix Engineering Company
CAIRO
Phone: +20 2 344 19 00
Fax: +20 2 346 04 57

MOROCCO
Renfor-Bat
TANGIER
Phone: +212 39 95 80 87
Fax: +212 39 95 80 85

SOUTH AFRICA
Tsala-RMS Construction Solutions (Pty) Ltd
Johannesburg
Phone: +27 11 878 6820
Fax: +27 11 878 6821

Europe

AUSTRIA
Grund-Pfahl- und Sonderbau GmbH
HIMBERG
Phone: +43 2235 87 777
Fax: +43 2235 86 561

CROATIA
Tehnički projekt d.o.o.
10000 Zagreb
Phone: +385 1 4664 586
Fax: +385 1 4664 549

CZECH REPUBLIC
VSL Systems (CZ) Ltd.
PRAGUE
Phone: +420 2 51 09 16 80
Fax: +420 2 51 09 16 99

FRANCE
VSL France S.A.
LABÈGE
Phone: +33 05 61 00 96 59
Fax: +33 05 61 00 96 62

GERMANY
VSL Systems GmbH
BERLIN
Phone: +49 30 53 01 35 32
Fax: +49 30 53 01 35 34

GREAT BRITAIN
VSL Systems (UK) Ltd.
BEDFORDSHIRE
Phone: +41 58 456 30 30
Fax: +41 58 456 30 35

NETHERLANDS
Heijmans Beton en Waterbouw B.V.
ROSMALEN
Phone: +31 73 543 66 02
Fax: +31 73 543 66 11

NORWAY
SPENNARMERING NORGE AS
STAVANGER
Phone : +47 91 10 33 18
Fax : +47 51 41 94 80

PORTUGAL
VSL Sistemas Portugal
Pre-Esforço, Equipamento
e Montagens S.A.
S. DOMINGOS DE RANA
Phone: +351 21 445 83 10
Fax: +351 21 444 63 77

VSL GEO
Sistemas de Aplicação em Geotecnia SA
S. DOMINGOS DE RANA
Phone: + 351 21 445 83 10
Fax: + 351 21 445 83 28

SPAIN
CTT Stronghold
BARCELONA
Phone: +34 93 289 23 30
Fax: +34 93 289 23 31

VSL-SPAM, S.A.
BARCELONA
Phone: +34 93 846 70 07
Fax: +34 93 846 51 97

SWEDEN
Internordisk Spännarmering AB
VÄSTERHANINGE
Phone: +46 10 448 74 29
Fax: +46 8 753 49 73

SWITZERLAND
VSL (Switzerland) Ltd.
SUBINGEN
Phone: +41 58 456 30 30
Fax: +41 58 456 30 35

VSL (Suisse) SA
SAINT LEGIER
Phone: +41 58 456 30 00
Fax: +41 58 456 30 95

Middle East

UNITED ARAB EMIRATES
VSL Middle East LLC
DUBAI, UAE
Phone: +971 4 885 6635
Fax: +971 4 885 6639

Asia

BRUNEI
VSL Systems (B) Sdn. Bhd.
BRUNEI DARUSSALAM
Phone: +673 2 380 153 / 381 827
Fax: +673 2 381 954

CHINA PRC
VSL (China) Engineering Corp., Ltd.
HEFEI
Phone: +86 551 382 29 18
Fax: +86 551 382 28 78

HONG KONG
VSL Hong Kong Ltd.
CHAI WAN
Phone : +852 2590 22 88
Fax : +852 2590 02 90

Intrafor Hong Kong Ltd.
CHAI WAN
Phone : +852 2836 31 12
Fax : +852 2591 61 39

FT Laboratories Ltd.
PING CHE
Phone: +852 2758 48 61
Fax: +852 2758 89 62

INDIA
VSL India PVT Ltd.
CHENNAI
Phone: +91 44 4225 11 11
Fax: +91 44 4225 10 10

INDONESIA
PT VSL Indonesia
JAKARTA
Phone: +62 21 570 07 86
Fax: +62 21 573 75 57

JAPAN
VSL Japan Corporation
TOKYO
Phone: +81 3 3346 8913
Fax: +81 3 3345 9153

KOREA
VSL Korea Co. Ltd.
SEOUL
Phone: +82 2 553 8200
Fax: +82 2 553 8255

MALAYSIA
VSL Engineers (M) Sdn. Bhd.
KUALA LUMPUR
Phone: +603 7981 47 42
Fax: +603 7981 84 22

PHILIPPINES
VSL Philippines Inc.
PASIG CITY
Phone: +632 672 17 03
Fax: +632 672 13 95

SINGAPORE
VSL Singapore Pte. Ltd.
SINGAPORE
Phone: +65 6559 12 22
Fax: +65 6257 77 51

TAIWAN
VSL Taiwan Ltd.
TAIPEI
Phone: +886 2 2759 6819
Fax: +886 2 2759 6821

THAILAND
VSL (Thailand) Co. Ltd.
BANGKOK
Phone: +66 2 679 76 15 - 19
Fax: +66 2 679 76 45

TURKEY
Mega Yapi Construction & Trade Co. Ltd
ANKARA
Phone: +90 312 490 90 66
Fax: +90 312 490 90 55

VIETNAM
VSL Vietnam Ltd.
HANOI
Phone: +84 4 976 50 88
Fax: +84 4 976 50 89

Ho Chi Minh City
Phone: +84 8 810 6817
Fax: +84 8 810 6818

Australia

VSL Australia Pty. Ltd.
NEW SOUTH WALES
Phone: +61 2 9484 5944
Fax: +61 2 9875 3894

QUEENSLAND
Phone: +61 7 3265 64 00
Fax: +61 7 3265 75 34

VICTORIA
Phone: +61 3 979 503 66
Fax: +61 3 979 505 47

SOUTH AUSTRALIA
Phone: +61 8 8354 4884
Fax: +61 8 8354 4883

TASMANIA
Phone: +61 3 6225 3567
Fax: +61 3 6225 2226

PERTH
Phone/Fax: +61 8 9523 4686

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