



# NEWS

THE VSL NEWS MAGAZINE • ISSUE ONE 2006

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SYSTEMS & R&D

**What's new in VSL?**

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**Twin bridges  
in Bangkok**

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## FACTS&TRENDS

Morocco: Network portfolio expands

Partnering: VSL India plans to establish as a specialist partner for bridges in India

## COVER STORY

**Products and systems:**

**what's new in VSL's shop?**

*How VSL is addressing durability issues with new systems and services.*

## SITE INSIGHTS

Climbform: Double action at Stonecutters in Hong Kong

Macao: VSL has entered into a contract with Venetian Cotai

Korea: VSL Korea is playing a key role in the construction of the Machang Bridge

Germany : VSL lowered the "office bridges" for Berlin's new main railway station

## SPECIAL REPORT

**New arch solutions for ageing tunnels**

*The works on the Haivan pass renovation project in Vietnam entailed demolishing the existing tunnel lining, composed of both concrete and masonry , and then securing the excavation left open with rockbolts and shotcrete. Quite a job...*

## TECH SHOW

**Elegant twins on fast track**

*The latest bridge project in Bangkok Thailand is the Industrial Ring Road. From its sheer size and complexity in access ramp alignment, visually impressive structure is quite often referred to as the Mega Bridge project...*

Cover photo: Industrial Ring Road Bridges in Bangkok

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# EDITORIAL

## VSL: 50 years of innovation and passion

This year, VSL is celebrating its 50<sup>th</sup> year of activity introducing innovation into large-scale structures and infrastructure projects. Our ongoing objective has been to conceive, design, construct and implement with the best products on the market prestressing techniques, stay cable systems and bridge deck assembly methods.

VSL has built its reputation on the use of top-quality products and the ability of our teams to efficiently identify the right approach for the right job. We anticipate future growth to revolve around the same set of principles, through nurturing high valued-added market opportunities and constantly improving the professionalism of our services.

This issue of VSL News will present our most recent innovations and provide an idea of where we're headed over the next 50 years.

Our engineers all share the passion for stimulating technical progress and devising new solutions. This is where we draw our strength and pride in preparing with our clients and partners tomorrow's key challenges.



Jean-Philippe Trin



## Services

### 100<sup>th</sup> win as PT specialist

→ **VSL Argentina has been awarded its 100<sup>th</sup> contract** as a post-tensioning (PT) specialist subcontractor. A flexible organisation and a diverse range of products and services – including VSoL<sup>®</sup> walls, soil anchorages and heavy lifting – have helped to position VSL as a market leader. One of the latest projects is the Terrazas del Yacht in Puerto Madero, designed by F. Prieto: 48,000m<sup>2</sup> of PT slabs. ■ **Contact:** [epalos@vslsp.com](mailto:epalos@vslsp.com)



## Bridge partnership

### Major win in India

→ **VSL India has been awarded the contract to erect 8km of viaduct** (2,800 segments) to carry four lanes of traffic above the existing six-lane highway between Bangalore and the IT centre known as “Electronic City”. This high-profile project was awarded to VSL by a joint venture of SOMA Enterprises, Nagarajana Construction and Maytas Infra. VSL India plans to use this project to establish itself as a specialist partner for bridges in India, where there is enormous projected growth over the next 10 years. ■ **Contact:** [j.davies@vslindia.com](mailto:j.davies@vslindia.com)

## New markets

### A first for VSL

→ **The first VSL project in Equatorial Guinea** consisted of 61 post-tensioned beams for a new loading terminal used in the export of recently-discovered gas from the Island of Bioko. The scheme was built by Dubai-based Six Construct – a subsidiary of Besix of Belgium –



and the engineer was Bechtel from the US. VSL's scope of works included the design of the beams and the supply of post-tensioning materials, equipment and supervision as well as bearings. The scheduled time for completion was six months but the project was completed in just 4.5 months.

■ **Contact:** [vcabello@vslsp.com](mailto:vcabello@vslsp.com)

## Morocco

### Portfolio expands with Renfor-Bat

→ **VSL is present in many prestigious projects in the Kingdom of Morocco.** Thanks to the efforts of Renfor-Bat, VSL newly appointed Licensee, VSL systems are used projects built by contractors such as Handassa, Houar, Makyol, Megec, Salini and Tekfen. Renfor-Bat typical scope of works on these bridge projects precast beams decks is the complete fabrication of the post-tensioned beams (including the design and fabrication of the moulds) as well as the supply of bearings. Renfor-Bat is presently manufacturing beams of up to 40m and 2,4m high, which weight more than 140t. The bridge contracts awarded up to now represent more than 1,000t of post-tensioning.

Renfor-Bat and VSL are aiming to become the reference for special construction techniques in Morocco, as in the recently awarded project for the execution of 18,000m<sup>2</sup> VSoL<sup>®</sup> walls on the Route Nationale 16 near the new Tangier port for SGTm. VSL's scope of work will include design of walls, fabrication of panels, supply of soil reinforcement as well as wall erection.

The first major reference of VSL in Morocco dates back to 1979 with the Lalla Takerkoust Dam in Oued N'Fis, and includes works for Dragados in 1999 as well as the Laayoune beam replacement for SOMAGEC (see VSL News 2005 Issue I) awarded in 2001.

■ **Contact:** [epalos@vslsp.com](mailto:epalos@vslsp.com)





## Repair

# Fagilde Bridge complete

→ **VSL's expertise in jacking has been put to good use.** VSL Sistemas Portugal is invigorating its name in repair and strengthening works with another reference called Fagilde Bridge. VSL supported the main contractor OPCA during the tender phase, using its know-how and expertise to achieve a winning offer for the rehabilitation and strengthening works. After the

contract award, VSL Sistemas Portugal ended up responsible for all the works including almost 8,000 m<sup>2</sup> of surface cleaning, 400m<sup>2</sup> of concrete repair, 2,000m of sealing and injection of concrete cracks with epoxy fluid resin, 5,750m<sup>2</sup> of protective coating, 347m of bodyguard "in-situ" treatment and post-tensioning works. ■

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## New facilities

# Forest finish

wide range of colours and finishes for other projects. VSL originally developed the facility to supply VSoL<sup>®</sup> for the Albury-Wodonga bypass being built by Abigroup Contractors. Later contracts have required particularly difficult combinations of colours and finish: black, blue, yellow and plain grey with seven different textures including forest finish, ribbed, Swiss Alps, rock ballast, pebble finish, exposed aggregate and conventional plain. The facilities – which run up to 50 moulds – are benefiting from Sydney-produced epoxy / polyurethane liners. ■

**Contact:** [dtrayner@vsl-australia.com.au](mailto:dtrayner@vsl-australia.com.au)

→ **A new casting yard in Australia set up to supply a single contract** has successfully expanded and is now producing VSoL<sup>®</sup> panels in a

## NOTE PAD

**Canberra alliance.** Gungahlin Drive Extension's bridge in Canberra is not only the Australian capital's first cast in situ balanced cantilever bridge, but also VSL Australia's first as a full alliance partner. VSL's alternative proposal replaces the conforming cast in situ twin-cell post-tensioned deck with a single cell, and avoids the need for a complex falsework system.

**Top developer.** The DLF group – India's leading name in real estate – has awarded VSL contracts for the supply and execution of post-tensioning works for various projects, particularly in Chennai, Hyderabad and Bangalore. VSL had worked with the client for a year to secure the work.

**Service in action.** VSL has been committed to a continuous improvement in both products and services since the erection of its first VSoL<sup>®</sup> reinforced earth wall in Spain and has implemented a strict quality control system certified to ISO9001. More than 100,000m<sup>2</sup> of VSoL<sup>®</sup> is now installed.

**Extreme Engineering.** For its popular show *Extreme Engineering*, Discovery Channel filmed VSL equipment lifting 420t on the Woodrow Wilson Bridge improvement project in Maryland, USA. Selected and used by Potomac Constructors, VSL equipment was employed for the mammoth lift end 2005.

**Happy camel.** The need for camel underpasses on the Abu Dhabi to Dubai Truck Road project led to VSL designing and supplying VSoL<sup>®</sup> Polymeric reinforced soil walls. Scope of the works included the rental of moulds and liners, supply of polymeric friction ties and accessories, as well as site supervision.

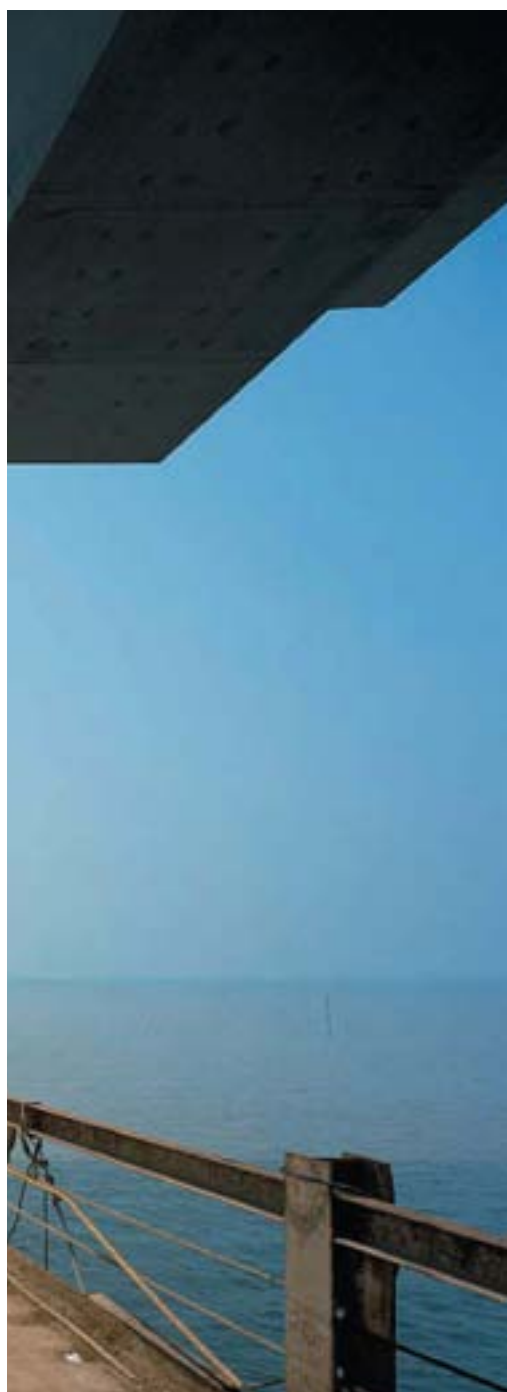
PRODUCTS AND SYSTEMS

# What's new in V





# SL's shop?



**C**lients and their advisors are increasingly aware of the vital importance of protecting post-tensioning tendons against corrosion. Demand has grown for solutions that safeguard tendons and provide continued reassurance that the system is performing perfectly. Corrosion in prestressing steel can pose a greater structural risk than decay in standard reinforcement. The cross-sectional area tends to be small and the tendons are subject to extremely high stresses. Instances of chloride attacks from de-icing salts and seawater are on the increase, emphasising the need to protect the steel from environmental hazards. Growing awareness of the issues has driven demand for improved durability through better corrosion resistance as well as the ability to monitor performance in post-tensioning systems. VSL has long been committed to developing enhanced protection and was the first company to introduce what is now a standard solution in many countries. The PT-PLUS® system uses robust plastic ducts to encapsulate the post-tensioning tendons, protecting them from corrosive elements. Development has continued with the more recent introduction of the CS 2000 system which fully encapsulates the anchorages in plastic, providing maximum protection especially when used in conjunction with PT-PLUS®. A further innovation of the CS 2000 system is its ability to isolate the tendon electrically from the structure. This means that the effectiveness of the protection can be monitored throughout the project's life. If the encapsulation develops a problem – such as letting water reach the tendon – then it will be picked up straightaway. Carrying out repairs at an early stage avoids more costly later solutions and ensures that the structure's safety is not jeopardised. VSL also offers advanced corrosion protection systems for the exposed surfaces of stay cable systems. Protection is specified according to the expected site conditions and the design life. Successful applications around the world continue to demonstrate how VSL's proven solutions can work singly or together to maximise durability and banish the threat of corrosion.

## POST-TENSIONING SYSTEMS

# Multi-layer options for durability

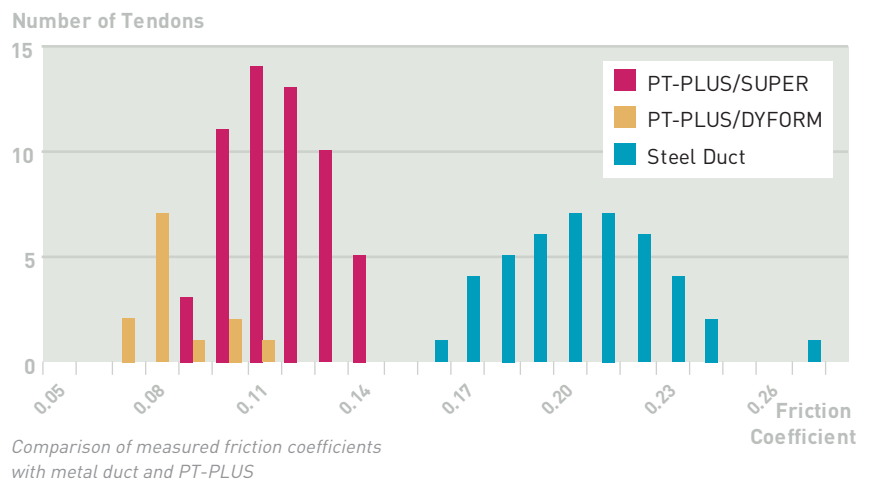
Over the last decade, the aspects of durability and monitoring/inspection of post-tensioning systems have become a priority for the R&D of the VSL Group. Recent developments and the evolution of the VSL post-tensioning systems are very much oriented towards enhanced durability issues.

### Plastic duct system for tendons

VSL PT-PLUS® is a robust, corrugated plastic duct system developed specifically for the use with post-tensioning tendons. It is extruded of new high quality plastic materials. PT-PLUS® duct complies with the requirements of fib Bulletin 7 and offers the following main advantages:

- Completely leak-tight, electrically isolating and durable encapsulation of the tendons
- Wear resistant to the transverse loads applied from the tendon during stressing

### Friction Coefficients Steel - Plastic Duct (112 Tendons)



- Reduced friction interface to prestressing steel, hence lower friction losses and more reliable friction losses since the duct cannot corrode
- Improved fatigue resistance to post-tensioning tendons such as e.g. specified in Eurocode 2
- Full bond to tendons equivalent to the one provided with traditional corrugated metal ducts.

### Full encapsulation of tendons

VSL CS 2000 multistrand anchorages have been developed to provide full encapsulation to post-tensioning tendons in the anchorage zone and to be fully compatible with PT-PLUS®. The CS plastic trumpet provides a leak tight envelope to the tendon in the anchorage zone and can be connected to PT-PLUS® with the standard PT-PLUS® couplers. Site personnel prefers this anchorage because of the standard details for easy installation and its light weight. Plastic caps complement the encapsulation over the anchor head. The CS 2000 bearing plate

**PT-PLUS® + coupler.** PT-PLUS® duct is available in different duct diameters from 21mm up to 150mm diameter, suitable for tendons ranging from 1 to 55 strands. There is also a flat duct 21/72mm for use in slabs with up to 4 strands.





Plastic caps complement the encapsulation over the anchor head. The CS 2000 bearing plate was designed as a composite plate made of ductile iron and high performance mortar.

was designed as a composite plate made of ductile iron and high performance mortar. Together with the special anchor head, the CS 2000 offers excellent fatigue resistance in excess of any specification for post-tensioning tendons.

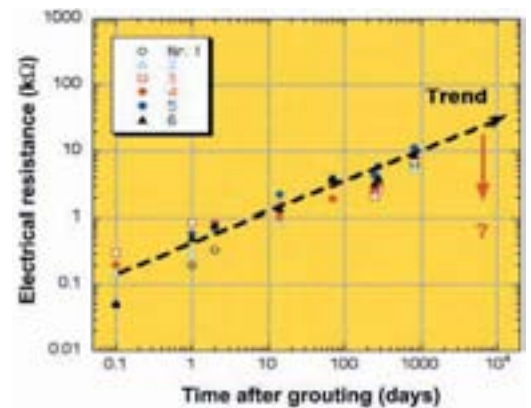
## Highest protection standards

CS 2000 anchorages can be used with either corrugated metal duct or preferably with PT-PLUS® duct. CS 2000 with metal duct is well suited for low aggressivity of the environment. CS 2000 with PT-PLUS® duct is the optimum choice for tendons in aggressive environments such as high / alternating humidity, exposure to salt-spray or de-icing salts, marine environment or exposure to earth. CS 2000 anchorages and PT-PLUS® can be complemented with special details to provide electrical isolation (EIT) to the tendon from the structure. This permits monitoring of the leak tight encapsulation of the tendon through simple electrical resistance measurements. A leak tight encapsulation will result in a high electrical resistance which

over time gradually increases because of hydration of grout and concrete. If the encapsulation is compromised and humidity penetrates into the tendon, the electrical resistance will drop significantly. This warning permits owners to investigate the causes and take adequate actions long before significant damage is caused to the tendon. These levels of tendon protection are fully compatible with the latest



**Florida adopts ECI.** VSL's ECI multistrand anchorage and PT-PLUS® system is unique in meeting Florida Department of Transportation's latest post-tensioning specifications. Bearing plates must be galvanised and ducts must be plastic and UV-resistant. Additionally, duct-to-duct and duct-to-anchor connections must be both air-tight and water-tight. Having met the new criteria, VSL's ECI System has been used in a variety of post-tensioning projects in Florida. The system uses 0.6" strand in configurations of 4, 7, 12 or 19 strands. A 31-strand system is currently in development.



Monitoring of electrical resistance of tendon  
(sudden drop warns owner for defect in tendon encapsulation)

recommendations for tendon durability published by the International Federation for Structural Concrete, fib Bulletin 33.

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Electrically-isolated tendons have been used on this rail bridge in Sweden to minimise the risk of stray currents.

## Non-metallic tendons : CarboStress

Sika and VSL have signed a worldwide, exclusive agreement on the marketing and sales of the Sika-VSL CarboStress system. This system consists of carbon fibre plates anchored in all carbon end anchorages. These end anchorages transfer the tendon force through metallic connections

## COVER STORY

to the structure. Various options exist for this load transfer to accommodate site specific details. The nominal ultimate strength of the CarboStress tendon with anchorage is 300kN, with an initial prestressing force of 220kN. The CarboStress system is an unbonded tendon with mechanical end anchorages. The carbon fibre plate can however, be bonded to the structure if desired. The Sika-VSL CarboStress system



is the optimum choice for strengthening of structural members where active forces need to be introduced to reinstate the desired performance, i.e. non-prestressed plates are not suitable. This particularly applies with excessive deformations and cracking or when the full tendon/plate strength needs to be developed at the tendon end and without significant deformation.

### High quality filling material

A complete encapsulation provides reliable protection from aggressive media applied from the outside of the tendon. This protection needs to be complemented with a high quality filling material on the inside of the encapsulation. VSL has completely reviewed its procedures for grout mix design and injection on sites over the last



*VSL-HPI: specific optimization procedures which permit VSL to verify the compatibility of grout constituents and the stability of grout mixes at a large temperature range.*

years. This development has led to specific optimization procedures which permit VSL to verify the compatibility of grout constituents and the stability of grout mixes at a large temperature range. VSL optimised HPI® grout mixes exhibit very low bleed when tested in wick-induced bleed and inclined tube tests such as specified in fib Bulletin 22.

### ETA approval ongoing

CS 2000 together with other anchorage types form the core of the VSL European Technical Approval (ETA) for post-tensioning kits for prestressing of structures.

VSL is expected to be granted the ETA in 2006. This approval will cover post-tensioning for internal bonded and unbonded multistrand tendons, external tendons, bonded and unbonded slab tendons, and various optional use categories such as encapsulated and electrically isolated tendons.

### New generation ground anchors

VSL has started to provide electrically isolated ground anchors as early as 1986. This first generation of electrically isolated ground anchors permitted the verification of the complete encapsulation, and hence protection of the ground anchors, at the time of installation but only before final stressing.

VSL therefore, developed a next generation of ground anchors with specific details ensuring electrical isolation and monitoring after stressing and during the entire design life of the anchors. Any defect which compromises the encapsulation is detected as a drop of the electrical resistance. These anchors have become standard practice in Switzerland over the last 6-8 years for all permanent anchor applications and have been specified in the Swiss Standards, European Standards and international recommendations.







GC anchor and AF anchor

## PT anchor evolution

Many VSL anchors have gone through a continuous evolution, steadily improving their performance and reliability to

## Combination on compression fittings

Another recent innovation is the VSL Flower Anchor, AF. This anchorage type is made of a cast iron body which ensures the load transfer into the concrete structure. However, instead of anchoring the prestressing steel by wedges, the strands are anchored by a combination of bond and end bearing of compression fittings, on an ultra-high performance AF anchorage grout, inside the anchorage body. This AF anchorage is primarily interesting for use as dead-end anchorage at the bottom of vertical tendons

which are not accessible during strand installation and stressing. This anchorage may thus permits elimination of costly wall down-stands below the slab. The AF anchorage may also be used instead of loop anchorages.



**Automated stressing records.** After developing the Automated Monostrand Stressing equipment for stay cables (AMS, see picture above), VSL is now introducing ADAPT, the Automatic Data Acquisition system for stressing of post-tensioning tendons. Adapt collects data of tendon force and elongation automatically during stressing and presents the data on a hand-held computer/ palm.



Cryogenic test

comply with the recent specifications. The VSL GC multistrand anchor is the latest example. It replaces the former EC and SC anchorages used in Europe and Asia and will be mainly used in the Asian markets and the USA. These anchorages are available for 0.6" tendons from 3 to 37 strands (150mm<sup>2</sup>, 1,860MPa). This anchorage type has been confirmed for cryogenic applications.



**VSL flower approved.** As part of its work on the 102-story International Commerce Centre at Kowloon Station, VSL Hong Kong has introduced Hong Kong to the AF anchorage 6-31 system and obtained approval from the Buildings Department. The complex project has involved challenges in stressing and detensioning 6-31 strand tendons at various stages of construction.

## Bonded monostrand system for slabs

The VSL Bondtech system includes a corrugated plastic duct, PT-PLUS® 6-1, a VSL monostrand anchorage and all the elements to provide effective encapsulation of monostrand tendons. It also includes the grout inlets and vents to ensure complete grouting once the monostrand has been post-tensioned. The new VSL Bondtech system combines the flexibility of monostrand with the design advantage of bonded PT: Lightness of components, full utilisation of tensile strength of prestressing steel at ultimate strength due to bond, lower friction coefficient due to plastic duct, flexibility of cable layout during construction, easier future modifications of slabs (cutting of openings) due to bond.



## BRIDGE CONSTRUCTION

# A partner of choice

VSL has evolved from a specialist post-tensioning company into a multi disciplined bridge partner. VSL has been erecting more than 100.000 precast bridge deck elements providing almost 5 million square meters of bridge surface.

VSL is able to provide contractors and engineers with construction and engineering services for highly complex and demanding projects. The localized organization of VSL provides clients with innovative practical designs and construction solutions adapted to suit the local market. The two VSL Technical Centres in Europe and in Asia assist the local Profit Centres technically to ensure that world wide made experiences and best practices are utilized on individual projects.

With extensive experience in large bridge projects, VSL has a proven

*Deep Bay link - Hong Kong*



record of developing project specific construction systems and methods that promote highly efficient rates of construction, which ensure, that program milestones are met, while maintaining safety and improving the quality of the end product. Lateral thinking encouraged within the design and production teams provide a suitable environment for nurturing novel, and often remarkably simple solutions to demanding problems.

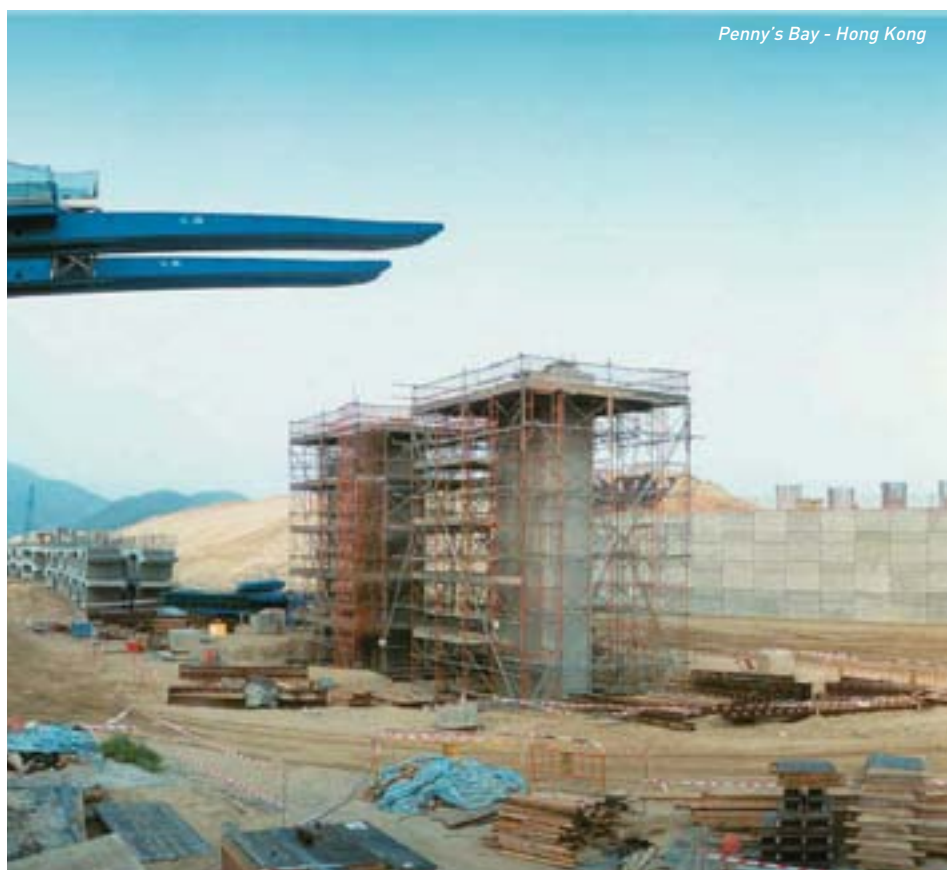
Today's state of the art bridge designs are very much driven not only by end user requirements like structural safety, serviceability and durability but as well by consideration about constructability, so that bridges can be built fast and high quality standards for permanent work can effectively be achieved in the field. Traditionally an owner employs a consultant to design, detail a bridge and prepare tender documents with bill of quantities for tendering of the work. The work is then executed by a main contractor, which subcontracts part of the work to companies like



*Lok Ma Chau CC202 - Hong Kong*

VSL. This approach is however not necessarily the most straight forward way any more to build today's state of the art bridges. This is, because there is too much interaction between design of permanent work and construction methods selected to build the

bridges. In the traditional approach design of permanent work is done before award of main contract, whereas final construction methods are only selected after award of main contract respectively after award of subcontracts for bridge deck construction work to companies like VSL. VSL is committed to offering clients a "best for project" service that has recently led to various innovative partnering and alliancing arrangements. Such arrangements between main contractor and VSL as subcontractor for bridge deck construction or even between owner, consultant, main contractor and VSL have proven to be highly successful and mutually beneficial to all parties involved. Bridges are built not by individuals but by a group of various parties. Main idea behind partnering and alliancing arrangements is to get all these parties to work as a team. Main objective of such a team shall be to get the best solutions for the final product with financial rewards for team members linked to successful delivery of the entire work.



*Penny's Bay - Hong Kong*



## HEAVY LIFTING

# Same reliability, more speed

Safety and price are important criteria, but more and more becomes the actual lifting speed a decisive factor as well. Lifting speeds of 10 to 30m per hour are achievable before impact loads may become a controlling factor. VSL has developed a hydraulic strand coiler which reduces the time for lowering or lifting of strand cables including attachments by 20 times. VSL has coilers for cables of up to 580t capacity and more than 100m strand length, realising speeds up to 8m/min: 8 coilers were used successfully for the 2 stay cabled bridges on the Industrial Ring Road in Bangkok.



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## DUCTAL®

# Extraordinary and protective

Ductal® is a reactive powder concrete with exceptional mechanical and durability properties. VSL has been involved in the development of Ductal® for

almost a decade and in the last five years has been able to create innovative solutions that utilize the extraordinary performance and economics of this material.

Applications range from architectural solutions including 20mm thick sound absorbing wall panels at the underground railway station in Monaco; to structural solutions such as the world's longest 120m span Sunyudo RPC Footbridge in Seoul; to protective solutions that provide blast and impact resistance using for example 100mm thick panels to protect a government installation in Baghdad; and to repair solutions required for bridges and other structures.



*Sunyudo footbridge, Seoul, South Korea.  
Applications of Ductal® range from  
architectural to structural solutions.*



## FLOOR CONSTRUCTION

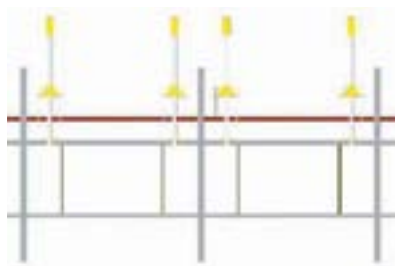
# No soffit formwork!

VSL Australia, in association with Hebertec Pty Ltd, have developed and applied a unique system that significantly reduces the labour and operations required to construct the concrete floors in buildings. A new floor is cast directly on the previous floor and a series of finely controlled jacks lift the new floor to its final location, completely eliminating the need for soffit formwork.

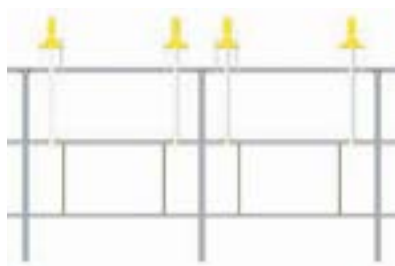


*Climbfloor :  
how it works.*

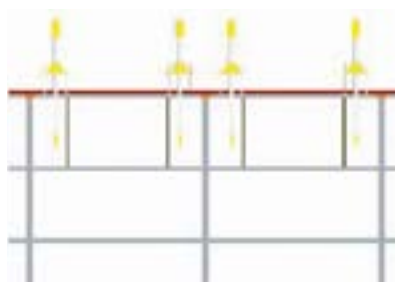
**Phase 1**



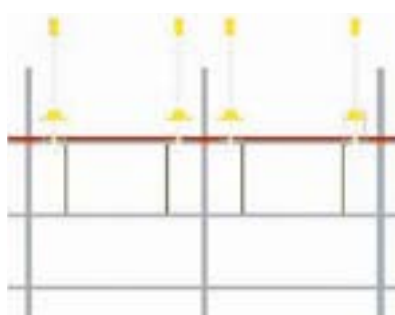
**Phase 2**



**Phase 3**



**Phase 4**



**Phase 1**



## STAY CABLE DEVELOPMENT

# Reduce the wind drag

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The well-known VSL SSI 2000 stay cable system has been amended recently with an optimised stay pipe design mainly for very long cables (over 400m) where the wind load on the cables can be an important parameter for the structural design of the bridge. VSL stay cables with the optimised stay pipes offer reduced wind drag coefficients and reduced cable diameters which result in wind loads of about 30% less than with traditional cables.

VSL now can offer two types of special damping devices for stay cables. These are the well-known VSL friction damper which have been presented previously, and now also the Gensui rubber damper. While the VSL friction damper is chosen for its superior damping performance, the Gensui damper is preferred for applications where damping shall be provided at low cable amplitudes already.

While many claim the possibility to, VSL has demonstrated the ability to replace SSI 2000 stay cables strand by strand with very light equipment and within a confined space with minimum disruption of the car traffic. Several stay cables of the Ching Chau Ming Jiang Bridge in China were damaged by a ship impact during a typhoon. VSL successfully replaced a 298m stay cable of this bridge in October 2001.

## SITE INSIGHTS

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### Hong Kong

## Pier to pier at Stonecutters

→ **Piers for the approach spans on the record-breaking Stonecutters Bridge** are being built using VSL's Climiform system. The bridge in Hong Kong will have the world's longest cable-stayed span to date. VSL Hong Kong was appointed by the Maeda-Hitachi-Yokogawa-Hsin Chong Joint Venture to design, supply, supervise and commission three sets of Climiform to

construct the piers, which reach up to 67m. The system is being reused from pier to pier. Work started with the east piers which were completed in January after just two and a half months, working to a five day cycle to build each 4m-high segment. The system was then moved to the west side. ■ **Contact:** [thomas.cheung@hk.vsl-intrafor.com](mailto:thomas.cheung@hk.vsl-intrafor.com)

### India

## Quick reactions

→ **VSL in India supplied and installed the post-tensioning** for the reactors 5 & 6 in the Rajasthan Atomic Power Plant Kota, India. Post-tensioning is applied on the inner containment walls of the reactors using VSL type EC 5-19 cables. The diameter of the reactors is 42.56m and the wall thickness is 610 mm, with 185 circumferential tendons anchored at four buttresses and 316 vertical tendons anchored in the ring beam. Laying and stressing of tendons in the 500mm-thick dome has been completed in record time.

■ **Contact:** [ganesh@vslindia.com](mailto:ganesh@vslindia.com)

### Hong Kong

## Waterfront reshape

→ **Intrafor has been appointed by Leighton-China State-Van Oord Joint Venture** for the construction of deep excavation works in Hong Kong's Central Reclamation Phase III project. Intrafor's scope of works includes the construction and testing of 62 bored piles with diameter ranging from 1.2m to 1.5m with a bell-out of up to 2.5m diameter. Nine of these piles are to be bored in the alignment of an old seawall made of large concrete blocks and boulders.

■ **Contact:** [jean-christophe.gillard@hk.vsl-intrafor.com](mailto:jean-christophe.gillard@hk.vsl-intrafor.com)







## Australia

# Travelling in pairs

→ VSL Australia is erecting the first of two pairs of travellers for the construction of the Brunswick River Bridges in Northern NSW. This structure comprises three adjacent bridges of 60/86/60m spans and will be built using the cast in situ balanced cantilever method with VSL's Modular Form Travellers (MFTs). MFTs will be used to cast single cell segments - typically of 4.64m - and can cater for the bridge's difficult geometry. As the bridges are located within an aggressive marine environment, the specifications have required the incorporation of PT Plus ducts and VSL's optimised grouting procedures. ■ **Contact:** [dtayner@vsl-australia.com.au](mailto:dtayner@vsl-australia.com.au)

## NOTE PAD

**Distribution.** One of Australia's biggest food and drink retailers, Coles Myer, is redeveloping distribution system to maximize efficiency and VSL is playing a key role. VSL's client, Austrak and its consortium partners GPT and Bovis Lend Lease won the tender



to build a national distribution centre which consists of a 70,000m<sup>2</sup> warehouse and 40,000m<sup>2</sup> of hardstand pavement. The conforming design was of reinforced slabs; post-tensioned slabs will minimise joints and speed up construction.

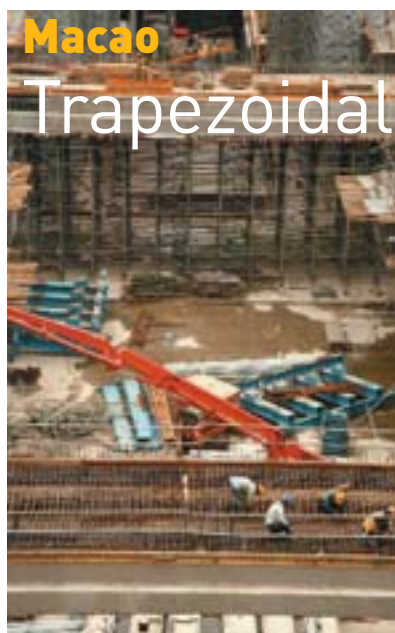
**Dual level.** A contract for the design, supply and installation of post-tensioning to a car park and retail area in Springwood on Australia's Pacific Highway consists of two levels of slab and band beams with a total area of 37,800m<sup>2</sup> cast in 16 pours. VSL had to design for traffic loadings of up to 15kPa.

**VSoL® duo.** VSL in Queensland, Australia has been awarded two more VSoL® contracts. Brunswick Heads (5310m<sup>2</sup> of 2m x 2m panels with a grooved finish and inclined at 5°) and Dawson Coal Mine with design loads to suit mining dump trucks of 210t capacity.

**Multi-tasking.** Programme requirements of the Westfield Shopping Centre in Queensland are such that VSL is carrying out simultaneous installation in several different areas. The floors have been designed for speed of construction with band beams in conventional formwork and Condeck in the slab.

## Macao

# Trapezoidal alternative



→ VSL, in joint venture with Dragages and China Civil, for the Venetian Cotai in Macao casino project, has provided the design concepts and methodology for the erection of a concrete frame as part of a successful alternative to the original cast-in-situ proposal. The scheme uses stitched together precast beams that are able to span between the piers without the use of temporary supports, enabling them to carry the precast secondary beams and planks.

■ **Contact:** [jean-marie.laurens@hk.vsl-intrafor.com](mailto:jean-marie.laurens@hk.vsl-intrafor.com)





## Singapore

### Monolithic stitching

→ Singapore's Land Transport Authority has embarked on a programme to add an additional lane to all major expressways, prompting the need to widen flyovers and bridges and carry out strengthening. Three main bridges were identified for upgrading: Asrama Bridge, Mandai Flyover and Kwok Min Bridge. All have twin decks, ranging from three to 10 spans and from 122m to 378m. VSL proposed the solution of having diaphragms constructed and post-tensioned at every support, together with two external post-tensioning tendons on each existing beam. New post-tensioned beams were constructed in situ to accommodate the widening of the bridge and the new deck slab was monolithically stitched to the existing slab by demolishing its edge to expose the rebars in order to create a lap. ■

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## Australia

### Dynamic tension

→ VSL has been active on several major structures in two new residential and commercial precincts in Melbourne - the Docklands and Southbank. Work has included the installation of post-tensioning for the Dockland Stadium, 50-storey Victoria Point Apartments, Watergate Apartments, Watergate Commercial Offices, Digital

Harbour Office, 60-storey Freshwater Apartments, Crown Casino and the Melbourne Exhibition Building. VSL has also manufactured precast beams and installed the post-tensioning for the Collins Street Bridge, which provides the major road access from the city's central business district to Docklands. ■ **Contact:** [dwallis@vsl-australia.com.au](mailto:dwallis@vsl-australia.com.au)

## Hong Kong

### High challenges at Lai Chi Kok

→ An alliance of VSL and Acciona is in charge of superstructure erection for the Lai Chi Kok Viaduct (Route 8). This is one of the most technically complex and challenging projects VSL Hong Kong has ever undertaken. Due to severe constraints in terms of traffic, site access and avoiding disruption for local residents, the structure is built using the cantilever method and so the permanent works are not always inherently stable during erection. Various techniques are needed to

provide temporary stability, including towers and an eccentric counterweight. One pier required what was probably a world first, with the use of two 100t crawler cranes at each tip of the cantilever to erect segments. These were fed from the centre by a 200t crawler crane lifting the segments from the adjacent road to the deck. ■

**Contact:** [jean-marie.laurens@hk.vsl-intrafor.com](mailto:jean-marie.laurens@hk.vsl-intrafor.com)



## Hong Kong

# Craning forward



→ **Erection of 1,800 segments for the T3 Project in Tai Wai, Sha Tin** in Hong Kong's New Territories is on course for completion by the end of this year. Segment erection is carried out by the balanced cantilever system using a 108m-long launching girder and a combination of cranes. The spans currently under erection cross one of the New Territories' major routes, which carries much of the container traffic from China. The spans are 78m long, which is greater than the launching girder's original concept design. A re-design of the kinematics was required and this has led to an intermediate launch during segment erection where the two main supports of the girder are placed on the same cantilever at each tip. ■ **Contact:** [colin.calder@hk.vsl-intrafor.com](mailto:colin.calder@hk.vsl-intrafor.com)

## Malaysia

# Back to form



→ **The construction of the Kuala Kurau Bridge over a river mouth** between the small fishing villages of Kuala Kurau and Kuala Gula in Malaysia posed an unusual challenge. No barge was available for dismantling the traveller mid-stream and so it had to be modified to enable it to reverse and then be lowered down onto a temporary platform parallel to the bridge. ■ **Contact:** [ckchong@vsl.com.my](mailto:ckchong@vsl.com.my)

## Korea

# Machang tie-down

→ **VSL Korea is playing a key role in the construction of South Korea's longest cable-stayed span**, at the Machang Bridge over the neck of the Masan Bay. The contract covers the supply and installation of post-tensioning tendons for the cross beams of the two main pylons as well as the tendons for the deck-to-pile footing tie-down system in the

piers supporting the bridge's back spans. The bridge's main span is 400m and its total length, including the approach bridges, is 1,700m. It will be completed in 2008 by a contracting joint venture of Hyundai Engineering & Construction and Bouygues Travaux Publics.

■ **Contact:** [neil.thorburn@hk.vsl-intrafor.com](mailto:neil.thorburn@hk.vsl-intrafor.com)





## Malaysia

### Return to Batang Kemena

→ **Construction of a new bridge at Batang Kemena on the Sibul-Bintulu road** improvement project saw VSL Malaysia back on site alongside a bridge which it prestressed in 1982. The 456m-long bridge consists of 11 spans and was constructed using the incremental launching method. Segments were cast behind the abutment and launched with a 31.6m launching nose attached to the front of the first unit. Special care was needed to ensure that the pile caps and support frames were able to withstand the impact of logs being transported downstream. ■ **Contact:** [ckchong@vsl.com.my](mailto:ckchong@vsl.com.my)

## Malaysia

### Planning pays off

→ **Complex constraints led the main contractor** to bring in the expertise of VSL Malaysia for the construction of two segmental bridges in a congested location. The bridges were to be erected in the midst of four others, two existing and two under construction. Erection required the placement of some segments over a six lane highway and others over

one of the bridges under construction. VSL's scope included the casting, delivery and erection of precast segments together with post-tensioning works. Careful planning and co-ordination enabled VSL to complete the bridges on time and three months ahead of a similar bridge awarded to another contractor. ■ **Contact:** [ckchong@vsl.com.my](mailto:ckchong@vsl.com.my)



## Taiwan

### Natural ability

→ **The walls of the three 160,000m³ capacity liquefied natural gas tanks** being built in Taichung Western Receiving Terminal are being horizontally and vertically prestressed by VSL. The 81.6m-diameter, 54.6m-high tanks required horizontal tendons for both the bottom slab and the walls to be installed in corrugated ducts using VSL hydraulic strand pushers. Vertical tendons were pulled using a mobile crane and winches. VSL supplied post-tensioning materials, including anchorages, corrugated steel ducts and thin steel-walled tubes. ■ **Contact:** [fchang@vsl-tw.com](mailto:fchang@vsl-tw.com)





## Hong Kong Tendons brace mega- columns

→ **Construction of various landmark structures within Kowloon Station** has been made feasible through design alternatives proposed by VSL Hong Kong. The latest of these spectacular projects is the 102-storey International Commerce Centre. The structure is composed of "mega-columns" braced together by steel outriggers at intervals. VSL Hong Kong offered an alternative of post-tensioned outriggers for the bottom of the structure to meet the tight construction programme. This involves the installation of groups of vertical, horizontal and transversal tendons to brace the columns together. Potential differential settlement between the structures is catered for by leaving a 600mm structural gap between them during construction. Post-tensioning forces have to be applied in stages as construction proceeds to ensure that the outrigger wall will be self supporting of the pours above. Force can be applied across the structural gap by filling it temporarily with sand. The sand is later removed from the gap and replaced with a 90MPa concrete, prior to applying full post-tensioning forces. ■ **Contact:** [alice.lin@hk.vsl-intrafor.com](mailto:alice.lin@hk.vsl-intrafor.com)

## Australia

# Key position for VSoL<sup>®</sup> panels

→ **Australian's largest urban infrastructure project, the Eastlink project**, features some 17,000m<sup>2</sup> of VSoL<sup>®</sup> retaining walls – more than double the original order. Casting of the first 8,000m<sup>2</sup> section started in August 2005 and contractor Thiess John Holland JV had erected more than 5,000m<sup>2</sup> by Christmas. VSL Australia's successful performance in this first section of work secured an order for a further 9,000m<sup>2</sup> of walls. The majority of the walls were built using reinforced concrete hexagonal panels with a raised relief-style finish. Every panel has had to be cast and delivered in the



correct order as there are 26 colour and pattern combinations in the arrangement specified by the architect. ■ **Contact:** [mphillips@vsl-australia.com.au](mailto:mphillips@vsl-australia.com.au)

## Hong Kong

# Hole in two



→ **Intrafor was awarded a drilling contract by Fugro Geotechnical Services in October 2005** to form two sub-horizontal drill holes using the Directional Coring Technique. The work is part of a landslide prevention project for Po Shan, Mid-levels and follows on from earlier similar schemes. The solution involves building two drain tunnels of 200m and 300m,

each 3m in diameter, underneath the slope behind the Po Shan Mansion. The two sub-horizontal ground investigation holes are drilled along the axis of the future tunnels. The scope of the work also includes carrying out water outflow monitoring, Lugeon tests, and rock joint orientation tests on recovered rock cores. ■ **Contact:** [m-p.chan@hk.vsl-intrafor.com](mailto:m-p.chan@hk.vsl-intrafor.com)

## Columbia Bridge pair

→ **VSL Sistemas Especiales de Construcción is currently working on two bridges** over the Sinú and Magdalena rivers in Colombia. Both four-lane bridges are being built by the balanced cantilever method by local company Conconcreto and use

post-tensioning from Sistemas Especiales de Construcción as well as expansion joints and Teflon bearings. The Barranca-Yondó Bridge over the Magdalena is designed by Dario Farias & Cía and, with a central span of 200m, holds the record in Colombia

for this kind of bridge. The smaller Sinú Bridge is designed by ICC and has a total length of 300m. The deck is post-tensioned with VSL 6-12 cables. The project has been visited by Columbia's president Alvaro Uribe. ■ **Contact:** [agonzales@vslsp.com](mailto:agonzales@vslsp.com)

## Spain Structural tendons for Telefonica

→ **The project for a new 200,000m<sup>2</sup> headquarters** for Spain's largest telecommunications company is the country's biggest current office development and CTT Stronghold (VSL Spain) was contracted to design, supply and install structural tendons. The project includes the construction of 13 buildings to house 14,000 employees, as well as 20,000m<sup>2</sup> of shopping and service centres. VSL 620/460 architectural tension members were chosen to limit possible deflections. Complete corrosion

protection - including the use of epoxy paint - was required for all 64 tendons. The 100mm-diameter tendons were fabricated off site, as were the bars, couplers, nuts and anchorages. Tendons were installed vertically by crane and were stressed in strict sequence in groups of six. CTT Stronghold also supplied the project's pot bearings and was awarded the heavy lifting works for erection of a 600t steel truss for the central corporate building. ■ **Contact :** [jmartinez@vslsp.com](mailto:jmartinez@vslsp.com)

## Spain VSL saves façade

→ **A vital part is being played by VSL** in the preservation of the historical Mudejar façade on Barcelona's bullring. A huge, partially transparent dome will cover the bullring as part of the project to convert this historical building built in 1898 into a 100,000m<sup>2</sup> leisure and entertainment complex. The project enables the façade to be retained and refurbished. VSL has worked with teams from Boma, Bovis and Dragados on the design and later subcontract that will allow the current façade to be moved onto a transfer slab, creating an entrance to the new building and parking levels beneath. ■ **Contact:** [posso@vslsp.com](mailto:posso@vslsp.com)



## Mexico

# Precast segmental viaduct

→ VSL is taking part in the construction of the 7km elevated section of a new metro line due for completion next year in Monterrey, Mexico. The concrete deck will be constructed with precast segments and a typical span is 37m long, weighs 360t and comprises 11 elements. Transversal post-tensioning is applied in the precast yard while the longitudinal tensioning takes place during erection. VSL will erect the deck and supply and install the bearings together with the post-tensioning.

■ Contact :

[bdelalande@vslmex.com.mx](mailto:bdelalande@vslmex.com.mx)

## Portugal

# Meeting the challenge

→ VSL Sistemas Portugal recently partnered with Mecanotubo for the construction of bridge structures over the river Leça in SCUT Grande Porto. The superstructure consists of two decks with three parallel U-shape precast beams, placed on piers with a top slab cast over precast planks. The beam-slab connection was cast with post-tensioned cables. Precast beams of this size are usually produced in specialist facilities, but the precasting company Vigobloco cast them on site, supplied the moulds and managed the pouring operations. The JV Mecanotubo + VSL was responsible for all aspects of the construction except for piling. ■

Contact: [ralmeida@vslsistemas.pt](mailto:ralmeida@vslsistemas.pt)

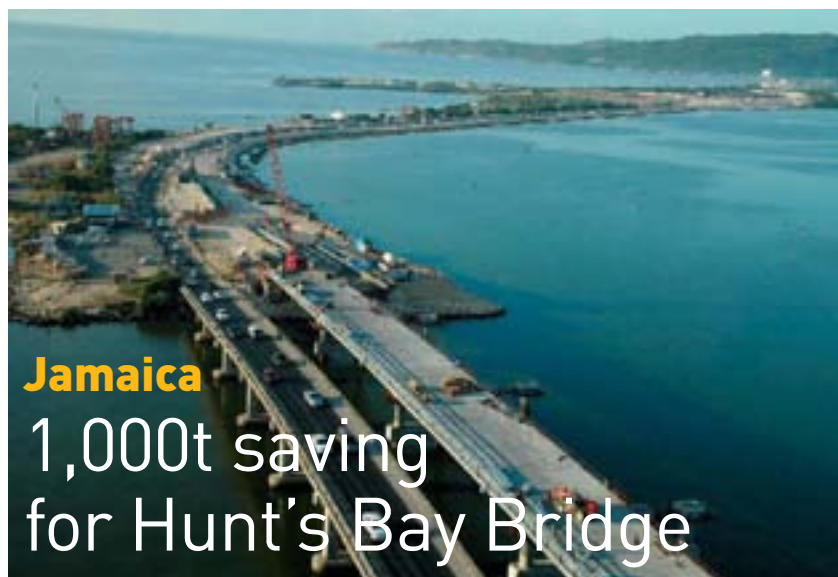
## NOTE PAD

**Office space.** VSL NSW has recently completed post tensioning installation at one of the largest commercial office buildings in Sydney, Australia, the A\$680 million KENS project. More than 115,000m<sup>2</sup> of post-tensioned office, retail and parking slabs were constructed. Typical office floors are made up of 2,600m<sup>2</sup> of one way slab and band beam construction.



**Station revival.** The Washington DC's Union Station parking garage expansion plan (27,400m<sup>2</sup>) called for large open areas uninterrupted by columns. VSL was chosen to supply an encapsulated unbonded post-tensioned system for the slabs and beams, as well as to supply and install a bonded system in the girders. VSL used post-tensioned concrete girders built monolithically with a beam and slab system.

**Adding on.** Rapid sales in the original 33-storey tower of residential units in the W Dallas Victory Hotel & Residences project Dallas, Texas, led to the addition of a 10-storey building mid-way through construction. VSL worked hand-in-hand with the project engineer to ensure the bonded PT system met the needs of the modified design.



## Jamaica

# 1,000t saving for Hunt's Bay Bridge

→ January 2006 saw VSL complete the launching of the deck of the Kingston's Hunt's Bay Bridge, which forms part of the first toll highway in Jamaica. The design proposed by VSL involved launching the steel deck using VSL Heavy Lifting jacks. VSL's involvement included the design of the bridge

(together with IBT from San Diego in the US), the fabrication and shipping of the steel deck from Mexico, assembly on site and the transversal post-tensioning with the monostrand Bondtech system.

■ Contact:

[mmartinez@vslmex.com.mx](mailto:mmartinez@vslmex.com.mx)



## Germany

### Balancing act

→ VSL lowered the steel skeletons of two 87m-long "office bridges" to the final horizontal level for Berlin's new main railway station. The bridges will accommodate four levels of offices and span over the glass roof that covers the railway lines and platforms. The main contractor - a joint venture headed by Donges Stahlbau - opted to assemble each bridge in two halves in a vertical position on top of the four office towers adjacent to the station. VSL's proposal for tilting the structures to achieve the final horizontal position involved first pivoting each section with four strand lifting units to a point of

balance. Separate groups of four strand lowering units were then used to retain the 1,250t structures as they were moved to the horizontal. Controlled rotation was ensured by connecting the retaining cables and activating the lowering units well before the structures reached and passed the point of balance. The tilting of the two western bridge halves took place at the end of July and was concluded on time despite a violent thunderstorm, while the second tilt a fortnight later was without incident. ■ **Contact:** [djunker@vsl-schweiz.ch](mailto:djunker@vsl-schweiz.ch)

## Dubai

### Diaphragm walls for Burjuman station

→ Intrafor has secured a large subcontract for the construction of permanent diaphragm walls for a cut and cover section on the Dubai metro project at the Burjuman underground station. The unusual cross-shaped station will serve as an

interchange between the red and the green lines of the metro. Work will take place around the clock for a total duration of nine months. Equipment including a BC40 cutter will be mobilised. ■ **Contact:** [khalil.ibrahim@hk.vsl-intrafor.com](mailto:khalil.ibrahim@hk.vsl-intrafor.com)

## Switzerland

### CERN shaft

→ VSL Switzerland is assisting the CERN particle physics laboratory with the installation of a huge 12,000t detector for one of its major experiments. VSL's contract covers the design, supply and operation of a 2,000t gantry crane to lower detector elements weighing up to 1,920t down a 90m shaft into an underground cavern. The gantry's lattice towers and main beams have already been installed ready for testing and commissioning in June. ■ **Contact:** [emoeschler@vsl-schweiz.ch](mailto:emoeschler@vsl-schweiz.ch)

## Switzerland

### School move

→ Part of a 19<sup>th</sup> century school in Geneva faced demolition to make way for an international railway but VSL's proposed the move of the structure. The fragile, historic stone and masonry gymnasium required reinforcement before being lifted 30mm on eight 150t-capacity jacks and then slid sideways 4.5m by four SLU 40t jacks. VSL successfully moved the 550t building onto its new foundations in February 2006. ■ **Contact:** [dgratteau@vsl-schweiz.ch](mailto:dgratteau@vsl-schweiz.ch)



## Dubai

# Festival for VSL

→ **Dubai Festival City is one of the major developments in Dubai.**

The entire development is on a 6 million m<sup>2</sup> plot of land by the Dubai Creek. The city is divided into 15 zones. VSL is involved in post-tensioning building works in 3 zones. Zone 1 work is completed, and currently VSL is working on 2 zones. VSL Switzerland - Dubai Office signed two sub-contracts with the main contractor, Al Futtaim Carillion. The first sub-

contract is for Zone 8b, which involves PT works for four structures over a total of 128,811m<sup>2</sup>. The second sub-contract is for Zone 2b over 90,459m<sup>2</sup>. VSL's scope of work for this project includes the preparation of the PT shop drawings as well as the supply of PT material and supervision for PT works, i.e. installation, stressing and grouting of the post tensioned tendons. ■ **Contact:** [ysl100@hotmail.com](mailto:ysl100@hotmail.com)

## Italy

# Joint-free slab aids Tenax robot



→ **Installation by VSL of a high quality floor slab** has enabled an old warehouse to be fitted with the latest storage technology. Italian company Tenax needed to restore the building near Monza as part of an investment

to equip it to store large coils of plastics. The coils are stored on back-to-back shelving which transmits a point load of 8t per leg to the slab. Materials are moved around the warehouse by a robotic system led by magnetic sensors which are set in the floor. The heavy loads and magnetic guidance system mean that a high-performance floor slab was needed, leading to the appointment of VSL as the preferred designer and subcontractor. VSL drew on its extensive engineering and pavement construction experience to propose a post-tensioned joint-free flat slab. The 120m by 50m slab was concreted in eight pours of approximately 750m<sup>2</sup> each. ■ **Contact:** [richard.austin@hk.vsl-intrafor.com](mailto:richard.austin@hk.vsl-intrafor.com)

## Czech Republic

# Curving bridge

→ **VSL has successfully launched the 20,000t superstructure** for a highway bridge over the Rybný Potok valley in the Czech Republic. The entire 354m-long structure was launched in just five months, despite the added complexity of the bridge curving both vertically and horizontally. It stands on slim piers up to 47m high and has a width in excess of 30m and typical spans of 58m. Segments – generally 30m long – were cast to a 10 day cycle. VSL Switzerland supplied the launching system. VSL's scope includes also all post-tensioning. The project consortium was led by Strabag, with Skanska as a partner and Metrostav as a subcontractor of the bridge. Completion is on course for later this year. ■ **Contact:** [jbesta@vsl.cz](mailto:jbesta@vsl.cz)





### Hai Van Pass renovation project in Vietnam

# New arch solutions for

**This four-tunnel renovation project involved demolishing the existing railway arches and replacing them with a shotcrete lining reinforced by a welded lattice and steel profiles. The ring voids were filled and an efficient drainage system was created behind the structure. Work was constrained by the high volumes of rail traffic.**

The four tunnels scheduled for relining are all located in the "Cloud Peak" region about halfway along the 1,800-km line that provides the only rail connection between the capital Hanoi and Ho Chi Minh City, the country's economic centre in the south. The tunnels were built in the beginning of the century and were in dire need of renovation, given the strategic importance to Vietnam and its economy of this unique north-south rail link. Renovation of the four tunnels was awarded by Vietnam Railways to the VSL/Freyssinet joint venture (known as JO HVTR) as part of the ODA protocol established between France and Vietnam, which is responsible for programme financing.

#### Simultaneous working

Existing railway arches have been replaced by shotcrete linings reinforced by welded lattices and steel profiles. The ring voids have been filled and an efficient drainage system created behind the structure.

Faced with the impossibility of interrupting train traffic, the job had to be performed in six-hour segments allocated between 9:00pm and 3:00am six days a week. The two work trains were stationed during the daytime at rail yards 25 km apart, in Lien Chieu



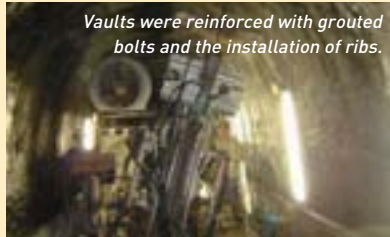
*The project had a number of risks including tunnel extremities with only minimal cover, hazardous ground conditions from ancient backfill and the proximity of utilities and major roads. Technical solutions included ground pre-treatment by cement grout, installation of an umbrella vault and adaptation of the demolition process.*



# ageing tunnels



Tunnel T9. Four tunnels (T7, T9, T10 and T13) have been repaired along a total length of 670m.



Vaults were reinforced with grouted bolts and the installation of ribs.



Ribs were used for protection.



Vault cutting took place before the each section of demolition.

for Tunnel 13 and in Lang Co for the other tunnels. This layout enabled work to take place simultaneously on two tunnels each night.

A high level of mechanisation was required, out of concern for productivity and above all to ensure the safety of workers and rail services. As a consequence,

## Some figures

### Main participants:

**Client:** Railway Projects Management Unit (on behalf of Vietnam Railways and the Vietnamese Ministry of Transport)

**Engineer:** Systra

**Primary contractor:**

VSL – Freyssinet Joint Venture

**Total contract amount:** approx. € 13.2 million

### Staffing:

- 5 expatriate team leaders
- An average of 124 local construction workers:
  - 10 local office employees
  - 18 + 16 for the daytime team
  - 80 for the nighttime team

### Technical overview:

**Length of renovated**

**tunnel sections:**

322 (T13) + 124 (T10) + 169 (T9) + 55 (T7) = 670m

**Masonry and rock demolition:** 7,000m<sup>3</sup>

**Fiberglass bolts and studs:** 4,000 units

**Steel arches:** 370 units

**Standard shotcrete:** 2,000m<sup>3</sup>

**Shotcrete reinforced with**

**metallic fibers:** 1,250m<sup>3</sup>

**Drainage strips:** 1,700m<sup>2</sup>

a well-trained construction preparation crew was assigned in order to ensure proper maintenance and timely repair of the hydraulic demolition equipment and boring machines. The crew's mission included removing that shift's debris and loading the construction material necessary for the subsequent night's programme. Managing spare parts and inventories was critical, especially as many of the parts required could not be supplied locally.

## Catering for varying geology

The sites' geological conditions proved much more complicated than initially anticipated from the tender documents and so a revised technical solution was devised to



*Shotcrete relined the vaults.*



*A final shotcrete layer completed each section of tunnel.*



*Lang Co Station was one of two bases for the work trains.*

ensure stability of the surrounding soil prior to demolishing existing tunnel linings. This work was supervised by JO HVTR in co-ordination.

The night time construction crew of 40, led by one expatriate per team, had to face the nightly challenge of varied geological conditions, especially during the demolition phase. In some instances these conditions were unpredictable and so working procedures had to be constantly

adapted, while ensuring the safety of personnel and trains and freeing the track for the 3am deadline.

Tunnel renovation advanced according to schedule and was successfully completed on 15 January 2006, with the contract terminating as planned on 31 March 2006. ■

## Works carried out

- Mapping of every tunnel
- Pre-treatment
- Installation of safety devices in the form of protective cages before starting demolition in tunnels
- Vault sawing before every stage of demolition
- Spraying of a shotcrete confinement layer immediately after vault demolition and stability control
- Ground reinforcement by grouted bolts or steel ribs
- Side wall demolition
- Side wall reinforcement by grouted bolts or steel ribs
- Spraying of a shotcrete relining layer.
- Drainage system installation
- Formation of the permanent tunnel structure by a steel fibre shotcrete layer, protected by a 30mm-thick standard shotcrete layer



# Industrial Ring Road Bridges in Bangkok Elegant twins on fast track

The latest bridge project in Bangkok Thailand is the Industrial Ring Road. From its sheer size and complexity in access ramp alignment, the visually impressive structure is quite often referred to as the Mega Bridge project...



## 1 Double landmark.

His Majesty King Bhumibol Adulyadej initiated a ring road system to ease the congestion of commercial traffic within Bangkok. The Industrial Ring Road will form a significant part of this system by crossing the Chao Phraya river twice.

## Twin stay cable bridges.

The project includes two cable stayed bridges of dimensions 702m long and 582m long with concrete pylons 172m and 162m high respectively, 396m and 376m main spans. Some 2,500t of PT will be installed together with 2,300t of stay cables and 60 deck units weighing 500t each will be lifted. VSL's scope of work is to install the PT, lift the deck units and erect the cables.







### 3 Approach ramps.

Part of the same project, but awarded in a separate Package to KTU JV, access onto the bridge is by 3.5km of approach ramps rising to 50m above ground from the North and South as well as a 9.1km central interchange with its labyrinth of entrance and exit lanes to cover each direction of traffic. The access ramps were constructed by conventional cast in situ methods using some of the world's largest Movable Scaffolding System's (MSS).

### 4 Main spans.

This was done using the VSL self launching erection gantry to lift the deck segments from the river after being delivered by a barge. Each deck unit was of a composite section with typical dimensions 36m wide, 2.8m deep, 12m long and weighing up to 500 t. The deck units were lifted with the concrete deck in place.





## 5 Segments delivered on barge.

Using a barge posed problems of its own, as the Chao Phraya River is extremely busy with commercial river traffic in the vicinity of the bridge, which was further compounded by a narrow navigational channel required by the larger vessels. The lifting speed of the VSL system was set such that the lifting could be completed safely in approximately two hours. With the anchoring of the barge taking approximately one hour, the overall duration of works causing hindrance to the existing river traffic was only three hours. This was co-ordinated with the local marine department such that works were carried out at the most suitable times so that obstructions to river traffic were of no significant concern.

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## 6 **Fast track deck construction**

The key works of deck lifting and stay cable installation were carried out by VSL. Operating on a twenty four hour working day, seven days a week, the co-ordination between the two disciplines resulted in a erection cycle two days faster than initially anticipated, allowing a gain of about one month in the main deck erection program.



## 7 **Single strand installation.**

With 2,300t of stay cables (6-43 to 6-91 monostrands) installed in only 4 months of deck erection works, VSL SSI 2000 stay cable system single strand installation technique proved once again perfectly suited to fast track erection programs of stay cable bridge utilizing prefabricated segments.



8

**Closing.**

*The closure units were erected by the end of March 2006. After that all that remains is for the motorists to enjoy some additional relief from the congestion and the views from the deck over the Chao Phraya River.*



## The players

**Owner :**

Kingdom of Thailand; Ministry of Transport,  
Department of rural Roads

**Engineer :**

Asian Engineering Consultants Corp., Ltd  
Team Consulting Engineering & Management Co., Ltd  
Thai Engineering Consultants Co., Ltd  
Index International Group Co., Ltd  
Jean Muller International

**Main Contractor :**

TNNS-JV  
Taisei Corporation  
Nishimatsu Construction Co., Ltd  
JFE Engineering Corporation (formerly known as  
NKK Corporation)  
Sino Thai Engineering and Construction PLC

**Main Sub-Contractors :**

Deck Lifting Specialist : VSL Thailand  
Stay Cable Installation : VSL Thailand  
Post Tensioning : VSL Thailand  
Deck Bolting : STP&I

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CREATING SOLUTIONS TOGETHER

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