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For the longest fully automated rail system in the world, the Dubai Metro, VSL, in a joint venture, is responsible for the precasting and erection of the elevated superstructure for the Red and Green Lines. Get on the train...



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# **EDITORIAL**

## R&D and performance

Enhancing research and development in a company only makes sense if the new technologies conceived in the laboratories are rapidly tested, verified and implemented.

Every year, VSL spends more than 1% of its worldwide turnover on R&D, with the continuous aim of improving existing systems and optimising both



technically and financially the innovative solutions proposed to our clients. Our R&D teams work in a project-based mode to ensure the development of innovative, reliable and relevant products and solutions that meet the expectations of designers, consultants and main contractors. This VSL News Magazine highlights our recent progress in stay cable technology, featuring a competitive new concept in saddles that has already been successfully tested and installed on Un-am Bridge in South Korea and will soon be fitted on Catumbela Bridge in Angola.

This important and recently-patented innovation reinforces our technical leadership in the field of stay cables, a traditional VSL strength. In recent years, VSL has introduced numerous new developments: dehumidification systems to reduce the cable diameter and improve durability; anchorages without a guide deviator, allowing for simplified design and construction of the pylon; and new cable vibration damping systems, such as Gensui dampers.

The use of the VSL Flower Anchorage at the Marina Bay Sands Resort in Singapore is a perfect example of our capacity to conceive new products whose performance allows for simplification and optimisation of structures.

Today's innovations create our markets of the future and enhance the optimisation of construction methods.

Jean-Philippe Trin, CEO

## SUSTAINABLE DEVELOPMENT

#### TRAINING

## VSL Academy World's first post-tensioning training centre

To ensure the high level of know-how in all countries, a unique academy has been launched to train VSL Staff





SL Group has made a strategic decision to formalise and standardise the training of all its posttensioning foremen, supervisors and site managers. Centralised training takes place at the new VSL Academy in Bangkok, Thailand, which opened to trainees in February 2008.

In many cases, post-tensioning allows construction that would otherwise be impossible because of either site constraints or architectural requirements. Fabrication, assembly and installation of post-tensioning systems, all require specialised knowledge and expertise. The aim of the new training centre is to harmonise the technical knowledge of staff and to supply the trainees with proven best practice in the post-tensioning field. The trainers - all experienced VSL Staff - provide theoretical training followed by practical sessions. Post-tensioning mock-ups have been built on the Academy's premises to enable hands-on training. Further mockups are being designed to cover further aspects of operational procedures.

Courses have been developed to train participants in three stages from foreman to site manager level. The training sessions are based on the latest updated VSL Field Manual, to ensure that the courses cover current best practice. Trainees have to pass a written exam to meet the stage certification requirements. Before proceeding to the next level, participants have to be involved in post-tensioning works for a minimum of one year, a must. This is entered in a project log book, which records the comments and approval of their project or site managers. The Academy currently schedules one certification class per month and staff will be attending from all regions within the VSL Group. The launch of the Academy represents a major step in ensuring a consistent approach and a wider sharing of PT best practice among foremen, supervisors and site managers within VSL. This is expected to contribute significantly to improving the quality, safety and productivity of work on site.

VSL Academy aims to extend its scope and certification beyond post-tensioning works to include courses on topics such as stay cable and heavy lifting works. VSL emphasis on harmonising working standards and knowledge

demonstrates the company's position as market leader and specialist in the posttensioning field. In deploying highly-qualified and expert staff at its worksites around the world VSL will anticipate clients' increasing demands for a rigorously safe execution of projects in ever tighter schedules.

Patch indicating the level of training

#### SAFETY OHSAS certification for VSL Chile



SL Chile successfully applied for Occupational Health and Safety Assessment Series (OHSAS) certification in November 2007 following just six months' preparation, with pre-certification auditing by Bureau Veritas. OHSAS 18001 is the internationally recognised assessment specification for occupational health and safety management systems. The certificate proves that the systems comply with best practice standards. It demonstrates that VSL Chile has successfully passed an audit which has established that a formal management system has been implemented that manages and controls activities effectively and is aimed to bring about continual improvement.

Achieving the award was the latest step in VSL Chile's plan for certification of its management systems. Experience had already been acquired through the quality management system and the development of an occupational health and safety programme.

#### GREENHOUSE GASES New tool helps cut CO<sub>2</sub>

he VSL Technical Centre in Switzerland is providing the VSL Network with a tool to bring about reductions in Carbon Dioxide  $(CO_2)$  emissions. The aim is to achieve a better understanding of the issues involved and to determine and reduce VSL's carbon footprint. This method guantifies the amount of  $CO_2$  for every resource or energy source used. It calculates the Carbon or Carbon Dioxide equivalent in terms of equivalent tonnes of  $CO_2$ , also known as TeC. This is the unit used as a measurement for emissions

of greenhouse gases. The method encompasses a wide spectrum that includes the emissions relating to the materials purchased and those produced by the product during its lifetime. A rough figure of 1t is sometimes given for the CO<sub>2</sub> equivalent of a tonne of reinforced concrete. Using prestressed concrete as an alternative to plain reinforced concrete will usually lead to savings in concrete volumes, with corresponding reductions in  $CO_2$ emissions. VSL is keen to promote such savings.

#### REUSE OF MATERIALS Sustainable restoration



design and build consortium led by VSL France has carried out the restoration of Lameilhé Footbridge in the city of Castres in south western France. The consortium, which also included an architect and engineering consultant, bid for the contract with a proposal for the preservation and rehabilitation of the footbridge's four spans over the road, and demolition of the remaining eight spans. Quality and sustainability were central to the consortium's approach, which included the reuse on site of materials from the demolished section. Work began with the demolition, together with a reduction in width of the remaining spans. Tasks carried out included the application of sealants, addition of carbon fibre to the joists and the installation of new cornices, railings and lighting. The deck surface was treated with a textured resin-based coating.

# FACTS & TRENDS

## Partnership VSL and SRI extend co-operation



→ VSL has signed new agreements that will extend its distribution of the Gensui damping system for building projects to new regions around the world. The two agreements between SRI Hybrid and VSL International were signed in December 2007. The first agreement is for the exclusive distribution of Gensui dampers for building applications in the European Union, Eastern Europe, former Soviet Union countries, the Middle East, Northern Africa, Australia, New Zealand and selected countries in South and South-East Asia and in Central and South America. The second agreement is for nonexclusive distribution of the dampers in all other countries except for Japan, China, the USA and Canada.

Gensui dampers for building applications typically consist of a number of rubber pads installed in two lavers between three parallel steel plates. When the building is subject to lateral displacement. the steel plates move relative to each other and introduce shear deformations into the rubber. The Gensui rubber's special characteristics ensure that high damping is generated. Gensui dampers are equally effective for small displacements under wind loading and for large seismic movements. Contact: hansrudolf.ganz@vsl.com

## Slabs First for Czech Republic



→ VSL CZ, in collaboration with CTT Stronghold, has successfully installed a post-tensioned slab for a new aircraft maintenance hangar in Mosnov. The joint-free concrete slab measures 146m by 77m. Construction consisted of six main pours, cast every second day, and two side strip pours, which were completed after stressing. Almost 130t of monostrands system were installed. The main contractor is

## Award Double top

The North Arm Bridge in Canada has won two top awards given by the Consulting Engineers of British Columbia. The project took the award of excellence in the transportation category and was also named the winner of the Lieutenant Governor's Award for the best overall project. It has furthermore won the award of excellence in the Bridge category from the Post-Tensioning Institute. VSL contributed to the success of the signature span cable-stayed bridge, built to carry the Canada Line Light Rail System over the north arm of the Fraser River in Vancouver. British Columbia. Canada. The crossing is North America's first extradosed cable stay bridge and its first to use Gensui dampers. CTT-Stronghold (VSL in Spain) joined forces with US licensee VStructural to supply both the dampers and the VSL Stay Cable system, which included anchorages for 61 strands of 0.6" (15mm). The joint venture's responsibilities extended to fulltime technical assistance on site. The bridge also features a 139mwide side span, two 45m-high main pylons and two approach piers on each side of the river's north arm. The pylons above deck at the main piers are designed in steel and provide anchorage for the extradosed main span tendons. Construction of the first pylon was completed in August 2007 and the bridge was delivered in spring 2008. Contact: bsward@structural.net; epalos@vslsp.com

Vitkovice Revmont, a.s. and the slab section was provided by OHL ZS, a.s. VSL CZ had previously carried out another local first, with the lifting of the hangar roof. Contact: psmisek@vsl.cz



## <mark>Network</mark> New licensee in Bolivia

→ VSL welcomes Postensados de Bolivia (PTB) as its newlyappointed licensee in Bolivia. PTB. based in La Paz, will provide VSL's services more efficiently to local and foreign contractors working in this promising market. PTB is already experienced in posttensioned slabs and its typical scope of works will now extend to post-tensioning services in civil works, stay cables, VSoL<sup>®</sup> walls and the full range of VSL construction solutions. The two companies are working together to assess projects being tendered in Bolivia, with the aim of becoming the leader in special construction techniques in the country. This will build on some major Bolivian projects which VSL worked on in the early 1990s, including the Americas and Santa Rosa cable-stayed bridges. Contact: ealonso@vslsp.com

## Group Teamwork Polish highway

→ A joint venture of DTP, Bouygues Civil Works and VSL in Switzerland is carrying out the construction of the A4 highway between Zgorzelec and Wykroty in Poland. Work began in February 2007 and is due for completion by September 2008. The project's scope includes the construction of 22km of dual two-lane highway with eight overpasses and nine underpasses. VSL's role in the joint venture involves the supply and installation of the post-tensioning for seven of the overpasses and the stay cables for the WD22 bridge. Contact: christophe.petrel@vsl.com

## VSoL<sup>®</sup> First for Chile

→ VSL Chile is constructing its first polymeric VSoL® wall in its home country in a successful project that will provide a showcase for future sales. Approval from the government authorities was achieved in record time even though this was the first use of the system in Chile and involved both challenging dimensions and a 0.4g seismic



loading. The 7m-high wall has an area of 4,500m<sup>2</sup>. There is considerable experience in Chile of standard VSoL<sup>®</sup> walls but increases in steel prices convinced the client to change to the polymeric system instead of steel mesh. Combining rectangular panels has made installation speed very fast, reaching up to 1,400m<sup>2</sup> a month.

## Dampers Rapid progress

VSL has followed its successful fast-track provision of stav cables for St Petersburg's 2<sup>nd</sup> Neva Stay-Cable Bridge with the installation of VSL friction dampers. The bridge opened to traffic in October 2007 and crosses the River Neva alongside an identical earlier bridge. Installation of all 112 stays for the second bridge had taken less than five months. which was half the time of the first, thanks to the experience that had been gained. The combination of cables up to 200m long and a flexible 730m steel deck prompted the decision to install the 224 friction dampers. Work began in December. Main contractor Mostootriad 19 supplied the steel supports to connect the friction dampers to the deck guide pipes while VSL was responsible for the design. manufacture and installation of the dampers in sizes ranging from type 6-19 to 6-91. Engineer for the scheme was Institut Giprostroymost. Contact: christophe.petrel@vsl.com

## <mark>vs₀L</mark>® A41 finale



The fourth and final VSoL<sup>®</sup> reinforced soil structure has recently been delivered for the A41 highway project, which will connect the French city of Annecy and Geneva. Switzerland. from 2009. This last structure, built on behalf of GIE A41, is France's first bridge abutment constructed exclusively in VSoL<sup>®</sup> segmental precast concrete panels without any surface treatment. It has a total surface area of 600m<sup>2</sup> and has been designed in particular for the seismic conditions at its location near the French Alps. The four diverse structures required for the A41 project represent a wide spectrum of VSoL<sup>®</sup> applications. As well as the 600m<sup>2</sup> bridge abutment, the scheme includes a 450m<sup>2</sup> mixed bridge abutment and two retained earth walls, of 800m<sup>2</sup> and 300m<sup>2</sup> respectively, supporting a highway. **Contact**: b.chanteperdrix@vsl.com

# COVER STORY

N E W S N ° 1 • 2 0 0 8



# VSL in the saddle

VSL has developed a new saddle for its SSI 2000 Stay Cable system. The VSL SSI Saddle is wellsuited not only for extradosed cables but also for cable-stayed bridges where the pylons may be subjected to unbalanced cable loads.

oday's bridges are designed with a lifespan of 120 years, whereas stays generally are specified for 60. Stay replacement might be required, but this can cause traffic disruption. VSL's R&D team therefore launched the development of a new saddle to meet the needs of both bridge designers and road authorities. Throughout the saddle development, an important design feature was to create a saddle that simplifies the pylon design, allowing for reduced dimensions and improved appearance while guaranteeing the same technical performance.

#### **Independent strands**

Cable-stayed bridges designed with pylon saddles can benefit from VSL's latest saddle, designed for use with its SSI 2000 Stay Cable System. The VSL SSI Saddle is composed of a rectangular steel box filled with Ductal® highstrength cement grout. The compact saddle does not reduce the stay cable's fatigue performance and provides a high friction to transfer the differential forces from the cable into the pylon. Cables can be installed or replaced strand by strand, and the strands can be tensioned independently. Corrosion

#### VSL IN THE SADDLE

#### COVER STORY

protection barriers safeguard the cable inside the saddle.

Each cable strand is free and completely independent within the VSL SSI Saddle. There are no steel tubes, to avoid the risk of corrosion. Instead, each cable strand is installed through the saddle in an individual hole, which is formed using specific VSLdesigned formwork and grout.

#### **Oval holes**

In particular, the section of the strand hole is new. It is oval instead of the usual circular shape



Un-am Bridge: the VSL Saddle before concreting



General view of Un-am Bridg



mechanical strength. The new VSL SSI Saddle incorporates special features to avoid this. Strand that is subjected to angular deviations is protected by using a special elastomeric casting resin to extend the ends of the grout strand support. The stay pipe's connection to the saddle is not rigid, but instead provides some flexibility to eliminate the risk of progressive deterioration if the cable is repeatedly subjected to angular deviation cycles.



Installation of stay pipes and strands

used on saddles with individual tubes. VSL carried out extensive testing to determine the optimum section and this has ensured very high friction between the strand and the saddle, while still allowing easy strand installation and replacement.

The saddle is composed of a steel box filled with a high strength Ductal<sup>®</sup> type cement grout. Inside the saddle, the strands are completely independent of each other and they are installed in individual holes. Special formwork has been designed to create the holes within the cement grout. The risk of corrosion is limited by installing the cable directly into the saddle without steel tubes. The number of holes corresponds to the number of strands. Additional holes can be added to allow planned strand inspection in the future.

## Cost-saving standardisation

The VSL SSI Saddle requires no expensive strand or special sheathing as it uses standard strand. The system is ideally suited both for extradosed cables and for cable-stayed bridges where the pylons are subjected to unbalanced cable loads. The cable is composed of a bundle of strands. The strands used for the new VSL SSI Saddle are the



Correct alignment of the saddle

the VSL SSI 2000 system. Before installation, the sheathing of the strand is removed along a

same standard galvanised waxed

and sheathed strands as used in

#### Hole in one

The holes are not true circles. The particular geometry is the result of comprehensive testing carried out in the VSL Laboratory.

The slightly ovalised V-shape is in response to two technical requirements. One aim is to obtain high friction values and increased bonding of the cable on the saddle. To achieve this, the strand is not in contact with the lower end of the hole, but only with the two sides that are inclined at a defined angle. Secondly, the section of the upper part of the hole is slightly enlarged to enable easy strand installation. The cement mortar is replaced by an elastomeric resin at each end of the saddle. As the strand moves along its axis, the resin protects the strand where it exits the saddle and is submitted to angular deviations.

Transverse plates are installed every 300mm along the saddle, to keep the lateral forces contained within the saddle without relying on any additional lateral confining effect arising from the pylon.

A cable passing through the saddle can experience different tension values on each side of the pylon. This could induce cable sliding within the saddle, but this is prevented by the friction of the strands inside the oval holes. Tests carried out in VSL's laboratories have shown that the friction of the strand with the new saddle will be between 0.4 and 0.6. The strand holes

#### COVER STORY

specific length where the strand will touch the saddle. After installation, the unsheathed length of the strand is then in direct contact with the Ductal® - there is no tube.

The holes are injected with a special filler after installation to maintain the corrosion protection of the unsheathed part of the strand within the saddle. This filler protects the steel components, offers guaranteed adherence to the steel parts and adapts to the cable movements thanks to its

flexibility. The filler is placed into the saddle using a pump or an air vacuum after the overall installation and tensioning of all the bridge's cables.

The filler is the same product as that used by VSL for the protection of strands within VSL SSI Anchorages. Its great efficiency has already been demonstrated by the successful PTI and *fib* leaktightness tests carried out on VSL anchorages in 2007. The filler provides another benefit besides protecting the unsheathed cable inside the saddle against corrosion. It also contributes to the cable's fatigue performance by reducing the risk of fretting corrosion.

## Easy stay pipe connection

The connection of the stay pipe to the saddle is very similar to the standard pylon connection of the SSI 2000 stay cable system. On extradosed bridges - which usually have short cables and stiff decks the steel expansion sleeve of the HDPE stay pipe can be connected

#### Un-am Bridge, Korea

Main contractor Ssangyong Engineering & Construction is building an extradosed bridge for the Ministry of Construction & Transportation, Iskan Regional Construction & Management Office. The Un-am Bridge is being built using the free cantilever method. VSL's scope covers the supply and installation of SSI 2000 stay cables (6-37) and the saddles together with 776t of prestressing tendons. The work also includes execution of a fatigue test for the VSL SSI Saddle as well as pylon, pier and deck construction for the structure, construction engineering, pre-camber calculations and the design and supply of the form-traveller. The works started in May 2006 and are scheduled to be completed in October 2009.



#### Made in VSL

The VSL Saddle is manufactured in CTT Stronghold's factory in Spain. Before implementation on Catumbela Bridge in Angola, a prototype saddle was built and tested in CTT Stronghold's premises.

The manufacturing plant has more than 50 years of experience in manufacturing post-tensioning components and other VSL products: PT components for civil works: anchor heads, wedges (more than 100 different references), pot bearings, rubber bearings, PT-steel ducts, PT-PLUS® 23 duct, PT building components, elastomeric bearings and expansion joints, pre-stressing equipment and components, PT equipment, cable stay system SSI 2000, anchorages for cable-stayed bridges, CS 2000 system, bars, ground and rock anchors. CTT Stronghold's factory has also developed anti-seismic pot bearings, friction damper, dead load cells 1000kN and automatic stressing controls. The Barcelona-based factory is certified ISO 9000:2000.



#### **Recent VSL developments in stay cable technologies**

- **The VSL Saddle**, a patented solution allowing a great simplification of the design of the pylons and enhancing bridge aesthetics (2007).
- Compact cable arrangement using dehumidification techniques, resulting in a tight arrangement of the strands and hence a reduced cable diameter, enhanced with a reduced wind drag (2007).
- VSL Anchorage without guide deviator, leading to simplified design and construction of the pylon and the superstructure (2008).
- A choice of cable vibration damping systems, which permit optimum adaptation to structures: VSL friction damper and Gensui damper (2006).



Dehumidifier unit: The new SSI 2000(D) stay cable system is featuring individual strands within an HDPE stay pipe as previously but is also offering a reduced cable diameter allowing the lowest cable wind load on the market. This advantage is particularly valuable for long stay cables of large bridges. It also provides a new approach to corrosion protection featuring easy monitoring and maintenance on any size of bridge. The dehumidifier unit placed within the pylon supplies the dry air to the pylon anchorages. The dry air introduced within the pylon anchorages will move down to the deck anchorages. The space between the strands inside the HDPE pipe allows a circulation of the dry air around the steel strands with a pressure at the deck anchorage slightly larger than the atmospheric pressure.

#### VSL IN THE SADDLE

## COVER STORY

#### THE SADDLE TESTING PROCESS

#### VSL has carried out extensive and successful testing in developing the SSI Saddle

#### **Friction tests**

The first series of testing involved friction tests using monostrands and was carried out in VSL's laboratories in Switzerland and Korea and at the CTT manufacturing plant in Spain. The aim was to measure the friction between strands covered with



different types of sheathing and saddles with different hole geometries and materials. The friction measured within the VSL SSI Saddle varied from 0.4 to 0.6 depending on the loads on each side of the saddle. In addition, the cable friction on the VSL SSI Saddle is increased by about 25% during the deck construction, before placing the filler.

#### **Fatigue tests**

It is not a straightforward operation to carry out fatigue tests on a representative stay cable, as specified in the stay cable recommendations. The different testing laboratories are not equipped for this type of test and significant investments are required. The VSL SSI Saddle uses 100% individual strands. Tests with a reduced number of strands confirmed that the VSL SSI Saddle does not reduce the fatigue performance of the cable. Fatigue tests were carried out in Korea to approve the use of the VSL SSI Saddle on the Un-am Bridge project there. A second test has been performed this year in the Applus laboratory near Barcelona, for the Catumbela Bridge project in Angola. Four sheathed strands were installed in the saddle, which was 4.5m long and had a radius of 4.5m. Testing lasted two million cycles, with the four strands (1860MPa) tensioned to 60% GUTS with a stress range of 70MPa. The fatigue test was passed



successfully and the saddle was approved for installation on the bridge.

The four strands (1770MPa) were tensioned during two million cycles to 45% GUTS with a 200MPa stress range. After the fatigue cycles, each strand was tensioned until breaking point, to determine whether there was any effect of fatigue on the cable's performance. No wire break was observed within the saddle. The test laboratory concluded: *"The fatigue*"



Catumbela Bridge, Angola. The 9.2m-long 4-strand cable is led through the saddle at a radius of 2.5m.

test showed that the tested VSL Saddle does not reduce the tensile and fatigue strength of the cable. The contact surface of the saddle with the cable is designed to allow the transfer of high differential forces. Inspection of the strands removed from the saddle after the fatigue test showed that the (galvanised) metallic coating of the strands was not deteriorated at the saddle contact surfaces. The dismantling operation of the strands realised on the saddle after the fatigue test demonstrated the feasibility of strand by strand removability/replaceability".

#### ...

with bolts to the end of the saddle. For cable-stayed bridges, the use of a flexible connection is recommended as it is better adapted to the variable angles of deviation of the cables. The standard HDPE stay pipe can move freely inside the expansion sleeve. A tension ring is installed on the strand bundle at a distance from the saddle. This tension ring collects the outer strands of the cable to produce an overall diameter slightly less than the internal stay pipe diameter.

### Competitive advantages

Tests have confirmed the main features that make this saddle so competitive - two independent barriers against corrosion, excellent bonding with high friction values to guarantee the load transfer, and the stay's fatigue performance. This new solution is also convenient as it is compact and allows strand-by-strand installation and replacement of stays. Last but not least, it encourages more aesthetic bridge designs.

Construction started in late 2007 on the Catumbela site near the city of Lobito in Angola. The saddles have been fabricated in VSL's manufacturing plant in Barcelona, Spain, and installation will begin in May 2008. VSL's scope of work also covers the design, supply and installation of post-tensioning (bars and strand) and stay cables as well as supply of the bearings.



## SITE INSIGHTS

#### Australia

## Full height for Deer Park

→ VSL Australia is carrying out a design and supply contract for 13,400m<sup>2</sup> of VSoL<sup>®</sup> wall panels for 21 bridge abutments on the Deer Park Bypass project in Melbourne. This is the first VSoL<sup>®</sup> project where full height panels have been used. Leighton is main contractor for the bypass, which is one of several major road schemes currently being constructed to improve traffic flow around the city. The VSoL<sup>®</sup> panels are precast to the full height of the abutment walls. The panels are 2m wide and up to 14m in height. Production of the precast elements started in September 2007 and will be completed by the end of April 2008. The walls are cast in VSL Australia's Thomastown Precast Yard. Contact: ccheong@vsl-australia.com.au

## Vietnam Stays for Rach Mieu

→ VSL Vietnam is nearing completion of a contract to supply and install 450t of VSL SSI 2000 stay cables for the Rach Mieu



cable-stayed bridge in Vietnam's Ben Tre province. The project involves the installation of 28 stay cables ranging in size from 6-19 to 6-55. The bridge has a 270m central span and two 117m side spans. Its deck is constructed in typically 9m-long sections using form travellers. VSL Vietnam has worked with the owner, Project Management Unit No 9 - Ministry of Transports, and designer Tedi-MOT during the project. VSL is also supplying a monitoring system, with assistance from Hong Kongbased sister company FT Laboratories.

Contact: lan.tranduc@vn.vsl.com

## Thailand Chill out on the 19<sup>th</sup> floor

→ VSL Thailand has recently completed the lifting and lowering of six air-conditioning chiller units using an ingenious system involving strand jacking and double-acting long-stroke jacks. The project at the city-centre Bangkok Bank building involved removal and replacement of airconditioning units located in the 19<sup>th</sup> storey plant room. Conventional crane methods could not be used because of a unique combination of constraints in



terms of weight, head-room limits and the height required for lifting and lowering. Long-stroke jacks were used to lift the units into the lifting frame as head-room limitations prevented them from being connected directly to the strand jacks. The units were then slid through a small opening before being transferred to the SLU 10 strand jacks for lowering 50m to the 8<sup>th</sup> floor. They were then relocated to an area accessible by crane, for removal from site. The sequence was reversed to install the new units. VSL Thailand's scope of works included design of the temporary steel as well as supply and operation of the lifting system. Main contractor was Thai Obayashi and the engineer was Atkins China. Contact: jmckenzie@vsl-th.com

## Australia Green light for system trial



→ VSL Australia is trialling a "traffic light" system for control of its electric strand pushers (ESPs) on a new bridge nearing completion south of Sydney. VSL is working with Abigroup Contractors on the incrementally-launched Alfords Point Bridge Duplication project, where its scope involves the supply and installation of ground anchors for the abutments, post-tensioning and the launching system, which it also operates. The traffic light system allows the easy and safe control of an ESP from either end of the tendon whilst working in a confined space condition. Red and green lights indicate the pusher in operation or halted. Typically the operator at the pushing end would run the ESP and a green light at the opposite end would indicate that the strand is being pushed through the tendon. A labourer then hits the "stop" button when the strand reaches the end of the ducting. The strand is cut at the pushing end before the process is repeated. The ESP can be stopped from either end at any time without the need for radio communication and the system cannot be restarted until both operators agree. **Contact:** dtravner@vsl-australia.com.au

## Thailand Flying segments

Bangkok's new international Suvarnabhumi Airport will soon be equipped with its new rail service linking it to the city. VSL is playing a major role in the construction after being contracted by Sino-Thai Engineering & Construction (STECON) to supply and operate five gantries to erect 684 of the 893 spans that form the 28.5km precast segmental bridge deck. All the external post-tensioning is also by VSL. The structure is built using span-by-span methods, with a typical 35.5m span made up of 13 segments. VSL has provided four underslung gantries and one overhead unit from the group's equipment pool in Hong Kong. STECON provided five additional overhead gantries. The underslung

gantries were equipped with segment loaders to handle deliveries of segments arriving from behind along the bridge deck. Use of the loader simplified the logistics of segment delivery. VSL developed the loader concept, which was then fabricated and operated by STECON. Segments for the overhead gantry erection were normally delivered to the span location and off-loaded onto the ground in advance of placement. Client for the scheme is the Kingdom of Thailand Ministry of Transport State Rail. 🗖 Contact: jmckenzie@vsl-th.com





## <mark>Australia</mark> Queensland first

→ VSL is in an alliance with Leighton Contractors and Abigroup Contractors that is making excellent progress on the construction of the New Gateway Bridge in Brisbane, Australia. The iconic structure will resemble the existing Gateway Bridge that was built in 1985. Its 260m main span is being cast in situ using the balanced cantilever method and will tower some 70m above the Brisbane River. The 1km approach structure will be constructed using match-cast segmental technology - a first for Queensland. The scope of work includes operation of a large precast yard and abutmentto-abutment construction of the whole bridge, including foundations, substructure and superstructure. The foundations are substantially complete and about half the work has been carried out on the approach pier blades. The massive supports to the main span are quickly taking shape and segmental erection has also started. In addition to the construction of the bridge, the Alliance is also responsible for casting elements for the remainder of the project: 45km of prestressed octagonal piles, 35km of prestressed beams and 750 match-cast segments. Contact: ian.barringham@lajv.com.au



→ Northern Gateway Alliance (NGA) has called on the expertise of VSL to build complex twin viaducts across the picturesque Waiwera Valley in New Zealand. The 520m-long viaducts have spans up to 76m and form part of a 7km motorway extension north of Auckland for Transit New Zealand. VSL was engaged as a sub-alliance partner for superstructure construction right from the concept design stage. Construction is by the match-cast segmental balanced cantilever method, and the scope of the sub-alliance includes both segment casting and erection by overhead launching gantry. VSL has also provided the system for the 480t of posttensioning. One viaduct is complete and the final segments for the second are due for erection in late April. The superstructure is made up of a total of 356 precast segments. A challenge for the management was to school the local labour force in new methods.

The introduction of key supervisory and managerial staff from VSL soon ensured that one-day segment production cycles became the norm. VSL also brought its experience to the erection works, including the supply of the erection gantry and key staff to operate it. The project has led to a further appointment for VSL by NGA, this time as a full alliance partner on a project in Auckland. *Contact: dodonnell@vsl-australia.com.au* 

ightarrow VSL (Thailand) has lifted the roof trusses for the main building

being built by Sino-Thai Engineering & Construction for a government complex in Bangkok. Construction of nine steel roof trusses weighing over 600t was a critical task and VSL proposed an efficient heavy lifting solution. The trusses were lifted from their second-floor assembly point in three 200t modules. Lifting frames equipped with SLU 70 lifting units were installed at the roof-top. The lift to the 32m-high final level took roughly 10 hours, using manual control and laser measurements. Good coordination of the site crews and stringent operational methods helped avoid the need for complex monitoring systems.

Contact: natthawut@vsl-th.com

## THAILAND Close coordination



## Hong Kong On-track transfer

→ VSL HK is nearing completion of a subcontract for Hip Hing-Ngo Kee JV for the difficult installation by lifting and launching of four main roof trusses for a new bridging link for the expanded Hong Kong Convention and Exhibition Centre. The trusses weigh between 1,290t and 1,800t and span approximately 90m across a harbour channel, spaced at 27m from one another. They are supported on columns at 41m and 57m above ground level and are



being installed in a complex operation involving lifts and sideways launches and some 1,650t of temporary steelwork. Each roof truss is lifted using eight centrally-controlled 330t-capacity SLU 330 hydraulic jacks, mounted on self-balancing lifting brackets on top of the permanent columns. The sliding of the roof trusses will be done using four SLU 70 jacks. The successful 4,000t lift of the first pair of trusses and temporary works involved synchronisation of 16 jacks. Lifting of the final two trusses is due for completion shortly. Contact: henrypc.chan@vsl-intrafor.com

## Vietnam Segments set sail



Prefabrication of the segments for the Thu Thiem immersed tunnel, which will cross under the Saigon River in Ho Chi Minh City, Vietnam is almost completed. The tunnel includes four precast units. 33m wide, 9m high and 90m long. Main contractor Obayashi Corporation awarded VSL Vietnam the design, supply and erection of four sets of formwork to cast the 15m-long segments. A total of 820t of formwork steel has been fabricated. The VSL Post-Tensioning system is being installed in the precast units, using 350t strand with EC 6-12 anchorages. Units will be sealed at both ends, then floated, towed to site and sunk.

Contact: lan.tranduc@vn.vsl.com

## Hong Kong Successful alternative



→ VSL Hong Kong has completed a major transfer plate project for a residential development at Tseung Kwan 0 for MTR and

Cheung Kong Development. The scope of VSL's work involved the design, supply and installation of the post-tensioning system for the seven transfer plates, which used 665t of strand. VSL's alternative design achieved significant savings compared to the traditional reinforced concrete construction, including a 50% reduction in reinforcement and a switch to lower grade concrete. VSL worked closely with the main contractor and completed work ahead of schedule in less than three months, despite a rebar fixers' strike. Contact: alice.lin@vslintrafor.com





→ VSL has carried out a 55m lift of a restaurant which is suspended underneath a bridge arch in Moscow, to give panoramic views across the city. The Zhivopisny Bridge's 409.5m main cable-stayed span is supported by a 100m-high arch, from which the 6,600kN restaurant also hangs. VSL Heavy Lifting used four SLU 330/550 strand lifting units to lift the 24m by 33m ellipsoid-shaped unit from its assembly point on the deck to its final suspended position. Power from four EHPS 32 MS electric pump units enabled the restaurant to be lifted in just five hours. VSL's BRAVO control system maintained the correct positioning, keeping the fully glazed structure horizontal and minimising twisting. Measurement of the remaining distance by high-precision infrared sensors at the four lifting points enabled the BRAVO computer to monitor and control the height of each point while the pistons were moved. Height differences were kept to within a few millimetres even heavy snowfall didn't affect

the precision. The bridge is owned by the Municipality of Moscow, the main contractor is OAO Mostotrest and the engineering consultant is Institut Giprostroymost. Contact: daniel.junker@vsl.com

## Netherlands External upgrade

The Meuse Bridge on highway A2 near Empel, Netherlands, was built in the 1970s and VSL's posttensioning system has been used to upgrade it to the latest standards. The bridge had been built using two techniques. The free cantilever method was used for the 261m river section while the 364m approaches were built using 3m-long prefabricated segments. The bridge has a cross-section of four square boxes. Compressive stresses in the joints between the segments were found to be insufficient to meet current requirements and so Heijmans Beton & Waterbouw has recently provided additional external posttensioning to achieve compliance.



The four boxes contain eight VSL E6-19 cables, made up of two 180m lengths joined using VSL V 6-19 couplers. Stabilizers have been used to reduce cable vibration. *Contact: MPronk@heijmans.nl* 



## Switzerland Avalanche-proof anchors

 $\rightarrow$  The unique 88.5m-long Rohrbach Bridge is an avalancheproof tunnel-bridge on the St Gotthard Alptransit Railway. Installation of VSL Anchors is ensuring that it continues to survive the worst avalanches. The original steel bridge was twice demolished by the notorious Rohrbach Avalanche and a new concrete structure was built to replace it. The 8.000t tubular structure is both a bridge and a tunnel to protect against avalanches and falling rocks. A 1999 avalanche led the Swiss Railway Authority to revisit the structure's avalanche resistance. A 300-year worst-case scenario revealed the need for strengthening of crucial parts including the foundations and

abutments. Additional anchoring for the abutments involved installation of 42 VSL Prestressed Anchors, with lengths of up to 47m to reach load-bearing rock. The exceptional length necessitated the joint services of a crane and a helicopter to home the anchors. More than half of the anchors are vertical and required special installation to ensure they were lowered without touching the lowest point of the borehole. This prevents damage and ensures that they hang straight, avoiding unwanted forces. All anchors are electrically isolated, which provides a barrier against stray currents and allows the integrity of the corrosion protection to be checked throughout the anchor's life. 🗖 Contact: markus.rickli@vsl.com

## Czech Republic Power lift

Reconstruction of the Tusimice II power plant entailed the lifting of 16 boiler pipe blocks to a final height of 42m. The blocks, each weighing 100t, were lifted by two synchronised pairs of VSL SLU 30 hydraulic lifting units. Up to four sets were in use at a time, with 16 units supplied to the site. A typical cycle of eight to ten days was achieved for the assembly and lifting of the 16 blocks. Successful execution of the project was a result of close cooperation between client Hutni Montaze, which arranged assembly of the boiler drum blocks, VSL CZ and VSL Heavy Lifting, supplying heavy lift works. Contact: pvanek@vsl.cz



#### NOTE PAD

Mega parking. Huge amounts of post-tensioning are being used in the 14-floor car park podium building for the Palm Jumeirah Gateway Towers project under construction in Dubai. VSL is responsible for the posttensioned slabs in the podium building and is using more than 330,000m of tendons. VSL's type S5-4, S5-5 and S6-4 slab anchorages are being used. The estimated strand quantity is 1,100t.

**Stay monitoring.** VSL Switzerland is carrying out the installation of the stay cables on the Rades La Goulette Bridge in Tunisia. The extradosed cables are made up of 37 strands passing through a saddle in the pylon and anchored in the deck with VSL SSI 2000 DS6-37 anchorages. The bridge is monitored by VSL Switzerland. Eight of the 16 stays are equipped with HC160 load cells connected to VSL software, in order to check the forces in the stays.

Irish spectacle. VSL Systems (UK) began work in November 2007 on a five-span bridge over the spectacular Mulroy Bay in northern County Donegal, Ireland. The contractor Ascon uses formtravellers to build the bridge with a main span of 100m. Construction of the 340m-long structure is scheduled for completion by the end of 2009. VSL's involvement in the project includes the posttensioning works for both internal and external tendons as well as the construction engineering for the balanced cantilever construction.

**Spout exchange.** VSL Switzerland has erected its second system to handle the regular exchange of the spout at a steel-furnace at ThyssenKrupp Steel in Duisburg, Germany. The new system, which has a capacity of 80t, consists of four VSL rod system lifting and lowering units for use when the spout is replaced every four to five weeks.

## SITE INSIGHTS



## USA Slip-form for corn

→ VSL provided assistance to the structural engineer, technical support and furnished the posttensioning materials and labour for installation of new corn silos being built as part of a major ethanol plant in Texas. The plant is a design-build project being completed by ICM for Levelland/Hockley County Ethanol. It includes two 38m-tall silos with diameters of 21m. They will hold corn prior to grinding and fermentation for the production of ethanol. The silos were built simultaneously under a subcontract to Agri-Systems using the slip-form method of construction. The use of posttensioning in the walls reduced the amount of concrete and rebar that was required and allowed the slipforming to proceed more efficiently. The reinforcement included horizontal posttensioning in the walls, provided by 190 tendons using the VSL ECI 6-7 anchorage system and galvanized duct. The slip was completed in seven days, with VSL providing continuous on-site support during the duct and anchorage placement. The strand was installed into the ducts using a special suspended version of the strand pusher. The slip was completed in November 2007 and the silos were operational on schedule in mid-February. Contact: bforbes@structural.net

## usa Signature signing

→ VSL has been contracted to supply and install stay cables for the Margaret Hunt Hill Bridge in Dallas, Texas. The bridge is a signature span designed by architect Santiago Calatrava in conjunction with engineering firm Huitt-Zollars. The scope of VSL includes supplying its SSI 2000 Stay Cable System and providing labour, supervision and equipment to erect the stays. VSL was appointed by Cimolai, which is fabricating and erecting the steel for both the arch and the deck on behalf of general contractor Williams Brothers Construction. The central design feature of the bridge is a 136m-tall parabolic arch with fan-like cables reeling off to the deck below. The bridge will measure 596m from abutment to abutment and will have 58 stays. up to 195m in length. Construction began in spring 2007. Engineering and procurement are ongoing, with the installation of stays scheduled for mid-2009 and completion of the entire project by the end of 2009. It is the first of three bridges being built to span the Trinity River as part of the City of Dallas Trinity River Project. **Contact:** bsward@structural.net





→ A new interchange is being built for traffic to enter and exit the main highway connecting Abu Dhabi and Dubai to facilitate journeys to Yas Island, developed by Aldar. The new interchange includes earth fill and bridges. VSL Middle East was awarded a contract for the supply and installation of 1,200t of posttensioning for the in-situ box girder bridges. The work also involves the design, supply and supervision of 40,000m<sup>2</sup> of precast earth retaining wall panels using the VSoL® system. Two bridges that have 60m main spans connect the mainland to Yas Island across the canal. Bridges with spans of up 50m provide links to the main highway, Sheikh Maktoum bin Rashid Road, which runs between Abu Dhabi and Dubai. The scheme's main contractor Six Construct and consultant Halcrow International Partnership chose VSL because of its proven track record on similar projects in the region. Contact: sburke@vslme.ae

## Dubai Marina access



VSL is playing a key role in a **project** to provide improved access to the Dubai Marina area and Jumeirah Lake Towers along the Sheikh Zayed Road in Dubai. Work includes construction of 19 cast insitu bridge structures and four VSoL<sup>®</sup> mechanically-stabilised earth walls with a total area of 5,000m<sup>2</sup>. VSL is providing technical detailing, supply and supervision for the post-tensioning, which requires more than 2.300t of 0.6" (15mm) low-relaxation strand and more than 1,700 sets of VSL posttensioning anchorages in various sizes up to 37 strands 0.6". VSL's scope of work also includes the design, supply and supervision of the new VSoL<sup>®</sup> walls, which use polymeric friction ties with a loop and toggle rod system. **Contact:** sburke@vslme.ae

# Ras Al Khor double



Dubai

VSL Middle East is working on two major projects as part of Dubai's Ras Al Khor Crossing Corridor. Taisei Corporation is building elevated viaducts and Salini Costruttori is replacing an existing interchange. Parsons is consultant for both contracts. VSL is installing more than 49km of tendons on each scheme, pushing more than 3,640km of strand for the two projects and stressing almost 2,500 anchor heads of sizes 6-12 and 6-19. The new interchange involves the construction of several bridges

and underpasses to cater for the high volumes of traffic that will access the area's new developments. The bridges connect to the elevated viaducts being built under Taisei's contract. Work began in late 2006 and is due for completion in March 2009. *Contact: sburke@vslme.ae* 

## Germany Bars in the bank

→ Micro-piles manufactured and supplied by VSL Systems GmbH have been used to reinforce about 5km of banks for a cycle track near Koblenz. VSL Systems supplied Max Bögl Bauunternehmung with more 15,000m of double corrosionprotected micro-piles made from BSt 500/550 S bars of 40mm diameter. The project used a total of 155t of bars. The bars were used



as vertical and inclined piles to reinforce a combined cycleway and footpath running along the banks of the River Rhine. The lowest soil layer was very porous and so most of the piles had to be mounted in "grout stockings" to prevent the grout leaking from the borehole. *Contact: t.langer@vsl-germany.com* 

## SITE INSIGHTS

## Colombia Speedy stays

→ VSL has recently completed the installation of 24 stays on a bridge over the Bogotá Canal, in Cúcuta, Colombia. The stays were installed in just 5 weeks. This bridge is the second cable-stayed crossing in Colombia to use VSL technology, following the Peldar Bridge completed in 2003. The bridge's owner, the Municipality of Cúcuta, has employed UT Jorge González & Cia – Uribe y Abreu Engineers as main contractor and designer. VSL SSI 2000 stay cables sized from 6-19 to 6-37 have been used to support the concrete deck. There are steel saddles at the pylon. The scheme has involved a total of 40t of galvanised, waxed monostrands placed in an external PE pipe without grouting. VSL's Colombian licensee, Sistemas Especiales de Construcción, joined forces with IPSALA Special Projects to supply and install the stays.

## Argentina Mega Mall



→ VSL Argentina has been awarded the design, supply and installation of the post-tensioned slabs for the new Shopping Pan-American Mall. The 160,000m<sup>2</sup> mall is the largest in Buenos Aires and incorporates 125,000m<sup>2</sup> of posttensioned slabs. VSL's bonded monostrand system, Bondtec, has been used, with 600t of strands installed in slabs with typical spans of 11m by 8m. The owner is IRSA, the main contractor is Spain's Constructora San José and the engineering consultants are AHF and C-DV. Post-tensioning work is due to finish in May 2008. Contact: aloguercio@vslarg.com.ar

## <sup>Chile</sup> Repeat business



 $\rightarrow$  The successful completion of a 30,000m<sup>2</sup> ground-level super-flat slab by VSL Chile two years ago has led to the award of a repeat contract from the same retail client. The new slab is, at 36,000m<sup>2</sup>, significantly larger than the first and the project features VSL's latest developments that make it even more competitive in this field. The slab is divided into just two areas and so has a single joint. It was an important goal of the client to achieve a super-flat slab that reduces the need of maintenance of the distribution centre's tri-loader cranes. fpino@vslchile.cl

## Spain Barcelona showcase



The state-of-the-art Barcelona Exhibition Centre, designed by Japanese architect Tovo Ito, is set to reach 240.000m<sup>2</sup> of new floor space by 2009 and VSL has been working during the last three years in two major areas - the main hall and an underground car park. Fira Barcelona is an international leader in industrial and trade shows and plays a strategic role in the Catalan and Spanish economies. It is building on a history spanning more than 100 years with the major development of new exhibition space in the last five years. VSL's scope of work has covered floor design and posttensioning in the 58,000m<sup>2</sup> parking area and the impressive main hall. Key characteristics of the twolevel hall structure are its 25m clear span bearing onto organic walls and its cantilevers of more than 6m. The underground parking area extends to two levels with typical spans of 14.5m.

Contact: cmassip@vslsp.com





## Portugal Bridge make over

→ Soares da Costa has completed the rehabilitation and strengthening of the Lanheses Bridge over the River Lima on Portugal's EN 305 road. VSL proposed a new external posttensioning system for the deck and VSL bars were used in the foundations. The entire structure of the 41-span bridge was given a complete overhaul, which included concrete repair, replacement of bearings and strengthening of both piers and superstructure. All the pier foundations were widened with new concrete and reinforced with high-strength VSL bars. The deck's external post-tensioning can be retensioned or replaced as necessary. The cables pass through existing beams and are anchored in new reinforced concrete blocks. In total, 60t of unbonded strand were installed, consisting of four longitudinal cables with nine strands in every span. Contact: ralmeida@vslsistemas.pt

## Spain Aqueduct launch

OTT Stronghold (VSL in Spain) has successfully finished the launching and post-tensioning works of an aqueduct for the first phase of the new Segarra-Garriques water channel in the north of Spain, 150km from Barcelona. The 390m-long aqueduct was built using the incremental launching method with friction jacks. The typical span is 40m long and the cross-section is 5.4m high. The deck was cast and launched in 20m-long segments, half the typical span length. Segments were cast to a five-day cycle. A total of 100t of PT was used. Design of the project



was by Carlos Fernandez Casado and the main contractor was a joint venture of Dragados and ACSA-Sorigué. Contact: pferrer@vslsp.com

## SPECIAL REPORT

# AF Anchorages Use a VSL Flower when no access !

The VSL Flower Anchorage, Type AF, is particularly suited for vertical tendons without access to the lower end. The system is currently being installed on the Marina Bay Sands Integrated Resort project in Singapore.

The unique VSL Type AF Flower Anchorage system makes it feasible to have a dead-end anchorage in what would otherwise be an inaccessible location. The neat and elegant



Vertical cables are installed and stressed in stages

solution it provides is proving ideal for use on the dramatic towers of Singapore's Marina Bay Sands Integrated Resort. Unlike the normal VSL Type H dead-end anchorage, the AF anchorage's special characteristics allow the casting to be preinstalled with the duct, without the need for strand to be installed at the time of concrete casting. A cast-iron anchorage forms the dead end and transfers the tendon load to the concrete structure, in a similar manner to the VSL EC Stressing Anchorage.

The development will combine state-of-the-art convention and exhibition facilities, a luxury hotel comprising three 56-storey hotel towers, world-class gaming and entertainment, and an unparalleled spread of shopping and dining outlest in one landmark structure. VSL started on the project in August 2007. The three focal 50-storey towers will be linked by a high-level "sky garden". The towers consist of vertical and sloping walls which merge into one at the 23<sup>rd</sup> level, creating an A-shaped atrium frame. VSL has been appointed by main contractor Ssangyong to undertake the construction engineering for two of the three towers, particularly in relation to the temporary stability and geometry control of the vertical shear walls. A construction method has been developed that uses temporary propping and temporary vertical post-tensioning in the walls to keep the maximum moments and forces at the bases within the acceptable limits. The temporary works involve the use of a series of 6-19 cables running inside the shear walls from the pile cap up as high as the 23<sup>rd</sup> level, with three levels of props between the vertical and the sloping walls.

These supports are engaged in stages as construction progresses.

The VSL AF Flower Anchorage has been introduced for the dead end cast inside the pile cap to resolve a significant issue in the posttensioning. Its use in the basement raft slab has enabled the vertical cables to be installed and stressed in stages.





Schematic drawing of Tower 1

Secure fixing of the prestressing strands inside the Flower Anchorage is assured by compression fittings on each individual strand end, encased before stressing into a highperformance, proprietary AF Anchorage Grout.

Tendon installation involves a series of main steps. First, the dead-end type AF anchorage is placed inside the formwork and a duct of suitable length is connected to the anchorage. A stressing anchorage, such as type E or EC, is placed at the other tendon end once the entire tendon has been installed. Compression fittings are then attached to the end of the strands, which are then installed by pushing them individually from the stressing anchorage, through the duct and into the dead end. Once all the strands are installed and checked, the AF anchorage can be filled with the high-performance AF Anchorage Grout. At Marina Bay Sands, it usually takes just two days for the anchorage grout to reach its target strength of about 100MPa. The cable can then be



Detail 1: Typical application of the AF Anchorage

stressed and grouted as normal. Key advantages of the Flower Anchorage system include the simplicity of the strand-by-strand tendon installation after construction of the structure. There is no need for prefabrication of the tendon bundle or for tendon installation before the structure is concreted. Use of the system also avoids the need for stressing galleries in certain types of structures by eliminating recesses or openings for installation or stressing at the dead-end anchorage. The simple and compact anchorage reduces congestion in the structure. The full tendon load is transferred at the bottom end of the anchorage near the bottom of the structure, which avoids downstands in the concrete soffit and therefore often allows reduced concrete volumes.

> Tendon layout in the pile cap (elevation)



# TECH SHOW

# Big, bigger, Dubai



28

For the longest fully automated rail system in the world, the Dubai Metro, VSL, in a joint venture, is responsible for the precasting and erection of the elevated superstructure for the Red and Green Lines. Get on the train...



#### LRT PROJECT

#### **TECH SHOW**



**Take up the red and green challenge** The challenge is to meet the needs of the growing population. Dubai, which counted 183,000 inhabitants in 1970, has today roughly 1.3 million. And the population will continue to grow at an annual rate of 6.4% to reach 3 million inhabitants in 2017. To respond to the forecast increasing demands for public transportation, the LRT project was launched in 2005. The project comprises two lines (Red and Green) of 52 and 18km respectively and RTA, the Dubai Road and Transport Authority has already announced the launching of further lines, the Purple and the Blue lines.

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**Operate biggest casting yard in the world** The joint venture between VSL, Freyssinet and Rizzani de Eccher has been contracted by JT Metro (Obayashi, Kashima, Yapi Merkesi Joint Venture) for precasting and installing approximately 1700 spans with a total of 16,000 segments. Nine tower cranes, 11 gantry cranes (of 100t and of 80t) and 64 casting machines produce 35 - 40 segments a day, using roughly 800m<sup>3</sup> of concrete and 120 - 160t of reinforcement steel. More than 350,000 m<sup>3</sup> of concrete, 75,000t of steel and 13,500t of post-tensioning steel and 500t of epoxy will be required. Two types of moulds are used: long line and short line moulds used for the different span elements. Within these types, a total of 33 different designs are required depending on the later use of the element to be casted.

> Care for the staff The Jebel Ali Casting Yard is one of the biggest in the world and spreads over more than 50ha. VFR employs more than 2,000 workers. Considerable efforts have been undertaken for the staff. The newly built living compound at the precasting plant is composed of a junior staff compound for 160 persons (single rooms) and labour quarters (2 or 4 per room). Medical care is provided in a clinic with a doctor and two nurses employed by the joint venture. There are a canteen, recreation rooms and sports areas. A sewage treatment plant has also been erected.



Match cast segments by numbers Concrete segments are transported, on demand, from the casting yard to the launching gantry sites using heavy haulage trucks. The viaduct deck segments typically measure 10 metres wide by 4 metres long. The lengths of the spans vary from 24 to 72 metres whereas the minimum number of segments per span is 8 and the maximum is 20. Depending on the site conditions, span-by-span or balanced cantilever erection methods are used.

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#### LRT PROJECT

## **TECH SHOW**



#### Erect one span in two days

Launching gantries are used for the majority of the viaduct construction and provide a fast-track installation process which enables the erection of a complete viaduct span in approximately two days. The launching gantries comprise two steel box girders connected together by steel frames. The best construction sequence achieved for a span erection including post-tensioning, stressing and launching girder displacement is 13 hours. **Launch ten girders at a time** Ten launching girders are working at a time along the two lines. The most commonly used construction method is span-by-span erection. The precast segments are delivered from below, the pier segments and field segments are placed, adjusted and aligned. The segments are glued and temporarily stressed. Then, the load is transferred to the piers. Whenever site constraints, such as power lines or existing structures that limit the work space, prevent the use of launching girders, the spans are erected using falsework and heavy shoring systems. Six work fronts are mobilised on the project.



#### LRT PROJECT

### TECH SHOW

**Use balanced cantilever** to overcome obstacles The balanced cantilever erection method is used for about 8% of the overall project for special bridges spanning 72m and above urban obstacles such as traffic interchanges and canals. Upon erection of the temporary supports and the pier head preparation, the first two segments are positioned, glued and temporarily stressed. Subsequently, lifting frames are used to erect the remaining segments. The end span segments are erected by crane on falsework.





#### HEADQUARTERS

VSL International Ltd. Scheibenstrasse 70 – Bern CH-3014 – Switzerland Phone: +41 58 456 30 30 +41 58 456 30 35 Fax:

#### Americas

#### ARGENTINA

VSL Sistemas Especiales de Construcción Argentina SA **BIIFNOS 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

#### CHILF 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 5 396 86 21 Fax: +52 5 396 84 88

#### **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 +20 2 346 04 57 Fax:

#### 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

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

GFRMANY VSL Systems GmbH RFRI IN Phone: +49 30 53 01 35 32 Fax: +49 30 53 01 35 34

**GRFAT BRITAIN** VSL Systems (UK) Ltd. REDEORDSHIRE Phone: +41 58 456 30 30 Fax: +41 58 456 30 35

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

#### NORWAY VSL Norge A/S STAVANGER

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

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

#### **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 8 5007 3820 Fax: +46 8 753 49 73

#### **SWIT7FRI AND** VSL (Switzerland) Ltd.

SUBINGEN Phone: +41 58 456 30 30 Fax: +41 58 456 30 35

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

#### **Middle East**

**UNITED ARAB EMIRATES VSL Middle East LLC** DUBAL UAE Phone: +971 4 333 6262 Fax: +971 4 333 0008

#### Asia

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

CREATING SOLUTIONS TOGETHER

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 VSI 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 12 17

ΙΔΡΔΝ **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

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

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

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

Ho Chi Minh City Phone: +84 8 8106 817 Fax: +84 8 8106 818

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#### Australia

VSL Australia Pty. Ltd. **NEW SOUTH WALES** Phone: +61 2 9 484 59 44 Fax: +61 2 9 875 38 94

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

## **NETHERLANDS** Fax: +31 73 543 66 11

Phone : +47 51 52 50 20 Fax : +47 51 56 27 21

#### +351 21 444 63 77 Fax:

**VSL GEO** 

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