

HEAVY LIFTING High expectations

Green VSoL<sup>®</sup> walls Hodariyat Bridge

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#### **TECH SHOW**

#### Hodariyat Bridge, Abu Dhabi

By proposing an alternative design to the planned two-deck cast-in-situ bridge in balanced cantilever, VSL won the contract to build the first cable-stayed bridge in the UAE.













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# EDITORIAL

# Adding value with VSL

Our high level of technical expertise coupled with our culture of innovation allows us to bring added-value solutions to clients. VSL's heavy lifting work is one outstanding example of our highly technical niche activities: constant involvement in innovative construction allows VSL to take on the most challenging lifting operations. Our heavy lifting services are backed by strong R&D and one of the largest fleets of highperformance jacks and equipment as well as the skills of trained engineers and technicians. New systems, applications and technologies are designed and implemented to increase our performance and provide more efficient workflow on site. Issues relating to sustainable development and construction methods are another driving force for innovation.



VSL's expertise together with its highly skilled engineers has led the teams to take on major projects as main contractor, where appropriate. On the Hodariyat Bridge, for example, VSL proposed an alternative to the originally planned design and won the contract to build the first cable-stayed bridge in the UAE – and completed the project in a record-breaking time.

Providing clients with services and technologies that bring high added value is a VSL must and benefits both parties. We are happy to present some of our recent achievements – the result of your trust and our dedication.

# **BUSINESS IMPROVEMENT**



A sa decentralised organisation working worldwide in over 40 countries and in hundreds of locations, VSL has a significant environmental footprint from air travel. In addition this travel takes up a lot of staff time - including time away from home - and is expensive. Most of the travel is considered essential as it involves staff travelling to carry out construction-related activities. However, a smaller but important proportion is for meetings.

As part of VSL's response to this issue, a programme was initiated in 2010 to install videoconferencing facilities in the majority of offices and at major project locations - rather than just in regional offices. Although the main objective is to reduce air travel, improvements in communication were also seen as an important secondary objective. The environmental impact of air travel is generally estimated at between 3% and 5% of CO<sub>2</sub> emissions worldwide. It also generates significant emissions of other 'greenhouse' gases that are difficult to estimate. Of particular concern is the impact of these greenhouse gases on the higher layers of the earth's atmosphere, together with the continuing trend for increased air travel.

So far 25 offices now have a videoconferencing capability. Staff can also join video-conferences from their personal computers if they are running the appropriate software and are 'inside' the company computer network. The system furthermore allows callers from ordinary telephones to be included in the conference. As a consequence there has been a huge increase in the number of meetings using video-conferencing and in the amount of time that these systems are in use. The general feedback is that this has reduced air travel, and that the quality of remote communications has improved significantly. It is too early for an accurate estimate of the reduction in air travel; however initial analysis puts it in the order of 5% to 10% annually over recent years. While this cannot definitively be explained by videoconferencing, it should be noted that VSL's activity levels have been increasing since 2008, and that the geographical spread of activity is also increasing. The savings in  $CO_2$  emissions are estimated to be in the order of 100 tonnes to 200 tonnes per year so far, and the trend is up.

## **COMMUNITY ACTION** Extension for Long Hai

SL staff remains committed to helping making things better for the children at the Long Hai Social Centre in Vietnam. An extension of the building was officially handed over recently to the centre's officials. The opening ceremony was held in the presence of VSL's staff members supporting the project.

The new extension will allow the centre to welcome disabled children and victims of dioxin poisoning.

### RISK PREVENTION 5-star award for VSL Chile

SL's Chile has been recognised for its excellence in risk prevention at an awards ceremony held by the Chilean Chamber of Construction and achieved the full Five Stars in the 'Honour Roll in Risk Prevention'. To earn this recognition, VSL had to achieve a series of stringent safety requirements aimed at companies with an average of more than 100 workers.

### HEALTH & SAFETY Zero accident

D uring the construction which started in October 2009 and was completed in March 2012, the Hodariyat Bridge Project reported zero lost time accident and achieved 4,750,000 safe man hours. VSL Middle East LLC and Overseas AST Joint Venture is the main contractor that undertook the design/build of the Hodariyat Bridge in Abu Dhabi. The bridge is the first stay cable bridge built in the UAE (see page 36).

# SAFETY Automatic cut-out for mini mixer



o prevent the risk of a blowout when post-tensioning ducts are being grouted after stressing, VSL's new Mini-mixer incorporates an automatic safety cut-out. Traditionally, safety relies on the machine operator being aware of any sudden rise in pressure due to a blockage. Action has to be taken immediately to stop the grout pump as a blow-out could result in serious injuries. The new Mini-mixer's automatic cut-out stops the pump when the maximum target pressure is reached. The innovation, developed by VSL's Equipment Department, will contribute positively to VSL's site safety.



### SUSTAINABLE CONSTRUCTION Reducing the carbon footprint of telecom towers

SL is working with Ericsson on a new generation of telecommunication towers. VSL has provided design, precasting and construction services for a pilot project to build eight of the patented, awardwinning Ericsson Tower Tubes (ETT) in Saudi Arabia. The towers house base stations and antennas, fully enclosing them in an attractive concrete structure that has a smaller footprint and a lower environmental impact than a traditional steel tower. Total CO<sub>2</sub> emissions are lower and operations use less power. 🔳

### AWARD VSL best sub-contractor

Amsung C&T has named VSL Singapore as 'Best Sub-contractor of the Year 2011' for its work on the Singapore LNG Terminal project. The award is the recognition of VSL's continuous efforts, performance and achievements in health, safety, security and the environment on the project. There were no reportable lost-time injuries and VSL was best subcontractor of the month four times in 2011. In addition, 60 VSL workers were awarded the title of 'best safety conscious worker' in 2011. VSL was also awarded "Best Sub-contractor of the month" for February 2012.



# FACTS & TRENDS

Stay cables

Largest quantity of stays for one bridge



→ A joint venture led by VSL has been awarded the stay cable works for the Forth Replacement Crossing near Edinburgh in the UK. The VFM joint venture's work is for FCBC, a consortium of Hochtief, Dragados, American Bridge and Morrison Construction. The Transport Scotland project is currently being designed for FCBC by Ramboll, Leonhardt Andrä und Partner and Grontmij, following a concept design by Jacobs and Arup. VFM is set to mobilise in 2014 to install the 7,000t of stay cables from three single column towers to support the single composite deck, which will represent the largest quantity of stays ever installed for one bridge, which will be built west of the existing road bridge and iconic rail bridge. Contact: david.addison@vsl.com



#### Ground engineering Successful grouted friction barrette design

→ Intrafor has been awarded a contract to install friction barrettes for a public housing development in Hong Kong where the piles are being installed in a marble-zone area. The scope of work includes the construction of 65 friction (shaft grouted) barrettes and four 3,100t loading tests. The barrettes will be excavated to a depth of 55m. Ove Arup & Partners chose the shaft grouted barrette design to enhance the friction between the soil and the barrette pile. ■ *Contact: alan.liu@vsl-intrafor.com* 



#### Nuclear containments PT access platform fully certified

→ A full-scale mock-up of VSL's nuclear posttensioning access platform has been inspected, tested and certified in accordance with the latest stringent European (CE mark) and Russian requirements. One of the most challenging



aspects of VSL's scope on Russia's LAES-2 nuclear power plant is to design and supply four platforms for installation in the confined space of the reactor buildings. VSL's platforms will allow work to take place for the installation of horizontal and dome tendons during construction. The platforms will remain operational throughout the life of the nuclear plant, to allow future inspection and maintenance of the VSL NC 6-55 unbonded posttensioning system installed in the concrete structure. Contact: sebastien.elias@vsl.com

#### Launching gantries Bangalore first

→ VSL India is constructing a 4.5km viaduct on the Bangalore International Airport Expressway. The six-lane viaduct is the first of its kind to be erected in India using a single overhead launching gantry. The structure is divided into a main viaduct of 3.4km and two flyovers totalling 1.1km, erected by two gantries. VSL scope includes the supply and operation of the erection gantries, post-tensioning and the supply of precast cells. VSL has achieved an excellent cycle time of 2.5 days per 34m span, working amid very busy traffic. Contact: saravanan.subramanian@vsl.com





#### Award Global winner

 $\rightarrow$  The scale and design of México's Atotonilco treatment **plan** has won it the Global Water Award for the world's best public-private water project. For its client ATVM, VSL is providing and supervising the installation of 1,700t of post-tensioning for 30 digester tanks, each 25m in diameter and 35m high. Atotonilco is México's largest wastewater treatment plant, designed to treat 23m<sup>3</sup> of water per second. Its function is to transform Mexico City's sewage into water for use on the thousands of hectares of arable land in the Mezquital Valley and for aquifer recharge. Completion is due end of 2012. Contact: prangel@vslmex.com.mx

#### AF Anchorage Australian pioneers

 $\rightarrow$  A project to build LNG tanks in Queensland is set to pioneer Australian use of the AF anchorage system. VSL Australia is to supply and install approximately 1,500t of post-tensioning for two 160.000m<sup>3</sup> LNG tanks on Curtis Island near Gladstone. The tanks are part of the Australia Pacific LNG project for CB&I under Bechtel. The casting of the base slab has started and the tendons are due to be installed and stressed in the second half of 2013. Contact: david.trayner@vsl.com

#### Post-tensioning slab 5 million square metres and growing



→ Plaza Egaña's shopping centre has required 125,000m<sup>2</sup> of post-tensioned slabs, making

a major contribution to the 774,000m<sup>2</sup> of slabs sold by VSL in Chile last year. With this and other projects, VSL has reached a major milestone as it has now designed and delivered more than five million square metres of post-tensioned slabs in the country. This confirms its position as one of the leaders in PT slabs. The main contractor for the Plaza Egaña project, Sigro, it is one of the largest contractors in the country. **Contact: mmeier@vslchile.cl** 

# COVER STORY

# HEAVY LIFTING Pushing the limits for high expectations

As one of the world leaders in heavy lifting technologies, VSL is now extending its range of services to include new heavy lifting techniques and applications for bridges, tunnels, offshore projects and wind turbines. Watch out for more big structures on the move...

Port of Tangiers, Morocco, 2012: handling of 105 concrete caissons, each weighing 3,400t. VSL's fleet of lifting equipment has the second largest capacity in the world, amounting to more than 100,000 tonnes



# COVER STORY

At the end of the 1960s, VSL came up with the visionary idea of lifting heavy loads by combining proven components from its strand posttensioning system with hydraulic jacks and pumps. The initial application involved three 490t concrete dome shells for a series of circular aluminium silos in Sardinia. They were lifted 28m. Lifting and stressing of the steel cable-net system for the acrylic tent-shaped roofs at Munich's Olympic Stadium in 1971 served as another milestone in the development of this new erection technique.

#### Heavy lifting with VSL

VSL offers a complete range of services from the initial concept through engineering, planning, equipment supply and execution of the heavy lifting project. The approach is flexible and the extent of VSL's services is tailored to specific project requirements. Services include feasibility studies and preliminary consultation, project design and planning, equipment specification, scheduling and budgeting, design, manufacture and supply of special equipment and temporary structures, leasing and operation of VSL equipment and execution of work planned either by VSL or other parties.

With its custom-designed solutions, VSL can plan the work or serve as a single point of contact for lifting, horizontal jacking or lowering operations; as well as designing the necessary temporary structures to suit project requirements.

VSL Heavy Lifting is a Swiss-rooted centralised business unit within the VSL network and assists local entities on any project, thus providing the specialist knowhow wherever it is required worldwide.

#### State-of-the-art techniques for lifting

Many of today's civil engineering structures and industrial plants are assembled from large, heavy, prefabricated components and heavy lifting is very often a safe, economic and practical solution for clients. Strong growth in the market for new architecture and the demand for alternative heavy lifting methods (lifting by means other than cranes) has spurred the use of the state-ofthe-art strand-lifting technique, with VSL a major player in the market. Automatically controlled hydraulic jacks together with strands allow for lifting, lowering, tilting or sliding of very heavy loads; equipment and controls have been improved and new fields of application have opened up. The strand-lifting technique has become ever more technologically advanced to meet the demand for moving very heavy loads without using cranes: lifts of bridges, roofs, antennas, pinnacles, boilers and other equipment or structures can all be carried out with strand and jacks.

#### Minimising the environmental impact

Not only has VSL's specialised hydraulic lifting equipment contributed to enhancing quality and safety as well as compressing construction schedules and costs, but it is also environmentally friendly. The strand lifting unit has the capacity to lift 100 to 500 times its own weight - in comparison the ratio for a crane might be as low as one, depending on the load and the height of the lift. As a result, the resources required to mobilise the equipment on site are substantially lower, depending on the size. There is no impact on the surroundings and the equipment needs less energy to be operated, which makes heavy lifting an environmentally friendly solution.

#### A pushing system for 9,000t tunnel segments in China

VSL has been awarded the first subcontract for the Zhuhai section of the massive Hong Kong-Zhuhai-Macau Bridge project for the design, supply and commissioning of a hydraulic system with monitoring features to move a precast segmental tube tunnel.

The tube is being launched from the precast yard to a floating dock at Guishan Island in Zhuhai, China. The immersed tunnel is 5.94km long and comprises 33 tunnel tubes, each 180m long. Each tube is made up from eight 22.5m-long segments, each weighing approximately 9,000t. This gives a total weight for each tube of 72,000t. The tubes will be cast and launched in two lines.

VSL is responsible for the design of the sliding track system, including the reinforced concrete beams, steel sliding plates, hydraulic equipment and the monitoring system. The first mock-up segment was successfully launched on 24 February and the first actual segment is due to be slid in June.



#### **Custom-built systems**

Thanks to more than four decades of experience, clear thinking and sound engineering skills, VSL has developed advanced and reliable inhouse hydraulic equipment. The pool of available equipment includes a large number and variety of hydraulic jacks with piston-strokes between 160mm and 550mm and capacities from 100t to 660t. Units can be used in tandem to cater for exceptional loads and/or requirements for high-speed operation. Accessories such as hydraulically driven coilers, emergency devices, sensorcontrolled measuring units and other system-completing installations are available as part of the range.

Connections and adaptations of the control systems can be made to link with the clients' own ones. VSL also designs and supplies custom-built hydraulic systems for special applications.

#### Boiling down to just eight points in Norway



VSL has been involved in the replacement of the Aalborg boiler at one of the world's most energy-efficient ferrosilicon plants. The plant is located north of the Arctic Circle in Finnfjord, near Trondheim in Norway. The 300t boiler was lifted about 25m by eight SLU-40 strand lifting units. Freezing temperatures and the short period of daylight during the winter months posed a challenge for the first lift. After the annual winter break, work was completed with the lift of a second unit in spring 2012. A specific challenge with heavy lifting operations is that the value of the object being lifted or lowered is generally well in excess of the value of the contract. Risks are high, which is why these operations are carried out only by specialists. Reliability and confidence in the team are of utmost importance. Some operations have been particularly challenging, such as lowering the Large Hadron Collider at CERN in Switzerland, lifting the pier-table segments as well as a double-deck span for each pylon on Stonecutters Bridge in Hong Kong, or lifting the 2,800t structure of the Ski dome of the Dubai Mall and stadium roof lifting operations. Long-term relationships with clients are the rule in this highly specialised skill.

#### **Cost-effective but safe**

VSL is known for innovative engineering, high safety standards and reliable performance. Top priority remains absolute safety:

#### **Offshore lift in Nigeria**

A subsea network of 16 umbilical cables and risers had to be connected to a floating production vessel shortly before the oil production started at the USAN field, about 100km off the coast of Nigeria. VSL used 16 SLU-70 units to lift the risers and umbilical cables about 100m and manoeuvre them through preinstalled tubes on the floating vessel. The original requirement had been to lift the cables by 300m and the equipment used on site has been designed accordingly. The lifting operations began in mid-October 2011 and were completed in mid-December.



#### HEAVY LIFTING

# COVER STORY



#### A 600m-long bridge replaced in a single day in Germany

A maximum tolerance of 10mm gave the Heavy Lifting team a real challenge when sliding a 600m-long replacement bridge in Worms, Germany. The Rheinvorlandbrücke was exceptionally long to be moved sideways in one piece, but it took just nine SLU-120 units and a single day to position the new 17,000t structure. Very careful planning was needed as rail traffic could only be stopped for a short period.

of personnel, of components, of the environment. Creativity is key: for instance, the use of heavy lifting allows for a structure to be built or assembled close to ground level, which brings greater safety for staff and requires fewer supports, less falsework and smaller cranes, hence saving time and money. VSL's specialised hydraulic lifting equipment is designed for the highest level of reliability and all equipment is rigorously tested and serviced through a quality control and maintenance programme. Field service teams all have a total commitment to safety and continuous in-house training of the staff, with new training courses at the VSL Academy in Bangkok, ensures the same high level of competence throughout the whole network.



# **Heavy lifting for**



#### 'Impossible' operations

Reliability, high-tech equipment and drive for innovation make VSL an invaluable partner for new challenges in fields where cranes and other equipment are not suitable.

# safe roof installation in Dubai



Al Khaleej Sugar has expanded its storage by building three additional sugar silos in the Dubai Jebel Ali Port Free Zone. VSL played a vital role in reducing the construction period by devising an alternative solution that allowed the preassembled dome-shaped roofs to be raised 70m into position in a single day, providing a high level of safety and quality, allowing much of the work to be done at ground level.

Continuous innovation, pushing the limits further, finding solutions for 'impossible' operations... these are keys to VSL's success. In the beginning, VSL's heavy-lifting equipment evolved from posttensioning equipment but that was a long time ago. Today the requirements are completely different, with each of type of equipment working at a different pressure level. The main criteria for heavy-lifting equipment today include: the higher lifting speeds required; performing lowering, which has become

#### Angled lift



CZ Mont picked VSL to lift a 32.2t boiler in Kosice in the Slovak Republic. The 8.56mlong boiler was raised 34m into position by two SLU 30 units. It had to be lifted at a 40° angle in a carefully controlled operation due to space limitations. The lifting units were installed on movable carriages 40m above ground.

# Alternate slides for alternator alterations

To remove and replace the old equipment at the Thatoom Power Station in Prachinburi Province, VSL Thailand used a H450 frame which can be adjusted transversally to accommodate any type of generator equipment up to 6m in diameter. The operation was carried out in phases, covering lifting, longitudinal and lateral sliding, before final lowering.



#### Lift, slide, rotate, lift, lower and reverse



VSL carried out the replacement of a 70t transformer for Hong Kong Electric. The old transformer was lifted onto a sledge system, slid out and rotated in plan and elevation. Long-stroke jacks were then used to launch it along a 30m track across a car park ramp with restricted headroom. The transformer could then be lowered onto a trailer.



HEAVY LIFTING

a substantial part of the work and requires different operating conditions; and the need for equipment to be adaptable so that many units can be controlled from the same computer.

VSL's range of equipment allows lifting or lowering of single loads

**Bridging the heights** 



In Abu Dhabi, VSL has conducted the 240mhigh lift of the roof bridge for the Gate District towers, raising four steel frame sections with a total weight of more than 2,000t. The main challenge was to avoid any contact between the steel frame sections and the cladding of the inclined towers. The bridge was brought into position with a tolerance of just 25mm. VSL used the CSL12 (continuous strand lifting) system. This allowed a lifting speed of almost 60m/h for the installation of auxiliary equipment and material before the big lift. To date, this system had rarely been used for such high lifting distances.

#### 3,400t caisson load-out with 3mm accuracy in Tangiers



complex Α on-site challenge is being carried out to skid and lower offshore caissons at the new harbour under construction in Tangiers, Morocco. VSL is handling 105 concrete caissons: each of them is 28m by 28m in plan view, 12.5m high and weighs 3,400t. The caissons are produced on site and skidded to a gantry area for transfer to the water.

VSL has provided the two 105m-long skidding track lines together with 10 skid shoes, each with 14 hydraulic jacks, six push/pull units, six pumps and a computerised monitoring and control system. The operation is achieved with an accuracy of within 3mm between each of the 14 lifting points of the same caisson. VSL has also supplied, installed and commissioned the gantry that picks up the caissons at the transfer area, moves them 45m away and lowers them into the water from where they float by themselves. The operation is scheduled to last until summer 2013, with a load-out sequence of up to two caissons per week.

weighing well in excess of 20,000t. It includes a large selection of hydraulic jacks, pumps, control units, monitoring systems and modular lifting/jacking frames such as lifting towers, generator lifting frames and turntables. Together they give the capability and flexibility to carry out virtually any project that requires lifting, lowering, tilting or horizontal jacking.

#### Innovative linear winch

An example of innovation is the linear winch, which allows for the continuous movement of large loads in inclined shafts. The boom in wind power has dramatically increased the demand for pumped-storage hydropower plants and therefore the need to move heavy tunnelling equipment in inclined shafts, which can be more than 1km in length.

Winches are normally used but reach their limits when the loads exceed 20t and the distances are very long. Strand jacking using strand lifting units (SLUs) or strand motive units (SMUs) is perfect for standard heavy lifting tasks but the limited stroke length of the jacks means that movement is intermittent. Lowering operations even require a reversal of the direction for a short distance during each piston cycle. To provide a continuous movement, VSL places two jacking units in series on the same strand bundle to form a tandem motive unit (TMU). While one piston moves the load, the other returns to its start position. The TMUs that have been developed have a capacity of up to 144t each at a speed of 40m/h. The equipment was needed at La Muela hydroelectric power station in Spain last year to build a 750m pressure shaft, inclined at 45° (see box below).



#### Uphill launch in Spain

CTT Stronghold (VSL Spain) has successfully launched the 260m-long four-span composite Arbisa Bridge in Aragón using strand holding units to control and adjust horizontal displacements by bracing two of the piers: 2,250t of steel and concrete had to be launched up a 3.5% slope.

#### **Repeated tandem lifts in Spain**

VSL Heavy Lifting developed a new tandem lifting and lowering system to transport tunnelling equipment in an inclined shaft at Europe's largest pumped storage plant, La Muela hydroelectric power station. The equipment was needed to build a 750m pressure shaft, inclined at 45°, and so the complete installation for drilling, blasting, excavation and material transport was built on a platform that ran on rails. The entire 110t cart had to be repeatedly raised 40m for blasting and then lowered to allow excavation and drilling for the next blast. The strand movements performed during the whole operation added up to an impressive 22km.



The new TMU-70/550 system is based on SMU-70/550 units. Tenders are being submitted for further projects.

This was a complex process, especially for lowering, and would be impossible to handle manually. Hydraulic circuitry and an automated control system have been developed so that the operator has just three buttons - up, down and stop. It is simple to operate, with a high degree of redundancy as there are several individually anchored strands instead of a single winch cable. To move any weight, in any way and everywhere, you just need strand. jacks - and true specialists. Pick VSL: they are on the move to pushing the limits...

# SITE INSIGHTS

# Poland **Final push**

The VSL Polska team has completed the final PT stressing operations for the largest viaduct on the A-4 highway between Tarnow and Debica. VSL teams had to stress 24 cables, push 60t of

strand and install 24 couplers in four days to keep to the 14-day erection cycle. The work, which began in August 2011, has involved supply and installation of posttensioning, as well as grouting.

VSL is on schedule for a July completion of the overall project, which involves a total of 2,600t of post-tensioning materials. Contact: m.targowski@vsl.com.pl



# Switzerland Repairing the cracks

VSL Switzerland has completed repair works for an underground car park in Lausanne, where large cracks had been discovered in columns supporting a 370mmthick concrete slab. Investigations had shown that the supports did not allow enough slab movement and rotation. The solution was to

install neoprene bearings. VSL's capabilities in the sector led to its appointment as main contractor. The scope of work included cutting, coring and sawing of the columns as well as the installation of the bearings, supplied by CTT Stronghold. Contact: christophe.candolfi@vsl.com

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# France LNG teamwork

→ VSL in JV, has signed a contract with Bouygues Civil works for the post-tensioning works on the Dunkerque LNG project in northern France. Construction of the three LNG tanks involves the supply and installation of in excess of 1,700t of strand and more than 1,500 GC anchorages. The JV will be also providing both the crew and supervision for the posttensioning activities. Main posttensioning works will take place in 2013. Contact: antoine.samaha@vsl.com



# **Azerbaijan** Just in time

→ VSL is making rapid progress with the installation of stay cables for a bridge in Baku, Azerbaijan. The project with Azerkorpu is part of a complex road interchange that will be the main artery during this year's Eurovision Song Contest. Opening

was scheduled for 15 May, just one week before the start of the contest. The 358m-long deck is supported by a total of 52 stays, using the VSL SSI 2000 Stay Cable System and Gensui Dampers. Contact: julien.violle@vsl.com



# Russia Cable completion

-> VSL is nearing completion of its work on the Kirovskiy Bridge in Samara, Russia. The work for Volgospetstroy involves stay cable design and the supply of components and equipment as well as technical assistance. The cablestayed bridge over the Samara River has a 369m-long deck supported from two pylons by means of 56 VSL SSI 2000 stav cables. Four of the cables are equipped with VSL Friction dampers. Stay cable erection is due for completion by mid-June. Contact: julien.violle@vsl.com

# SITE INSIGHTS

# Rapid slabs

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→ Sacyr is completing the construction of the REPSOL YPF headquarters in Madrid and VSL has been appointed for the posttensioning subcontract. The work has involved 785t of PT steel using the 6-7 multistrand system for a slab area of 106,200m<sup>2</sup>. The structural solution for the 8 by 16m column layout is a 250mm-thick PT slab with 600mm flat beams. VSL has had to produce up to 20,000m<sup>2</sup> a month to meet the schedule. Structural design for the scheme is by NB35. Contact: gsalazar@vslsp.com

# Spain Repair with self-supporting



→ CTT Stronghold (VSL Spain) has used a specialised prestressed system for strengthening several damaged cantilevers in a Spanish building. The repairs were required as a detail had been executed incorrectly during construction and new elastomeric bearings had to be installed. VSL opted to use a selfsupporting temporary prestressed structure instead of shoring towers. This minimised the impact of the work and facilitated installation and lifting. The damaged cantilevers were repaired using high-pressure injected epoxy and the new bearings were fitted. Forces and displacements were closely monitored throughout the operation. Contact: ccots@vslsp.com



→ VSL Portugal has been busy working on the rehabilitation of nine historic bridges in Alentejo. The bridges, all more than 100 years old, are built of plaster-coated brick masonry, finished with stone. Repairs were needed to all the stone masonry elements and the joints and cracks were injected with nonshrinking grout. The plaster was very degraded and was replaced and given a protective paint coating, with a total area of about 4,000m<sup>2</sup>. VSL also installed 580m of 26.5mm-diameter passive rod reinforcement in the gable walls to bring the structures in line with the latest regulations. Rebar and sprayed concrete were used under the arches. Contact: rrodrigues@vslsistemas.pt



# Portugal Typhoon remedy

The passage of a typhoon caused considerable damage to the roof and beams of a distribution warehouse. Structural analysis of the remaining beams identified that all had problems including structural cracks, particularly over the refrigerated chambers. VSL proposed strengthening the beams by applying carbon fibre in the flanges and using layers of carbon strapping in the webs, anchored with steel plates. A total of 263 beams were reinforced through the application of some 3,500m of 50mm by 1.4mm carbon laminates with an elastic modulus of 168MPa, and 1,500m<sup>2</sup> of carbon sheet glued with epoxy resin. Contact: rrodrigues@vslsistemas.pt



→ Terralia Construcciones has recently completed the construction of the Alhambra building in Madrid. The building has a semi-circular plan and an irregular column pattern, with spacings of between 8m and 10m by 16m. VSL was awarded a subcontract for structural design of the slabs and the posttensioning. The work involved 16,000m<sup>2</sup> of one-way voided 600mm flat PT slabs using VSL's bonded monostrand system, Bondtec. Its flexibility resulted in an ideal solution for the project as it was able to cater for the irregular building layout. Contact: gsalazar@vslsp.com 19

# SITE INSIGHTS



# Colombia Stays for 4 Street South

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→ VSL and Sistemas Especiales de Construcción (SEC) have completed their work on the new 4 Street South Bridge in Medellin, Colombia. The project's main contractor was Conconcreto and the owner is the Medellin Government. The 560m bridge has a 108m cable-stayed main span, which is 40.5m wide. VSL and SEC have supplied and installed 51 stays from the VSL SSI 2000 system, with stays ranging from 22 to 109 strands. The project has also involved installation of 480t of posttensioning, including anchorages and couplers. Contact: agonzalez@vslsp.com

# Portugal Colourful solution

A colourful VSoL<sup>®</sup> wall has been built at the paediatric hospital in Coimbra. Use of raised hexagonal panels and colours has made the wall at the hospital entrance particularly welcoming for the young patients. The VSoL<sup>®</sup> system was chosen as the ideal solution to optimise the available space at the urban site, where there was little room available. Several support structures were required and VSoL® provided a more economical solution than traditional stabilisation walls. VSoL® could also be installed quickly enough to meet the tight construction schedule. **Contact:** zmartins@vslsistemas.pt



# Portugal Dual slabs



→ VSL Sistemas de Portugal has recently completed two 12,000m<sup>2</sup> slabs for the ground level and upper storey of a car park at Porto's Francisco Sá Carneiro airport. The slab on grade consists of 300mm of hardcore together with polyethylene film installed below and a 150mm-thick concrete layer with 20kg/m<sup>3</sup> of steel and 600g/m<sup>3</sup> of polypropylene fibres. The elevated slab has a composite design, using profiled steel sheeting and a 3.8mm steel reinforcement mesh with 100mmthick concrete. The structure's main contractor was HCI Construções.

# Portugal Specialist treatment



→ Major repairs are taking place on the 1,940m-long Açude Bridge while traffic continues to flow. Obrecol is the main contractor responsible for the full project, with VSL brought in for specialist repairs to the approach viaducts. Significant cracks identified in most of the piers led to several structural interventions from the foundations until the connection with the superstructure, involving the introduction of bearings in some cases. Abutments are also being strengthened with high

strength bars and new bearings. In total, 47,000m<sup>2</sup> of structural concrete is being treated with crack epoxy sealing, rebars treatment, spalling refurbishment, cleaning and a final surface coating. VSL's scope also involves the replacement of 260m of expansion joint, 4.270m of safe parapets' surface protection, 33.700m<sup>2</sup> of deck waterproofing with bituminous reinforced by glass fibers and the rehabilitation of the drainage system. Contact: carlos.pereira@vsl.com

# Portugal Synthetic resin to protect Ponte da Vagueira



Repairs to the Vagueira Bridge are giving it a new lease of life. The three-span concrete structure provides access to the beaches of Vaqueira and is exposed to aggressive weather conditions. The repair works have focused mainly on the concrete together with provision of corrosion protection for the whole structure and other repairs to concrete and metalwork. VSL recommended an alternative approach for concrete protection. This involves covering the entire 6.000m<sup>2</sup> surface with a special thick mortar using a flexible synthetic resin that has excellent waterproofing characteristics but also allows the structure to breathe. cpereira@vslsistemas.pt

# SITE INSIGHTS

# Vietnam Off to a good start

→ VSL Vietnam finally started work on the Tran Thi Ly cable-stayed bridge project in Danang in central Vietnam in late 2011, following the contract award earlier in the year. VSL is now the main subcontractor for main contractor Cienco 1, responsible for all the specialist work involved in the installation of record-capacity bearings, construction of the pylon and the installation of the stays. VSL Vietnam has achieved an impressive four-day cycle and is nearing 50% completion of the inclined pylon construction.

The purpose-built climb-form equipment should be finishing its duty towards the middle of the year, leaving the remaining installation of the stay cables to be carried out up to 2013. Contact: ronan.hasle@vsl.com

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# Hong Kong Easy removal

 $\rightarrow$  VSL HK has been supplying and installing temporary ground anchors to retain a 70m-long and 20m-high vertical cut surface. The anchors had to be designed for removal as they penetrate outside the site boundary. A Removable Anchor was employed and five trial anchors confirmed the whole working process, especially the strand removal after destressing. In total. 107 anchors were installed in four rows. Work began in December last year and the final anchor monitoring is due for completion in May. Contact: km.lui@vsl-intrafor.com

#### Hong Kong



→ On May 25, 2012, a Dragages-China Harbour-VSL Joint Venture was awarded a contract by the Highways Department of the Government of the HKSAR for the design and build of the Hong Kong-Zhuhai-Macao Bridge (HZMB) Hong Kong Link Road, the largest contract ever for a design and build project in Hong Kong. The main scope of the project is to design and build a 9.4km-long viaduct section from the HKSAR Boundary to Scenic Hill on the Airport Island, supporting dual 3-lane carriageways over the Hong Kong Harbor's deep western waters. The viaducts box girders will have a typical span length of 75m. Some sections of the viaduct will have span lengths of up to 180m. VSL-Intrafor contributed in the DCV JV tender team with thorough studies in the foundation and superstructure works, whilst FT Laboratories proposed a comprehensive Structural Health Monitoring System (SHM). VSL is part of the fully integrated DCV JV team, the main contractor of the project. *Contact: ys.li@vsl.com* 



# Hong Kong Third win for Intrafor

→ Intrafor has won its third contract on the Guangzhou-Shenzhen-Hong Kong Express Rail Link. The latest contract involves the construction of diaphragm walls for a cut and cover tunnel on the 26km-long Hong Kong section. The diaphragm wall has a total volume of 13,000m<sup>3</sup> and is composed of 60 panels with an average depth of 35m. Intrafor has mobilised two hydraulic cutters, three grabs and three service cranes. Work had to be carefully planned and sequenced around the diversion of a river running through the site. Intrafor has worked in close collaboration with the joint venture main contractor, Maeda and China State. Contact: guillaume.lamoitier@vslintrafor.com



# Indonesia Tidal challenge

VSL is at work on the two Pedamaran cable-stayed bridges, which are being built to shorten journeys between Bagansiapiapi and Kubu. A particular challenge is a 2m-high tidal bore, known as the bono or 'little tsunami'. Construction was awarded to Waskita Karya and work is well under way on both bridges. Each bridge, designed by Ganeshatama Consulting, has four 32m-high pylons and typical spans of 111m. The concrete deck is built by form-travellers using temporary support stays. The current cycle is two segments a week per pair of travellers. **Contact**: tmijarsa@vslin.com



→ VSL India is currently constructing a bridge that is the first of its kind in the world. The cable-stayed bridge for the Mumbai Metro project has Ushaped girder segments. It crosses an existing flyover on Mumbai's busy western express highway. VSL

India's scope includes design, supply and operation of two pairs of form-travellers as well as the supply and installation of stays and post-tensioning. Space constraints and the heavy volume of non-stop 24-hour-a-day traffic running in 12 lanes at ground level and on the flyover beneath the construction posed a considerable challenge for VSL in implementing the project. VSL has succeeded in maintaining the highest safety standards in the construction of the bridge. *Contact: saravanan.subramanian@vsl.com* 

# SITE INSIGHTS



# Australia Triple solution

→ Works continue on the Peninsula link, near Melbourne, where VSL is designing a series of VSoL<sup>®</sup> walls as well as supplying straps and precast panels. The Pines section features 9,300m<sup>2</sup> of hexagonal panels in three different colours, patterns and textures. The panels have been arranged to generate a gentle transition of 27 different perceived colours. At the Mornington Tourist Railway, 2m by 2m panels are used where the motorway passes over the railway. The Eastlink interchange section will have a two-stage wall with painted full-height panels. *Contact: jamie.mckenzie@vsl.com* 

# Australia Retail success



→ VSL has won the contract for the supply, installation, stressing and grouting of the post-tensioning for the Channel Court Shopping Centre approximately 10km south of Hobart in Tasmania. The project consists of 34,000m<sup>2</sup> of car park, retail and office space. VSL's work comprises 187t of 15.2mmdiameter strand and involves a combination of band beam and flat plate post-tensioning methods, totalling 23,500m<sup>2</sup>. The success of the project is due to the close coordination and communication between the three main structural partners - Apple Constructions, Stephen Little Constructions and VSL. Contact: glen.wakefield@vsl.com



# Australia 18m-high panels

→ VSL Australia was commissioned by the Banora Point Upgrade Alliance (BPUA) to provide the precast concrete facia panels to decorate the main cutting through Sextons Hill in northern NSW. In collaboration with BPUA, VSL established the precast yard 5km from the site. The production was set up to provide the best value for money for the clients. The project, which requires the delivery of approximately 9,000m<sup>2</sup> of 2m-wide, 200mm-thick precast panels, up to 18m in height, began in November 2011 and was completed in March 2012. *Contact: gregg.hoesman@vsl.com* 



# Australia Gantry set for action

→ The gantry for the Hunter Expressway project has been fully assembled and commissioned by VSL Australia. Load tests were carried out before the launch of the gantry out to the first pier, over a steep ravine approximately 35m deep. Use of the balanced cantilever method allows VSL to limit the number of piers required and the amount of land that needs to be cleared, as well as mitigating mining subsidence issues. *Contact: jonathan.davies@vsl.com* 

# New Zealand Newmarket milestone

A key milestone has been **reached** on NZ Transport Agency's Newmarket Viaduct replacement project. Work on the new northbound viaduct is complete following the erection and posttensioning of 468 precast segments. Finishing works were completed in November and the 860t launching gantry was shifted transversely from the new viaduct to the old alignment. The new northbound viaduct opened to traffic in January 2012, well ahead of schedule. The NGA Newmarket Alliance team is now focusing on the last major task: the deconstruction of the second old viaduct. The first segment was lowered successfully in March after six months of preparation. Contact: patrick.arnold@vsl.com

# Australia Long-distance segments



 $\rightarrow$  Segments weighing up to 68t have been precast by VSL for the 5.5km Seaford Rail Extension project's 1.2km rail bridge. The Department of Transport, Energy & Infrastructure awarded the overall construction contract to the Thiess McConnell Dowell Joint Venture VSL won the subcontract to supply the pier precast units from Melbourne to the site some 900km away. A total of 21 piers up to 15m high were constructed using precast pier segments, each weighing up to 68t supplied by VSL, which was also awarded the supply and installation of the vertical stressing for the piers. Contact: jamie.mckenzie@vsl.com

# Australia JV underground

VSL is undertaking ground engineering works for the Perth City Link project, which will reconnect two districts that were separated by railway lines. VSL in Australia and Intrafor are in joint venture with local piling contractor Avopiling. The JV deploys a wide range of ground engineering methods including diaphragm walls, cut-off walls, cutter soil mixing, piles, minipiles and injection grouting. Some applications will reach from 38 to 44 meters in depth. **Contact:** quillaume.chamroux@vslintrafor.com

# R&D

# THE VSL DATA ACQUISITION SYSTEM (DAS) Data with immediate added value

A new tool to report all information linked to post-tensioning operations is born in VSL's lab.

The capacity to provide accurate post-tensioning data will be strengthened further thanks to VSL's development of a new tool to collect and report all the information linked with posttensioning operations. This development has arisen from the latest requirements and needs of the nuclear sector. Keeping records of all the stressing parameters has become compulsory with the construction of the latest, third-generation, prestressed nuclear containments. VSL DAS is based on a measurement system that automatically acquires information of jack extension and pressure throughout stressing. The data display on site uses a tablet or computer, enabling the VSL operator to check the various stressing parameters and validate the records.

# Accurate and continuous data

The system provides a choice of several different user interfaces, which can be customised to individual project and client needs. It is made with 3 modules that work together. A first module for use in the office allows preparation of all the tendon and stressing theoretical data, which are set to suit local regulations and project requirements. The workshop



module simplifies the management of the posttensioning quality records, providing information and checking of the materials used for each tendon. Finally, the interface to be used on site is designed to capture stressing records and to assist the operator in their interpretation. The computer automatically and continuously records stressing data at a set frequency, performs the relevant calculations, and alerts the operator if or when stressing limits are reached. Different versions are offered to suit the needs of individual projects. The intention is to cover all the types and sizes of projects that are carried out to VSL International's post-tensioning standards. Several prototypes have been developed

and tested and the new final version will be made available within the VSL's network during 2012. Traditional manual recording on paper may still be used on site, particularly as it may remain compulsory in several countries.

#### Efficient feedback

VSL DAS provides reliable data recording and full traceability of the operation, giving immediate added value both for the project and the client:

- management of equipment and calibration, with direct access to the calibration and maintenance records for the jacks and pressure gauges or other sensors;

- management of the post-tensioning material's records and full traceability, through links to project databases including the quality assurance records for the materials;

- management of the tendons and stressing records with real-time reporting.

The development of VSL DAS is expected to be further extended to other post-tensioning operations including grouting to provide a fully integrated system and a more accurate feedback to clients on the full scope of post-tensioning operations.

# **TECHNICAL REPORT**

# VSOL® WALLS Grow your own!

The increasing demand for attractive landscaping on civil engineering projects has led VSL to develop VSoL® Retained Earth walls with vegetated facings : the VSoL® Green Wall system is the happy outcome.

VSoL<sup>®</sup> green wall under construction at Mont Saint Michel, France. A VSoL<sup>®</sup> solution was selected for the construction of green dykes to cross a marshland as part of the restoration efforts under way in the coastal setting of Mont Saint-Michel, listed as UNESCO world heritage and very popular tourist destination.

# **TECHNICAL** REPORT

Several recent projects are drawing attention to this new sustainable construction option: VSoL® Green Walls. The first project is at Mount Saint Michel in France where a VSoL® solution was selected for the construction of 'green' dykes to cross a marshland as part of the restoration work under way in the coastal setting of Mont Saint-Michel. A UNESCO listed world heritage site, it is the most popular tourist destination in France after the Eiffel Tower. The future car park for Mont Saint-Michel visitors will be located on a marshland area which needed to be preserved. This resulted in the 4,000-space parking area being split right down the middle. The smooth circulation of pedestrian traffic also required the construction of several dykes to facilitate the flow of visitors



The Liez dam stabilisation project

towards the shuttle bus terminal connecting the parking area with the Mont Saint-Michel monument. It was important to ensure that the five dykes across the marshy zone would integrate perfectly into the site's overall landscaping. It was decided to use earthwork dykes covered with vegetation and reinforced by means of VSoL® galvanised steel rebar. The advantages of the VSoL® Green Wall solution lie in its installation flexibility and ability sustain a

#### The construction process step by step



Installation of VSoL<sup>®</sup> panels and VSoL<sup>®</sup> reinforcing ladders



*Geotextile covering wrapped round the two embankment layers* 



Geotextile layer positioned



'Botanical carpet' layer installed to retain the soil mixture



1<sup>st</sup> embankment layer placed and compacted



Installation of the next tier of VSoL® facing panels and soil reinforcing ladders

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vegetated finish on a steep slope facing – thus ensuring that it will fit perfectly into the natural environment.

Another example, still in France is the Liez Dam stabilisation project: The Liez Dam has been stabilised by the construction of a VSoL® Retained Earth wall as a toe-berm. This 30m-high earth dam required downstream foundation soil consolidation in order to improve its overall stability. The presence of a highway at the base of the dam meant that there was no room to add a traditional embankment to improve the stability. This led to the implementation of a solution using a reinforced embankment with a steep face. The appearance of the existing grass-covered earth dyke led the owner to opt for a 'green' solution and a VSoL® Green Wall



2<sup>nd</sup> embankment layer placed and compacted



Repetition of the installation stages until the final height is achieved

for the toe berm on the project. Last, but not least, to facilitate the greening of steep slopes on the access ramp leading to a Meurthe Canal culvert in Eastern France, the project's owner opted for a VSoL<sup>®</sup> Green Wall solution with staggered walls.

# How to build a green wall?

Incorporate a layer of stabilised topsoil which can sustain plant growth, and add it to the conventional structural elements of a VSoL<sup>®</sup> wall, to improve the aesthetics of the wall and integrate the wall into the environment.

#### Features of a Green Wall

A VSoL<sup>®</sup> Green Wall has a welded wire mesh facing panel which serves to support the soil and vegetation; a mesh reinforcing ladder incorporated into the body of the embankment fill in order to provide stability; a 'botanical carpet' layer of biodegradable, coconut-fibre matting which serves to retain the soil, fertiliser and seeds and a non-woven geotextile layer wrapped around the embankment fill layers to prevent the loss of fine-grained materials. VSoL<sup>®</sup> Green Walls offer many advantages, including: improved integration of retaining walls with the local environment: excellent adaptation of retaining walls to suit complex geotechnical design problems such as compressible soils, dykes, marshland and mountainous regions; an economical alternative to standard green walls, which present difficult challenges in construction.

# VSoL<sup>®</sup> Green Wall surfaced with vegetation



The facing is composed of a welded mesh panel with a mesh size of 100mm x 100mm. The standard panel dimension is: 2.8m x 1.55m. The soil reinforcing ladders comprises steel mesh with 10mm or 12mm longitudinal wires and transverse wires every 300mm to 600mm. Both the length and density of the soil reinforcement depend on the wall geometry and structural design. The facing/soil reinforcement joint uses a simple pinned connection. A nonwoven geotextile layer is installed to prevent the migration of fine-grained materials from the reinforced embankment fill towards the wall face.

#### Water and light as prerequisites

Without water, life ceases and especially vegetation! The greening of a surface relies in large part on the right input of water, as desiccation would lead to the loss of plant coverage. A suitable plant species and wall orientation is necessary to support plant growth. In order to ensure the durability of the vegetation, light is an essential factor for the success of any vertical greening scheme as plants need light for steady growth.

# FOCUS

# 37% savings using VSL post-tensioning

Thanks to its post-tensioning technology, VSL can be a valuable partner for owners, developers and contractors seeking to achieve environmentally friendly objectives in terms of greenhouse gas emissions and green building solutions.

Post-tensioning is a very efficient technology for optimising building designs in terms of the materials used to build the structure as well as for the overall lifetime costs.

#### **Reducing our CO<sub>2</sub> footprint**

The reduction of embedded CO<sub>2</sub> emissions is a direct consequence of reduced material quantities and is a crucial element in sustainable construction. Other advantages include reduced consumption of natural resources and reduced lifetime costs by enhancing the flexibility of the building's use through larger column-free spaces. Post-tensioning also cuts the amount of construction waste

Field	RC solution (tonnes equiv. CO2)	PT solution (tonnes equiv. CO2)	Emissions reduction
Energy	541	340	37%
Materials	7,567	4,760	
Freight	2,162	1,360	
Site staff transportation	216	136	
Plant	108	68	
Site waste	216	136	
Total	10,811	6,800	

at the time of demolition. As Greenhouse gas emission is a major factor in the market's move towards sustainable projects, VSL is demonstrating the major advantages that VSL's post-tensioning solutions bring to the development of green building solutions.

### Case study on savings in CO<sub>2</sub> emissions

A case study was carried out with the objective of comparing the carbon footprints of two technical solutions – one using traditional reinforced concrete slabs and the other designed using VSL post-tensioned





The new VSLAB® series allows the use 0.6 inch strand technology even in the thinnest slabs. It can be used with flat steel ducts or VSL's PT-Plus® plastic ducts for reduced friction during stressing and enhanced corrosion protection.



concrete slabs. The case study considered a 21-storey building, with a slab area of 1,072m<sup>2</sup> and floor height of 4m. The building had 12 circular columns of 1m diameter.

Both alternatives were designed to avoid the need for punching shear reinforcement. In seismic areas, post-tensioning solutions can reduce wall reinforcement even more because the horizontal loads to be withstood are directly linked to the weight of the concrete elements.

Carbon footprint emissions were calculated for both of the structural

### What represents 1.8t equivalent CO<sub>2</sub> (per person)?

- Return flight Paris New York
- 7,000km by car, equivalent to a 30km daily commute to work for a year
- Heating a 45m<sup>2</sup> office for a year using gas
- Construction of 7m<sup>2</sup> of housing
- Construction of 2m<sup>2</sup> of a concrete bridge deck

designs using the in-house calculation tool, CarbonEco®. The calculation is carried out by associating emission factors with each aspect of the project. For a quick and easy calculation, only the main quantities of structural materials need to be entered. Values are calculated using ratios that have been established from test projects.

In terms of material quantities, post-tensioning brings 23% savings for the concrete and a 48% saving in steel compared to the reinforced concrete alternative. The steel savings are made up of a 56% reduction in reinforcement steel offset by an 8% increase in post-tensioning.

The PT steel represents only 7% of the material emissions and 4.9% of the total emissions but post-tensioning allows the whole project to reduce its global emissions by 37%. Offering the client a carbon footprint calculation that demonstrates the large savings proves post-tensioning as a sustainable solution.



### CarbonEco<sup>®</sup>: a software package for carbon audits

CarbonEco<sup>®</sup> is a software package that gives owners an assessment of the greenhouse gas emissions that will be generated by their projects, from design through to demolition, including the operational phase. CarbonEco® makes it possible to forecast every project's carbon footprint, enabling VSL's clients to choose the best design and build options offered by the group. The tool can be applied to all building and civil works projects - whether for construction or renovation - including housing, offices, schools, industrial buildings, engineering structures and tunnels. The software can also be used during the operational phase of a structure, after handover.

VSL is aiming at establishing comprehensive carbon footprint accounting throughout the network.

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# **TECH SHOW**

# VSL's winning alt

By proposing an alternative design to the planned two-deck castin-situ bridge in balanced cantilever, VSL won the contract to build the first cable-stayed bridge in the UAE. VSL was in charge of managing a joint venture in association with Overseas AST to design and build this impressive project...

VSL Middle East was responsible for the superstructure work while its partner Overseas AST, which specialises in maritime works, took on the supporting infrastructure.

# ernative design

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# **TECH SHOW**

Provide an alternative

When in 2008 Abu Dhabi's Tourism Development & Investment Company (TDIC) identified the requirement for better access to the island of Hodariyat, the engineer, Parsons recommended calling for design and build alternatives to achieve the best cost. The conforming design was for a two-deck cast-in-situ bridge built in balanced cantilever using formtravellers. Instead, VSL proposed an alternative design combining the two decks into a single 36m-wide deck to be built using two methods incremental launching for the approach spans and precast segmental construction for the three cable-stayed central spans.



<image>

Use full range of skills Construction of Hodariyat Bridge in merely 26 months required the full range of skills and expertise that VSL can provide. The project drew on experience in bridge design and engineering together with architectural concepts; precast shells for pile caps; precast columns; construction by the incremental launching method for the approaches; precast segmental construction and heavy lifting as well as the use of stay cables and saddles. These were combined to produce a complete road bridge superstructure offering six lanes of traffic and two pedestrian walkways. The resulting 1.3km-long and 36m-wide deck has one of the largest single-cell box girders used anywhere in the world to build an incrementally launched bridge with prefabricated components.



Launch bridge with very strong jacks The approach spans from both the Abu Dhabi and Hodariyat Island ends of the bridge were built using the incremental launching method. The concrete construction took place behind the abutment. Jacks pulling against the abutment then advanced the superstructure deck forward as each segment was cast. While the first launch was for a weight of 'just' 660t with a jacking force of 107t, the final launch was 31,400t with a jacking force of 2,600t!

**3 Minimise temporary works** Together with the designer, VSL developed designs and methods to use precast elements to improve the schedule and resource use. All elements of the precast pile caps and columns were cast on site and handled directly by gantry crane or barge crane. Precast elements for the columns were set in place with stress bars positioned between each pair of elements. Final permanent post-tensioning was then applied from the pier head down to the pile caps.



#### Some figures about Hodariyat Bridge

63,540m<sup>3</sup>: concrete for the whole project
8,470t: rebar steel for the whole project
1,650t of post-tensioning cables
400t of cable-stays

- **135:** total number of segments
- 200t: weight of heaviest segment
- 4.75 million hours without a single
- $\operatorname{accident}$  the record  $\operatorname{achieved}$  on the site

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## **TECH SHOW**



# Use precast segmental erection for the main spans

The central main spans are made up of two 100m side spans and a central 200m span. VSL employed a single-cell box girder precasting technique for 3m by 36m-wide segments (135 in total). Precasting allowed for easier ground-level working conditions, easier delivery of concrete and shorter construction times, given that the time required for the concrete to set is no longer part of the critical path. Production reached eight box girders a week.

#### **Go for elegant** solutions The bridge's posttensioning is practically invisible since it is located inside the concrete itself or inside the deck. Together with the 26 pairs of stay cables, they allow for a lighter structure and thus bestow on the bridge its elegant nature.



*Use furthermore balanced cantilever method* 

The second technique for erecting the main spans was the balanced cantilever method. The precast single-cell box segments were raised from barges. Each box girder segment was installed and then fastened to the preceding one with post-tensioned cables and bars.



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#### BRIDGE CONSTRUCTION

# TECH SHOW

#### **Rely on specialists**

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By suggesting a cable-stayed bridge, VSL offered the best value for money. It was a technically solid proposal – using tried and tested procedures such as prefabrication, incremental launching, the balanced cantilever method and post-tensioning. And it was also economically attractive, due to the added use of post-tensioning to reduce the quantities of concrete and steel. Another positive aspect of the design is the graceful – almost ethereal – finish that the lighter structure gives, thanks to the use of the VSL Saddle and the 27m deck height that provides a maritime thoroughfare for the regular sea-traffic using the port of Musaffah.

#### CREATING SOLUTIONS TOGETHER

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