

BUSINESS DEVELOPMENT Abu Dhabi: The place to be?

Sky Park lift at Marina Sands Cadagua viaduct



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Think lateral for tandem launch An ingenious and economical solution from VSL has been used to install the four structures that make up the Cadagua Link toll road on Bilbao's southern bypass.





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NEWS, magazine published by VSL International Ltd. • Köniz, Switzerland Director of Publication: Daniel Rigout• daniel.rigout@vsl.com Editor in chief: Jane Rousseau • jane.rousseau@vsl.com Editor : Elisabeth Lichter-Rodriguez • elisabeth.lichter@vsl.com Co-ordinators: Carlos Such, Emilie Parati, Doris Tong. Distribution: Myriam Doré • myriam.dore@vsl.com Design: Red Line Photos: Derek Allan, Philippe Guignard, Hervé Gouband, VSL staff, others Copyright: VSL 2010 •

EDITORIAL

Partners you can rely on

The worldwide economic crisis born of the fragility of our financial institutions has seriously affected our markets, in particular through the scaling down or postponement of many infrastructure projects across all continents.

In the difficult environment of this highly competitive market, VSL has maintained the quality of its long-term partnerships with its clients, particularly by continuously striving for greater competitiveness.

This enduring confidence in VSL results from our strong values in the service of our clients and partners: quality and safety at all times, innovation and creativity for improved performance, relevant technical solutions adapted to the most complex situations, and a strict adherence to our commitments in terms of costs and time.

Today, as the world is back on track for growth, driven by the dynamic economies of Asia, we continue to pursue our main goal: to make long-term partnerships with our clients a focus of our strategy.

This shared ambition, which is based on the same core values and nourished by the new opportunities that are arising, will allow each of the parties involved to capitalise on the effects of the recovery.

BUSINESS IMPROVEMENT

Health and safety: leading the way

VSL Group's policy is to "lead our business sector in terms of occupational health and safety". It takes a variety of actions for constant improvements.

ith standards still varying from country to country and a working environment that is constantly changing, many hazards still exist. Many of the industry's safety issues such as falls from heights remain the same as in the past they just occur less frequently. VSL believes in the use of established measures such as training and seeks to change behaviour so that everyone on site sees safety as the norm. This means to 'design out risk', eliminating the hazards in the first place.

Updating VSL equipment

Careful review of VSL equipment has led to a number of enhancements in operational safety. Changes to the standard twin grout mixer included additional protective covers as well



Pump EHPS-10 produces less noise and greater oil delivery with higher capacity, dual flow rates and improved hydraulic hose couplings.

as the provision of two emergency stop buttons. Similarly, hydraulic pushers benefit from an additional remote control valve, movable to suit working arrangements. Introducing distinct connectors for pressure and return lines has been designed to avoid coupling mix-



Pump EHPS-3/4H features different couplers for the pressure and return lines to avoid mixups and is quieter than the older model.

ups on pumps. Pumps are now quieter and have more oil storage and dual flow rates. Electrical distribution panels adapted for site use allow easier, safer connections. New hydraulic cutters make strand cutting safer and more efficient. Maintenance has also been improved through the adoption of controlled sandblasting instead of grinders to remove old paint.

PPE as standard



Personal Protective Equipment (or PPE) is the last line of defence. Items such as safety boots, helmets and masks also deal with low-risk issues that have already been controlled as much as is practical. Established rules enforce the wearing of basic equipment in many situations and significant benefits are gained for a relatively small cost and inconvenience.

Staff involvement

Group-wide safety days are organised every year and staff involvement is key to their success. They cover aspects such as the identification of risks and feature exercises to highlight the importance of procedures, including fire and evacuation drills.

New logo: Safe, Around the Clock, Around the World

VSL's new safety logo highlights three key messages. The health and safety of

**** employees and the public are top priorities with 'Safe' being at the top of the logo. Safety awareness is a 'Around the Clock' issue. Vigilance must be maintained at all times. The third message emphasises that VSL operates 'Around the World' and expects the same high standards everywhere.

COMMUNITY Enter the dragon... boat!



ntering Hong Kong's renowned Stanley dragon boat race is part of VSL Intrafor Hong Kong's efforts to increase community involvement and have fun. Despite only a few hours training, the team reached this year's final, eventually coming 8th out of 48 in their category – the target for 2011 is the top four!

EMERGENCY SUPPORT City2Surf 2010

SL Australia and Emergency Architects were among a record 80,000 participants in the 14km City2Surf race in Sydney. The 36 VSL entrants completed the scenic course from central Sydney to Bondi Beach via a fiendish halfway point, Heartbreak Hill. Their efforts were in support of Emergency Architects projects and also proved a great team-building opportunity.





AWARDS Success for VSL Saddle system

evelopment of the VSL Saddle system for bridges won third prize for VSL in the technical and R&D category of this year's Bouygues Construction Innovation Competition. Rachid Annan and Thibault Collin-Delavaud represented VSL in the competition, which attracted 500 submissions from more than 2,000 participants vying for the 24 awards.

ACTITUDES Funday success



D ragages Hong Kong, Byme, Asiaworld Expo and VSL Intrafor held a "funday" to support sustainable development and local charities. Over 1,000 people attended the event, which was also supported by many suppliers and subcontractors. The event included charity stalls, information booths and games such as a mini World Cup won by FT Laboratories.

sustainable construction Slab savings

S ustainability features highly in the development of Tata Consultancy Services' new 20ha complex in Pune, India, with the use of fly ash saving more than 5,000t of cement. VSL India has been awarded the design, supply and installation of the 1,045t of post-tensioning for the project's slabs and beams. Other "green" aspects include the use of bio-gas and daylight harvesting.

REPAIR Culvert cure





SL technology has enabled deteriorated corrugated steel pipes to be strengthened while still in the ground, avoiding disruptive replacement. A joint venture between VSL Brunei and Insituform Asia Limited (IAL) carried out the contract using the Cured in Place Pipes (CIPP) technique. The culverts run 15m below a major highway, carrying stormwater and run-off water to the sea. Work took place at four locations and was completed in September 2010.

FACTS & TRENDS

NEW MARKET First in Azerbaijan



→ VSL Hong Kong was awarded work on two cement silos in Azerbaijan last year and began installation in May, with

completion scheduled for December. The project involves provision of transport and storage facilities for both raw meal and clinker on behalf of owner Garadagh Cement OJSC, part of the Holcim Group. The main contractor is CBMI Construction Co., Ltd (China). The 68.9m-high raw meal storage silo is circular in shape with a 15m internal diameter and a 500mm-thick wall. Its 53 pairs of horizontal post-tensioning use VSL GC6-12 tendons. The clinker silo has a 47.25m internal diameter. a wall thickness of 450mm and stands 35m high. It uses 62 pairs of VSL GC6-19 tendons as horizontal posttensioning. Contact: cn.guo@vsl.com

Testing services In-house help

→ FT Laboratories - a subsidiary of VSL International – has been working with VSL HK to carry out static load testing in Hong Kong on GC tendon anchorages. The testing had originally only been available in VSL's test laboratory in Subingen, Switzerland. The tests studied deformation characteristics of

loaded tendons and involved the monitoring of parameters including strand elongation, wedge displacement and anchor-head deflection. FT Laboratories serves as an



alternative base in Asia for inhouse testing within the VSL group. It has been expanding its scope of services to meet the challenges of technically demanding projects in Taiwan, Vietnam and Dubai. Contact: eric.ho@ft.com.hk

Intrafor Strategic equipment



ightarrow Intrafor's investment in equipment continues to help secure key contracts. A new Klemm 702-2 rig is installing 16 micro-piles for an elevator inside Abu Dhabi's Presidential Palace. The rig is the only one in the UAE that could gain access without extensive demolition. In Hong Kong, Intrafor's acquisition of a third new trench cutter is helping reinforce its position as a leader in special foundations. Its new Bauer Cutter MC64/BC40 is already at work on the Express Rail Link. Contact: sebastien.frebourg@vslintrafor.com - h.cowie@intrafor.ae

R&D Project debut for core barrel

→ Intrafor Hong Kong's new proprietary directional core barrel is at work on its first project. Maeda-Crec-Seli JV awarded Intrafor the contract for ground investigation along a drainage tunnel. The new barrel developed in 2009 is being used for a 160m-long hole with two horizontal curves. The hole will also be used for rock fissure grouting to treat a known fault zone. Contact: olivier.haye@vsl-intrafor.com



Tanks AF arrives in China



ightarrow China's first use of the VSL **AF anchorage** is taking place as part of containment construction projects. TGE Gas Engineering of Germany awarded VSL Hong Kong the work as post-tensioning specialist on the Ningbo Ethylene Tank and Zhejiang LNG Terminal projects, based on VSL's reputation on previous LNG projects in China. The Ningbo tank, which has a capacity of 30,000m³, will use the AF anchorage at the bottom of the vertical tendons. The Zhejiang project requires the construction of three tanks of 160,000m³ capacity, using 1,496t of strand. Experienced civil contractor China Nuclear Huaxing Construction Company is building the tanks and has previously worked with VSL on more than 70% of its containment projects. **Contact:** hayden.tang@vsl-intrafor.com

vsoL® Polymeric production drive

→ VSL India has recently won a contract in northern India for 100,200m² of VSoL[®] polymeric reinforcement on the Panipat-Jalandhar stretch of National Highway No. 1. SOMA Enterprises awarded VSL a turnkey contract for the design, casting, erection and supervision of VSoL® walls for a 57km section. The 2m by 1.5m panels for the 13 month contract are to be cast at the rate of 190 a day to supply the 25 structures, which have a maximum height of 9.5m. *Contact: m.phillips@vslindia.com*

Diaphragm walls Patented solution

 \rightarrow Use of a new patented "soft milled joint" developed by Intrafor has avoided the need for extensive concrete cutting between panels on a 91m-deep diaphragm wall shaft as part of Hong Kong's HATS project. The shaft diameter of just 12.3m makes the excavation works very challenging. Trapezoidal blocks made of lightweight precast concrete replace the same volume of hard concrete and create a soft spot to ease the milling of panel joints. The main contractor will begin excavation down to the toe following panel completion, grouting and testing. Quality is of prime importance as the full height of the diaphragm wall will be exposed. Contact: henrypc.chan@vsl-intrafor.com



Foundations Challenging win on XRL

→ Intrafor has secured a major contract to construct one of the most challenging sections of the MTR's new Express Rail Link (XRL). The work forms a significant part of Contract 820, which is being carried out by a Dragages-Bouygues joint



venture. The section passes under a densely populated and heavily piled area where challenges include avoiding causing any settlement. Intrafor's responsibilities encompass foundations, ground treatment and diaphragm wall shaft work. Over 100 personnel will be deployed and two cutters will be mobilized for this challenging project. Contact: dennis.barlow@vsl-intrafor.com

COVER STORY



Abu Dhabi: The new place to be?



Is Abu Dhabi the leading property investment and construction destination in the UAE? As a matter of fact, Abu Dhabi is forging ahead with major long-term construction initiatives as part of an ambitious 20-year regional development plan, despite the global economic downturn. VSL is forging ahead too, by providing technical added value to its clients through all-inclusive design & build packages.

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COVER STORY

ost-tensioning is used in 90% of the bridges and 80% of the buildings in the UAE¹. As a consequence of the global crisis, most infrastructure budgets have been trimmed and the financial viability of many projects is being challenged. Both public and private owners are keen to re-examine their projects in order to ensure that they remain viable. The first effect of this situation has been that the traditional post-tensioning supply market has become more competitive. As a renowned specialist contractor, VSL is earning its share of these projects thanks to its 50 years of experience in posttensioning and to having had a presence in the UAE for more than 15 years. Its portfolio is extensive, covering supply and installation packages for post-tensioning, stays and soil-wall systems as well as heavy lifting services, repairs and strengthening. By having a proactive attitude and providing technical added value to clients through its services and all-inclusive design and build packages, VSL Middle East stands out as a key partner in the region's bridge design and construction market, achieving some major commercial successes in 2010.

But what makes a main contractor choose VSL? "You start discussion with potential subcontractors and after a few weeks you only have three or four serious candidates left," explains François Springuel, Project Manager at SixConstruct-Samsung JV for the Cleveland Clinic's car park. "These candidates gave us the confidence that they will do it. and their names are verv well known." Then comes discussion of the contractual details and other aspects before, finally, a decision is taken. "SixConstruct and VSL know each other, have a good experience



together." Not only is there past collaboration, but also trust. "We know that if we go with VSL, we should succeed together." Generally speaking, a subcontractor on fast-track projects needs to be reliable, in all aspects. Partnerships need to be made with organisations that the client can rely on. "We need to work with someone we can count on - reliable in all senses of the word, flexible, professional, timely, quality-wise, not "claim minded", everything." This includes the ability to work out of sequence as sometimes things need to be done faster than originally planned. "We expect our subcontractors to adapt. I don't see VSL as a potential risk in any way on this project. I do not make the decision, but when it comes to senior management there are some names that give confidence."

Quality approach

When the global downturn reached the shores of the UAE in 2008, all of the major players in the market had to resize to adjust to the new realities. Not only did contractors and consultants have to become more selective in terms of their projects and partners, but they also needed to feel confident about their partners and to be more proactive in their business approach. As Wail A. Farsakh, General Manager at Dutco Balfour Beatty puts it: "We are proud of what we have achieved, proud of what we do. Our aim is to always come up with better ideas. We have a quality approach. At the end of the day, you are as good as your weakest link. That's why we work with the best suppliers that share our values; there is no room for errors." To provide what is best for the project and the client, VSL's teams of specialists, engineers and project managers work with consultants and contractors from the early project stage onwards. VSL's capacity to provide expert consultancy and alternative solutions very often makes the difference and its reputation as a specialist civil works company goes way beyond local markets. "To win work, we need to undertake value engineering, offer alternatives, be cost-conscious. We like to work very closely with competent companies like VSL from the tender stage. because with companies like VSL we can think out of the box and are. in the end, in a win-win situation."

VSL provides skilled and trained staff and construction specialists for all project stages. New methods, new equipment and new materials are benchmarked and dedicated teams tackle any challenges and

¹ Construction Week magazine, edition 13-19 March 2010, pages 22ff

technical issues from the project's outset. The ability to come up with solutions for any type of project and application is enshrined within VSL's company values.

Better solutions

VSL and Taisei have worked together on some very important projects in recent years, such as Ras Al Khor 5, Gateway, Waterhomes and Downtown Jebel Ali. "We work together from the very early stages of a project and look for alternative solutions to *better serve our client,* " comments Katsumi Tamura, General Manager in the civil engineering department of Taisei Corporation's Dubai offices. "We are a general contractor and VSL is a very professional specialist in post-tensioning and precast construction, looking forward to new challenges." The need to explore creative solutions is important in a market like Abu Dhabi, which is very tough and has tough competition. Local construction companies have a very aggressive market approach.



Abu Dhabi: visit our sites!

Let's take a "walk" to visit a number of VSL projects from the past year, spread across the capital. The city of Abu Dhabi had been carefully and cautiously developed over 30 years; however, the pace increased dramatically in early 2005 with the announcement of the first major new development at Al Raha Beach and the start of construction soon afterwards.

The New Islands

The Emirate of Abu Dhabi, whose capital city is itself on an island, hasn't needed to engage land reclamation as it has no shortage of shoreline and has hundreds of natural islands to develop. There are now several "new" island developments ongoing in Abu Dhabi and VSL Middle East is involved in almost all of them in some way, as you will find out.

Yas Island and Saddiyat Island

Some 20km before reaching the Maqta Bridge at the Abu Dhabi city gateway, a new interchange leads to Yas Island and onto the Shahamma-Saddiyat Freeway. Yas Island is well known to Formula One fans as the final race in the F1 calendar and the Yas Mariana circuit opened in October 2009. VSL has been heavily involved in the main access infrastructure works on the island, working for the main contractor SixCo and its client Aldar on two large bridge packages involving 3,000t of post-tensioning as well as over 90,000m² of mechanically stabilised earth (MSE) walls.

If we continue along the freeway towards Saddiyat Island, we cross two bridges where VSL has completed 21,000m² of MSE walls for a recently opened bridge built by Taisei. The freeway's final section also features 1,850t of VSL post tensioning and 9,500m² of MSE walls for bridges and ramps constructed by Leighton for TDIC. The most amazing feature of the 10-lane 27km-long freeway is the fast-track construction period of just over 18 months, especially given the large amount of bridge and roadworks over its complete length.

Al Reem City of Lights

As you enter Abu Dhabi city and join the Corniche from the new 10-lane Sheikh Khalifa Bridge, you are at an ideal vantage point to see the scale of development in the city and on its islands.



By far the largest is Al Reem Island, where VSL has recently completed the post-tensioning works on one of the island's first towers. At present VSL is working on the post-tensioned slabs for two large projects for the developer Tamouh. Towers of 61 and 41 storeys are being built by main contractor China State Hong Kong. Close by, VSL is also working on two of the five towers being built by main contractor SK Engineering & Construction and Namkang Engineering & Construction J.V. Both projects are progressing at a fast pace, rising on average one level every week.

Al Sowwah Island - The Rosewood Hotel

The striking Rosewood Hotel on the adjacent island of Al Sowwah is being constructed by ACC, which has in turn awarded VSL Middle East the design, supply and supervision work for the post-tensioned slab beam system.

The Cleveland Clinic

Adjacent to the Rosewood Hotel, Cleveland Clinic Abu Dhabi will be a 360-bed facility on Al Sowa Island, just across from the Abu Dhabi Mall. One of the clinic's main objectives is to meet the needs of patients who currently have to travel abroad for treatment. Work started in March 2010 and the clinic is scheduled for opening after merely 36 months. VSL is in charge of the PT slabs and beams, casting the first beams at the end of November 2010, as the sub-contractor for the Six Construct-Samsung JV. As we now travel along the wide expanse of Abu Dhabi's new Corniche, we pass Capital Plaza - also being constructed by ACC – which consists of five towers varying from 38 to 52 storeys on a single podium. VSL recently completed the post-tensioning works involving transfer beams in the podium and post-tensioned beams at each floor level. Still further along the corniche is the aptly named Landmark Tower, rising high above its neighbours

BUSINESS DEVELOPMENT

COVER STORY



Breaking







Cap DI Moza





at over 330m, with 72 storeys. Here VSL's scope of work includes post-tensioned slabs and transfer walls for the main contractor, a joint venture of Al Habtoor Engineering and CCC. Continuing to the west, we find the four towers of the Khalidiya Palace, where VSL has recently completed the post-tensioned flat slabs for main contractor Nurol and has just commenced on Nurol's adjacent Bab al Qasar which includes a 375-room luxury hotel and a 234-unit serviced apartment over its 32 floors, 5 podium levels with swimming pools and hotel facilities, and 4 basement floors and will have a total closed area of 155,000m².

ADNEC Capital Gate Tower

You cannot fail to miss the next landmark on the horizon, the ADNEC (Abu Dhabi National Exhibition Centre) Capital Gate Tower, which has recently reached its full height of over 160m. The iconic tower is already well known as Abu



Dhabi's leaning tower and is inclined at an incredible 18° - which is 14° more than Pisa's famous tower. The core slants in the opposite direction to the lean of the building, straightening as it grows in a design that has never been attempted anywhere before. It was designed by RMJM and the main contractor is Al Habtoor Engineering. VSL designed, supplied and installed vertical bar tendons in the lower sections of the core and multi-strand vertical tendons higher up.





A few Streets across on the east coast, intrator has just completed a 16m deep, 3,500m³ diaphragm wall project at the Eastern Mangroves. The client for the development is TDIC, with Leighton as main contractor and AST as the subcontractor and Intrafor's client. The Maqta Bridge is the oldest route onto Abu Dhabi Island and just to its east is the new Sheik Zayed Bridge. For several years, VSL has been involved as subcontractor to Archirodon-SixCo

for a variety of the specialist aspects such as MSE walls, post-tensioning, heavy lifting and the supply and installation of the stays for this incredibly complex 842m-long structure. In late 2009, together with the main contractor, VSL erected the secondary arches followed by the main arches, of which the heaviest section weighed in at 600t. Heading back, North Est, we reach one of VSL Middle East's largest groups of projects to date.

Al Raha Beach

The Al Raha Beach development is a beachfront project being built along the Abu Dhabi-Dubai highway, opposite Al Raha Gardens. Developed by Aldar, Al Raha Beach will accommodate

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120,000 residents in high-rise towers and lowrise developments. The district will serve as a new gateway to the city and is being built in 11 residential and commercial precincts, each with its own distinct personality and appeal. VSL has been working on PT building projects at Al Raha Beach for some years and the latest project - Al Muneera, awarded in 2009 - will bring the total area of post-tensioned slabs carried out by VSL to almost 1,000,000m² upon completion.

On the civil works side, VSL has also been kept busy from late 2008 until today, working on a total of 21 bridges, requiring 1,900t of tendons as well as bearings and stress bars.

VIP terminal roof lifting, Abu Dhabi Airport

Standing next to the existing Abu Dhabi Emiri Terminal, the new Presidential Flight State Guest Terminal will play an active role for the city. The current economic outlook means that contractors require cost-effective solutions built to ever tighter schedules and VSL responded by coming up with a challenging method to lift the VIP reception hall's entire roof structure in one go. The 330t steel roof comprises a 65m by 85m space frame with four main steel trusses on top. It was assembled in record time at ground level and smoothly lifted by 20m into its final position.



Our journey today ends here but Abu Dhabi has active development plans for a metro system, nuclear plants, museums, major bridges to many of the remaining islands, a new highway to the Saudi border and the "green" Masdar city... and many more schemes on a list that will continue to grow. "We, at Taisei, can do any work required on a construction site. But we work with sub-contractors from whom we expect know-how, experience, good solutions and close co-operation. Together we can come up with better solutions and we always look for synergies."

Transfer of knowledge

To perform as a preferred construction partner, VSL is constantly innovating and implementing new work methods. Proper training is a vital first step in sharing knowledge and in emphasising that safety is of utmost importance for VSL and its clients. VSL Middle East's training centre in Dubai was created to spread the VSL Academy's knowledge and best practices. VSL's training premises allow for the installation of practical equipment and there is also a dedicated classroom for more theoretical lessons taught by a senior project manager with long experience in training. External trainers cover non-technical topics such as internal auditing, first aid or office software. The training manager regularly goes out to sites to assess the courses' efficiency. Competence cards are issued and knowledge transfer is organised in three steps: training, assessment and re-training, if necessary. In addition, the training centre organises sessions giving clients an "Introduction to VSL systems" and these are very much appreciated as they help providing a better mutual understanding of procedures and requirements.

Safety is the No. 1 priority

"The challenge of projects in the region is that you have to deliver a high quality project quickly," says Mick Timmons, Project Commercial Director of Al-Futtaim Carillion LLC on Al Muneera Project, Khor al Raha Precinct and Al Raha beach Development, "At the end of the day, however, it all comes down to safety. We are applying safety standards and we are proud of having achieved over 21 million man hours without a reportable accident." To make sure everyone understands and follows this, VSL has been involved - as has every other subcontractor - in the different actions needed to come up to UK standards. This demanded a huge amount of management input, but "the number one priority is safety. We can build a successful project, but need to be safe at all times."

VSL's actions are not limited to construction sites; safety is also a concern for office staff. VSL Middle East picks up and drops off staff travelling to and from work. One of the items highlighted in an internal inquiry was that members of staff are sometimes concerned by the driving standards. As a result, VSL implemented a tracking system in September 2010 covering all company vehicles. It gives information about the routes, travel times and speed at all times. Positive effects on the drivers' behaviour showed immediately. The expected results are improved safety, fewer accidents, fewer speeding tickets, less exposure to risky situations and a better use of resources with better planning and improved travel times.

"Safety is a big issue, like for all professionals such as VSL,' confirms François Springuel, from SixConstruct-Samsung JV. As reputable international companies, VSL and SixConstruct-Samsung JV have the same high safety standards. More and more over recent years, a dramatic change in mentality can be noted where safety is concerned. "It was difficult..." recalls François Springuel. At Dutco Balfour Beatty too, safety is of utmost priority at all times. "Our company initiative is to achieve zero harm by 2012 - all initiatives are aimed at making the sites as safe as the office environment," says Wail A. Farsakh.

Growing strength

The mushrooming growth in the Middle East throughout the last decade has created a potential market for structural upgrading repair work. Structural Preservation Middle East (SPME) - a joint venture between VSL Middle East and Structural Preservation - uses the latest technologies to develop innovative strategies to upgrade and repair, restore and increase the load-carrying capacity of concrete, steel, masonry and timber structures. It offers a unique blend of design support, contracting, systems and materials, making the company the leader in the strengthening of existing structures. The goals of owners, engineers and general contractors are typically the same: to deliver a safe, efficient and economical solution, whether the structure requiring strengthening is under construction or in service. SPME assists project teams in the development of comprehensive solutions, providing structural repair, strengthening and corrosion prevention for industrial and commercial structures throughout the Middle East. Strengthening projects are always critical; SPME's teams are able to mobilise at short notice. "We can't afford a learning curve as the lead time for our projects can be as little as two days," says Muneer M. Merchant, SPME's Manager. "We need to come up with solutions and be ready to start work almost immediately." SPME has no less than 65 permanent staff and is now expanding its presence in the Abu Dhabi market.

Best for bars

VSL has been marketing bars for the construction industry since the early 1970s and offers an extensive range of products complying with international standards. To provide the best quality in the shortest possible time and VSL Middle East has launched a 50/50 joint venture with Stahlwerke Annahütte, the world's leading manufacturer of SAS threadbar systems. "Our premises here in the UAE allow us to reduce the lead time to a minimum because we have sufficient storage space to carry stock," says Shemi P.S., Sales Manager for bar systems. "We also have all the necessary equipment, such as automated indutrial cutting equipment to crop the bars to the required length as well as a customised handling equipment to handle the large diameter bars." SAS bars are of high quality and can be re-used; they are self-cleaning for maximum efficiency and can be

Half of the major projects currently being undertaken in the UAE are located in Abu Dhabi, which is a very wealthy region. It has roughly 9% of the world's total oil reserves, 4% of the total gas supply and one of the largest sovereign wealth funds anywhere. Abu Dhabi has always been cautious in taking on debt and has set up a plan running through to 2030, involving long-term project initiatives that include development of the surrounding islands. The projects include major infrastructure schemes such as roads, railways, airports, ports, and bridges.



provided with different degrees of corrosion protection depending on the specifications. The range of products and applications is extensive: from rock anchors or bolts for geotechnical applications to temporary or permanent posttensioning applications and marine projects. "Form-ties are sold over the counter, the ability to stock selected bar diameters and grades makes VSL highly competitive in terms of price and lead times." Shemi P.S. concludes. Some recent applications include work in the marine environment of Dubai drydocks, post-tensioning for Doha Sports City, geotechnical

applications on the Dafah–Shish road and tunnel and the Abu Dhabi Salam street tunnel. Abu Dhabi has already launched a large number of major projects and has plans in place to launch a multitude of projects throughout the coming years involving residential developments. luxury tourist accommodation, shopping malls, huge infrastructure projects (roads, public transportation and bridges), the extension of the airport and the development of the surrounding islands. It is up to VSL to identify the potential of these projects and to become involved from the beginning.

SITE INSIGHTS





→ CCT Stronghold has completed the design and construction of a 150m-long VSoL® wall for a new high-speed rail line from Madrid to France. The 7.8km section, 100km north of Barcelona, includes viaducts up to 245m long and a 1.75km tunnel. Facing

elements were formed from concrete panels, using polymeric reinforcement to avoid stray currents. Erection of the 12m-high wall was completed in record time with total geometric accuracy. *Contact: rroussillon@vslsp.com*

Portugal Deck doubling

Varela Bridge near Aveiro has reopened with a wider deck after a complex rehabilitation and strengthening project designed by A2P and carried out by Obrecol. The 308m-long curved deck crosses the Ovar Channel with ten 30.8m-long spans. The original bridge had a 6.5m-wide crosssection with a concrete slab supported on six T-shaped beams. Increasing the width to 12.5m involved installing identical precast beams on either side, connected transversally by steel beams. VSL Portugal used bars and external post-tensioning to enlarge and strengthen the pier heads. VSL's scope also included lifting operations, concrete repairs and the supply of new pot bearings. Contact: ralmeida@vslsistemas.pt

Spain Spherical suspension

→ iGuzzini Illuminazione Spain has built an iconic new headquarters building near Barcelona. The structure's singular design takes the form of a slightly deformed sphere emerging from the ground. All the floors are suspended from a central group of columns in the centre of the sphere.VSL has provided technical assistance and supplied a large quantity of its 75mm-diameter Y1035 bar for the floor suspension system. ■ *Contact: vsancho@vslsp.com*



<mark>Spain</mark> Downhill launch

→ The 236m-long superstructure of the Porcia Bridge in Asturias, north-west Spain has been launched successfully by CTT Stronghold. Assembly took place on temporary steel supports. The bridge was jacked up with the standard VSS skidding system to ensure the correct alignment for a smooth downhill launch of the entire steel and concrete deck



structure. The 1,750t launch across three intermediate piers (80m main span) was done in two phases in a pushing/pulling procedure using the VSS 500 skidding system and the SLU. Its main advantage was that the VSL skidshoes included double-acting vertical hydraulic jacks, which meant that VSL could control and correct the loads and levels throughout the launch. Contact: jmmartinez@vslsp.com

Spain Precision sawing



→ Two complex silo projects have been carried out by CTT Stronghold. A new 120m-high silo with an internal multi-cell configuration has been reinforced using unbonded NSM (Near Surface Mounted) post-tensioning to increase the shear response of the internal walls by 70%. The technique involves precision sawing to create grooves, together with drilling, anchorage placement, controlled tensioning and the use of non-shrinking mortar. An existing 47m-high silo was patch-repaired and provided with external post-tensioning and waterproof mortar protection. *Contact: ccots@vslsp.com*

Spain TBM extraction

→ A delicate operation to remove three TBM sections weighing up to 120t from a new water tunnel being built at Barxeta has been completed by CTT Stronghold. A 7.5m-wide cave was created to give room to load the sections, which were up to 5m in diameter. VSL pulled each piece with a 70t cable hydraulic unit and then jacked it up 1.5m with four 90t climbing jacks so that a transport platform could be reversed underneath. Once loaded, it could then be driven out. 🗖 Contact: jmmartinez@vslsp.com





→ Barcelona's new Design Hub by architect MBM will be a centre for promoting design excellence. Its three main areas have different uses and structural demands. VSL's involvement has covered posttensioning and design assistance to main contractor Acciona-Copcisa JV and consultant Boma. Key aspects include Block 2's two unbalanced steel cantilevers, which are up to 35m long. VSL's Bondtech® system was chosen for the slabs of the central core that caters for the cantilever loads. CS crossed tendons withstand the high tensile stresses in the walls. Block 3 also has an unusual feature: a double-height 4,000m² slab with a 16m by 19.4m column layout. VSL's solution consists of a 750mm flat concrete waffle slab, providing an extremely high stiffness to self-weight ratio. *Contact: posso@vslsp.com*



CTT Stronghold has successfully carried out a second drill-head replacement for a

tunnel boring machine building Barcelona Underground Line 9. The work at the Guinardó shaft followed manoeuvres at Habaneras (see VSL News 2009/2). Geometric differences between the two sites led VSL to design a steel structure to allow the reuse of the hydraulic jacks from Habaneras. Equipment was further optimised by the use of larger VSS 500t skidding equipment to avoid the need for the substantial steel beams required at Habaneras. Once again, the most important factor in the operation's success was the achievement of accuracy to the millimetre in three dimensions. Contact: jmmartinez@vslsp.com



<mark>Spain</mark> Absolute zero

→ New parking arrangements required the repositioning of a first-floor column while the eight floors above remained in use and fully loaded. CTT Stronghold carried out the successful highprecision reverse beam transfer. The primary constraint of the design was a requirement for "absolute zero displacement" to

avoid cracks in the façade. This was achieved using active jacking, post-tensioning and non-shrinking self-compacting concrete. Operations included lifting and load transfer using a new steel structure, controlled demolition and installation of a new active beam using post-tensioned beam transfer. Contact: ccots@vslsp.com

Spain From ground to roof



→ CTT Stronghold and VSL Switzerland have successfully lifted the 1,325t roof structure

of El Prat Airport's huge new 25m-high maintenance hangar, measuring 155.5m by 87.5m at an average speed of 4m/h. VSL began working with Iberia and Assad Desarrollo well in advance of the installation. Appointed contractor Cobra and VSL found that the best solution was to build the roof at ground level and lift it in a single movement. VSL proposed double and balanced lifting points to avoid the need for temporary reinforcement for the final columns. The 14 strand lifting units (SLU) of different capacities were balanced with another 14 SLUs for a retaining force of 850t. Contact: jmmartinez@vslsp.com



Mexico Up to 20% savings

Meridiano Tower is a new icon in the business centre of Monterrey City in Nuevo Leon, Mexico. The 23-storey tower was built by one of Monterrey's most important construction companies and the construction works took about 12 months. VSL developed the project's structural design as well as supplying and installing the post-tensioning materials. Use of VSL's post-tensioned solution instead of traditional reinforcement achieved a 10% cost saving for the slabs and a 20% saving for the foundations. In total, the 27,600m² of post-tensioned slabs required about 70t of 0.5" (12.7mm) strand. VSL's scope in the foundation construction involved the provision of 26t of strand. Contact: ceciliaalto@vslmex.com.mx



Russia Nuclear first

ightarrow VSL Switzerland has embedded

its first anchorages for the Russian Federation's expanding nuclear power market. The anchorages are for the inner containment of the first block of the LAES-2 Nuclear Power Plant in Sosnovyi Bor. The VVER-1000 plant is being built by OAO Metrostroy for Atomenergoprojekt Saint Petersburg, acting as designer and general contractor. VSL is supplying NC 6-55 unbonded posttensioning, which is a greased and sheathed system that complies with the latest nuclear requirements. The project includes 50 vertical tendons and 76 horizontal hoop tendons for each block, requiring a total of about 1,400t of strand. Contact: sebastien.elias@vsl.com

<mark>Slovakia</mark> Viaduct variety



→ Various VSL PT systems are **being used** for a 960m-long viaduct on the Nitra - Banska Bystrica section of the R1 expressway. Bridge 205 has been designed by Stráský, Hustý a partneři and the contractor is the Slovakia branch of Eurovia CS. The concrete bridge has typical spans of 69m and its superstructure consists of a single box girder with overhangs supported by precast struts. It uses internal and external VSL post-tensioning systems. The top slab is transversally posttensioned using the VSL S 6-4 bonded slab system while the VSL thread bar system is implemented to fix the struts prior deck casting. Contact: psmisek@vsl.cz



→ The 88.5m-span Aare River Bridge in the Swiss city of Olten will lead directly into a tunnel and the designers have opted for an extradosed structure anchored on one side only to the tunnel portal. The 2.6m-high main girders are suspended on prestressed "concrete sails" and anchored so that the tunnel becomes a loadbearing component of the bridge. Challenges for VSL include the congested arrangement of tendons within the sails, the requirement for a deviation tube at the top of the sails and fixing the sail tendons at the tunnel walls. Contact: hannes.mueller@vsl.com

Bulgaria Weight lifting event



→ VSL CZ and VSL Heavy Lifting recently lifted the 1,500t roof of a multi-purpose sports hall in Sofia. The roof was assembled at a 19mhigh level and lifted to its final position at 30.5m. VSL's in-house Bravo control system monitored lifting forces and ensured that the height difference between the eight lifting points was kept within the 25mm tolerance. The operation was one of the first of its kind in Bulgaria. Contact: psevcik@vsl.cz

Poland Airport interchange



VSL Poland is supplying and installing the post-tensioning systems for the three viaducts of Warsaw's Okecie Interchange. Construction is being carried out by Karmar, a subsidiary of Bouygues International Building division. This interchange will provide access from the Chopin Warsaw Airport. The viaduct beams are stressed by cables of type 19L15 and 22L15. Posttensioning work on the first viaduct started during the summer and VSL Poland's work is due for completion by the end of the year. Contact: m.targowski@vsl.com.pl

Hungary V-saddle enters use

→ VSL has completed the first cable-stayed project to use its new SSI 2000 V-saddle technology. The V-saddle represents the latest development in stay cable systems and simplifies pylon design. The M43 Bridge in southern Hungary crosses the River Tisza with a 180m-long main span supported by two pylons. Hidepito has built the bridge, which has a total of 64 SSI 2000 stays of size 6-37. Contact: felix.blumschein@vsl.com



→ VSL's Washington D.C. office recently carried out an emergency repair to the Oneida River Bridge in New York state. The project, which involved strengthening with external posttensioning, was prompted by investigations that showed significant corrosion on the fascia girders of this first-generation splice-girder bridge, built more than 50 years ago. VSL designed the retrofit as well as provided materials, equipment, and technical assistance on site. Work began in mid-March and took approximately eight weeks to complete, with VSL working with local contractor Slate Hill. *Contact: cellis@vsl.net*

USA Multiple successes

→ VSL's Civil Projects Team has recently secured contracts for several key bridge projects, including the New Mississippi River Bridge, which will become the USA's third-longest cable-stayed bridge. VSL will supply 1,142t of stay cables together with 136 friction dampers and 425t of posttensioning for the bridge, which is in St Louis, Missouri. VSL is working with Figg Bridge Developers on the new South Norfolk Jordan Bridge in Chesapeake. Virginia. where it is supplying 702t of post-tensioning for the precast segmental construction. Archer-Western Contractors selected VSL to furnish 360t of post-tensioning and provide a leased set of VSL modular form travellers for two new bridges over the Colorado River in Marble Falls, Texas. Contact: bsward@vsl.net

usa Proactive inspections

Oklahoma Department of Transportation has awarded VSL's Washington D.C. office a contract to inspect 18 post-tensioned bridges in a proactive measure to ensure long-term durability. The VSL team is working with URS and Siva Corrosion Services on the project, which represents the largest number of bridges inspected by VSL under a single contract. Inspections began in mid-March and involve the use of ground penetration radar and borescope equipment to determine the condition of the tendons. The structures include Oklahoma's oldest precast segmental bridge, the signature Sailboat Bridge over the Grand O'Lake of the Cherokees.

Contact: cellis@vsl.net

SITE INSIGHTS

Johor approaches completion

→ A 1.7km-long cable stayed bridge over the Johor River delta is expected to be opened to traffic in early 2011. The Sungei Johor Cable-Stayed Bridge has a 500m main span flanked by 137m side spans and 484m approaches consisting of concrete post-tensioned three-cell box-girders. Both approaches were constructed using a VSL-designed incremental launching method, which was supplied and operated by VSL Malaysia. The scope of works also included the supply and installation of post-tensioning for the concrete deck. In addition, VSL supplied and installed the bridge's 84 stays, which use the SSI 2000 system. The 7.85m-long steel composite segments for the side and main spans were delivered by barge and erected using a crane mounted on the bridge. *Contact: cschai@vsl.com.my*

Philippines Skyway return



→ VSL Philippines has been working with Citra Metro Manila Tollways Corporation and main contractor DM Consunji Inc. on a major project designed to reduce congestion in Metro Manila. South Metro Manila Skyway Stage 2 project is a six-lane, 7km expressway that will double road capacity. VSL is involved in the post-tensioning of 104 pier heads and columns as well as 1,832 precast girders. The work follows on from VSL's involvement in the first stage of the project, which opened in 1999. Contact: bvergnes@vsl.com

Malaysia 476 segments

→ Medium Term Link is a 1km elevated bridge project designed to connect the Malaysia-Singapore



Causeway with new customs, immigration and quarantine facilities. VSL worked in joint venture with a local contractor to cast and erect 476 precast box girder segments for the bridge superstructure. Erection of the twin carriageways was by the free cantilever method using an overhead launching gantry. The 23 cantilevers had spans ranging from 34m to 44m. Construction logistics were very challenging as the bridge passes over major water pipelines and existing road and rail traffic. 🗖 Contact: ckchong@vsl.com.my

Australia Rail quadruplication



→ VSL Australia provided a full design and supply package for 12 different VSoL® Retained Earth Walls for one of Sydney's largest rail infrastructure projects. The walls stand up to 5m high and have a total panel area of 3,660m². The Kingsgrove to Revesby Quadruplication (K2RQ) Project will provide two additional tracks to separate local and express services operating on the East Hills Line. It is part of the NSW Government's Rail Clearways project, designed to improve capacity and reliability on the City Rail network. Contact: fwagner@vsl-australia.com.au

NOTE PAD

Complex ground anchors. VSL was appointed by VEC Thiess JV to drill, supply and install 14 permanent anchors on the Brighton Bypass project in Hobart, Tasmania. VSL was chosen for its ability to meet the project's complex technical constraints.

Careful planning. Shanghai Power Engineering & Construction awarded VSL the PT work on the 50,000m³ Ningxia LNG tank project. A two-month winter shutdown on the worksite required VSL to plan the works carefully to accommodate temperature constraints and meet time limitation between strand installation and grouting phases.

Centennial challenges. The University of Hong Kong's new Centennial Campus extends constructions over a former reservoir. VSL's scope involved drilling, supply, installation and stressing of 200 temporary ground anchors to hold back sheet piles during phased excavation works. Challenges included unpredictable ground conditions.

VSoL® double. VSL Australia was recently awarded a contract to design and supply retained earth walls for the Banora Point upgrade project. The contract involves 11,000m² of patterned VSoL® walls up to 12m high as well as 2,400m² of temporary VSoL® walls.

Windy city. VSL provided an engineering solution to heavy lift the preassembled retractable roof structure of the 14,000-seat Perth Arena, in Australia, from the ground to its final position, while avoiding any issues arising from local strong seasonal winds.

Brunei bridges. Bridge repair and strengthening work on the Brunei Muara District Phase 1 contract involves rehabilitation of 24 different bridge types. VSL's scope on the 12-month contract covers concrete assessment, repair and protection as well as a bridge deck replacement.





High-strength solution

→ The use of high-strength thread bars as proposed by VSL's Technical Centre Asia/Australia has proved an effective solution for counteracting expected ground heave during construction of Singapore's 5kmlong Marina Coastal Expressway. Using the Y950/1050 steel bars as tension reinforcement in the temporary tie-down piles resulted in lighter and less congested reinforcement, which enabled easier and faster construction despite the extra time required for technical approval. VSL Bar Systems division - a joint venture between Stahlwerk Annahutte and VSL Singapore - completed the 1,300t supply in June and a second phase requiring similar quantities is expected to start in early 2011.

Australia No crane at Geelong

→ Section 4A of the Geelong Ring Road involves the construction of 2.5km of four-lane, dualcarriageway freeway from Princes Highway to the junction of Anglesea Road and Hams Road. VSL Australia was appointed by Fulton Hogan to supply innovative and high-quality precast crossheads and match-cast piers as well as supplying and installing stress bars. One of the major highlights of the project was the way in which the VSL team was able to store and load the 115t segments without the use of cranes. Contact: jmckenzie@vslaustralia.com.au

Australia Both decks at once



VSL Australia is achieving a consistent average cycle time of

eight segments a night in a sevenhour erection window for a major roundabout upgrade at Brisbane airport. The project involves the construction of a 641m-long segmental balanced cantilever bridge. Segments are being erected by a VSL-designed segment lifter at one end and a 280t crawler crane at the other. Being able to erect segments on both decks before relocating the lifter has had significant programme benefits. The segment lifter has also minimised traffic impact as it does not require set-up time during the nightshift. The main contractor is Thiess John Holland JV. Contact: dhoffman@vsl-australia.com.au

Australia Perfect finish

→ VSL Australia has used innovative edge forms to achieve a perfect slab finish on a contract to design and build a 16,000 m³ concrete water tank. This tank is part of Southern Sea Water Alliance's Binningup Desalination Plant project and has a 2,800m² post-tensioned slab cast in two pours. The slab was formed using innovative hybrid steel and ply edge forms, which resulted in a crack-free surface finish. Sixty precast panels were manufactured at VSL's precast facility in Perth. Western Australia has been using desalination as a major public water source since 2006, when it opened the country's first plant.



VSL Australia has carried out a number of other precast and installation projects on the strength of its delivery of a complete design and construction package on the initial project, where it brought cost and time savings through the use of alternative design and innovative engineering. Contact: thaydon@vsl-australia.com.au

Hong Kong Top trusses



India PT for IT



ightarrow VSL has been awarded a

21-month contract for the design, supply and installation of 1,270t of post-tensioning for 350,000m² of the Ramanujan IT Park in Chennai. Partial stressing is being used to avoid early shrinkage cracks and to facilitate early formwork removal. VSL is working as a nominated sub-contractor on the project, which is being constructed by an alliance of Tata Realty & Infrastructure, Leighton India and specialist consultants. *Contact: m.phillips@vslindia.com* VSL Hong Kong has lifted six 'mega trusses' totalling 2,560t for Hong Kong's prestigious Tamar Development project. They will become a roof structure that contains three office levels and links the two wings that will form the Central Government Complex. The trusses, which are 17m high and up to 58m long, were lifted by approximately 100m in two operations, each of three trusses. Target speed was 12.5m/h to allow completion of each lift in a single day in compliance with noise permits. Contact: yw.yung@vslintrafor.com

Hong Kong Tight clearances

→ A joint venture of VSL Hong Kong and Kaden is planning a heavy lift operation for June 2011 to position the 1,600t central span of the Crossing Bridge across Hong Kong's Eastern Channel. The 55mlong central span will be lifted from a barge using SLU 550 units and slid into position. Tight clearances will require meticulous monitoring of the tide levels. Contact: lewis.wong@vsl-intrafor.com



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R&D

GROUTING OPERATIONS How to avoid voids?

VSL has developed a Grout void sensor that reduces the risk of undetected defects when grouting post-tensioning tendons, ensuring a high degree of durability.

Poor grout quality, voids and the presence of bleed water are all potential risks in any structure that uses post-tensioning. VSL has developed a grout void sensor aimed at reducing the risk of undetected defects in the grout around post-tensioning tendons so that durability is ensured. VSL Grout void sensors can be installed at critical points along the tendon to monitor the grouting operation and measure the properties of the grout. This allows immediate corrective action to be taken if the specified criteria are not being met.

The sensor has three electrodes sensor, counter and reference for the required electrochemical passivation measurements. Installation of multiple sensors on a tendon is very easy as the sensor can simply be screwed into the duct and other fixings.

Successfully tested in the field

A successful field test on a posttensioning tendon equipped with VSL Grout void sensors has been carried out using a full-scale mock-up erected at VSL's workshop in Subingen, Switzerland. The test employed sensors made by SGK (Swiss Society of Corrosion Protection) on behalf of VSL. A supporting frame was used to form a 40m-long 12-strand tendon into an arch ready for injection. The tendon was equipped with VSL PT-Plus® plastic ducting and CS 2000 anchorages. The



Fig.1 The Grout Void Sensor used in the field test

anchorages cast into concrete boxes and the strands remained unstressed. In total, 21 sensors were installed at seven testing points. Three sensors at each testing point were arranged at various distances from the duct centre to monitor the degree of grout filling.

The sensors monitored two different parameters:

- measurement during the injection process to detect changes in current indicating how far the flowing grout had reached;
- measurements taken immediately after the completion of the injection to determine the passivating properties of the grout filling and to confirm the complete filling of the duct at the particular locations.

The results of the passivation measurements were checked five months after injection by visually inspecting the grouting at the testing points. The results confirmed that the sensors had correctly detected complete filling of the duct, presence of grout voids of 2/10mm (depth/ length) and defined the presence of bleed water.

Perspectives

The VSL patented Grout void sensor can be used for detection of incomplete filling during the grouting process. Passivation measurements of the sensors generally worked well in the fullscale test. The full-scale test provided valuable indications for the definition of the evaluation criteria which can now be finetuned to address the needs of a typical project. The next step will

be to fabricate equipment designed for use on site with the aim of confirming the concept

on a real project.

FOCUS

REPAIR & STRENGTHENING Seismic upgrade for historic viaduct

VSL has taken a step forward in the repairs market with the completion of the highly complex project on a key motorway viaduct across the Trancão valley, on the highway from Lisbon to Porto, Portugal.



SEISMIC UPGRADE FOR HISTORIC VIADUCT



Motorists crossing the Trancão River valley on the A1 Lisbon to Porto highway may not realise that a very distinctive structure lies beneath them. The viaduct, which has a web of concrete arches, was designed by António Franco e Abreu and Rui Correia and opened in 1959. It has remained in service throughout a recent major upgrade that has brought it up to today's seismic requirements and given it a new lease of life.

Retrofit required

The retrofit project was designed by consultant A2P on behalf of the owner, Brisa. Soares da Costa was the main contractor responsible for the overall project and chose VSL Portugal as the specialist for the complex tasks involved in the seismic strengthening as well as bearing and joint repairs, 1,200m² of concrete work and 32,000m² of painting.

The 290m-long viaduct has five 57m-long spans, each with six parallel arches. The deck's 26.5mwide slab runs across six longitudinal beams, each of which is supported directly on a concrete arch at mid-span and on additional inclined pillars. The six parallel arches are also connected together by transverse cylindrical concrete beams. All the spans created by the arches are structurally independent, as the deck between them is simply supported with a movable bearing at one side.

A2P analysed the structural behaviour and concluded that the bridge could handle general vertical and wind loads but that it was not in a condition to assure safety under today's design standard requirements. Indeed, seismic loads were not taken into consideration at the time when the viaduct was originally designed. The consultant found several critical deficiencies under today's design standard requirements.

Analysis

The first problem that A2P found was related to structural displacement under seismic loading. The lack of deck connections between the simplysupported spans allowed different behaviour for each independent section of the structure. The consultant also confirmed that the expansion joints and bearings had no capacity to accommodate any significant movements arising in extreme situations, such as adjacent beams moving out of phase.

The second deficiency related to the resistance capacity against seismic loads. Analysis showed that most of the structural elements – i.e. piles, arches and transverse beams - had insufficient resistance in the face of seismic events of medium or high intensity.

The retrofit was designed to reduce the effects of seismic loads and its main objectives were to control displacements, increase the capacity for resistance and improve the ductility of the structure. Several solutions to these issues were studied, such as strengthening the whole structure or adding new elements, but the best was the dissipation of seismic









energy and thus, the reduction of effects and displacements. So it was decided to opt for a solution that would connect the whole structure and to introduce a base isolation completed by a passive damping system.

Introduce base isolation

The load intensity is a function of the structure's main frequency and also of the damping effects. Base isolation reduces the frequency to levels where spectral accelerations are lower and so less damaging to the structure. Viscous dampers underneath the bases of the arches have the effect of producing a significant increase in the equivalent damping and so reduce the acceleration. Introduction of base isolation involved the installation of highdamping rubber bearings at the base of the arches, with viscous dampers in both the longitudinal and transversal directions. The

system was designed to achieve damping effects of 25% to 30%.

In total, 120 longitudinal and 30 transverse dampers were installed, using two longitudinal dampers for each bearing as well as transverse dampers between bearings. The system also has a cut-out, which is calibrated to break under seismic loads while allowing normal operational, temperature and wind loads. Additional steel devices were also fitted to restrain transverse displacements.

Install bearings

Installation of the bearings required cuts of 32cm to be made at the base of the arches with the help of steel work and temporary hydraulic jacks. This type of operation can cause significant changes in the structure during load transfer and so careful monitoring of the displacements was required together with strengthening of the arch bases. Overall deformation was difficult to predict because of foundation movements and other side effects, even though the displacements arising from dead loads and temperature were straightforward to calculate.

Cutting the structure had the effect of releasing the deformations, the extent of which had to be taken into account in ensuring the solution's accuracy. The A1 is key highway and so all operations had to be carried out while traffic continued to operate normally.

Eliminate deck joints

The retrofit solution reduced deck displacements and required the elimination of intermediate expansion joints on the deck.



High-strength bars were installed through the deck's transverse beams at the existing expansion joints and they were stressed in order to connect the longitudinal beams of the contiguous decks. In addition, the transverse cvlindrical beams were reinforced with 1.750m² of CFRP fabrics. Bearings were also replaced at the abutments to accommodate the new deck displacements. The project was carried out very successfully, without interruption of traffic, and has proven VSL's capacity to handle very sophisticated retrofit and strengthening works. 🗖

SPECIAL REPORT

SkyPark – lifting a landma

VSL successfully completed the heavy lifting works for 7,000t of steel superstructure to support the SkyPark that now runs on top of the towers of the Marina Bay Sands[®] resort in Singapore.

Marina Bay Sands® is an integrated resort in Singapore, boasting a 2,560-room hotel, a casino with 500 tables and 1.600 slot machines. world-class restaurants, major arts facilities and 120,000m² of exhibition space. One of the most remarkable features is the 340mlong SkyPark, which links the three hotel towers 200m above the ground level and includes the world's largest public cantilevered platform, overhanging the north tower by 64m. It offers stunning views of the city and the Singapore Straits from its restaurants, 150m-long infinity pool, jacuzzis and gardens.

VSL carried out the heavy lifting works for the 7,000t steel superstructure that supports the SkyPark: 14 heavy lifts of the major components over a period of three months.



VSL's scope of works for the heavy lifting operations included the design of approximately 2,100t of temporary steel structure for the lifts, the methodology, the supply of temporary VSL CT stress bars and the heavy lifting operation itself.

Lifting the SkyPark

The operation consisted of lifting and sliding a pair of box girders at the top of Tower 3, lifting six link bridges between Towers 1 and 2 and between Towers 2 and 3, and lifting six segments for the North Cantilever at Tower 3. The 200m lift of the Tower 3 box

girders was completed in a single 13-hour working day. Each of the two 76m-long box girders for Tower 3 weighed 760t. Their heights ranged from 5m to 10.5m. Two sets of lifting frames were placed on top of the Tower 3 shear walls and operated simultaneously. The main girder of each lifting frame was formed from built-up plate girders and spliced into different segment lengths to suit its installation and assembly by tower crane. VSL CT stress bars were used to connect splice blocks between the girder segments. Each lifting frame required four strand lifting units for the operation. SLU-330/550 and SLU-120/550 models were used. together with eight SC31-200 hydraulic coilers. Once at the top of the tower, the girders had to be slid by up to 16.7m into position. Lifting of the link bridge girders between towers was carried out



ark on Singapore's skyline



using lifting frames supporting rail beams on the adjacent towers. The lifting frames were erected on the permanent structure of the towers at level 55. One SLU lifting unit was installed on top of a cantilever beam in order to slide the link bridge girder along the rail beams. Tower crane obstruction meant that four of the six link bridge girders had to have their loads temporarily transferred onto a sliding beam. They were then slid for approximately 10m before they could be picked up again by a second set of lifting units for transfer to their final positions.

Three strand lifting units and two hydraulic coilers were used in lifting the 53m-long girders, which weighed between 301t and 391t. As with Tower 3, the whole operation was completed in a single working day, with a lifting speed of 18m/hr.

A pair of self-launching lifting frames was used to lift the six segments making up the 64m-long North Cantilever. Four SLU lifting units together with hydraulic coilers were installed on top of the lifting frame. The equipment had the ability to be adjusted independently in both the transverse and longitudinal directions to suit each segment's lifting position. The critical completion schedule led to work being carried out around the clock in two shifts, with each segment taking 10 hours to lift at a speed of 20m/hr. The segment lengths varied from 5.7m to 8.5m and they weighed between 94.7t and 202t.

Providing construction engineering

VSL had also been involved in several earlier key aspects of the construction starting with the design phase and including the



The segments were lifted at a rate of 15m/h. It took them 13hours to reach 220m.

use of the AF anchorage and temporary tendon installation. *(See VSL News Magazine 2008/1 and 2009/1).* The towers consist of vertical and sloping walls which merge into one at level 23, creating an A-shaped frame. VSL was appointed by the main contractor, Ssangyong, to carry out the construction engineering for two of the three towers, particularly in relation to the temporary stability and geometric control of the vertical shear walls. This involved checking the wall forces during the construction stages using a 3D building model in Sofistik software. A construction method was developed that used temporary propping and temporary vertical post-tensioning in the walls to ensure that the maximum moments and forces at the bases remained within acceptable limits.

Installing AF anchorage

The temporary works involved the use of a series of 6-19 cables running inside the shear walls in stages from the pile cap up to as high as level 23 with three levels of props introduced between the vertical and sloping walls. A critical post-tensioning challenge was the need to provide a system that could have anchorages in the basement raft slab while allowing the vertical cables to be installed and stressed in stages as construction progressed.

To achieve this, the VSL Type AF Flower Anchorage was used for the dead end cast inside the pile cap. This unique system makes it feasible to have a dead-end anchorage in what would otherwise be an inaccessible location thus allowing for a much neater and more elegant and economic solution. Successful project completion was achieved by close cooperation of VSL specialists throughout the network.



The last segment for the North Cantilever completed a series of spectacular lifts carried out by VSL.

TECH SHOW

world first on cadagua eridge Think lateral for tandem launch

VSL in Spain has overcome severe space constraints and saved structural steel by devising and carrying out what is believed to be a unique method for launching two viaducts and their lateral exit structures. Restricted space between tunnel portals led to an innovative 'double-deck' launching procedure: two main viaduct structures were launched with a lateral bridge on top. Each lateral bridge was then manoeuvered into its final position. Read about the steps of this world first...





The new crossing consists of two main viaducts carrying the road over several secondary roads, a rail track, the Cadagua River and a motorway, while two lateral bridges carry the exit roads from the main viaducts. All are composite bridges with steel box sections. All four bridges are curved in plan with different radius.

BRIDGE LAUNCHING

TECH SHOW

Think lateral

The new crossing consists of two main viaducts and two lateral bridges. All are composite bridges with steel section. The proposal in the original scheme had been for all four bridges to be built up behind the abutment and launched in pairs **Take care of the long nose** Two SLU 70 hydraulic strand lifting units installed in a steel gantry on the receiving pier catered for the 3.6m front deflection of the steel launching nose at the maximum cantilever of 102m.

Skid the steel boxes Only the main viaduct steel boxes were launched and the selfweight ranged from 3.25t/m for the lateral structures to 4.1t/m for the main viaducts. In total, VSL launched more than 4,000t of steel structures, with the 364m of the main bridges



(at the same level), but this created some significant issues because of the variable distance between their longitudinal axes, ranging from 1.95m to 5.14m. VSL proposed that these issues could be overcome by assembling each lateral bridge on top of the corresponding main viaduct before a 'double-deck' launch. The lateral bridges could then be skewed and slid before being lowered to their final position. The proximity of the tunnel portal to the launching abutment left only 55m for superstructure assembly. VSL increased that space by erecting temporary steel towers between the abutment and the first pier to provide a platform for manufacturing and skidding the bridge sections.





being launched in eight phases. During all launching phases the vertical loads and level at the abutment, towers and piers were continuously monitored and adjusted as per the calculations requirements. In all these skidding points, two jacks of 500t capacity and 600 mm of stroke were supplied by VSL. Skew and slide at the piers VSL also designed and supplied a skidding system allowing rotation of the lateral bridges at the piers. This involved a line of 10m of the VSS 500t skidding system, with a flat skid beam of 4.5m and a pushpull unit of 56t.



Use custom made gantries Two sets of equipment were installed behind the abutment – one set for each of the main launches. Each included two pairs of 300t mechanical skidding supports, three pairs of 225t jacks and two hydraulic strand-pulling units. Once each main launch was completed, VSL installed 300t-capacity steel gantries on the two main piers to skid and lower the lateral bridges to their final position.



Lift and lower the lateral bridges Each gantry on the main piers included a standard VSS transversal skidding system as well as SMU hydraulic strand units for lifting and lowering the lateral bridge. A standard 250t-capacity crane completed the equipment list for one of the lateral bridges installation.



TECH SHOW

Value engineering for an extraordinary project

The main viaducts have a total length of 364 m/each divided into four spans ranging from 80m to 102m. All four bridges are curved in plan (with different radius) and the longitudinal slope for the main viaducts meant that the bridges were always being launched uphill at gradients from 2% to 3%.





TECH SHOW





VSL's scope of works included the launching of the complete steel structure for the two main viaducts plus the skidding and lowering operations for the two lateral approach structures, including developing the detailed engineering. VSL also supplied all the permanent pot bearings for the link and the temporary stay cables for one of the lateral bridges. VSL's revised procedure involved a great deal of engineering but its adoption offered several advantages, including a considerable reduction in the space required at the abutment. This also allowed savings in the amount of temporary and structural steel required. Even though equipment changes were required, the VSL scheme proved cheaper for the client than the original proposals and brought benefits to the overall project schedule.

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