



NEWS

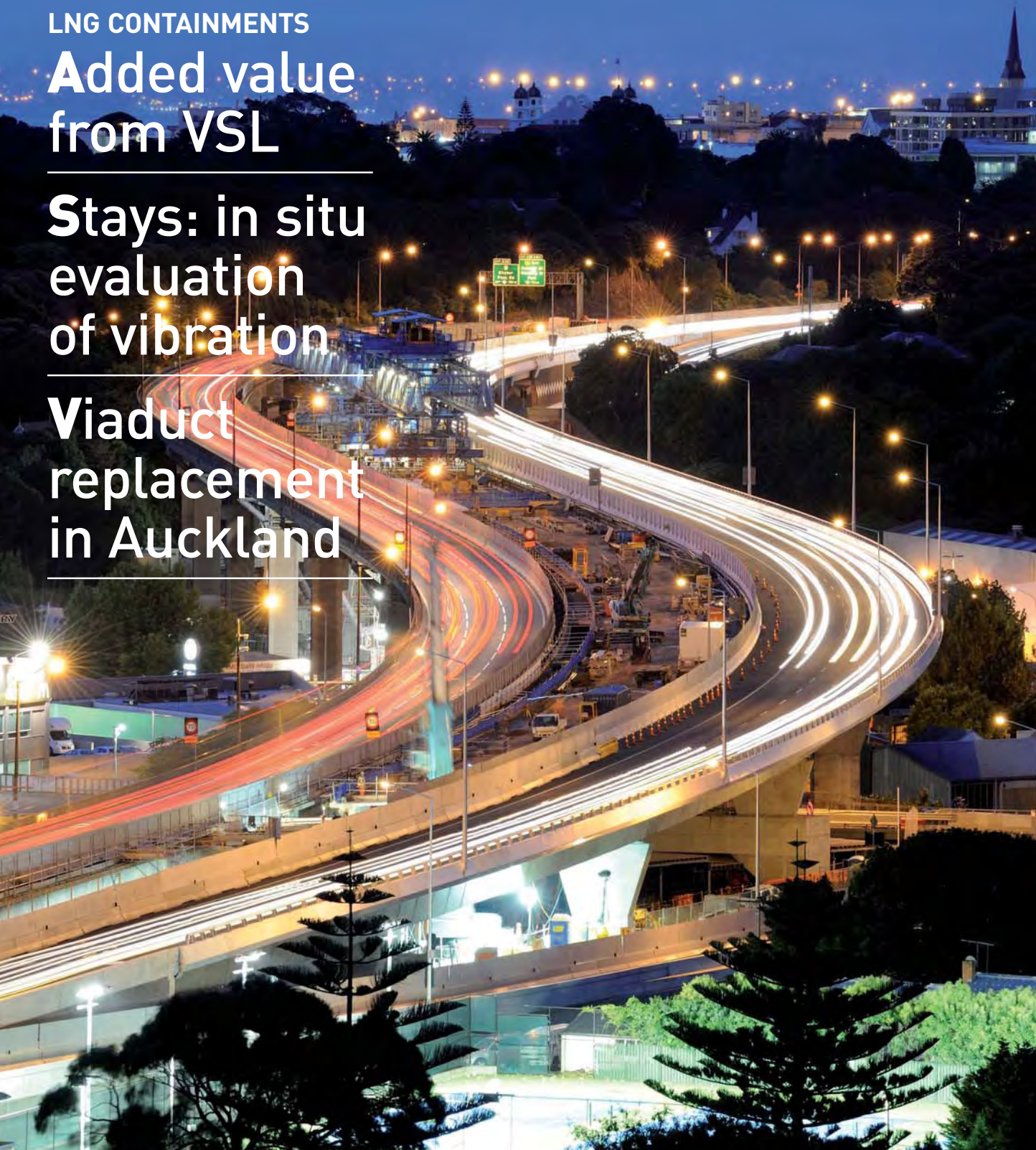
THE VSL NEWS MAGAZINE • ISSUE ONE 2011

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from VSL

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NEWS, magazine published by VSL International Ltd. • Künz, Switzerland Director of Publication: VSL communications • Jane Rousseau • jane.rousseau@vsl.com
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Cover photo: Newmarket Viaduct Replacement Project, Auckland, NZ

EDITORIAL

Highly dependable

VSL has been providing expert solutions to its partners throughout the world since 1956. Its renowned reliability and dependability in every aspect have been at the heart of this long and successful history.

Supplying the dependable systems required to build safe and durable projects: today's infrastructure projects must be both long-lasting and sustainable. VSL's systems enhance safety and longevity because they can be adapted to suit any application - even in challenging situations, such as LNG tanks¹.

Being a dependable partner in its business relationships: trusted and long-term business relationships, such as our bar activities² are of utmost importance in tackling the challenges of complex and demanding construction projects.

Providing dependable engineering for complex and/or unusual projects: experienced staff and the capacity to adapt to any site situation are underpinned by VSL's main asset - the strength of its technical centres and continuous R&D. A good example of this is the viaduct replacement project in Auckland³.

Dependability in all aspects is not enough on its own - a comprehensive approach is guaranteed by VSL's capacity to have a vision, to innovate and to come up with alternative solutions for the benefit of the project. We have always made the utmost efforts to be a reliable partner for all our clients, and will always continue to do so.



Daniel Rigout, Chairman and CEO

¹ Pages 8ff

² Pages 30/31

³ Pages 32ff

BUSINESS IMPROVEMENT

COMMUNITY ACTIONS

Enfants des Rizières – Children of the rice fields

Initiated in Vietnam, VSL staff members in Ho Chi Min, Hanoi, Hong Kong and Singapore have joined together to help make life better for the children at a community centre in Long Hai, Vietnam. The personal commitment of everyone involved was the key to success...

Pour les Enfants des Rizières is a non-profit organisation aimed at helping disadvantaged children in Vietnam. Bouygues Construction's charitable foundation Terre Plurielle is contributing funding towards the Long Hai centre, which will make it possible to feed and care for local disadvantaged children as well as giving them access to schooling. In 2009, the foundation contributed towards financing the construction of an administrative building, a classroom, kitchen, canteen and multi-purpose hall. The latest project includes the building of six new classrooms, physiotherapy facilities and a crèche.



abandoned children, as well as the children of families in great hardship in the city of Long Hai, Vietnam. The centre is also used for schooling the children or providing them with occupational training. Two hundred children are taken care of in the Maison Sociale, where they are fed, educated, given medical treatment when necessary and can play and live in a safe and caring environment. The Maison Sociale houses abandoned children and helps them to (re)integrate into a normal school education system, without needing to struggle to find the next meal or a place to sleep.

Touched by the project and its potential impact, the staff and management of VSL Vietnam decided to organise a collection of

clothes, books and toys for the Maison Sociale. The idea, initiated by the head office of VSL Vietnam was taken up and extended through the regional network by VSL Singapore and VSL Hong Kong. Staff members could hand over donations either at their project sites or in the main office; the donations received were stored and transported to the centre in January 2011. "I was deeply impressed by the personalities of the people in charge of the orphanage in Long Hai," says Ronan Hasle – Ground Engineering Regional Business Development Manager and Managing Director of VSL Vietnam, who initiated the



project within VSL. "The director is an impressive lady whose deep and personal involvement makes you want to participate in the project. She really does all she can to help the children in need. I am confident that our donations will be put to good use." ■



The APER (Association Pour les Enfants des Rizières) built the Maison Sociale de Long Hai to house street children and

HEALTH AND SAFETY

Relax and feel good

This year's safety day at VSL's St. Léger offices in Switzerland adopted the theme of preventing stress in the workplace. Part one was dedicated to nutrition, stress and physical activities, plus a quick guide to first aid. The second half of the day initiated discussions on topics requiring a more in-depth analysis of potential risks. Several proposals were suggested for further ways of improving well-being at work and their implementation is planned where possible. ■

EMERGENCY ARCHITECTS

Donations to the Solomon Islands

VSL Australia is a corporate member of the International Foundation of Emergency Architects Australia, which helps to rebuild devastated areas in a sustainable manner. Participation in this initiative stems from VSL's commitment to sustainable development, which encourages involvement in the economic and social life of others. At Christmas, VSL Australia donated toys to disadvantaged children in the Solomon Islands. Donations were also sent to the Smile Group in Vietnam whose mission is to help families affected by Aids. ■

FUND RAISING 1

City2Surf

VSL Australia joined Emergency Architects and a record 80,000 other budding athletes to participate - and complete - the 14km-long City2Surf race in Sydney. *"Your support is very much appreciated and the money raised by you and your generous supporters will go towards one of our upcoming projects such as building toilets in PNG. We have made over \$750 from your combined efforts and donations on the day"* (Emergency Architects Australia, August 2010). ■

FUND RAISING 2

Earth Melody

The Earth Melody event in Hanoi was organised by eco website nhansinhthai.com and GGIO Vietnam with funding from VSL Vietnam. With over 500 participants, it was the perfect opportunity to learn about environmental issues and exchange ideas on sustainability. The idea is that everything has its own melody, even the earth. People were encouraged to take an hour to listen to this melody and adjust their behaviour to enhance sustainable development. ■

SPONSORING

Touch rugby sponsorship

Intrafor sponsors the Dubai English College under-18 girls' touch rugby team and bought the team's kit and kit bags. The girls were coached to success by Jon Kendry in the 2010 / 2011 season, winning every match and every tournament they entered. ■

CERTIFICATION UPDATE

Three more successes

VSL's Technical Centre in Singapore, VSL Vietnam and VSL Chile recorded further milestones in 2011. The Technical Centre passed an audit in accordance with ISO9001:2008, ISO14001:2004 and OSHAS 18001:2007. TCAA always considers safety, environmental impacts and quality. VSL Vietnam's Health & Safety Management System passed its certification to OHSAS 18001:2007. VSL Vietnam is well aware that the hard work does not stop here and is committed to maintaining the certification as well as achieving ISO14001:2004 in 2011. With the ISO 14001 Environmental certification added to the previously obtained ISO9001 (Quality Management) and OHSAS 18001 (Health & Safety Management) certifications, VSL Chile has now also achieved triple certification. ■

FUND RAISING 3

Donations for earthquake victims

Staff and management of VSL Hong Kong joined efforts to support the victims of Japan's devastating earthquake and tsunami. People in the affected areas are suffering from shortages of shelter, food and water, on top of the loss of life. VSL HK's staff immediately organised in-house fund raising, donating almost HK\$ 18,000 (€1,650). The company donated the same amount and the donations were presented to the Consulate-General of Japan on 30 March. ■

European Technical Approval (ETA) VSL systems validated

→ VSL has recently extended its range of PT systems with two multi-strand stressing anchorages, a tendon coupler and a one-strand slab post-tensioning system. The systems are covered under VSL's European Technical Approval ETA 06/0006, which is in accordance with ETAG 013.



GC Anchorage

The stressing anchorage GC is primarily designed for the standard use of internal bonded PT tendons in the bridge construction industry. The standard anchorage units offer tendons with ultimate capacities between 780kN (three strands, 140mm²) and 10,323kN (37 strands, 150mm²). They can be used with both corrugated steel ducts and corrugated plastic PT-PLUS[®] ducts. PT-PLUS[®]

offers the advantage of enhanced corrosion protection of the tendons, in class PL2 according to fib bulletin 33. In addition to the classic application in internal bonded tendons, the GC stressing anchorage can also be used for external tendons and for cryogenic applications such as post-tensioning of LNG tanks. The GC anchorage is compatible with VSL tendon coupling systems and standard stressing equipment.



NC Anchorage

The NC stressing anchorage is made for 55 strands with 0.6" diameter with an ultimate capacity of 15,345kN (55 strands 150mm²). The anchorage body is built up with three load bearing surfaces for a more gradual load

introduction in the structural concrete and finds its major application in the post-tensioning of nuclear containments. Further units of the same anchorage type are under design to cover other tendon load ranges.

With the V tendon coupler, VSL adds a well-proven coupler, which allows a new tendon to be connected to a tendon that has already been placed in the concrete, but not stressed. This type of movable coupler offers a higher degree of flexibility to construction operations.

VSL has also introduced the S6-1 plus one-strand tendon system with a corrugated plastic duct (PT-PLUS[®] type 22) alongside its four-strand bonded slab post-tensioning system, which uses PT-PLUS[®] type 72/21 corrugated plastic duct. This type of tendon offers an enhanced level of corrosion protection, in addition to the bond achieved by grout injection. ■

Contact: adrian.gnaegi@vsl.com

Formwork Make it short

→ Use of a new VSL formwork traveller design has shortened construction cycles on a pair of new bridges in Malaysia. VSL designed, supplied and installed four pairs of formwork travellers, in which

fixing of the web reinforcement is no longer obstructed by the inner core formwork. This improvement shortened the construction period allowing the main contractor to achieve a seven to eight day cycle, rather than the 10 days initially planned. VSL's works also included prestressing for the bridges over Sungai Danga and Sungai Skudai. The bridges have 165m main spans and were built using the cast-in-situ segmental balanced cantilever method. ■ Contact: ckchong@vsl.com.my



Renewable energy Material savings

→ VSL Australia has been working with Civil & Allied Technical Construction (CATCON) on the design of wind turbine foundations that offer considerable material savings over conventional approaches. The foundations are for 23 Suzlon wind turbines at Tarago in New South Wales, Australia. VSL's works also include the supply and installation of post-tensioning and ground anchors for the 79m-tall turbines, which have a rotor diameter of 88m. VSL Australia has developed both gravity and ground-anchored foundations for the project to suit the differing ground conditions at each turbine location. ■ Contact: mthomason@vsl-australia.com.au

Bonded slab Longest pour



→ **The Lake Hefner Clearwell project** involved the longest application to date of VSL's bonded VSLAB system and crews were part of some of the largest slab pours in the tank industry. Both base and roof pours lasted nearly 24 hours and each consumed about 1,680m³ of concrete. The 152.4m-long slab is part of a 6.7m-high post-tensioned 45.6 million litre tank in Oklahoma. There were several challenges, including designing the walls, columns and roof to accommodate thermal expansion and contraction. ■
Contact: ashaughnessy@vsl.net

Equipment New rig for CWB

→ **Intrafor has secured another diaphragm wall project** in the heart of Hong Kong, where it will be using a specially developed rig. Challenges include contending with busy traffic, buried seawalls and low headroom, for which Intrafor has developed a rig to allow excavation in this restricted space. The Central Wanchai Bypass (CWB) Central Interchange adjoins the CR3 project, which Intrafor has recently completed. The new 21,000m³ project is the continuation of the CWB cut and cover tunnel and runs alongside the IFC building - one of the world's tallest towers. The project is due to start in August and will be completed in 11 months. A BC40 cutter and two excavation cranes will be mobilised for the project. ■
Contact: craig.kurten@vsl-intrafor.com

New markets Modernising Laos

→ **VSL has been at the forefront of introducing new building technologies into Laos**, where hydroelectric and mining projects are leading to rapid economic development. The capital Vientiane is being transformed into a modern city with many new building projects. Working closely with Lao contractors and designers, VSL has introduced the VSL Bonded Slab post-tensioning system to the market. This has brought significant advantages over reinforced concrete. In particular, reduced floor-to-floor heights allow an extra floor to be constructed



within the capital's 26m height limits. Other advantages include larger column-free areas, reduced construction times and reductions in overall construction costs and last but not least the reduction of the CO₂ emission by up to 27%. To date, VSL is working on or has completed nine projects in Vientiane, including the 45,776m² That Luang Trade Center. ■ *Contact: sambat.sermchareonkit@vsl.com*



Awards Scenic setting for PT

→ **The Sun Moon Lake tourist centre won the Taiwan Public Construction Golden Award - Excellent Quality in 2010.** The project is one of Taiwan's most popular scenic spots and VSL carried out the post-tensioning. The designer chose post-tensioning to create long-span arch beams and slabs. VSL provided consultancy at the design stage and also supplied and installed the post-tensioning. ■

Safety first

→ **The AST-VSL Joint Venture building a major bridge in Abu Dhabi** reached a significant safety milestone when two million man hours were accrued without any lost-time accidents. The client awarded the management team an award for excellence in safety to recognise the achievement, which represents more than a working year without incident. The project employs 840 personnel, split between office and site. ■

Second Gateway Bridge win

→ **Brisbane's Gateway Upgrade Project** has been named Australia's best infrastructure project of the year. The €1.55 billion project was presented with the title at Infrastructure Partnerships Australia's National Infrastructure Awards. VSL, in alliance with Abigroup Contractors and Leighton Contractors, built the duplicate of the existing bridge over the Brisbane River. The project also includes 19km of new or upgraded motorway. ■

COVER STORY



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Singapore LNG Terminal on Jurong Island will be the first open-access, multi-user LNG Terminal in Asia.

LNG/LPG CONTAINMENT STRUCTURES

Added value from VSL

VSL has a proven track record in LNG and LPG tank projects throughout the world and its ability to add value is a key factor for successful construction. The latest example in the booming market is the SLNG project in Singapore, one of the world's biggest LNG tank construction sites.

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COVER STORY

Who needs gas?

Today, Japan, South Korea and Taiwan are the leading LNG importers, representing more than two-third of world LNG imports. Indonesia, Malaysia and Algeria have been the leading LNG exporters for the last decade, with Qatar emerging as a major player in recent years.

The world's energy consumption is projected to increase considerably over the next 30 years with fossil fuels continuing to cover the majority of the world's energy needs. Global demand will continue to grow and so countries with a domestic surplus of natural gas will look into solutions to convert it into LNG or into liquefied petroleum gas (LPG). It can then be stored in specially developed storage tanks and shipped to wherever natural gas is required.

When its temperature is lowered to -161°C , natural gas liquefies and occupies just $1/600^{\text{th}}$ of the volume that it does in its gaseous state. Liquefaction thus offers a solution for transporting and storing natural gas in areas far from pipelines. Tankers typically carry between $145,000\text{m}^3$ and more than $200,000\text{m}^3$, which represents roughly the annual energy consumption of 50,000 households. When it reaches its port of destination, the LNG is regasified in special terminals and injected into the gas network.

Long considered only as a by-product, natural gas has become a serious alternative to oil and coal. Demand is increasing and natural gas's future market share is forecast to grow far beyond its current 21%. Before the development of liquefied natural gas (LNG) technology, natural gas could only be transported by pipeline. Gas could not take advantage of that mainstay of the international oil trade – marine transportation. The development of LNG has changed this and the improvements in technology and costs mean that gas is rapidly becoming an internationally traded commodity.

Meeting future demands

Modern LNG tanks are double-walled full containment to avoid any



possibility of spillage due to a failure of the inner steel tank containing the LNG. They typically feature a prestressed concrete outer wall and a high-nickel steel inner tank, with an extremely efficient insulation layer between walls.

Post-tensioned concrete is the ideal solution for providing a safe outer containment structure as it reduces crack width to safeguard against failure (*see box*). As a world specialist of post-tensioning, VSL is a natural partner to bring added value in these demanding projects. VSL is one of the most experienced

specialist contractors in the tank construction industry and has a portfolio of more than 60 reference sites worldwide, spread over the last 30 years, with tailor-made offers and scopes varying from the supply of post-tensioning, PT design, provision of special formwork systems required to construct the structure's walls, the economic Heavy Lifting solutions suitable for raising the tank roof shell prior to concreting, to larger full packages that can include all of the above, together with installation of the passive and PT reinforcement and the concrete. The SLNG project



Jongyeong LNG tank, VSL's works comprise the construction of the tank, supply and operation of the climbform, as well as the supply and installation of 793 tons of internal post-tensioning.

in Singapore with 3 major tanks under construction is among the most recent VSL's projects (see p. 12-13). Meanwhile, the Dabhol Power Corporation in India has recently been a major client, with three tanks for Dabhol 2, two for Dahej and two at Hazira. Other notable projects include PT for a tank in Quintero, Chile, whose 160,000m³ volume makes it the South America's largest, the Fujian LNG and the Shanghai LNG Project phase 1 in China, and the second phase of Korea's Pyeong Teak LNG Project, as well as tanks in Algeria and Poland (see boxes). In-depth

knowledge of containment structures and a strong R&D focus allow VSL to implement continuous improvements and to provide reliable solutions, while always looking for better ways of tackling the particular challenges of each project. The VSL approach is flexible and the range of services is tailored to the specific project requirements. When it comes to repair and maintenance, VSL also provides customers with the specialist advice needed for the rehabilitation, strengthening and

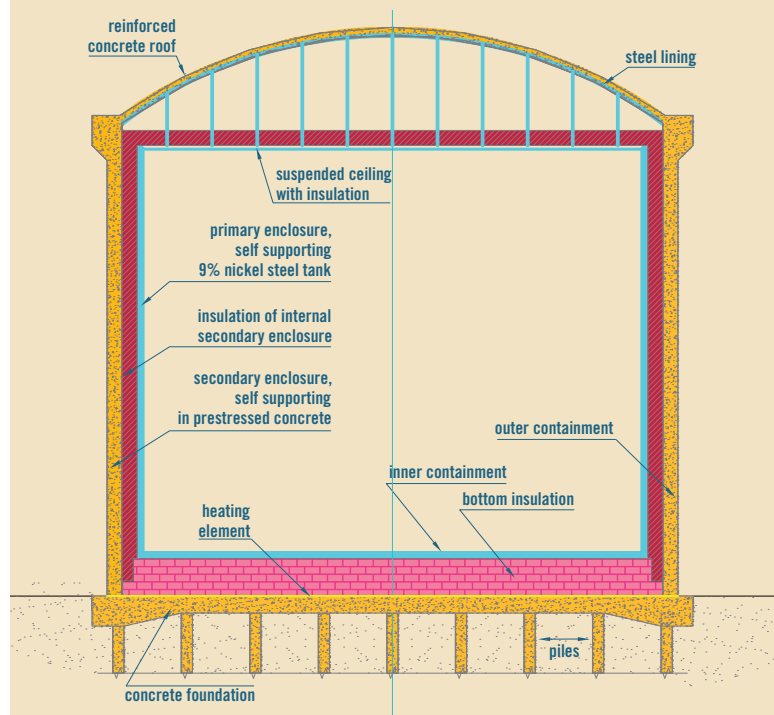


GC 6-19, one of VSL's anchorages used in LNG tanks



Providing safe structural solutions

The inner containment of an LNG/LPG containment structure holds the liquefied gas. If it fails, the outer containment steps in and must prevent gas leakage. The outer containment, which is typically made of post-tensioned concrete, also protects the inner structure from external impacts. Use of post-tensioned reinforced concrete for the secondary containment also allows for a thinner wall than with conventionally reinforced concrete. The reduced crack width achieved with post-tensioning helps make the secondary containment leak-tight in case of failure of the primary containment, as well as providing improved durability against corrosion of the structure. In the extreme case, the concrete and therefore also the prestressing tendons may be subjected to very low temperatures. This means that the prestressing steel and anchorages must withstand very low temperatures.



COVER STORY

protection of concrete structures, with skills in each of the main areas of structural investigation, repair, strengthening and protection.

Ongoing R&D initiatives

Extensive involvement in the construction of LNG containment structures has enabled VSL to develop innovative solutions. One of the latest is the optimised VSL LNG Tank Formwork system. This modular crane-handled system can be used to build the circular containment wall without the need for time-consuming and costly modifications to the formwork during construction especially at the top connection wall-ring area. It minimises typical construction cycles and provides optimised interactions between the various site activities. VSL's engineering

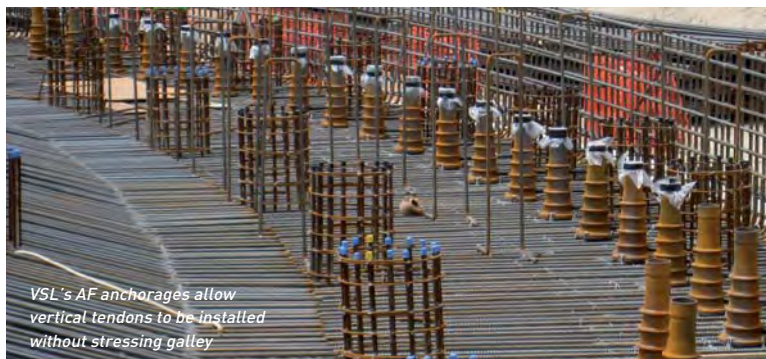
teams cater for the various tank configurations while taking into account the interfaces with other trades to make the overall project easy to build and cost-effective. Safety is also improved as the system allows for completion of the entire concrete tank construction without any major modifications after assembly and commissioning. It provides clear and unobstructed access to all working areas. The set-up is optimised and crane time requirement for formwork movement is kept to the minimum.

AF solves access issues

The AF anchorage is a unique VSL solution for the lower non-stressing anchorage of the vertical tendons (the AF can also be used for inclined tendons) that allows avoiding the need for a specific access such as a tendon gallery at the bottom of the tank structure. When the concrete works are completed at the walls, the strands, added with compression fittings, are threaded one by one from the top into the vertical tendon duct down to the bottom AF cast-iron anchorage. First-stage grouting uses VSL's high-performance AF Anchorage grout with a compressive strength in excess of 100MPa injected in the anchorage to secure the strand ends. The tendon is then stressed and secured normally from the top on its free length before being fully grouted with standard post-tensioning grout. The AF anchorage

POLAND Świnoujście tanks

The contract for the supply and installation of the post-tensioning for new tanks at an LNG terminal in Świnoujście, northwest Poland, was awarded to VSL Polska in early 2011. VSL Polska's client is a joint venture including Saipem, Techint and PBG. Each of the two 160,000m³ tanks has an 80m external diameter and a height of 42m. Installation of the 1,200t of strand, 1,000 GC6-19 anchorages and 200 U6-19 anchorages is expected to be completed in spring 2013.



VSL's AF anchorages allow vertical tendons to be installed without stressing gallery

SINGAPORE

SLNG: full const



VSL's involvement in LNG schemes now goes beyond the supply of post-tensioning and/or the operation of climbform systems. The company is also involved in the full scope of work required for construction of LNG containment structures. The Singapore LNG Terminal Project on Jurong Island includes the first tanks where VSL has expanded its scope to build the complete reinforced concrete structure that forms the outer tank, right from the base slab up to the roof dome. VSL's scope includes the concrete and reinforcement for the base slab, wall and roof dome in addition to the operation of the climbing formwork as well as the supply and installation of the post-tensioning system. The tanks use VSL's AF anchorages instead of the traditional U-loop type. Based on the latest design developments, each tank is fitted with 240 vertical 6-22 tendons and 50 horizontal 6-27 tendons, corresponding to about 800t of strand installed in each structure.

Singapore LNG Corporation Pte Ltd, wholly-owned by the Singapore Government- has awarded the engineering, procurement and construction contract of Singapore's first LNG Terminal to Samsung C&T. Key aspects of this base contract are the design and construction of a primary berth and three storage tanks along with the processing facilities. Kogastech from Korea designed

Construction of a LNG containment



Siteworks on SLNG in Singapore started in September 2010. The overall project is due for completion in 2012.

the LNG tanks. Each tank will have a capacity of 180,000m³, making them among the largest above-ground LNG tanks ever built.

Due to the project's strategic nature, all parties operate an open door policy. The VSL set-up clearly makes the difference. As Malcolm Thomas, construction manager for SLNG puts it: "We have a very good working relationship on site with VSL, they are very cooperative and proactive with regards to the tank civil construction".

Site works started in September 2010 and the two first tanks are being built in parallel. The main construction period will last 14 months

Swallowing five Airbus A380s

The overall volume of each concrete tank approaches 270,000m³ - a size that could comfortably hold five Airbus A380 aircraft - and each LNG tank will have a working capacity of 180,000m³.

- External diameter: 88.2m
- Perimeter: 277m
- Wall height: 40.9m
- Tank total height: 51m
- Wall thickness: 800mm

but overall project duration for VSL's work is 24 months. VSL has started works on the third tank in April 2011.



Health and safety first : warming up before starting the work helps preventing accidents

ALGERIA Arzew tanks coming up



The installation of U-anchorages and the base-slab tendons has marked the start of work by VSL on the Arzew LNG tanks project in Algeria. Strand installation and stressing will take place over the next 16 months for the four storage tanks. In total, 1,546 GC anchorages of sizes 6-12 and 6-19 and 1725t of PC strands will be installed for the post-tensioning works on the tanks, which vary in size from 120,000m³ to 160,000m³. The Italian contractor Bentini working for Saipem is in charge of the construction.

is the ideal alternative to U-loops that transmits the force right to the correct spot at the bottom of the structure, without any dissipation or loss. No access, opening or tendon gallery is required, except vents for the grouting works. The AF anchorage also allows enhancing safety as strands are handled one by one instead as a bundle.

Cryogenic confidence

VSL has successfully tested and confirmed its type E and Gc stressing anchorages for cryogenic applications to ensure that the materials perform as required at extreme temperatures in the unlikely event of an LNG tank's primary containment failure. Owners and general contractors need to ensure that the outer containment can perform under temperatures as low as -160°C. In recent years, VSL has successfully conducted numerous cryogenic



COVER STORY

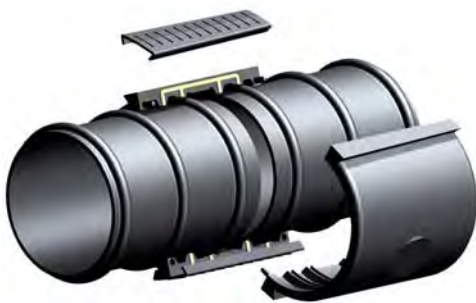


Fit for cryogenic applications:
VSL's anchors tested in the lab.

tests on its E and Gc anchorages initially at the Switzerland's Empa materials science laboratory and subsequently at Daewoo's laboratory in Seoul, Korea, to ensure that they perform as required at these extreme temperatures. In all the tests, the post-tensioning anchorages were exposed to very low cryogenic temperatures by injecting liquid nitrogen at -196°C .

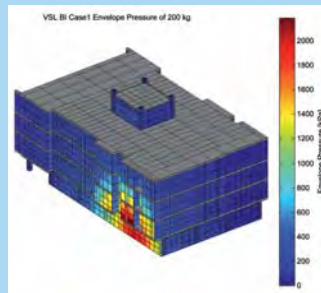
Steel PLUS plastic

The PT-PLUS[®] system is particularly suitable for situations where severe corrosion or high fatigue loading are expected.



In addition to standard steel ducts, VSL supplies its PT-PLUS[®] duct system for enhanced corrosion protection and fatigue resistance of the tendons.

Protecting infrastructure against extreme events



Infrastructure assets such as oil and gas refineries and terminals have an inherent risk of highly dramatic accidental explosions. Protection against such extreme events is essential for associated critical infrastructure, including control rooms. The commitment to safety is particularly well developed in the sector, and VSL can provide blast resilience and upgrade solutions for buildings and boundary controls. The risk of blast effects in the oil and gas infrastructure market can be further increased by the geographic locations of such installations. VSL Infrastructure Protection is a company that combines blast engineering analysis and design expertise with a global specialist construction network. This expertise allows VSL to provide relevant and secure infrastructure protection solutions.

Grout - the finishing touch

The quality of the post-tensioning grout is of utmost importance to ensure durability and performance of the tendons, and thus the safety of an LNG containment structure. VSL's HPI[®] High Performance Injection process is the result of intensive



HPI[®] grout to guarantee the quality of grouting.

research and development works to combine a special grout with stringent on-site testing and installation procedures that aim to improving the quality of grouting activities.

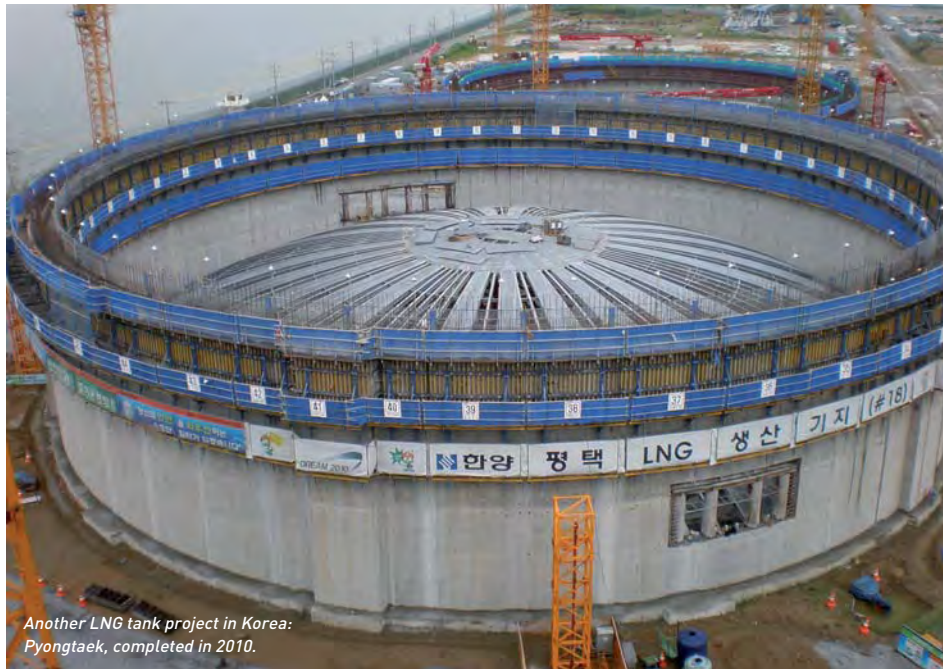
Locally available grout constituents are tested and assessed for their compatibility and an optimised grout is designed from there to meet the project specifications. Alternatively, VSL provides its VSL-HPI[®] high-performance grout mix pre-bagged. It complies with all standard tests for bleed, flow time, strength and volume change. It also meets the stringent requirements of the inclined tube test, wick-induced bleed test, mud balance test and stability of flow time, ensuring a high standard of grout at all times.

Achieving excellence

The VSL Academy training facilities bring together all of VSL's technical expertise in order to equip each trainee with proven knowledge about the company's post-tensioning systems. Three stages of

theoretical and hands-on training are provided, all in accordance with international recommendations for training and qualification of personnel in specialist post-tensioning works. This ensures a consistent approach and encourages the sharing of best practice.

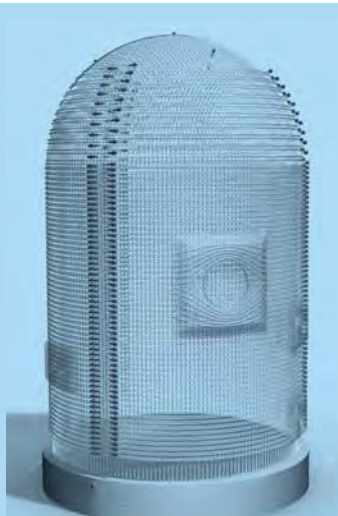
VSL's experience, technical knowledge and continuous development of products and solutions combine to make the difference. Long-term client relationships are testament to VSL's abilities as a reliable project manager. VSL's international network allows for cooperation across the group whenever additional expertise is needed on a project. Big players in the construction of containment structures repeatedly rely on VSL.



Another LNG tank project in Korea: Pyongtaek, completed in 2010.

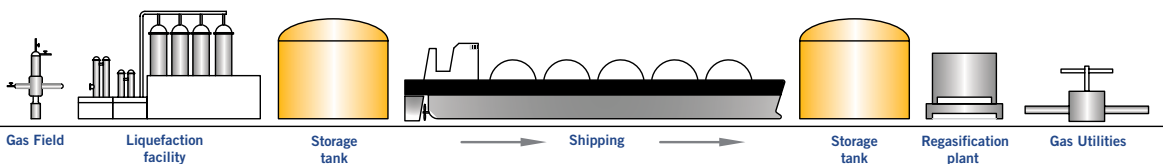
From LNG to nuclear applications

Nuclear containment structures present unique challenges in terms of the required performance, the difficulty of installation, the specialised layout and the size of the tendons. Special designs and methods are essential to meet the extremely stringent requirements for installation and long-term behaviour. Some of the issues encountered in nuclear applications are also met in LNG tanks due to the long circular tendons. VSL's recent R&D activities and involvement in the nuclear field are applied to other containment structures as well, ensuring the highest level of safety and durability at all times.



The best example is the amount of repeat works provided to the main contractor Samsung. After several successful projects in Korea in recent years, VSL is now working with Samsung on the SLNG site in Singapore (see box). "When problems occur, they look for solutions and solve them", says Shin Won Seob, site manager for Samsung C&T on the SLNG project. Bong-Doo Park, responsible for project control at SLNG adds: "We have already worked on several LNG tank projects in Korea with them and our cooperation is very successful. We will definitely recommend increasing VSL's scope in future projects." ■

Today, LNG accounts for nearly a quarter of the international natural gas trade.





Spain

Dramatic stays at Talavera

→ **CTT-Stronghold (VSL Spain) is nearing completion of work** on a project that includes a dramatic cable-stayed bridge over the Tajo River and its approach viaducts. Stays are covered with a deep red external pipe in contrast to the white concrete of the structure. The cable-stayed structure has a free span of 318m supported from a 185m-high inclined pylon by stays up to 410m

long. VSL has supplied and installed 2,000t of stay cable strand and 152 dampers. In total, 466t of PT strand have also been installed, with 1,700 CS 2000 anchorages. The client is Castilla-La Mancha's Department of Civil Works. Engineering is by Estudio AIA and the main contracting joint venture is led by SACYR, working with Aglomancha and J Bárcenas. ■ *Contact: jmartinez@vslsp.com*

Spain and Gibraltar

Terminal success

→ **VSL Spain's recent transport projects have included cruise and bus terminals**, as well as the departure and arrival halls at Murcia and Gibraltar airports. VSL scope has covered both, the post-tensioning specialist works and supply of special systems such as bearing, architectural bar systems and VSoL®.

A post-tensioned solution was chosen for both terminal buildings to allow spans of up to 14m. Dragados built the Gibraltar terminal to Valladares Ingeniería's design and the project was a great success, despite working in an operational airport. The new Murcia terminal – built by SACYR to a Pondio Ingenieros design – was also challenging because of the schedule, which required 40,000m² of slabs to be built in four months. ■ *Contact: posso@vslsp.com*



Spain

Spanning the Ulla river



→ **CTT-Stronghold (VSL Spain)** has recently completed the supply and installation of post-tensioning and temporary stays for a new high-speed rail viaduct over the Ulla River. The 168m main span of the 630m viaduct is formed by a 105m-high stilted arch. Anchorages connected the deck to a temporary abutment

and special SSI 2000 anchorages connect it to the permanent abutment. The cantilevered arch was supported by 24 pairs of temporary stay cables, which had to be adjusted during construction. The work required special stressing tools, hollow jacks and stressing chairs. ■ **Contact:** gislas@vslsp.com

Mexico

Valle Oriente variety

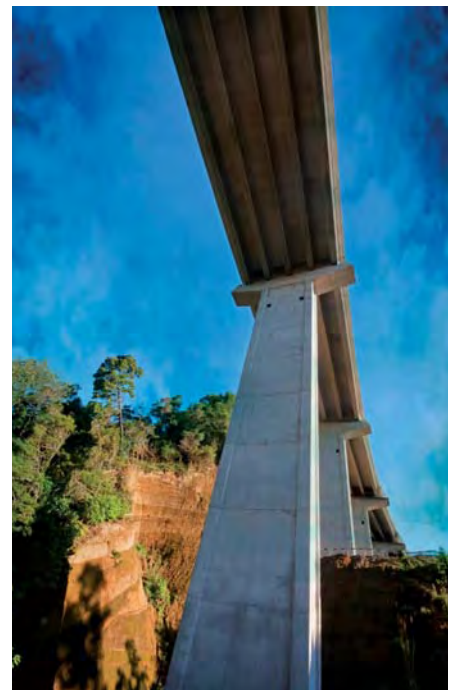
→ **The innovative VAO project at Valle Oriente in San Pedro** includes office, residential and commercial spaces together with a five-star hotel. VSL has been involved recently with the second and third of five phases of the scheme designed by V&FO Arquitectos for developer Internacional de Inversiones. Liu Residences is a post-tensioned 36-storey residential building where VSL has developed the structural design and the post-tensioning for 40,000m² of slabs. The third phase is creating a mixed-use 45-storey building with corporate and residential areas. VSL has been developing the structural engineering and has



recently begun the installation of post-tensioning for 71,000m² of slabs. The fourth and fifth phases are still under development and include a 60-storey mixed-use building. ■ **Contact:** mmartinez@vslmex.com.mx

Portugal

Precasting in the Azores



→ **A consortium of VSL Portugal and precasting specialist Vigbloco** has designed and cast elements for 19 viaducts and 39 overpasses on a new 95km highway being built by Ferrovial in the Azores. The viaduct decks are composed of five I-shaped longitudinal beams. These were installed on temporary bearings, together with precast planks, to support the casting of an in-site concrete slab in a second phase. The overpass cross-section features U-shaped beams and planks. The project's precasting plant produced 406 concrete beams and 50,000m² of planks at an average rate of four beams and 480m² of planks per week. ■ **Contact:** ralmeida@vslsistemas.pt



Spain Viaduct venture

→ A complex three-phase launching operation has taken place in San Sebastian to install a 160m composite bridge weighing 600t over the A-8 motorway for client JV Altuna y Uria – Murais. First step was to jack up the 600t curved viaduct from its

temporary supports before launching it in two phases using VSS skidding equipment and SLU 70 units. Temporary steel towers with jacks were used in controlling the loads and levels at the two piers. ■ Contact: jmmartinez@vslsp.com

Spain Twin tilt at Toledo



→ CTT-Stronghold (VSL Spain) has successfully completed jacking and tilting work to repair a concrete bridge in Toledo. The bridge is composed of two independent decks, each with seven prefabricated 2m-high double-T beams and a top slab. Differential ground subsidence had caused irregular cavities to appear. The client decided that the best solution involved installing new piers, raising each deck with the VSL VerSO® system and adding new crossbeams. ■ Contact: jmmartinez@vslsp.com



USA Bridge's last lift

→ VStructural and VSL have completed the first of two critical lifts for Granite Construction's dismantling of the Old River Bridge over the Mississippi River using VSL's lifting and lowering technology. Traffic now uses a new bridge, which features VSL stay cables. The old bridge has frequently been struck by barges and even survived a plane crash. In a single long shift, VSL used eight SMU 120s to lower its 125m-long 950t main span onto barges, held in the swift current by tugs. ■ Contact: jmctaggart@vsl.net

Germany Hannover's atrium lift

→ The expansion of HDI-Gerling's central office building in Hannover features a remarkable atrium roof that will cover the complete building. VSL executed the roof tensioning operation for client Max Bögl. Four pylons support the 50m by 50m area and tensioning was carried out simultaneously by 56 lifting units placed around the edges. The operation pulled the edge columns into position, enabling installation of 20t of glass façade. ■ Contact: robert.moger@vsl.com



Poland

Ready for kick-off

(photo courtesy of designer Schlaich Bergermann & Partner)



→ **Poland's New National Stadium in Warsaw** will play an important part in the 2012 UEFA European Football Championship, accommodating 56,000 spectators underneath a cable-net and membrane roof system. The roof structure features 144 radial cables

together with two tension rings and a stunning central spire. VSL was commissioned to install 148 jacks for the erection of the cable net roof structure. Erection was in two stages - cable lifting followed by tensioning. The stadium opens later this year. ■
Contact: lars.schoenlein@vsl.com

NOTE PAD

St Petersburg aqueduct. VSL has been awarded the stay cable works on the Petrokom Stay Bridge, which will carry two 2m-diameter water pipes. The 130m main span is supported from an inclined pylon by five pairs of SSI 2000 stays, and one pair for the back span.

Stays for Kirovskiy. VSL has been awarded by Volgospetsstroy the contract for stay cable design, component & equipment supply and technical assistance for the Kirovskiy bridge in Russia. The stay cables will be installed in a symmetric fan configuration. VSL will supply and install 56 SSI 2000 stays.

Dozens of decks. VSL is carrying out post-tensioning works for a project on the A4 highway in southeast Poland. The project requires post-tensioning for 36 bridge decks built on falsework. The largest viaduct will contain 1,200t of post-tensioning. In total, VSL will install 2,700t of strands, 2,000 GC anchorages and 430 GCK couplers.

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Spain

High-speed launch



→ **CTT-Stronghold (VSL in Spain)** has successfully launched a composite viaduct over the Verdugo River for Spain's high-

speed rail network. The viaduct is curved in plan with a total length of 120m and the total weight launched was 950t. It was built up

on temporary steel supports and launched in two phases using the VSS 500 skidding system. ■
Contact: jmmartinez@vslsp.com



Switzerland

Slope on the water

→ **Switzerland's A9 highway links Lausanne to Villeneuve** and about 30km runs along the shores of Lake Geneva. Steep slopes, deep ravines and spurs have dictated the construction of major viaducts,

bridges, tunnels and retaining walls. The lake section built in 1974 now needs major upgrades to meet today's safety and environmental standards. VSL has been appointed to supply and install anchors for a

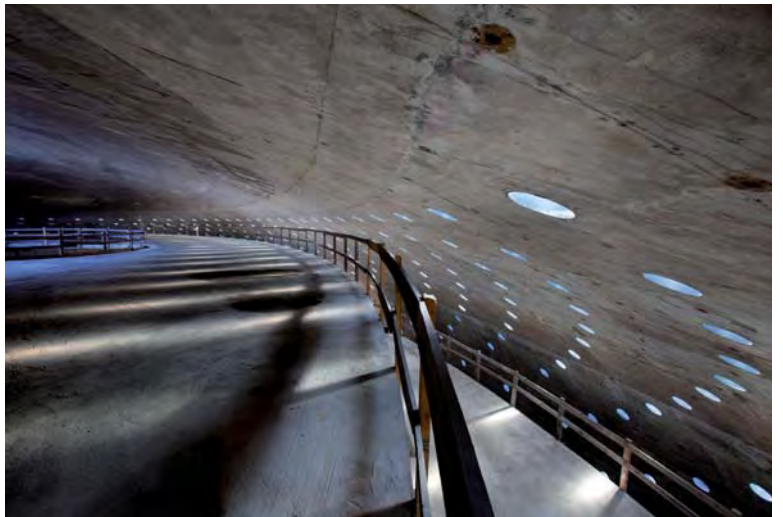
293m-long wall that stabilises slopes beneath the highway. Anchor installation began last year and the second phase is under way to install the remaining 54 anchors. ■ *Contact: christophe.candolfi@vsl.com*

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Switzerland

Thin eggshell

→ **The new Il Diamante de Chasso shopping mall** features the technically impressive feat of a huge but extremely thin concrete shell. The egg-shaped structure stands 22.5m high and has a width of 52m and length of 92m, with no intermediate columns. Its walls are just 100mm to 120mm thick. The shell's sloping zones are made from shotcrete, accounting for about 70% of the surface, while the rest of the structure is of poured concrete. VSL's post-tensioned cables are installed at the shell's median level, to withstand the hoop forces generated by the above structure working as a vault. ■ *Contact: Hannes.mueller@vsl.com*



Czech Republic

Historic renovation



→ The Forum Nova Karolina shopping and entertainment centre is a key aspect of an

extensive project to renovate part of Ostrava's historic district. Two L-shaped buildings together form a square, five-storey complex of offices and shops. The structure was designed with post-tensioned slabs using the four-strand system in a flat duct with SO 6-4 and H 6-4 anchorages. Multistrand cables and EC anchorages were installed in the beams, typically of 15m span. The VSL ADAPT system was used to control the stressing of the 117t of prestressing steel. The building's main contractor was Gemo Olomouc and the design was by PPP. ■ *Contact: pvanek@vsl.cz*

Qatar

Banking on PT



→ VSL Middle East continues its long history of challenging projects in Qatar with a contract for the new International Islamic Bank (IIB) headquarters and commercial tower. Work is currently about 50% complete. In 2009, Haman Bin Khalid Contracting awarded VSL Middle East the contract for the design, supply and supervision of post-

tensioning for 30,000m² of PT slabs. The project consultant is DARA, while Hyder Consulting is independent consultant for the PT works. The IIB headquarters building consists of 44 post-tensioned floors above basement, ground floor and mezzanine levels. Work began on site in October and is currently at level 29. ■ *Contact: a.dodds@vslme.ae*



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Switzerland

Writers' retreat

→ Six writers' 'cabins' will be attached to the canopy of Switzerland's Maison de l'Ecriture in Montricher, whose design resembles a honeycomb with 270 cells. The 400mm-thick canopy will have a 4,500m² surface area and will be supported by 96 pillars, which are between 9m and 18m high. The structure has been built with traditional reinforced concrete as well as non post-tensioned strands 1/4" and post-tensioned strands 0.6". In addition to the post-tensioning, VSL provided seven sliding neoprene bearings, which were required for part of the canopy. Post-tensioning has allowed two 12m-high buildings to be anchored to the ground in a column-free zone. ■ *Contact: christophe.candolfi@vsl.com*



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Australia Precast advantage

→ **Use of precast pier construction on Melbourne's 38km M80 Ring Road Upgrade** has allowed each pier to be erected in a single night shift, requiring only short, off-peak lane closures. The other major benefit is that the piers are cast indoors, unaffected by inclement weather. Conventional in-situ methods would have required long-term lane closures.

Work is being carried out by the Tulla Sydney Alliance, consisting of VicRoads, Thiess, Parsons Brinckerhoff and Hyder. VSL's sub-contract covered the supply of the precast and the supply and installation of pier post-tensioning, involving 69 pier segments and 28 crossheads. ■ **Contact:** jmckenzie@vsl-australia.com.au

Hong Kong

Truss for TKO



→ **VSL has designed a modular truss system** to erect the TKO Bridge, whose deck is supported on arch piers that cantilever 10m from the pile cap. The system will be first used to build the arch supports before being modified and repositioned for use in lifting the 1,600t deck. The truss system was pre-assembled on land in two sections weighing 30t and 70t, before being transported by barge and installed in March. ■ **Contact:** Lewis.wong@vsl-intrafor.com

Australia

Hunter alliance

→ **VSL Australia has formed a sub-alliance with Thiess** for the construction of three viaducts on the F11 Hunter Expressway. The viaducts will be built using the balanced cantilever method. The scope for VSL includes modification of the launching girder used on the Gateway Upgrade Project and the design, set-up and operation of the precast moulds for the 564 segments. The sub-alliance is also supplying and erecting the precast concrete columns. The design of the precast moulds is nearing completion and the erection of deck segments is due to start in late August, with project completion scheduled for November 2012. ■ **Contact:** ccalder@vsl-australia.com.au



Malaysia

No impact on traffic

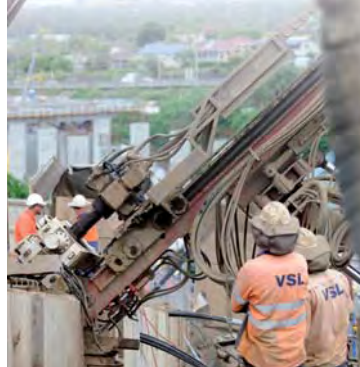
→ Kuala Lumpur City Hall adopted a fully precast solution for the Bangsar flyovers and VSL has worked in joint venture with a local contractor for the precasting and erection works. A total of 10 columns and 158 box girder segments were erected, using the free cantilever method for the deck. Day-time traffic disruption had to be minimised and so precast components were erected only at night. VSL's method required a width of just 4m, mitigating the impact on traffic. ■ **Contact:** ckchong@vsl.com.my

Australia

Anchors for Banora

→ Ground anchors are an important feature of the Pacific Highway bypass, where VSL was awarded a sub-contract by the Banora Point Upgrade Alliance, which is made up of Abigroup Contractors, Seymour White, RTA and SMEC. One of the main portions of work is the excavation of Sextons Hill to depths up to 18m. VSL's sub-contract covers supply and installation of permanent ground anchors, drainage and soil nails. The 434 anchors involve a total drilled length of 9,500m. VSL started the permanent works in January. ■

Contact: ghoesman@vsl-australia.com.au



NOTE PAD

Dolsan delivery. VSL Korea's scope on the cable-stayed Second Dolsan Bridge included deck construction, post-tensioning and stay cable supply and installation. VSL carried out tasks including the design of the form traveller and analysis for superstructure construction. The 230m main span was completed end 2010.

Cutting curves. The Anthony's Cutting project involves realigning 5km of highway to avoid steep inclines and tight curves. It is being undertaken by an alliance made up of VicRoads, John Holland and Aecom. VSL's sub-contract covers supply and post-tensioning of 102 pier segments. Precasting ensures speedier construction and enhances safety by reducing working at height.

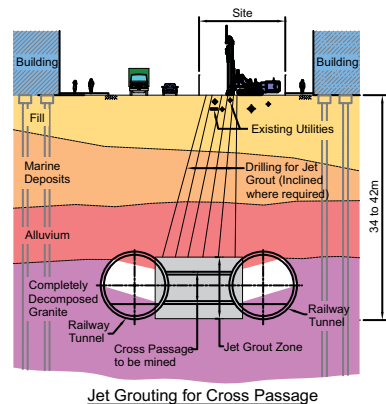
Saima overpass. North of Bangkok, the Department of Rural Roads designed an overpass to reduce traffic congestion at the Saima junction in Nontaburi Province. Main contractor Thaiwat Highways Engineering awarded VSL a sub-contract for 210t of post-tensioning. Completion is scheduled for July 2011.

Hong Kong

Beating granite

→ Dragages-Bouygues JV awarded Intrafor a contract to build diaphragm walls and carry out ground treatment works for a complex MTRC contract covering a section of Hong Kong's Express Rail Link project. Intrafor will be in charge of a wide range work for ground treatment to allow underground works and to limit the effects of tunnelling works as close as 1m to existing structures. Techniques include jet and rock

fissure grouting. Extensive utilities make drilling a challenge. Twin-bore tunnels are being excavated running 1.15km north and 2.4km south of a TBM launching shaft. Intrafor is also building the shaft, made of a 44m-deep diaphragm wall with a total excavation volume of 21,000m³. Ground conditions are difficult due to the presence of a concrete seawall founded on a rockfill bund with underlying granite. ■ **Contact:** olivier.haye@vsl-intrafor.com





Taiwan

Unusual design

→ **Ocean Grand in Taipei is a 15-storey residential building** featuring wave-shaped balconies, which have repeating shapes on alternate floors. The developer Da-In and the main contractor Continent Engineering Corporation both appreciated VSL's post-tensioned solution, which enabled this unusual design to become reality. Post-tensioning allowed cantilevers of up to 4.75m,

satisfying both structural safety and architectural objectives. VSL provided the post-tensioning design, materials and installation for the balcony slabs. The project uses the VSL S-5 slab bonded post-tensioned system anchorage for a total slab area of 13,000m². Since its completion in October 2010, Ocean Grand has become a landmark on the bank of the Dan-Sui River. ■ *Contact: jesse.chen@vsl.com*



Thailand

Expert advice

→ **VSL Thailand has been working on the reconstruction of Bangkok's Central World Shopping Centre** and Big C Ratchadamri mall, which were both damaged by arson attacks in last year's civil unrest. VSL provided expert post-tensioning advice during inspections of the fire-damaged structures, followed by cutting and re-anchoring of unbonded post-tensioning to allow safe demolition of slabs damaged beyond repair. In addition, sections of damaged floor slabs were rebuilt using the VSL Bonded Slab post-tensioning system. Both shopping centres have partially reopened, with full reopening expected this year. ■ *Contact: sombat.sermchareonkit@vsl.com*



Taiwan

Cable stayed and bascule

→ **Stay cable installation work was carried out** end 2010 for a combined cable-stayed and bascule bridge that will become a landmark at DaPeng Bay, Taiwan's largest lagoon and a national leisure area. The crossing of the lagoon's mouth features Taiwan's first bascule

bridge and its cable-stayed section has a 72.9m-high pylon designed to resemble a ship's sail. VSL Taiwan carried out the stay cable sub-contract, fitting a total of 20 stay cables. ■ *Contact: Jack.tsai@vsl.com*

South Korea

Fixing links

→ VSL has been extensively involved in the **Busan-Geoje Fixed Link project**, an 8.2km route linking Busan and the island of Geoje. The project includes 3.2km of immersed tunnel - for which VSL Korea carried out the precasting and construction – and two cable-stayed bridges. Bridge 1 has a three pylon arrangement with two 230m-long main spans and two 106m side spans. VSL Korea supplied and installed the stays, temporary stays and dampers and concrete panels. The composite



deck is made up of steel grillage and concrete panels with in-situ stitches. SSI 2000 stay cables of up to 6-55 were used, with lengths between 32m and 124m. VSL's technical centre in Asia worked on the choice of stay cables and installation method, as well as

dampers assessment, design and detailing. VSL friction dampers and Gensui dampers were installed following deck closure and fine tuning of the stays. The official opening took place in mid-December 2010. ■ **Contact:** whkang@vslkorea.co.kr



Thailand

Lines engaged with MRT

→ VSL and Intrafor's work on the **extension of the Bangkok MRT** continues a long history, which has seen them involved in every line so far. Main contractors Ch Karnchang and Sino Thai Engineering & Construction awarded VSL (Thailand) the external post-tensioning for the Purple Line's entire 14km length of precast concrete viaduct. VSL was also awarded a further 2,000t of internal post-tensioning, including

the AF-anchorage for vertical post-tensioning in the columns. In addition, VSL will carry out 5km of segment erection using its own gantry and will provide and operate a form traveller for a 70m-span bridge. Furthermore, VSL is supplying and installing 333t of post-tensioning for a balanced cantilever bridge for the State Railway's Red Line project. ■ **Contact:** sombat.sermchareonkit@vsl.com

Thailand

Roundabout overpass

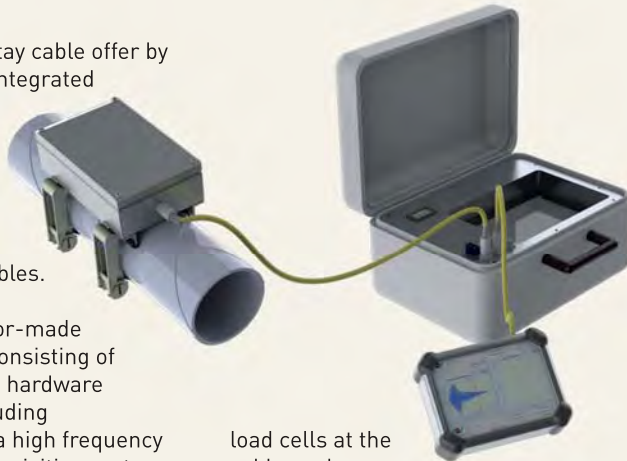
→ **Laksi Monument roundabout** is one of the most congested roundabouts in Bangkok. Even though a north-south tunnel was built a few years ago, Department of Highways has decided to construct an east-west overpass. Siam C Bridge was appointed as the contractor to build the segmental box girder structure and VSL was awarded a contract for supply and installation of 325t of post-tensioning. The project started in October 2010 and completion is scheduled for October 2011. ■ **Contact:** shaun.iles@vsl.com



STAY CABLES

In-situ performance analysis

VSL extends its stay cable offer by providing a fully integrated and compact analysis system based on in-situ evaluation of the vibration behaviour of individual stay cables.



Vibratest is a tailor-made monitoring unit consisting of custom-designed hardware components including accelerometers, a high frequency sampling data acquisition system and a robust computer with a graphical user interface. The system allows performing automatic data processing and analyses on-demand as well as generating measurement reports on the spot. The sensors are housed in a robust and fully encapsulated casing attached to the cable at a certain distance from the anchorage. All other electronic parts are integrated in a rugged carry-case including batteries for a completely flexible deployment during measurement campaigns.

Vibratest is a multi-functional system, offering a wide range of applications

- Monitoring of the stay cable tension on site during the construction phase avoiding the need for labour intensive tension measurements by jacking of the anchorage (lift-off) or the installation of permanent or temporary load cells.
- Tension monitoring after bridge completion during the maintenance phase as part of regular inspection operations without the requirement to install

load cells at the cable anchorages

- Damping performance assessment by determining the vibration behaviour of a cable with and without dampers. This allows the validation of the performance of an individual damper. The operating principle is based on the measurement of the cable's acceleration and subsequent processing of the signal according to different algorithms. By measuring the ambient vibration occurring on the cable due to continuous external effects like traffic or wind, Vibratest detects the tension with an accuracy in the range of the one obtained by force measurement using a hydraulic jack at the anchorage (lift-off). For evaluation of the damping characteristics, the cable is initially excited and Vibratest measures the cable's free response over time.

Vibratest is a complimentary offer to VSL's state-of-the-art SSI-2000 stay cable system with its Friction and Gensui Dampers, but can also be applied as part of an inspection and maintenance programme. VSL can assist its clients in the systematic planning of maintenance operations, the

implementation of inspection and maintenance plans as well as the performance of measurement campaigns and the subsequent evaluation of the obtained data. ■

In the field

Vibratest has been successfully applied for damper performance estimation on a number of projects.

Incheon Bridge - South Korea



Vibratest analysis performed on a landmark project

Incheon Bridge in South Korea, with its 800m long main span has been equipped with 192 VSL dampers. Part of the VSL scope was the assessment of the dampers' performance in-situ. The Vibratest analysis software has been applied to validate the damping characteristics against the specified requirements.

The results of the measurements have been presented at the fib (International Federation for Structural Concrete) convention in Washington 2010.

Luling Bridge - Louisiana, USA



Easy to use integrated system for accurate analysis

Vibratest has been used for the in-situ measurement and damping analysis on Luling Bridge. Cross analyses performed by external experts confirmed the accuracy of the measurements.

POST-TENSIONING SYSTEMS

Slab system to be born

The VSLAB® S-Series will become the latest member of VSL's anchorage family complying with ETAG 013 offering an interesting new alternative in the slab market. Launch is planned mid 2011.

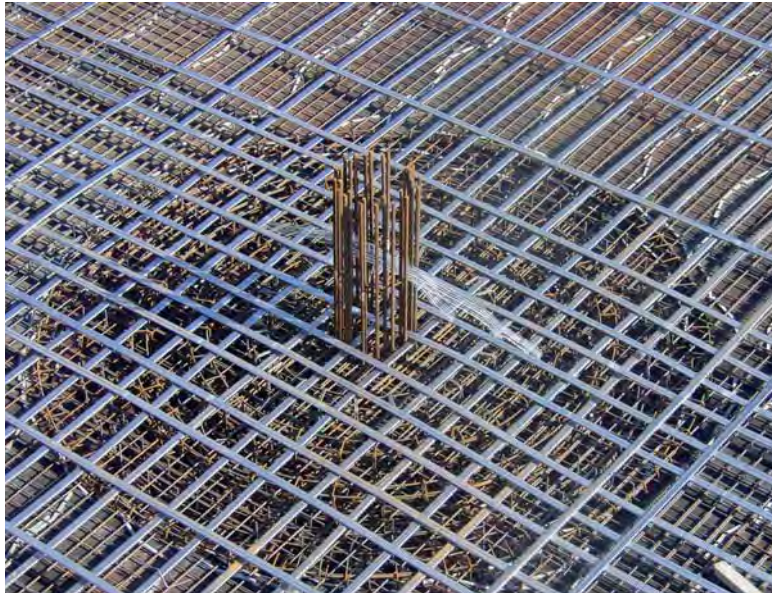


The improved constructability of post-tensioned slabs, the overall savings on materials and formwork systems due to more slender elements as well as accelerated construction cycles combined with larger spans and wider support column grids are the key success factors of modern post-tensioned floors in buildings. Enhanced durability due to crack control and a significant reduction in carbon emissions by drastically reducing the volume of concrete and reinforcing steel are becoming ever more important additional benefits in today's sustainable construction environment.

Modern quality requirements

Only the use of efficient and durable post-tensioning components designed to the latest quality requirements can ensure that owners, clients and users are getting the best value for their project.

Historically, regional preferences, codes and acceptance of different construction methods have led to a wide variety of anchorage and ducting systems used in slab construction around the world. As a result, the slab market has seen over time the appearance of a number of low grade components. Based on current knowledge and state-of-the-art, which are the result of continuous research & development in the post-tensioning industry, many of these systems have to be considered as incompatible with modern quality requirements jeopardizing the durability of a structure and resulting in a shorter service life and increased life-cycle costs.



VSL post-tensioning technology: a cost effective and elegant solution to tackle the challenges of modern construction.

Nowadays, modern and internationally applicable codes, guidelines and recommendations are available to assist owners, designers and post-tensioning specialists in specifying suitable systems for an enhanced performance. One of the most advanced documents in that respect is the European Technical Approval Guideline ETAG 013 integrating the know-how of numerous other international documents. VSL had early-on identified the need for enhanced systems in the building sector and its continuous development of the slab post-tensioning technology has also been at the origin of the creation of a new anchorage series which is currently undergoing extensive testing to ensure its compliance with the most stringent quality requirements.

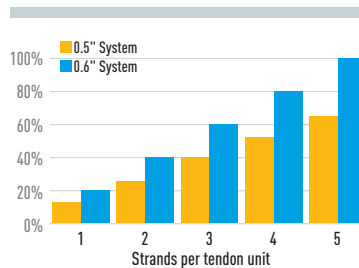
Introducing the VSLAB® S-Series

The new VSLAB® S-Series is a slab post-tensioning system based on 0.6-inch strand technology consisting of end anchorages and couplers combined with a flat duct for use in slender slab elements. The availability of tendon sizes S6-1, S6-2, S6-3, S6-4 and S6-5 with ultimate capacities between 260kN and 1,395kN allows a stepless selection of the required tendon force and spacing. Strand grades can be varied according to local availability in line with all commonly applicable standards. The S-Series has been detailed for maximum efficiency by minimizing friction losses. While its block-out size is designed to be integrated in the thinnest slabs it still allows early stressing for accelerated construction cycles. The 'slap-on'

principle (installation of the anchorage after casting of the concrete) offers major advantages to contractors by separating the critical paths of concreting and post-tensioning while at the same time minimizing finishing works. Grout caps are available as an optional accessory further enhancing the durability of the system by providing maximum protection against aggressive environmental agents.

By extending its range of slab anchorage units to all intermediate tendon sizes between one and five strands, VSL's 0.6-inch system offers a highly efficient alternative to existing 0.5-inch systems still in use in some areas. The application of a stepless 0.6-inch anchorage series provides vast productivity gains and hence significantly accelerates installation cycles.

The new VSLAB® S-Series can be used in combination with flat steel ducts or with VSL's proprietary PT-Plus® plastic ducts providing reduced friction during stressing and enhanced corrosion protection. ■



*Productivity of duct and anchorage installation
For the same amount of pre-stressing the use of 0.6-inch strand and larger anchorage units allows major savings on cycle times*



The new VSLAB® S-Series is a slab post-tensioning system based on 0.6-inch strand technology consisting of end anchorages and couplers combined with a flat duct for use in slender slab elements.

VSLAB® in the lab

The new VSLAB® S-Series is designed to comply with the requirements of the European Technical Approval Guideline ETAG 013:

- **Resistance to static load**

The system must withstand a specified percentage of the strands ultimate capacity without premature failure.



- **Resistance to fatigue loading**

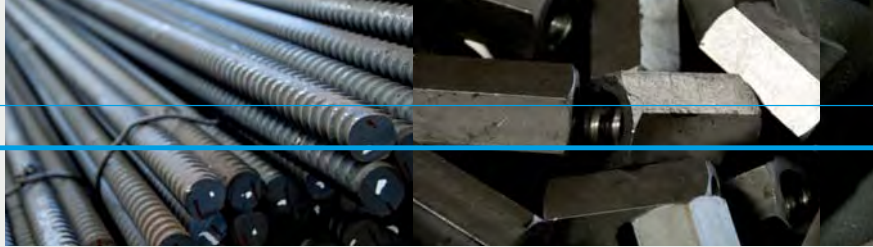
The tendon must withstand dynamic loading without exceeding a specified allowable loss of cross section.

- **Load transfer to the structure**

Anchorage and local zone reinforcement must be able to transfer a specified percentage of the tendon's ultimate strength to the concrete without undue cracking of the structure.



The new VSLAB® S-Series has moved a step closer to market introduction with the successful completion of testing according to FDOT (Florida Department of Transportation) requirements.



BARS

“Quality is now considered m



Stahlwerk Annahütte is world leader in the threadbar business with the market’s largest product range. Peter Meyer, CEO, comments for VSL News Magazine the business opportunities and challenges of the bar industry.

Where does Stahlwerk Annahütte stand?

Stahlwerk Annahütte (SAH) is the world number one in the production of hot rolled threaded steel bars. We have our own subsidiaries but also market our products via sales partners. We have – and this is a particular strength of ours – successfully applied for the different approvals required in design offices and on construction sites around the world.

We produce two product ranges: SAS Threadbars and SBQ bars. The SBQ bars are primarily used in the automotive industry. We provide the construction and civil engineering industries with our SAS threadbars. We roll a continuous thread along the whole length during manufacturing, so the bar can be cut to any length and coupled for specific requirements. Applications are limitless – we adapt to our clients’ requests. Diameters vary from 12mm-75mm, with steel grades ranging from a low 500 to a high 950 – 1050, used for post-tensioning applications. The threadbar systems are suitable for all kinds of applications: reinforcements, post-tensioning, geotechnical applications, mining and tunnelling, marine ties and formwork ties. Our forecast output

for 2011 is 70,000t, a figure that is likely to go up in the coming years. In addition, we also provide accessories, couplers, end anchorages, nuts and plates.

SAH’s growth rates are impressive, what are the reasons?

The first reason is that we produce high-quality products. Even in so-called low-wage countries, quality becomes more and more important. Frequently, we notice that quality is now considered more decisive than the price. German products are considered high quality and innovative. Clients

should never lose time and money because of bad quality of the parts. SAH’s competitors have difficulties in keeping to these quality levels.

How do you see the immediate future?

Countries such as China, India, Indonesia and the South-American continent are upgrading their infrastructure at an impressive speed. We are looking into the mining industry in Australia. We have products that are particularly well suited to mining applications, including fully grouted anchors, resin anchors and expansion shell anchors.



The stock of bars at the warehouse of VSL Middle East in Dubai allows to keep the lead time to a minimum



ore decisive than the price”

What is your relationship with VSL?

SAH is a system provider; we not only supply parts, but also complete solutions for technical engineering professionals throughout the world. We run our own sales offices in areas where our clients and partners, such as VSL, are not represented. We have close ties to VSL in regions such as the Middle East and Singapore, where we have joint venture agreements.

How do you innovate?

Originally, threadbars were used as post-tensioning elements in bridges. The surface of the product itself has not changed much during the last 50 years. At the beginning, there were only three different diameters; today we have broadened these ranges. Our innovations are in new applications, developed together with our clients. Our strength is to come up with innovations in applications and new products. We team up with the best in the field and come up with what's best for the end client and the project. We cooperate with the market leaders to develop new concepts. Also, SAH strives to achieve value-added sales with real partners, not mere resellers. We have worked hard to reach our position and we need to extend our economic lead and increase our distribution and sales network. To do so, we rely on market leaders that will not only buy and resell, but also develop with us new applications that confirm our business position. This interaction is very important for all parties involved.

Hot or cold?

VSL offers a wide range of hot-rolled and cold-rolled products. The VSL Bar system is used for soil nails, rock bolts, micropiles and similar applications. The corrosion protection depends on the required service life, the consequences of failure of a group of anchors and on prevailing environmental conditions. VSL provides a full range of protection options to meet project requirements and all comply with international regulations.

Is this always achieved through partnerships?

Partnerships can have different forms. In Switzerland, for instance, VSL is market leader in the threadbar business. We wanted to reinforce this strong position by creating a dedicated entity. VAS is a 70:30-owned company that demonstrates the cooperation between VSL and SAH and has brought together expertise from both companies. We have joint venture agreements in the Middle East and Asia, where VSL already has a presence and is a preferred partner. Sometimes, we opt for simple cooperation, as in Germany.

What makes you feel close to VSL?

VSL is market leader in technical engineering and develops innovative solutions worldwide which are always creative and technically challenging - they think out of the box. VSL is working throughout the world; this is what we aim to do, too. We speak the same language and understand each other. Our cooperation has been successful for more than

15 years now, our approaches are similar and our relationship is marked by respect and understanding. Neither VSL nor SAH provides low-quality, low-cost products and solutions. The ongoing exchange of ideas and communication between us helps us to create new potential applications and markets with a reliable long-term partner. ■

Made in Germany

The history of Stahlwerk Annahütte goes back to 1537, almost 475 years ago, when Prince-Archbishop of Salzburg, filed a decree of foundation. Stahlwerk Annahütte has been in production ever since and is the oldest steelworks in Europe, with three production facilities for accessories in Germany, in Slovakia and in Romania that follow stringent quality control and assurance procedures. It was taken over by Max Aicher group in 1975. Stahlwerk Annahütte supplies its customised steel bars to the automotive, tool and construction industries, always providing 'Made in Germany' quality for any application.



TECH SHOW

NEWMARKET VIADUCT REPLACEMENT PROJECT

Staged success

The Newmarket Viaduct Replacement project combines staged construction with deconstruction of the existing viaduct in the heart of Auckland, New Zealand. The staged approach allows the motorway to remain open to traffic throughout the project. This is the first time a bridge of this size has been taken apart in this way and VSL is part of the project alliance.



1 Start with creating the new southbound structure

Works started at the end of 2008. The first of 468 segments were cast in early May.

At the same time, substructure works started with the foundation and the piers. Half of the piers are built on pad footings and the remainder on piles and pile caps.



2 Erect the pier segment, commission gantry and launch the new southbound

The pier segment shells are delivered from the precast yard about 25km south of the viaduct and erected on top of the first two piers. The reinforcement is then fixed and the pier segment diaphragm is cast in-situ. During November 2009, the first two balanced cantilevers, consisting of 20 segments each, were erected by cranes and connected at the centre span with a cast in-situ closure pour. Completion of this 120m-long deck allowed assembly of the launching gantry, followed by commissioning and load testing. The gantry carried out segment erection from February to July 2010, ready for installation of the edge barriers, drainage, road lighting and pavement. The launching gantry was then moved away from the new structure during an 18 hour switchover, allowing the new southbound carriageway to open to traffic on 4 September 2010.

Construction sequence



Old southbound Old northbound



New southbound Old southbound Old northbound



New southbound Old southbound Old northbound



New southbound Old southbound Old northbound

3 Beware of traffic and cut out the old southbound carefully

The redundant southbound structure could not simply be torn down as no traffic interruptions during the project were allowed. Instead, it needed to be deconstructed segment by segment. Extensive temporary works and propping were required to assure the stability of the existing southbound and northbound carriageways throughout the duration of the works.



4 Engage VSL jacks for the mid-span closure stitch, lower the segments

Temporary works to support the mid-span closure stitch were installed on top of the deck. The mid-span segment was cut using diamond wire cutting equipment so that the VSL strand jacks installed on the stitching beams could be engaged, allowing the mid-span closure stitch segment to be lowered to the ground. The gantry used to build the new southbound bridge was then operated to deconstruct the rest of the cantilever. The same launching gantry - today almost a landmark in Auckland - had already been used on Hong Kong's Deep Link Bay and on the Waiwera project, just an hour down the road from Auckland.



New southbound Old southbound Old northbound



New southbound New northbound Old northbound



New southbound New northbound Old northbound



New southbound New northbound



5 **Organise separation**
Extensive non destructive and destructive investigation works were carried out on the existing structure to verify and confirm the design assumptions. This work had to be completed before deconstruction was allowed to start. During deconstruction, the main focus was on load monitoring, using strain gauges installed on the temporary works. Steel brackets and transverse propping were installed to allow separation of the old southbound and northbound sections. Installation of longitudinal propping and a shield beam enabled segment removal by launching gantry.



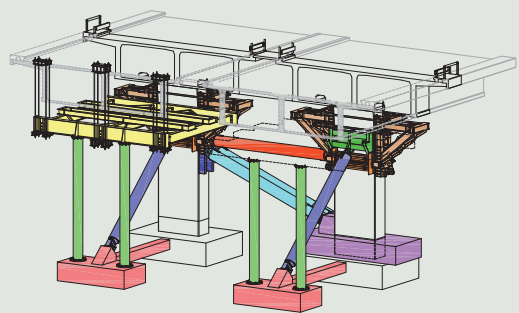
6 **Recycle the viaduct**
One of the most important aspects of the project is that the old structure will be completely recycled. Segments are torn apart, concrete and steel are separated; the gravel will be reused for road construction works and the steel recycled, too.





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Temporary works – steel brackets, transverse propping, shield beam – were massive on this challenging project. The overall project scope consists of: construction of a new viaduct, deconstruction of the existing viaduct, realignment of on- and off-ramps, the Mt Hobson Road noise wall, landscaping and the replacement of Dilworth Footbridge. The 160,000 vehicles a day crossing the Newmarket Viaduct in the heart of Auckland make it one of the busiest sections of New Zealand's motorway network. Built in the mid-sixties, the Newmarket Viaduct was New Zealand's first balanced cantilever cast-in-situ bridge. Increased traffic volumes and insufficient earthquake resistance have now taken their toll. In November 2008, the NGA Newmarket Alliance was awarded the contract to deliver the Newmarket Viaduct Replacement Project by December 2012. VSL is part of the Alliance in charge of this; the other partners include the client, New Zealand Transport Agency (NZTA) together with Leighton Contractors and Fulton Hogan on the construction side and, for the design, Beca, URS New Zealand, Tonkin & Taylor and Boffa Miskell.



Existing viaduct - temporary works



Following Maori tradition

A volcanic stone worked into the shape of an axe was cast into the first foundation and the bridge received Maori blessings.

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