

VSL*neuus*

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Cover photo: Blast contours on a compound















Services for a changing world

There is no doubt that companies and society in general are facing significant challenges. And while there is no one solution, many of the challenges can be tackled by innovation backed by engineering expertise. VSL's innovative approach is not limited to developing new technical solutions for today's construction industry. We also thrive on new approaches to business that allow us to make best use of our expertise when developing high-profile projects that truly serve our clients. Our portfolio of services is expanding beyond the technical challenges of projects such as the award-winning deconstruction and reconstruction of the Newmarket Viaduct in New Zealand. Requests for turnkey services that offer clients a total solution are becoming more common. The recently created VSL Infrastructure Protection business capitalises on VSL's core areas of expertise while at the same time extending the scope to provide comprehensive safeguarding of critical assets.

As times change and the needs of clients develop, so too must we anticipate the changes ahead in order to ensure that we continue to lead the way in the range and nature of the services we offer. Achieving the best for the project means combining the best methods with the best approaches. Whether you require construction or services – or both in a turnkey solution – our dedication to your projects remains the same. Just let us know what you need.



Daniel Rigout, Chairman and Chief Executive Officer

business improvement

Getting the point across



ooking after health and safety is a top priority for VSL, neatly summed up by its motto 'safe - around the world - around the clock'. Safety has to be an integral part of operations as VSL deals with the most challenging of construction activities and working environments. The task of ensuring the excellent standards that VSL, clients and employees expect is a complex, multi-faceted one ranging from technical measures that mitigate risks through to procedures and equipment to control the residual risks. Part of this is making sure that the personnel and those involved in operations understand the hazards faced and the best practices to be employed. When dealing with VSL's specialist activities, these issues cannot necessarily be left to common sense or equated with general hazards such as slipping, tripping and falling. For example, if you have never before

come across a coil of prestressing strand you may be unaware that the elastic energy stored within can cause devastating damage if accidentally released.

To help address some of these issues, VSL's new Post-tensioning handbook expands on the concepts outlined in the General site handbook. The tried and tested method of using simple sketches puts across key messages about general dangers and good practice on site. Particular emphasis has been placed on producing images that do not require a text explanation, though these are provided as a backup. The illustrations are even more useful on multi-lingual sites, and where some personnel may not be able to read the text. The pictorial style helps to get the message across without the need for further explanation. It is far better and more informative than a simple 'hazard' sign.

The new handbook focuses on specific issues relating to post-tensioning, and in particular those that are not obvious, such as stressing forces. All post-tensioning operatives will now be issued with the handbook as part of the induction training process when they start work. This will help to make sure that they understand and remember the hazards that they will encounter. Additionally, the handbook pictures can be:

- given to clients and to other contractors to help them understand hazards;
- used by supervisors during 'toolbox talks' to explain to their teams in more detail what should and should not be done;
- displayed as posters and signs to make hazards and best practice clearer to all personnel, in particular those who are not familiar with post-tensioning;
- used as 'trojan horse' messages directly on tools, equipment or components to send a message directly to workers as they use or encounter them;
- used for method statements, safety plans and drawings.









HEALTH & SAFETY Bike to work



MANUFACTURING Solvent recycling

new solvent recycling system has been introduced at VSL Systems Manufacturer's Spanish plant. The final sprayed surface treatment of pot bearings and other VSL components involves a mixture of paint and solvent. Any left-over mix can now be treated in the new recycling machine, which heats the mixture to the solvent's boiling point. The solvent vapour is condensed into a liquid and collected for re-use while the paint is sent to a specialist waste treatment company. Some 90% of the solvent is now being recovered and the amount of paint waste has been halved, saving on disposal costs. 🔳

SL Switzerland has participated for a fifth time in 'Bike to work', a nationwide campaign to motivate commuters to use bicycles instead of cars. Most kept on cycling even after the June campaign ended. Staff from VSL and 1,467 other Swiss companies pedalled 6.8 million kilometres – or 171 times round the earth.

SAFETY DAYS Local focus for 2012

ndividual companies were given the opportunity to focus on local priorities for this year's safety days. Many topics were tackled around the world, included lifting safety, office safety, health awareness, high-risk activities and risk assessment. The format was also more varied, with some countries targeting different groups of staff across several days. Previous experience from global annual events run by VSL International ensured that the days ran smoothly and individual companies will now take the lead every other year.



Giant Steps in Australia

SL Australia participated in the 8th Annual Giant Steps Autism Regatta. This charity fund raiser is in aid of children and young adults with autism. Eighteen yachts with 250 people competed in a social race. The weather was sensational with the added surprise of a spectacular show put on by a hump back whale and her calf surfacing and breaching only 30m from the yacht. The day was highly successful raising approximately \$100,000 for the charity, Giant Steps.

facts & trends

EIT First for Hong Kong

→ VSL Hong Kong is building a three-span cast-in-situ balanced cantilever bridge that features Hong Kong's first use of electrically isolated tendons (EIT). The bridge for MTR's South Island Line crosses the Aberdeen Channel with spans of up to 115m. VSL provided value engineering, which improved the constructability of the conforming design by eliminating the use of traditional falsework for the end spans. A total of 51 segments of up to 165t will be constructed using a modular form-traveller. The EIT system uses GC anchorages. Other project features include an impressed-current cathodic protection system for the pile caps and piers. ■ Contact: henrypc.chan@vsl-intrafor.com



Foundations Pioneering barettes



→ Intrafor is carrying out a pioneering contract to install the first friction grouted barrette piles in Hong Kong's 'marble zone'. The 65 barrettes are for housing in Yuen Long, famous for its challenging ground conditions. Test piles were installed to verify capacity. More than 4,500t of concrete and steel kentledge imparted a 3,300t load to each barrette during the testing. Performance exceeded all expectations, with less than 20mm settlement compared with the 66mm design limit. Contact:kenny. hung@vsl-intrafor.com

Testing Marked recognition

→ FT Laboratories has secured widespread international recognition for its testing and calibration capabilities. Results are now recognised in every country belonging to a specialist mutual recognition agreement (MRA). FT Laboratories is accredited by the Hong Kong Accreditation Service, which is a signatory to the International Laboratory Accreditation Cooperation (ILAC) agreement. FT Laboratories can now use the ILAC MRA Mark, which ensures international acceptance of data. ■ Contact: rowena.dejesus@ft.com.hk

vs₀L® Steel mesh in sea water



 \rightarrow VSL has been building a reinforced earth dam in France that features a world-first application of VSoL®. The earth dam is the first of its kind and uses back-to-back VSoL® with three different types of soil. There is clay in order to ensure watertightness, sand for its mechanical properties and gravel for internal drainage. This is the first VSoL[®] structure built in a marine environment with steel mesh reinforcement protected by a cathodic system using a sacrificial anode. Construction has been carried out onshore by progressively adding staggered panels. The sea water is being kept back until the earth dam is finished. Contact: b.chanteperdrix@vsl. com

Post-tensioning for Plexus

→ Global electronics manufacturer Plexus is expanding its presence in Malaysia with its first post-tensioned building there. The development comprises a three-storey office block together with a five-storey car park and 22,000m² of two-storey production and warehousing facilities. VSL Malaysia's post-tensioning appointment is for fast-track design and construction. It encompasses the redesign of various floor slabs and the



supply and installation of 150t of 12.7mm-diameter post-tensioning strand. Contact: cheeken.chong@vsl.com

Award Newmarket Viaduct

→ The NGA Newmarket Viaduct Replacement project has won the Civils Demolition Award for the unique way that the new viaduct was constructed while deconstructing the original one, and the ways in which the community of Auckland has been successfully engaged throughout the project. The price was awareded - judged by a panel of international experts - ahead of tough global competition. Contact: ian.barringham@vsl.com

Bridge construction Flying start in Lithuania

→ A successful start has been made on the first use of VSL post-tensioning for major viaducts in Lithuania. The full 91m-long deck of a bridge on the Vilnius southern bypass has been concreted, as have the first sections of twin 263m-long decks that cross a railway. The scope of work by VSL Systems (Cz) includes post-tensioning system supply, equipment rental and site supervision in cooperation with VSL's client Viacon Baltic. Bridge contractors are Panevéžio Keliai and Alkesta, designer Kelprojektas. ■ Contact: psmisek@vsl.cz





Protecting critical ass

Blasts, impact, seismic events, projectiles and fire... such threats to critical assets are a risk for owners and operators in the government, defence, industrial and commercial sectors. The newly launched VSL Infrastructure Protection business is addressing these issues to provide clients with resilient solutions.

V-Blast illustration of compound showing blast contours

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COUCT Story NEW BUSINESS LINE

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very structure and critical infrastructure asset within the built environment is subject to a unique set of risks. Critical buildings and assets can be governmental – such as police stations, embassies, and government buildings - or private sector, including power plants, bridges, LNG terminals and all types of control rooms.

Critical assets may require protection not only against direct threats but also against accidents or the extremes of nature. The potential risks include blast effects from explosive devices or accidental explosions, impact from vehicles or other objects and damage from projectiles including firearms and other ordnances, as well as fire and seismic hazards. "We are not only talking about intentional attacks," says Dr Mark Rebentrost, manager of VSL Infrastructure Protection. "An accidental explosion that damages a control room of a petrochemical or LNG installation can have a serious impact on safety and operations."

In today's world, owners need to be aware of the risks and be prepared to protect their investments and assets against potential natural and other threats. This has led VSL to introduce turnkey services and solutions aimed at increasing the resilience of all types of built infrastructure assets.

One partner

Owners and operators of critical infrastructure may have a need to assess their vulnerabilities and, if necessary, increase their investment in security. They need to take steps to identify the key assets and services under their responsibility and ensure that they are protected. But they may not be aware of the optimum solutions and products on the market and so need a trustworthy partner when dealing with sensitive information about their potential



Increasing structural resilience of a building in South America

In 2012, VSL Infrastructure Protection was asked to assist a client by assessing two possible office locations in a pre-lease due diligence process. The assessments included an evaluation of the security and structural condition of the buildings and the determination of both seismic performance and blast vulnerability. One of the outcomes of the two assessments was a recommendation on which property best met the client's security criteria, together with recommendations as to how to address any vulnerabilities that were identified.

vulnerabilities. The best approach is to exclude complicated interfaces between designers, procurement teams and construction contractors by choosing a turnkey solution where a physical security specialist is involved from the assessment phase through to commissioning and maintenance.

VSL Infrastructure Protection combines vulnerability assessment and mitigation analysis with design and construction delivery. The client is given realistic advice through all steps of a project, from the design of enhancements to the physical security through to the construction, implementation, commissioning and maintenance stage. Working with just one partner helps maintain confidentiality, which is vital when sensitive information is involved. It also increases the ease of communication.

VSL provides a global network of construction expertise to support VSL Infrastructure Protection. It is a well known provider of specialised construction services - techniques such as the use of Ductal®* ultra

*Ductal[®] is a material with a unique combination of superior characteristics and is used not only to build more slender and aesthetic bridges and buildings, but also to protect critical infrastructure. high performance concrete are of particular relevance in safeguarding assets. Thanks to VSL's on-going research and development efforts, its infrastructure protection specialists are at the forefront of the market in providing new and tailormade solutions. VSL has solutions that meet this new challenge of the modern world: increasing structural resilience.

Turnkey approach

Turnkey solutions are at the heart of the process to deliver safe, qualityassured, risk-managed construction applications. VSL Infrastructure Protection's approach to asset protection ensures that construction issues are considered throughout the project cycle. This reduces the margin for error as the design and technical teams are involved at all stages from project conception to commissioning. Their continuous involvement ensures that the installed solution exactly meets the client's requirement and the design intent (see box).

VSL Infrastructure Protection undertakes assessment and design, proposing independent options



that will perform and meet all requirements. The design is easily constructed in the local environment; the materials selected meet the required design and performance criteria; the project is delivered on time and uses local resources where possible; a proactive management approach is maintained throughout the project delivery process.

Improving the level of protection

A security audit and vulnerability assessment is the first step in improving the level of protection afforded by a crucial asset. Assessments begin either with a review of available engineering information or if necessary a site visit by specialist engineers to document the structural condition and obtain sufficient information to generate a 3D computer model of the asset and surrounds.

Forensic engineering

The owner of a building in South East Asia reported cracking of polycarbonate blast windows that had been designed by an engineering consultant and installed by a local third party. VSL IP carried out a site inspection and a forensic assessment of the design. It concluded that the design was faulty and that installation by the local contractor did not adhere to the manufacturer's specifications. VSL IP is currently discussing corrective works with the client.

VSL Infrastructure Protection consults with stakeholders during the initial phases to agree upon the scope of threats to be considered. These are based on internal or industry quidelines, or are in accordance with the outcomes of a specific risk assessment. The engineers then undertake specific analysis and modelling to determine loads on the structure and the vulnerabilities of the asset. They use in-house and specialist tools to evaluate the level of protection provided by the various structural elements. The results are depicted as a 3D illustration.

The team of engineers and physical security experts considers a wide range of solutions to improve the level of protection, initially by securing the boundaries and maximising standoff distances. This is followed by shielding the asset or protecting individual components, and finally



Protective façade design

For a greenfield new-build compound, the first step was to determine the blast performance of the facade, including doors and windows, for a range of threats. This was followed by the design of a solution meeting the required performance criteria and the development of a supply and installation package.



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by carrying out strengthening to improve the resilience of structural and architectural elements. Construction considerations feature from an early stage in the assessment and design process. VSL's global construction expertise means that each of the recommended upgrades will provide an improved level of protection without unanticipated construction delivery risks. Conclusive recommendations on the best options available are based on VSL's extensive engineering and construction knowledge, enabling clients to make an informed decision when weighing up the costs of a physical upgrade against the level of protection it will provide.

Key combination of skills

VSL's experts act as independent consultants; they assess the vulnerability of an asset and recommend a design. But also, if required, they can draw on VSL's worldwide network of specialists to construct, deliver and maintain the infrastructure. The key is the combination of initial design and local construction know-how. Other players in the market generally only provide parts of the overall service







Secure internal area

One of VSL IP's clients required fit-out services for a secure area with ballistic and intruder resistance. VSL liaised with the local architect to integrate this security design into the general design. The work also covered the supply and installation of security-rated windows and doors.

tion = a turnkey approach

Vulnerability assessments

They determine the consequences of a structure suffering an extreme event such as a blast, accidental explosion, projectile hit, vehicle impact, earthquake or fire. VSL Infrastructure Protection (VSL IP) cooperates closely with its US-based long-term engineering partner, which has specific expertise in blast, projectile, seismic, fire and anti-ram issues. This enables the provision of vulnerability assessments for existing and proposed infrastructure assets. At the same time, construction considerations are taken into account early in the design process, thereby reducing risks during project delivery. Assessments can include a structural site survey as part of the analysis of the response to incidents. VSL IP's specialists can also evaluate new assets, taking blast, seismic and other threats into consideration. A performance rating and comparison of mitigation measures can then be established.

Protective analysis and design

From the concept stage through to fabrication detailing and the choice of construction methods, the focus of this analysis is in providing physical protection solutions and details that suit the requirements of the client and project. The mitigation analysis and design produces a construction-focused solution that incorporates complex event-response modelling and extensive use of 3D-models to ensure constructability. A deep insight into blast mitigation technologies and country-specific construction methods helps ensure the best possible result.

Construction delivery

Extensive experience in civil and building construction works means that VSL can supply construction services across all stages of delivery, including planning, procurement, supply, on-site works, project management, commissioning and maintenance. VSL's expertise in construction management, delivery and installation allows it to provide a complete turnkey solution right through to commissioning. This ensures that the solution meets the design intent, minimises any risks during delivery and simplifies the process for the client.





Application of VSL Anti-Spall Liner

Clients in various locations have an issue with existing concrete or masonry walls at risk of secondary fragmentation from improvised explosive device threats. The VSL Anti-Spall Liner is a suitable treatment for reducing dangerous breakup of walls. VSL IP has a team skilled in its application and maintains a mobile containerised set of specialist equipment for the installation. The VSL Anti-Spall Liner has been applied to over 4,000m² of perimeter walls.

Assessing facilities

A recently secured contract is for the assessment of five non-governmental organisation building facilities. It includes blast and seismic vulnerability assessments for both structural and non-structural components. VSL IP's assessment team has collected detailed information and is undertaking desktop analysis including performance-based calculations in order to prepare concept mitigation measures and cost estimates. The work involves the newly developed V-Blast software, which allows for rapid illustration of blast effects on buildings and other structures and integrates directly with VSL's engineering partner's proprietary blast analysis system.



V-Blast can illustrate the blast threat and the level of protection afforded by glazing elements.

COUCT Story NEW BUSINESS VENTURE



Panel tests at Woomera, Australia

Optimised 100mm-thick Ductal[®] Protection Panels have proved their blast resistance in new trials even more severe that the original successful large-scale tests carried out in Woomera in 2004. The latest tests used a 5,000kg packed TNT charge. Two Ductal[®] Protection Panels were placed at stand-off distances of 20m and 30m, and an ordinary concrete panel was placed at 30m for comparison. The tests clearly demonstrated the superior performance of Ductal[®]. Even simple visual inspection revealed that the concrete panel had failed completely and showed significant spalling and scabbing. The Ductal[®] Protection Panel showed no scabbing or spalling and had only minor damage.

Tailor-made asset protection solutions

Resilience of a critical structure can be increased for new construction and retrofits by using a 'layered' security by design approach to reduce vulnerabilities.

1. Physical perimeter security

- Security fencing to provide anti-climb intruder resistance.
- Hostile vehicle mitigation systems consisting of:
- Shallow mount and retractable bollards
- Boom and wedge barriers
- Sliding gates and barrier arms
- Perimeter walls enhanced for blast resilience and anti-ram including
- VSL's Anti-Spall Liner: spray-applied durable mitigation measure that significantly reduces secondary fragmentation of reinforced concrete or masonry walls when subjected to blast.
- Prefabricated systems to enhance concrete wall performance against large vehicle-borne explosive threats.

2. Asset shielding

- Overhead protection systems against indirect fire threats
- Shielding walls

3. Structural system resilience

To increase the structural resilience of buildings by preventing progressive collapse including:

- Column jacketing or beam protection
- Cable shielding against fire and other threats

4. Built infrastructure enhancements

Including internal retrofit solutions for secure fit out with intruder and bullet resistance

- Catcher systems for infill wall blast resilience.
- Ballistic panels for walls.
- Doors and frame that are intruder, blast, ballistic and fire resistant.
- Blast, ballistic and intruder resistant windows systems.



Fire threat assessment and analysis

VSL Infrastructure Protection is undertaking advanced fire threat simulations for cable-supported structures. The analysis uses a computational fluid dynamics model to solve a form of the Navier-Stokes equations for low-Mach-number, thermally driven flow. This, in conjunction with extensively validated combustion models, allows VSL to evaluate heat and radiation transport, exposure duration and intensity, as well as fire growth and migration.



Turnkey asset protection for a secure compound

A client required a full assessment of protection measures when it acquired an existing building near an embassy complex. VSL Infrastructure Protection undertook detailed site modelling and proposed fast-track building protection solutions that included overhead and perimeter wall enhancement together with façade treatments.







but the strength of VSL's network gives it the specialist knowledge and resources to carry out the whole project. This covers everything from the initial assessment through mitigation analysis and design to procurement and supply followed by construction and commissioning. Early consideration of construction is vital when evaluating the feasibility of every aspect in the search for the best solution using the most appropriate products.

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By providing innovative construction solutions to increase the resilience of assets against extreme events, VSL Infrastructure Protection offers clients assured physical security.

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Errors when choosing a protection solution can have a major impact and a reliable specialist is needed, backed by a strong network. Providing an engineered solution is an advantage. VSL's expertise and invaluable R&D efforts are particularly useful when it comes to solving complex challenges. As Dr Mark Rebentrost says, "By providing innovative construction solutions to increase the resilience of assets against extreme events, VSL Infrastructure Protection offers clients assured physical security".

site insights

Gantry in action

→ Segments for a major viaduct in Central Jakarta have been erected using a gantry supplied and operated by VSL. Twin box girders with typically 50m spans make up the viaduct on the 1.15km Casablanca section of the 3.5km Kampung Melayu to Tanah Abang project. Each span is built from 17 of the 2.5m-high and 8.75m-wide segments. The structure's 801 segments, typically weighing 53t, were installed by the balanced cantilever method using the gantry. The first segment was erected in mid-October 2011 and the last was placed in July. VSL also carried out post-tensioning and provided pre-camber values for segment production. Contact: jmassie@vslin.com

Thailand All clear for Purple Line

→ Double form-travellers that were previously used on Australia's Ballina bypass have now been fully erected by VSL Thailand to work on Bangkok's MRTA Purple Line project. Proximity to a four-lane road and Bangkok's water supply canal not only limits space but also means that the work site and processes had to be kept particularly clean and clear. The section of work near Tao Poon interchange station is under the control of CH Tokyu. Contact: shaun.iles@vsl.com



Hong Kong Short and sweet



→ Intrafor's Sennebogen 690 HD has proved invaluable on the Hong Kong Central Wanchai bypass project, where it has been used in digging under a 7m-high bridge. The work involves installation of four 1,200mm diaphragm wall panels and a 1,500mm barrette. The 690 HD's boom design makes it particularly suited for use where headroom is low. In its short boom configuration, the crane's total height is just 6m. ■ Contact: denis.barlow@vsl-intrafor. com



Malaysia New centre for KL Sentral

Prestressed beams and slabs are incorporated into the superstructure of a new mixed-use development adjoining KL Sentral station and the Brickfield 'Little India' area of Kuala Lumpur. The KL Sentral Lot G project comprises a 45-storey office block and one of 33 storeys together with a hotel and a seven-storey shopping centre. VSL's work involves the installation of 1,700t of 12.7mm post-tensioning with more than 19,000 sets of anchorages in various sizes. Although the project schedule is very tight, VSL does not compromise on its vital safety, quality and environmental standards. The client is aiming to achieve LEED Gold certification. Contact: cheeken. chong@vsl.com

Hong Kong Tunnelling challenge



→ Intrafor Hong Kong is using an array of techniques to improve the challenging ground conditions for the XRL 820 express rail project. The work is taking place ahead of the tunnel drive to ensure uninterrupted progress of the Dragages TBMs. Of particular note is jet grouting at up to 40m below the existing ground. This type of work requires pin-point accuracy and it is the first time it has been achieved at these depths. Contact: sebastien.frebourg@vslintrafor.com

NOTE PAD

Expressway completion: VSL Australia has completed its VSoL® project for the Hunter Expressway. The subcontract for main contractors Abigroup and The Hunter Expressway Alliance (Thiess/Parsons Brinkerhoff) involved the combined production of 25,553m² of panels. Two types of VSoL® were used - a grey ribbed panel and one featuring exposed basalt aggregate.

Rail panels: VSL Australia has won a design and supply contract for 12 separate walls that will use approximately 16,000m² of VSoL® 2x2 modular panels. The 8,500m² Christies Road wall will be the largest under VSL's Regional Rail Package E contract. Casting is due to start imminently and will continue until mid-2013.

Laos hospital: A new 10-storey building for a hospital is under construction in the Ban Thungphanthong Sisattanak district of Vientiane, the capital of Laos. Main contractor for the 103 Hospital project is Daonern Development Group Company Limited, which chose VSL (Thailand) as subcontractor for the design, supply and installation of about 28,000m² of post-tensioned slabs.

Beer H0: VSL (Thailand) was engaged for the design, supply and installation of about 11,000m² of post-tensioned slabs for the new headquarters of Beer Lao. This building has five floors, including offices, a canteen and meeting rooms. Main contractor Guapa Lao Construction will complete the project end 2012.

site insights



Bulk realignment

→ May marked the completion of a complex project to reposition One Steel's quayside 1,400t bulk material unloading gantry, which had been derailed by strong winds. VSL Australia was engaged in association with Hatch Engineering to undertake realignment of the 60m span using VSL's heavy lifting expertise. The project involved a series of operations including an 11m lateral move of the front legs and lifting and rotation of the rear legs. The process required continuous and simultaneous adjustment of inclined props and load-adjustment jacks located on 22m-high VSL support towers.

Australia Raising the roof



VSL Australia has lifted a timber roof structure for Mulherin Rigging as part of renovation work at the University of Brisbane. The 200t project centrepiece had to be assembled on top of an existing building in a location that precluded use of conventional techniques. VSL's innovative solution involved preassembly and jacking the roof vertically into position. The method also allowed the staged fit-out of the structure during the lift. The project drew on equipment and expertise from the Heavy Lifting division. Contact: remy.varescon@vsl.com



→ The success of VSL Australia's work building a drinking water tank in Binningup has led to a repeat order. A second tank is now nearing completion under a subcontract to AJ Lucas, part of the Southern Sea Water Alliance. As for the first project, VSL has provided a complete package including design and construction of the 60m-diameter post-tensioned slab, 60 precast post-tensioned wall panels and an aluminium roof. Contact: david.kajpr@vsl.com



Australia On track in Perth

→ VSL Intrafor has helped Perth City Link Rail Alliance reach a major project milestone. Completion of more than 84% of diaphragm walling and 60% of micro-piles puts the Alliance in an excellent position to slew the rail line, which is a critical step for finishing the work. Ground engineering adjacent to the historic station will require 950m of diaphragm wall and extensive micropiling. Intrafor is confident of winning a contract extension. Contact: guillaume.chamroux@vsl-intrafor. com

Australia Fully loaded VSoL®

→ VSL Australia has recently completed the design and supply of 2,972m² of full-height VSoL[®] panels for two ordnance loading areas at the RAAF base in Adelaide. The benefits of the full-height panels include speed and ease of erection. VSL assisted the contractor in the erection and back-filling works. BMD was the construction manager. Contact: connor.chakraborty@vsl.com



Australia Market movement



→ Relocation of Melbourne Market is one of the largest logistics hub projects ever undertaken in Victoria. Bovis Lend Lease won the contract and VSL Australia was appointed to undertake the post-tensioning and reinforcement works for all the pavement structures. It is taking 36 consecutive pours to create the 80,000m² of post-tensioned slabs. VSL's reputation for delivering highperformance pavements to a close tolerance was a critical factor in the contract award. ■ Contact: adam. goulding@vsl.com

site insights

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High visibility

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→ Intrafor has successfully completed a high-profile project in central Hong Kong opposite the new IFC tower and shopping complex. Work involved the installation of 530m of diaphragm wall and 22 barrettes in a very constrained area. The project was in full view of the public as it was beneath a viewing platform and restaurants. Special covers were manufactured for the bentonite storage pools to improve the site's visual impact. Contact: craig.kurten@vsl-intrafor.com

intrafor

Taiwan Seismic control



→ More than 206 sets of VSL dampers are to be installed in the 28-storey Century ChongHong residential building in New Taipei City. The project features 1.5m-high walltype dampers incorporating two to four viscoelastic damper units per set. The dampers absorb and dissipate seismic energy, giving excellent control of structural behaviour. They are integrated into prefabricated steel panels that are installed during construction. VSL's scope includes seismic force analysis, design and supply of the damping system and supervision of the installation. Contact: jack.tsai@vsl.com

Abu Dhabi Vibro challenge

→ Soil improvement works are now complete for the expansion of DAS Island, a key oil-and-gas facility northwest of Abu Dhabi. Owner ADGAS retained Intrafor to prepare the ground for building new structures. Intrafor chose to use vibro compaction, which increased the bearing capacity, reduced any settlement and mitigated earthquake risk. Work involved coordination with multiple contractors and was carried out around the clock in very challenging conditions including extreme weather and close proximity to gas processing and an active runway. Contact: francisco.baez(d) vsl-intrafor.com

Taiwan High-rise palace

→ Damper installation has now been completed for the Crystal Palace, a 41-storey residential building in New Taipei City. VSL damper systems were installed from the 17th floor to the 31st. Each of the 30 sets of 2.7m-high walltype dampers is made of four viscoelastic damper units integrated into prefabricated steel panels. The dampers underwent performance tests as part of VSL's scope of work, which covered design, supply and technical support. Contact: jack.tsai@vsl.com



Taiwan Taipei travellers



Four pairs of VSL formtravellers have completed their work on a major viaduct in New Taipei City, Taiwan. The superstructure of Taipei Viaduct No. 2 has spans of up to 183m. It was built by the cast-in-situ balanced cantilever method and includes 240 segments with depths from 8.5 to 3m. The form-traveller design was modular and it could be adapted to suit the changing cross-section. VSL supplied the form-travellers, supervised their installation and provided technical consultancy for their operation. Contact: jack.tsai@vsl.com

NOTE PAD

Tunisian teamwork: VSL has now fully mobilised its technical assistance team on the RFR (Réseau Ferroviaire Rapide) project in Tunis. The scheme involves the modernisation of 85km of railway. VSL's current contract includes segment manufacture, launching girder erection with supply of posttensioning for the construction of 2 viaducts.

site insights

Switzerland Hitting the spot

→ Two 2,000t manifold caissons have been lowered by VSL Heavy Lifting into their precise positions deep in the Emosson reservoir. Each concrete caisson for the new Nant de Drance pump storage power plant was manufactured onshore at the site 1,930m above sea level. They were then suspended by four SLU-120 jacks from a pontoon before being moved to the exact location - determined by GPS - and lowered over 100m to the lake bottom. Work took place in September 2011 and 2012. Contact: robert.monger@vsl.com



Algeria First of many

→ VSL (Switzerland) has been awarded a post-tensioning supply and installation contract for four LPG and LNG concrete storage tanks in Arzew. It is hoped that this will be the first of many similar projects in the region. The tanks vary in capacity from 12,000m³ and 56,000m³ for LPG through to 160,000m³ for LNG. Contractor Saipem awarded the local work to experienced Italian contractor Bentini. Completion is due by the end of 2012. Contact: julien. violle@vsl.com

Czech Republic Protective measures



→ VSL Systems (Cz) is working on one of its largest-ever geotechnical projects. Melník is being protected from flooding by measures including concrete walls, river embankments and mobile flood barriers with a total length of almost 3km. The embankment work is divided into two sections of lengths 970m and 240m. It incorporates permanent embankment ties installed between the bulkhead and the concrete piles. The 370 tensile members are typically 15m long and are fitted with E6-4 anchorages and permanent grout caps. Contact: pvanek@vsl.cz



usa Bridge replacement

→ Spans the size of two football fields have been lifted into place for the Milton-Madison Bridge project. The new bridge is built on temporary piers next to the old crossing. In July and September, VSL Heavy Lifting lifted the two middle spans, each weighing 1,610t, and 1,875t respectively. The spans were preassembled onshore, placed on pontoons and floated out for the seven-hour lift. Contact: wolfgang.schroeppel@vsl.com

Czech Republic Highway teamwork



→ VSL has been working on four bridges on the Jánovce - Jablonov I section of the D1 highway. The scope of works for VSL Systems (Cz) includes the supply and installation of 73 bearings in addition to 700t of strands and bars for the posttensioning. VSL's client is Bögl a Krýsl, which is part of the project consortium together with Vahostav. Two of the bridges have been designed by Novák & Partner while ISPO and Valbek have each designed one. Contact: psmisek@vsl.cz



Switzerland Twist and lift

→ August 2012 saw VSL Heavy Lifting replace the 470t stator at a Swiss power plant in an operation that took just three weeks. The old stator at the Leibstadt plant was lifted, slid laterally and longitudinally, rotated through 90° and then lowered through an opening onto a specialist transport vehicle. The reverse operation was used to install the new stator. ■ Contact: rolf.oesch@vsl.com



Cameroon Barge lift

→ VSL Heavy Lifting participated in the final installation of the Sanaga Leg Barge1 8km offshore Kribi in Cameroon. The lowering of the 145t support legs and the lifting of the 2,300t hull was performed by 16 SLU-330 and 8 SLU-220. The strand jacks were installed at barge level around the support legs which allowed tightening the lifting and lowering strands and hence minimised the effect of swell during offshore operations. Contact: peter.siegfried@vsl.com

site insights



Portugal Good as new

→ One of Portugal's first concrete bridges built using the free cantilever method has been repaired by main contractor Obrecol, working with VSL as rehabilitation and strengthening specialist. The 250m-long concrete deck was built in 1980 and has five spans. Its box girder has been strengthened by applying external post-tensioning and carbon fibres to the upper slab. All bearings were replaced and viscous dampers were installed at one abutment. VSL also carried out crack injection and painted and waterproofed the deck. Portugal Bridge facelift



→ Praia Bridge in Constancia has been given a new lease of life thanks to intervention from VSL Portugal. The structure has independent 498m-long road and rail decks supported on concrete piers. Deck lifting allowed the existing rocker bearings to be treated but a new pot bearing was needed at the north abutment. Pier bases were strengthened with unbonded post-tensioning and all concrete was repaired using crack injection. Masonry abutment walls were treated with lime mortar. Obrecol was the main contractor. Contact: romao.almeida@vsl.com



Mexico Coastal connection

→ Guamuchil II Bridge is part of the largest infrastructure project currently under way in Mexico. The Durango-Mazatlan highway will improve connections for commerce and industry between the Gulf of Mexico and the Pacific coast. VSL Mexico was appointed to supply Tradeco Group with two pairs of form travellers, expansion joints and 116t of post-tensioning. The five-month contract also covers supervision of the installation. **Contact: prangel@vslmex.com.mx**



→ VSL Argentina has begun work on post-tensioned slabs for the expansion of the country's busiest airport. The project marks a return to Aeroparque Jorge Newbery in Buenos Aires for VSL, which installed slabs there in 2001. A project to expand the airport began this year and concessionaire Aeropuertos Argentina 2000 appointed Helport to build 35,000m² of post-tensioned slabs. VSL is responsible for the engineering, procurement and installation of 100t of bonded post-tensioning. Contact: aloguercio@vslarg.com.ar

Spain Winning team

→ Top footballers from Real Madrid will be enjoying the results of VSL's engineering this season. A joint venture of FCC and Constructora San José nominated VSL as subcontractor for fast-tracked construction of a residential structure. The building, designed by Ingenieria Valladares, features long spans and cantilevers. It incorporates 60 apartments – enough to accommodate the first team players, coach and technical staff. VSL, as usual, partners with the winning team. Contact: gerardo.salazar@vsl.com

Spain Careful manoeuvres



→ The new 3,750t Extebarri railway bridge has been jacked and slid into position in a carefully orchestrated operation carried out by VSL. The 80m-long concrete bowstring arch bridge was built on temporary piers downstream of the old bridge, 11.25m away from the final position and 535mm above the final level. ■ Contact: jmmartinez@ vsl.com

NOTE PAD

Slab slide: VSL jacked and slid eight 375t concrete slabs under the tracks of the Madrid-Barcelona high-speed railway at the Pallaresos Gorge Viaduct. Four 13m-long slabs were precast at each abutment perpendicular to the rail tracks and 25m from their final positions. Two slabs were slid into position every four weeks.

High-speed tilt: CTT Stronghold (VSL Spain) has successfully completed the tilting of the two concrete semi arches for the Arnoia Viaduct on the Madrid-Galicia high-speed rail line. The 1,350t semi arches are 70.8m high and were each built almost vertically at their closest pier. Each semi arch was turned by 41.4° in a single day. VSL's scope also included 410t of post-tensioning and the supply of 64 pot bearings with capacities up to 2,600t.

interviews



THE HONG KONG - ZHUHAI - MACAO BRIDGE PROJECT Challenges over the sea

Work is now up and running on the largest design & build project ever awarded by the government of Hong Kong, and project leaders from the JV share their thoughts on the mega scheme.

Why a partnership between China Harbour, Dragages Hong Kong and VSL?

WK Poon

Dragages is very skilled technically and they are a good bunch to work with, and I had a good impression when working with them on the East Tsing Yi viaduct project. In bridge construction, VSL is one of the major players in Hong Kong. It was a strategic decision to take a specialist on board.

Chan Man

We have a good name working together here – Dragages and China Harbour have already been successful on the East Tsing Yi Viaduct. China Harbour is the key marine contractor in the region, VSL is providing its specialist services and Dragages is an experienced main contractor renowned for good project management. The JV is even stronger with VSL. We have some staff members on board who have already been with us for the East Tsing Yi Viaduct - this is good. China Harbour has a rich experience in marine works and is backed by a strong parent company in China.

Steve Grogan

We won the contract because we are a complementary team and did a good job during the tender phase. The client gains economic and organisational advantages in working with a joint venture: it enhances the chances of achieving the highest levels of quality for a good price.





The biggest design and build contract in Hong Kong

Dragages-China Harbour-VSL Joint Venture was awarded a contract for the design and construction of the Hong Kong-Zhuhai-Macao Bridge Hong Kong Link Road. The main scope of the project is to design and construct a 9.4km-long viaduct section from the Hong Kong Boundary to Scenic Hill on the Airport Island. It will carry dual three-lane carriageways across deep waters.

The viaduct is in the form of post-tensioned reinforced concrete box girders with a typical span length of 75m. Some sections of the viaduct will have spans up to 190m long. Variable water depths and difficult geological conditions mean that the viaduct will be founded on bored piles up to 80m in length. Other associated major tasks include highways, electrical and mechanical works as well as the provision of marine navigational aids, a ship impact protection system, structural health monitoring and a maintenance management system.





interviews The Hong Kong – Zhuhai – Macao Bridge Project

This project team is a fully integrated joint venture. How is the project organised?

Chan Man

Whatever the decision is, we take it together. Some individual tasks will be allocated and executed depending on the specialisations of the members of the Joint Venture but they will always be coordinated with the JV partners. We have experts in all technologies on our team. We all come from different cultures, we have different work habits, and are used to different environments. People are used to work in different ways; this may lead to intercultural challenges. Good



and transparent communication with designers, supervising officers and the client will help us to form a first-class and successful team. The project team is already close to 100 people, and will be increased to 200 before mid-2013. Forming a good team requires efforts from everyone. Decisions that are taken will be open and transparent. Everyone will be able to feel part of the decision making.

Steve Grogan

We are treated as one company, which implies a different approach for the partners: instead of looking at one part of the job, you see the



overall project. You learn new ways of doing things. The advantage for the client is that he does not have to bother to know who is responsible for what aspect - he is working with one "company" set up for the project with experts for the different aspects, but treated as one organisation.

WK Poon

Staff members are all fully integrated. This is a real opportunity to work with companies that are different in nature and culture - picking up ideas and learning from one another. The joint venture merges different cultures -French, Chinese, Australian and others. All have to adapt to work together successfully. It is my role to facilitate communications between various parties.

What are the challenges of the project?

Steve Grogan

A key challenge concerns the technical aspects of the project environment. We have to face important marine logistics issues as 8 km of twin bridge will be over the water. This requires the allocation of resources, including staff and equipment, to match the scale of the project. We will need special piling equipment and marine resources. We will also be building the biggest segmental cantilevers ever built.

The environmental constraints are very stringent in order to prevent as far as possible any impact on the environment. We will be using silt curtains for the piling to prevent dust and gravel from polluting the marine environment and we will maximise our efforts to protect coral reefs, wildlife such as white dolphins, and trees on the shore. We have an environmental consultant working on all these aspects.

Chan Man

The challenges of the project are manifold. Firstly, the size! This is the biggest project ever awarded in Hong Kong and we have just four years to deliver the construction. The approval processes for the design take time; we need to start on site while design works are still under way. We are still working hard on the solutions to some technical challenges, such as seismic problems; durability issues that may affect the use of stainless steel reinforcement and the waterproofing required for the marine works.

We also need to apply for an environmental permit. An example of the constraints is that no piling is allowed along the Western Waters between May and June, because this is the breeding period of the white dolphin, an endangered species.

The importance of the marine works means that we need to take into account the typhoon season and the risks involved: we have to face a potential loss of up to four months working because we will need to clear the site and bring all the workforce and equipment to shelter whenever the typhoon alarm is at level T3. This will be an issue until all the piling works are completed. Offshore works require experienced staff - we are still facing a lack of qualified people in the construction industry and the government regulations for the import of workers are very strict.

WK Poon

Our main challenge is the tight schedule: at 54 months for the construction of the bridge, this will be a fast-track project for Hong Kong, even though we are used to tight production lead times. The remoteness of some open sea areas is a real challenge in terms of logistics. The nature of the work



adds to the need for high vigilance in terms of safety; heavy lifting operations on the open sea and the height of the structure will be key issues. Marine works are strongly affected by the weather; we need to be able to evacuate the staff rapidly if necessary.

As required by the regulations, the Highways Department commissioned an Environmental Impact Assessment before starting theworks;wearesubjecttostringent requirements. The environmental permit for construction stipulates, among other things, that we may not have more than 35 work fronts at a time in the Western Waters. Near the airport, this figure goes down to not more than 10. There are also piling restrictions to protect the Chinese White Dolphins. We need to monitor the work's impact on water, air and noise. The public awareness of this project is very high.

What are the most important innovations on the project?

Chan Man

The mere size of the project does not really require specific innovations, but sound technical know-how and experience are indispensable to the successful delivery of the project. We are facing several constraints along the site - height, for example. At certain spots, a minimum height is required to maintain the navigation channel; however, the proximity to the airport imposes height restrictions. Alignment is also a challenge. We are creating new solutions. I would rather define it as continuous improvement with the support of VSL's technical centre TCAA. We have already held six workshops to formulate new ways to move forward!

Steve Grogan

The main innovation is in the construction of the precast balanced cantilever spans. At the airport channel, they will be up to 180m long and thus the longest that will have ever been built without using stay cable technology. We will also introduce new techniques for making the precast pier segments at the precast yard in Chong Shan, in the Pearl River Delta. The pier segments – which will be up to 10m tall - will have to be lifted from the barges with special Heavy Lifting methods. For the deck erection, two launching gantries will be used. One was used by VSL on the Second Gateway Bridge in Brisbane and the other - from Dragages Hong Kong worked on the East Tsing Yi Viaduct. For the longest spans, purpose in-house lifting frames will be designed and built by the Joint Venture with the assistance of VSL's Technical Centre in Singapore.

WK Poon

The Hong Kong – Zhuhai – Macao Bridge is the first open-sea bridge for Hong Kong. In its structural design we will have, among other things, prestressed precast columns and precast pile caps. Whereas we can say that the viaduct in itself is "routine", the lifting methods however will be special. We will be assembling the longest precast segmental cantilevers ever built and will use floating batching plants for in-situ piling, with marine traffic maintained at all times. This again is a first for Hong Kong.



TRAINING New courses on offer at VSL Academy

More than 1,000 participants have attended training courses at VSL's unique training centre in Bangkok since it started operation in 2008. New initiatives broaden its scope.



new full-sized mock-up that allows people to practise heavy lifting is the latest addition to VSL's international training centre in Thailand.

Best practices

The VSL Academy in Bangkok has been in successful operation since 2008 and more than 1,000 people have passed through its doors. Training sessions are led by experienced staff who pass on the best practices and run hands-on simulations to give trainees proficiency.

The Academy has performed audits on post-tensioning work at a significant number of projects within VSL's network over the last two years. The results leave no doubt about the positive impact that proper training is having on quality, safety and productivity.

Further simulations

The success of the post-tensioning simulations has prompted the development of further simulations to cover other key operational procedures. This year, VSL has taken steps to add courses such as heavy lifting, stressing jack maintenance, VSoL® reinforced earth walls, ...

In preparation for these new courses, VSL has made a major investment in a large 50m-long and 16.8m-tall mock-up for heavy lifting. This new facility at the Academy will allow participants to practise



activities at a scale comparable to real sites.

In August 2012, VSL specialists from all over the world gathered for a week at the VSL Academy to

validate the course structure and course material. The mock-up was tried out during the workshop.

The structural set-up for the mockup allows additional features to be

The mock-up in detail

Heavy-lifting training

The main pylon has been made ready for heavy-lifting with the pylon base jacked up sufficiently to disengage the main pins. Shims are installed under each column of the pylon and tie-downs between pylon and main beam are installed and made spanner tight. Horizontal stress bars connecting the two upper kentledge blocks are installed and stressed to 20% UTS with vertical stress bars connecting the lower kentledge blocks if required.

Post-tensioning of internal tendons

Training in the use of post-tensioning of internal tendons is as per the current training within the PT course, but with more realistic conditions using a longer cable. The tendons are to be alternatively stressed in maximum increments of 25% of maximum force (i.e. steps of 500kN).

Stressing of CT-bars

Training in the use of bar jacks to stress a VSL CT-bar is carried out in the kentledge blocks for the heavy lifting with standard CT bar components. The bar is only to be stressed to 25% UTS for training.

CTT bearing installation/replacement

Training in the replacement of bridge bearings is carried out at Pier A, where the main beam is supported on the pier via CTT bearings. The beam is jacked up using two jacks simultaneously at the specified jacking points.



added in future to simulate techniques such as the post-tensioning of long internal tendons and CT-stress bars, lifting of concrete weights and the installation of bearings.

Heavy lifting system

Heavy lifting operations on site may face structural constraints and issues such as a lack of crane availability. Practising different options for installing the equipment and strands is an integral part of the new heavy lifting training at the VSL Academy.

The simulator is designed to accommodate a heavy lifting mockup with four SLU 40 strand jacks used to lift and lower a 60t concrete block.

Installation and dismantling of heavy lifting equipment is to be a key element of the course. Incorporation of different types of connection details allows a variety of installation methods to be practised. Training includes the set-up and operation of a heavy lifting system using SLU 40 jacks and lifting tendons under various conditions, including the simulation of balanced or unbalanced loads.

New for 2013

In 2013, the current range of VSL Academy training classes will be complemented by a training and certification scheme for bridge gantry engineers and supervisors. This scheme for staff involved in segment erection will run under the umbrella of the VSL Academy and will feature both practical and theoretical parts. Practical activities will be carried out on site in Malaysia, Singapore and Thailand on new gantries that will start operation in 2013. The theoretical training and certification will take place at VSL's premises in both Malaysia and Singapore, as well as at the VSL Academy in Thailand. Training will initially emphasise the precast segmental span-by-span erection method, but will later be extended to include precast segmental balanced cantilever construction.

The VSL Academy is a unique tool in the post-tensioning industry and provides an ideal method of training staff and improving site quality and productivity. It is also an excellent way of demonstrating to clients and others – including supervisory bodies - the level of VSL's commitment to training. The Academy plays a key role in raising skill and safety standards on site around the world around the clock.







Post-tensioning For the laes-2 project Power for for Russia

VSL is currently working on its first nuclear power plant contract with a Russian contractor on the LAES-2 project near St. Petersburg to supply the post-tensioning and monitoring systems for two reactor containment structures. Safety requirements are particularly stringent. Nine key points to manage this demanding contract...

The VSL system with 55 greased and sheathed 0.6" strands is used for the inner containment.

tech show post-tensioning for the laes-2 project



Develop, test and demonstrate efficiency

In anticipation of new projects in the energy market, VSL has demonstrated its capabilities in the latest technologies by setting up a full-scale mock-up of a slice of a containment structure similar to that of a European Pressurized Reactor (EPR). The testing programme and results have demonstrated the efficiency of VSL's post-tensioning solutions for the latest generation of VVER containments such as the ones of the LAES-2 project.

Use specific equipment and stressing processes

Installation of the post-tensioning in the LAES-2 structures requires special equipment and methods due to specific nuclear requirements and the exceptional size of the tendons. The equipment and methods are designed to address each step of the process, covering the strand installation and the injection of grout filler as well as the stressing and logging of the tendon forces and elongation followed by capping and provision of the external protection.





Position vertical tendons

The project requires the installation of 50 vertical tendons formed in an 'inverted U'. They are to be stressed from the ceiling of a post-tensioning gallery located in the basement of the structure. The average length of these tendons is about 170m. In addition, there are 63 horizontal tendons in the cylindrical section and these will be stressed from the buttress. Installing these tendons involves vertical deviations of up to 4.3m for a length of about 150m. The 13 horizontal dome tendons will be stressed from the inclined part of the buttress.



tech show post-tensioning for the laes-2 project

Design the containment's tendon layout with tight constraints

VSL is in charge of the post-tensioning system for the inner containments. On the LAES-2 project, the internal shell has a wall thickness of 1.2m and is 67.7m high. The distance between the two shells is just 1.8m, which creates space constraints for the installation of the post-tensioning. The internal shell is made up of a cylindrical section topped by a hemispherical dome. VSL was responsible for the design of the containment's tendon layout and provided the construction detailing for the ducting, which is made from shaped rigid steel pipes and corrugated ducts.

Use VSL's products to ensure durability

VSL chose to use its NC 6-55 unbonded nuclear system. The system's features include 55 greased and sheathed strands per cable, two NC-U 6-55 flange castings and a strand protection cap equipped with high-performance fire protection. All key elements of the system have been certified for nuclear applications in the Russian Federation. This VSL nuclear post-tensioning system has been granted European Technical Approval (ETA-06/0006) in accordance with the ETAG 013 guideline and has obtained CE marking.



tech show Post-tensioning for the laes-2 project



Provide special PT access platforms

VSL's access platforms for posttensioning have been designed for the installation of horizontal and dome tendons during construction with operations in a confined space. They will remain operational throughout the life of the nuclear plant, to allow future inspection, maintenance and upgrading of the system.



Record the quality and efficiency of site works VSL DAS - the Data Acquisition System for post-tensioning automatically records all the relevant stressing parameters, including global forces, strand elongation and individual strand forces. It processes the information for further use in quality control, providing transparency to the client.



Guarantee performance that will last

that will last External factors have a direct impact on nuclear safety, as do changes in the mechanical properties of concrete and steel as

they age. As such, regulations often mandate comprehensive surveillance strategies to monitor containment structures. VSL will provide the in-service monitoring system for LAES-2, allowing data to be exported and logged using a secure online access system. The VSL monitoring system is a key tool for the plant operator to understand the structure's behaviour, especially during control stress-tests.

Supervise system implementation

VSL's highly experienced production and technical teams on site provide close supervision

of the installation of the post-tensioning and monitoring systems. This day-to-day involvement leads to the high levels of quality and efficiency that the client needs.

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