VSL

A member of
Bouygues Construction

2019 EDITION

INSIGHT

Creative solutions to meet your challenges

Every structure carries loads and is subject to forces on an ongoing basis, and this can lead to material deformation or failure. It may therefore be necessary to strengthen the structure at critical areas or to control the behaviour of the ground on which it stands.

This is where VSL can take action... As a specialist in post-tensioned and cable-stayed structures, foundations and ground engineering, VSL contributes to the design and construction of major engineered structures and maintains, repairs and upgrades all structural systems that guarantee safety and durability.

Our purpose lies in understanding a structure as a whole - its structural components, environment and use - in order to propose and deliver the best technical solutions to turn even the most complex schemes into reality.

How do we do it? Our strength comes from our three-pillar approach that combines engineering and construction methods, ever-evolving in-house structural systems and technologies, and operational skills for project execution: this approach allows us to achieve the best results for our clients' projects.

VSL is part of Bouygues Construction group. It has 3,500 employees in 25 countries, mainly located in Asia, Oceania, the Middle East, Europe, Canada and Latin America.

2019 PROJECTS OVERVIEW

2019 JOB REPORTS

INSIGHT

2019 Overview

NEW STRUC-TURES

As a specialist in post-tensioned and cable-stayed structures, foundations and ground engineering, VSL contributes to the design and construction of major engineered structures.

TRANSPORT INFRASTRUCTURE

- Bridges
- Tunnels
- Roads & Railways

BUILDINGS

INDUSTRIAL & ENERGY-PRODUCING STRUCTURES

- Wind towers
- Nuclear containments
- LNG tanks
- Industrial facilities
- Water tanks, Digesters, Silos
- Offshore structures
- Dams
- Mines

Carrying out the PT works for a 5km coastal viaduct

VSL carried out post-tensioning works in JV with Freyssinet for a 5,400m-long cantilevered viaduct as part of the new coastal road linking key cities on Reunion Island. The viaduct was built by a JV bringing together Bouygues Travaux Publics, Vinci and Demathieu & Bar.

Post-tensioning

More details p.41

REUNION ISLAND

NEW COASTAL ROAD,
INDIAN OCEAN

Devising a new way to erect bridge segments over a heavily used navigation channel

How do you erect a bridge's main span over one of the main navigation channels of North America without interfering with river traffic? This was the question that VSL managed to answer, by proposing an innovative erection method that was used at an exceptional scale for the first time ever. 60m-wide concrete segments were retrieved from beside the bridge pylon and were transferred below the deck, using lifting machinery and trolleys that slide along the deck. VSL delivered technical expertise, designed and supplied equipment, and carried out supervision to erect the main span of the new 3.4 km-long Samuel De Champlain bridge, over the St Lawrence River in Montreal, Canada.

- Design, supply, commissioning and operation of specialised equipment
- Technical assistance for segment erection

More details p.43

CANADA

NEW SAMUEL DE CHAMPLAIN BRIDGE, MONTREAL

Designing and providing stay-cable systems and protection solutions for an iconic new bridge

VSL supplied and supervised the installation of stay-cables together with a saddle system for an iconic new two tower-cable-stayed bridge in Muara, Brunei. The saddle allowed the pylon dimensions to be optimised and reduced material costs and maintenance access requirements. The project also included stay-cable protection: fire protection, rubber dampers to avoid stay-cable vibrations and an anti-vandalism solution.

- Cable-stayed bridge construction with saddle system
- Fire protection
- Anti-vandalism protection
- Vibration protection with rubber dampers

More details p.45

BRUNEI

CC3 PROJECT
FOR TEMBURONG
BRIDGE

Saving two months in the construction of an iconic bridge

VSL supplied and installed 144 stay cables and wind cables as well as friction dampers for a new two tower cable-stayed bridge in Can Tho City, in Dong Thap Province. VSL's innovative solutions enabled a significant amount of time and money to be saved on the landmark cable-stayed structure.

- Cable-stayed bridge construction
- Stay-cable vibration protection with dampers

More details p.47

VIETNAM

VAM CONG CABLE-STAYED BRIDGE, CAN THO CITY

Delivering a full solution for the deck construction of 13 bridges

KUWAIT

AL GHOUSE ROAD,
MUBARAK AL-KABEER

VSL provided a complete solution that included the design and supply of segment precasting moulds, the supply of PT material and equipment, and span-by-span erection of concrete segments for the construction of six flyovers and seven footbridges along Al Ghouse Road.

- Design and supply of segment precasting moulds
- Precasting yard supervision
- Deck erection supervision
- Supply of PT material and equipment

More details p.49

Performing PT works for viaducts on a key expressway

VSL carried out post-tensioning works simultaneously for 4,000 metres of viaducts at three different sites on a key expressway leading to the Tatra Mountains in Poland.

POLAND

KRAKOW – ZAKOPANE EXPRESSWAY

- Post-tensioning
- Bearing installation

More details p.51

USA
I59/20 CBD – BIRMINGHAM, ALABAMA

Carrying out bridge works to a tight schedule

VSL contributed to the construction of two segmental bridges being built in less than ten months as part of road improvements in Birmingham, Alabama.
VSL proposed to erect the deck segments on a series of customised shoring systems. Thanks to this method, the works were finished in record time, two months ahead of the contracted completion date.

- Design & procurement of deck erection equipment
- Precasting of two segmental bridges

More details p.53

Precasting, erection and post-tensioning for nine bridges in the heart of Sydney

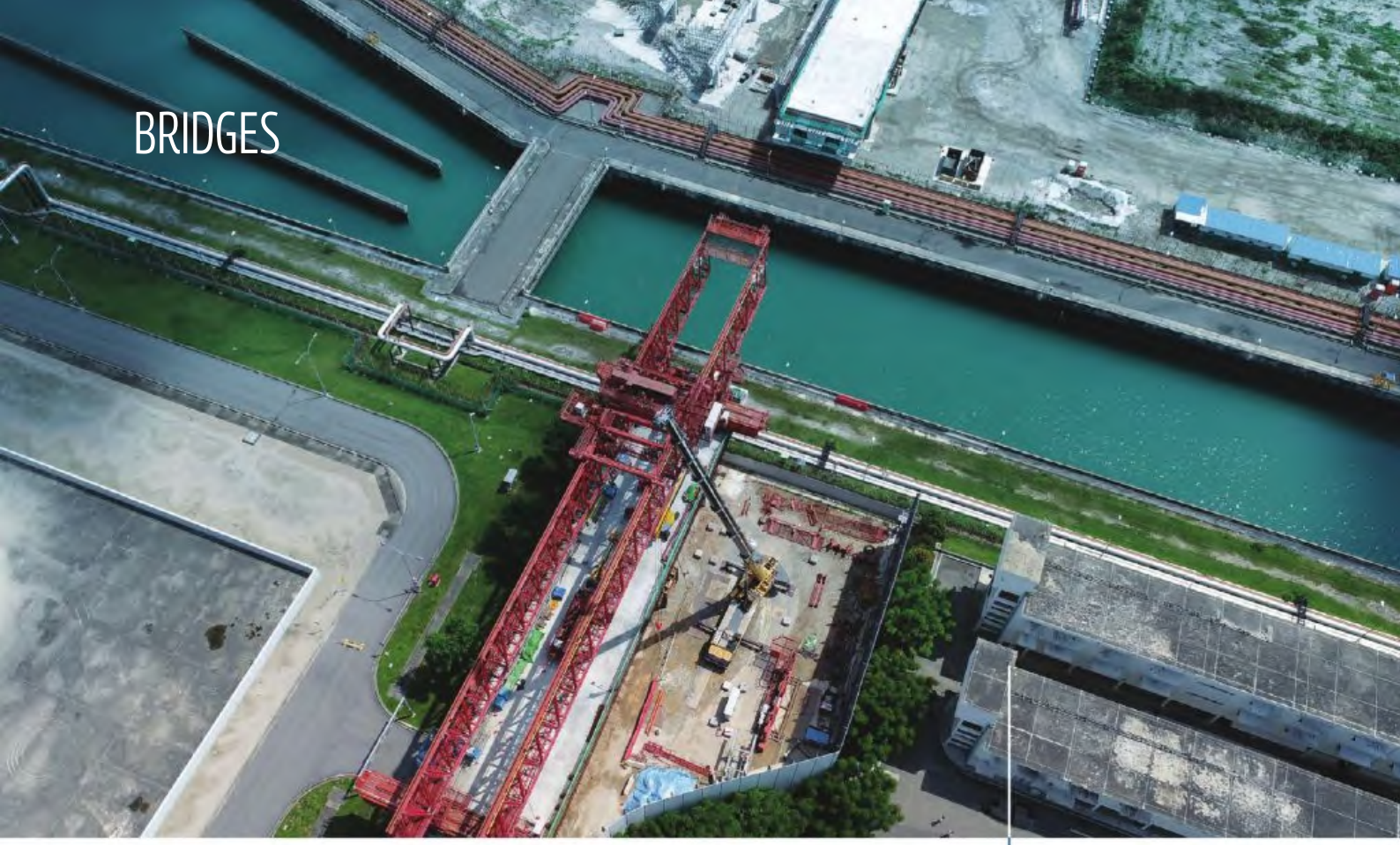
AUSTRALIA

ST PETERS INTERCHANGE, WESTCONNEX MOTORWAY, SYDNEY

VSL contributed to the construction of nine bridges of the St Peters Interchange, one of the key sections of the new 33km WestConnex motorway in Sydney. The motorway will ease traffic flow and help the economic growth of the most populated city in Australia.
One of the main challenges arose from working in the heart of Sydney on this major interchange made up of multi-layered overlapping viaducts with tight radiuses.

- Precasting
- Deck construction
- Post-tensioning
- Bearing supply & installation

More details p.55



Gantry operation and pre-tensioning works for a new bridge over a sensitive site

SINGAPORE
TUAS VIEW BASIN ACCESS BRIDGE

In order to build two bridges in an industrial area of Singapore, VSL suggested and used a launching gantry instead of a form-traveller. The decision ensured a smooth operation for the erection over a sensitive site of seven U-girders weighing up to 283 tonnes.

- Design, procurement, assembly and operation of the gantry
- Post-tensioning

More details p.57

Carrying out erection works for a major viaduct on Kuala Lumpur's MTR

VSL operated one of its launching gantries to erect 32 bridge spans made of 376 segments for northbound and southbound viaducts merging into a double-track viaduct. One of the key challenges was that VSL had to slide the launching gantry from the southbound viaduct to the northbound one.
Contract V203 is one of 10 packages for the construction of a 40km-long elevated viaduct on the new mass rapid transit line in Kuala Lumpur.

MALAYSIA

V203 PROJECT, MRT LINE
KUALA LUMPUR

- Launching gantry procurement and operation
- Post-tensioning

More details p.59

TRANSPORT INFRASTRUCTURE

Performing PT works for a cut-and-cover tunnel and eight bridges on a motorway

VSL supplied and installed its post-tensioning system to a tight schedule for a new cut-and-cover tunnel and eight bridges, as part of a widening programme for the Zurich bypass, one of the busiest sections of motorway on the Swiss network.

- Post-tensioning

More details p.61

SWITZERLAND

EXTENSION OF THE NORTHERN BYPASS - KATZENSEE, ZURICH

Building the world's longest caterpillar trench in adverse geology

VSL carried out ground improvements, diaphragm wall design & construction and foundation works for a new undersea tunnel in Hong Kong. The project included the innovative use of a record-breaking, caterpillar, structure to provide support and enable efficient tunnelling in the site's difficult ground conditions.

- Access shaft construction
- Ground improvement
- Foundations

HONG KONG

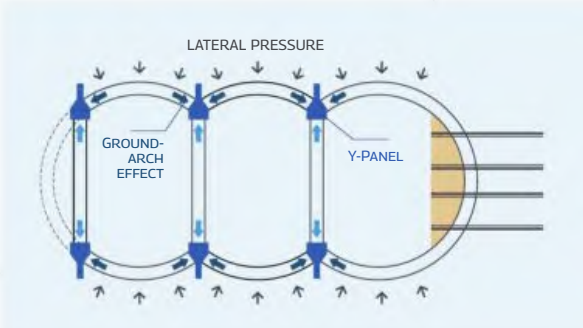
TUEN MUN - CHEK LAP KOK LINK'S NORTHERN CONNECTION

More details p.63

Y-PANELS: A WORLD-LEADING TECHNICAL FEAT

In order to deal with adverse geological conditions caused by a very deep and thick layer of soft marine deposit, an innovation referred to as Y-panels has been implemented to construct the world's largest caterpillar-shaped cofferdam for a cut-and-cover tunnel.

The basic principle involves using the arch effect to resist lateral water and earth pressures, thus limiting the effect of vertical bending. Arched wall segments shift the load to the connection panels, in other words the Y-panels, which redistribute the transverse load via reinforced concrete bracing (built during the excavation) and transverse diaphragm walls below the final excavation level.



TRANSPORT INFRASTRUCTURE

Building Mechanically Stabilised Earth (MSE) retaining walls with curved and inclined panels

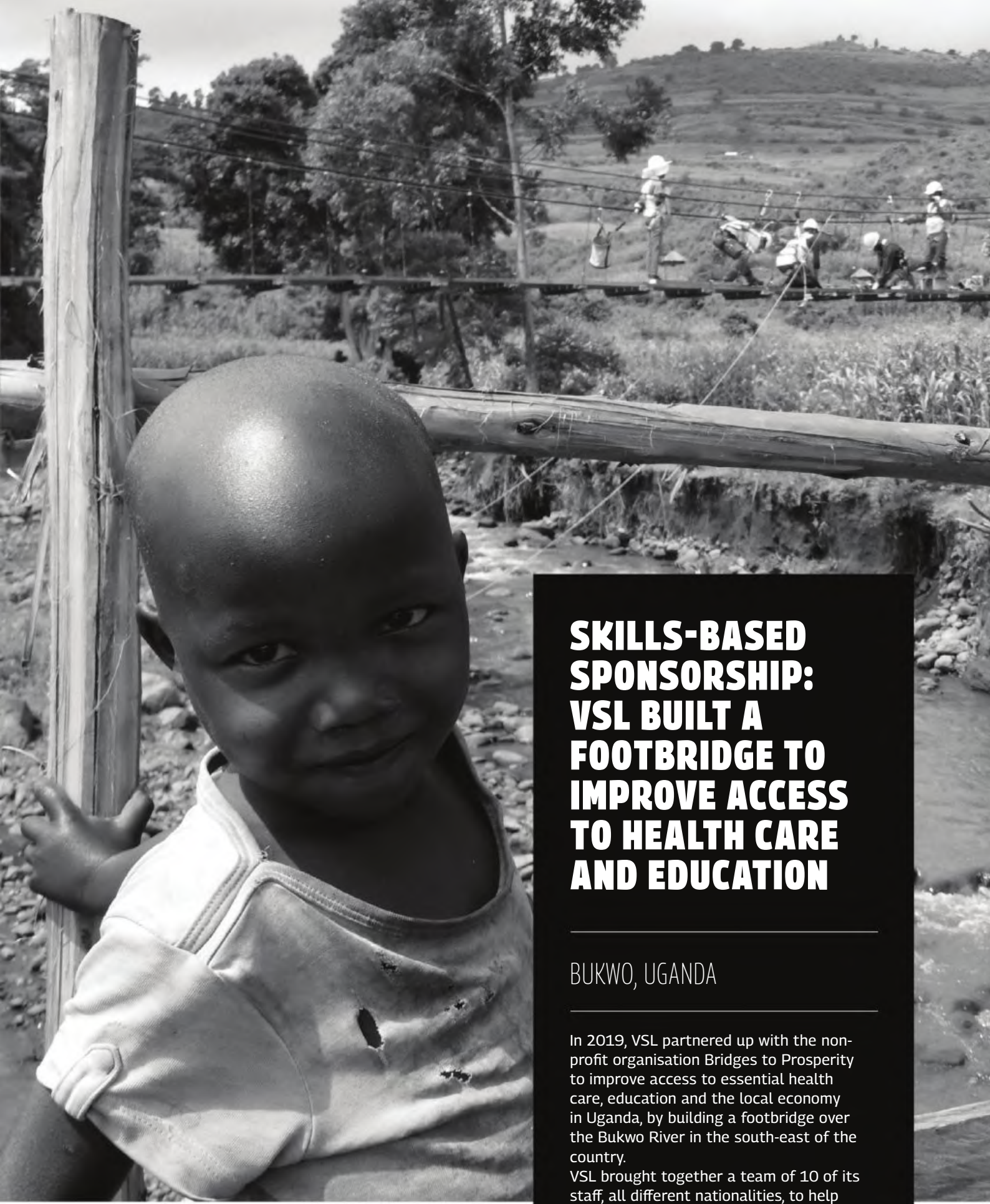
CANADA

SAMUEL DE CHAMPLAIN BRIDGE, MONTREAL

VSL developed an innovative variant of its VSoL® system to build MSE walls for the east abutment of the new Samuel De Champlain Bridge in Montreal. This abutment supports the main bridge span.
It was the first time that MSE walls were built with non-staggered, curved and inclined panels in the history of structural engineering.

Design and construction of Mechanically Stabilised Earth retaining walls using the VSoL®system

More details p.65



SKILLS-BASED SPONSORSHIP: VSL BUILT A FOOTBRIDGE TO IMPROVE ACCESS TO HEALTH CARE AND EDUCATION

BUKWO, UGANDA

In 2019, VSL partnered up with the non-profit organisation Bridges to Prosperity to improve access to essential health care, education and the local economy in Uganda, by building a footbridge over the Bukwo River in the south-east of the country.

VSL brought together a team of 10 of its staff, all different nationalities, to help build the 50-metre-long bridge that serves 1,700 people, 650 of whom are children.

WATCH THE FILM

Girder precasting and PT works for a new airport terminal building

VSL carried out precasting of 116 AASHTO girders, post-tensioning works and beam installation using mobile cranes for the construction of a new terminal building at Clark International Airport between Angeles and Mabalacat in the Pampanga province of the Philippines. The new terminal will help raise the airport's capacity from 8 to 12 million passengers per year.

- Design, procurement and installation of 116 girders
- Post-tensioning

More details p.67

THE PHILIPPINES

NEW TERMINAL BUILDING, CLARK INTERNATIONAL AIRPORT

Design, supply & construction of PT slabs and beams for a major shopping mall

VSL had to work to a tight schedule in carrying out post-tensioning works and laying down a 113,000 m² slab for a new shopping mall in the Ha Dong district of Hanoi City in Vietnam.

- Post-tensioning
- Installation of beams

More details p.69

VIETNAM

AEON MALL HA DONG, HANOI CITY

Building Chile's first wind farm with precast concrete towers

VSL has completed a successful project to construct Chile's first wind farm with towers made of precast concrete. The wind farm comprises 61 towers - each 120m high and made up of 22 concrete segments - and will produce a total output of more than 180MW.

- Precasting yard construction

More details p.71

CHILE

SAN GABRIEL WIND FARM, RENAICO

Carrying out mechanical works for a solar power plant

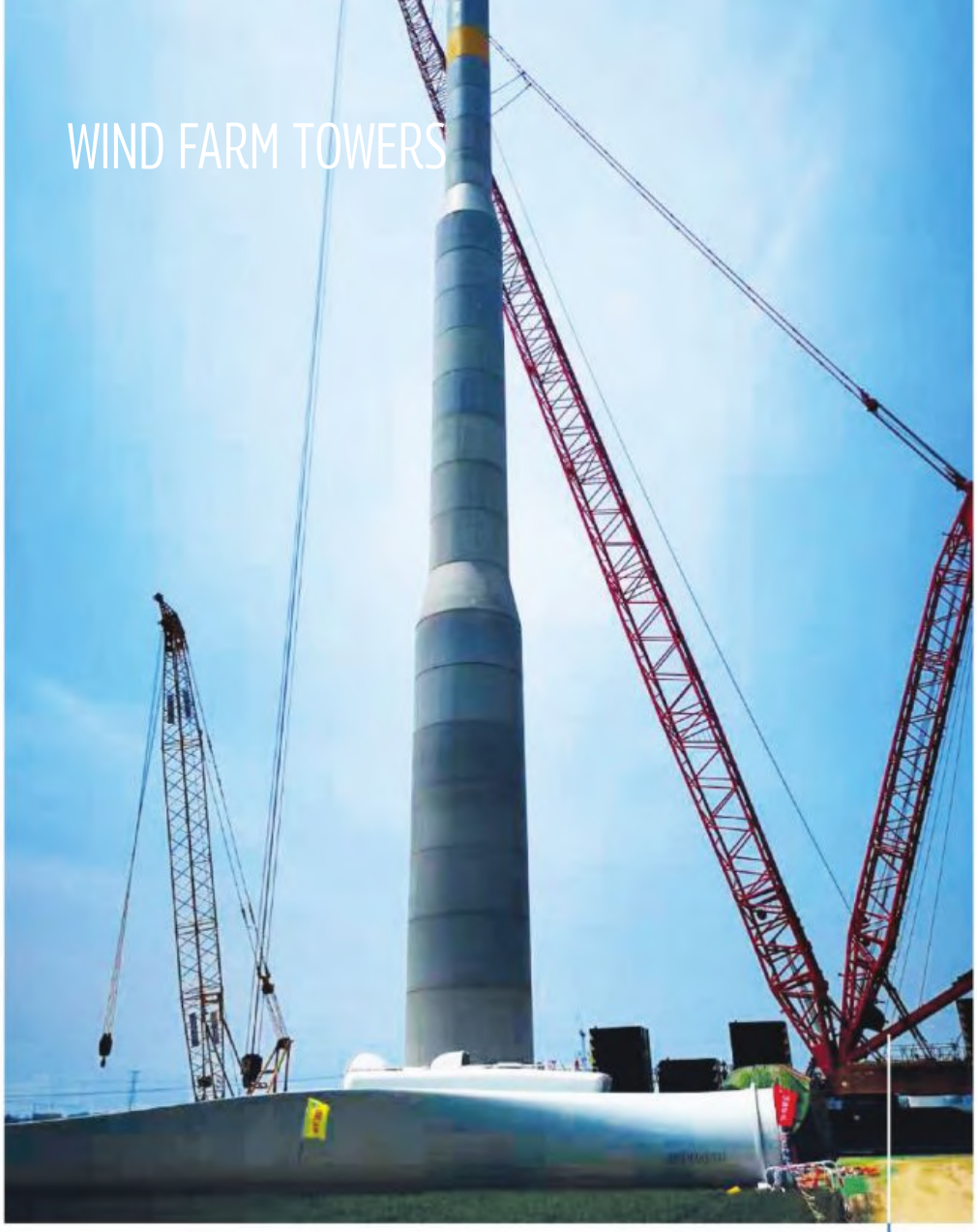
VSL was appointed to carry out a third of the mechanical works for the BIM 2 solar farm, which has become the largest of its kind in Southeast Asia, with an expected production capacity of over 250MWp.

VIETNAM

BIM 2 SOLAR FARM
PROJECT, NINH THUAN

- Screws, mounting structures and photovoltaic module installation

More details p.73



Carrying out post-tensioning works for China's first hybrid wind farm

VSL performed post-tensioning works and external tendon installation for the construction of 150 hybrid towers in the first wind farm project of its kind in China, in Henan Province.

Post-tensioning

More details p.75

CHINA

HENAN WIND TOWERS,
HENAN PROVINCE

Using HDD to install a 573m-long steel conduit to carry a fibre-optic cable

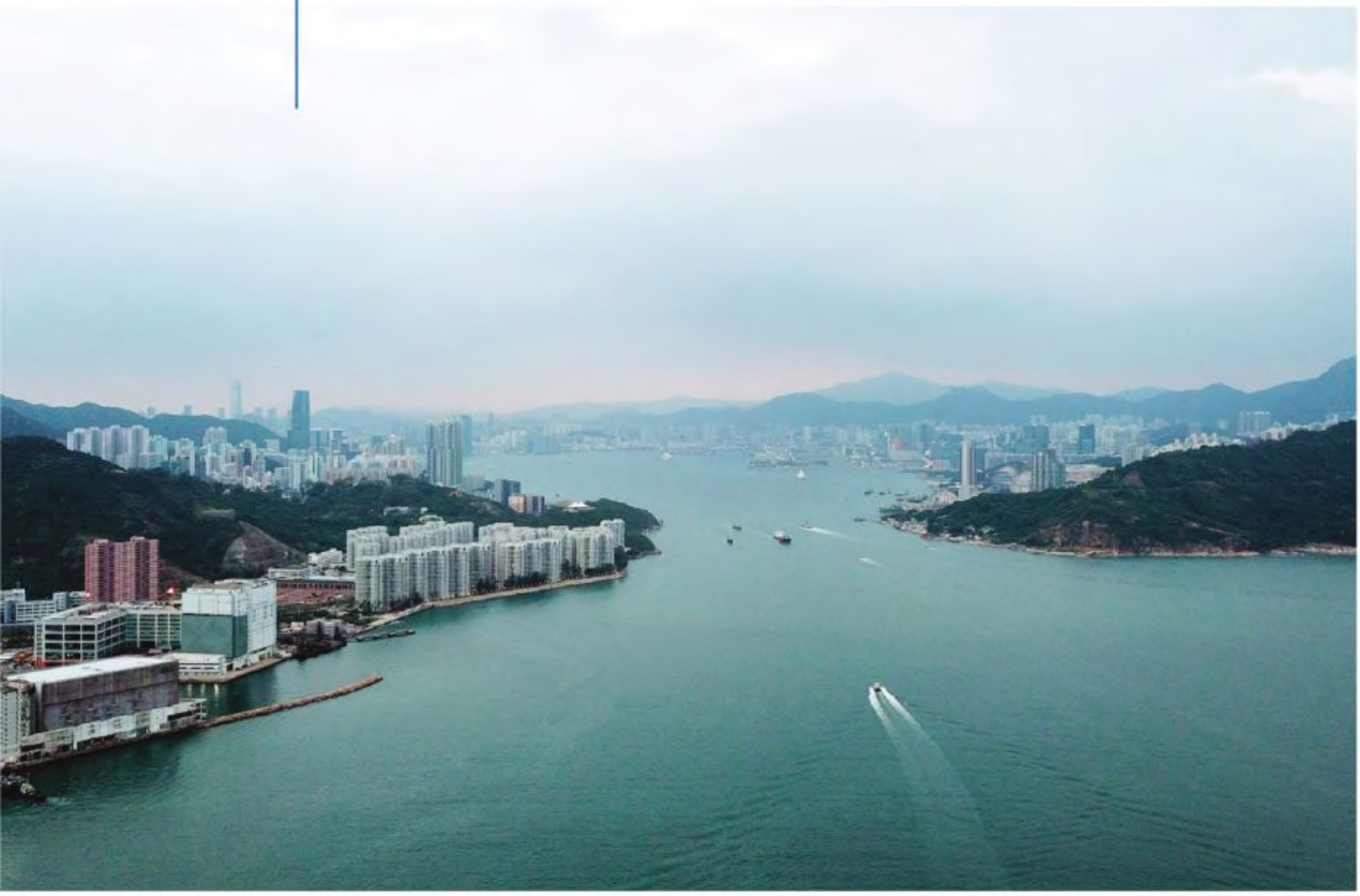
VSL installed a 573m-long land-to-sea conduit and built a beach manhole using Horizontal Directional Drilling (HDD) as part of a project to lay down a fibre-optic cable for Hong Kong Telecommunications Ltd (HKT), one of the largest telecommunications companies in Hong Kong. HDD enabled the product pipe to be installed from land to sea with a punch-out on the seabed, without disturbing either the seawall with its 30m-deep foundations or the offshore coral.

Marine Horizontal Directional Drilling (HDD)

More details p.77

HONG KONG

CABLE LANDING FOR HONG KONG TELE-COMMUNICATIONS ULTRA EXPRESS



EXIS-TING STRUC-TURES

VSL maintains, repairs and upgrades all the structural systems that guarantee the safety and durability of structures.

ASSET PRESERVATION

- Inspections
- Preventive maintenance
- Monitoring

STRUCTURAL REPAIRS

- Repairs
- Replacement

UPGRADE

- Strengthening
- Change of use

SPAIN

SANTA MARÍA DE GUÍA-EL PAGADOR ROUTE, GRAN CANARIA

Carrying out all repair and maintenance works on 13 bridges in the Canary Islands

VSL carried out refurbishment and maintenance works on 13 bridges along the route between Santa María de Guía and El Pagador in Gran Canaria, Spain.
Most of the tasks took place on structures more than 25m high and required the use of an underbridge unit, hanging scaffolds or a rope access team.

- Concrete repair
- Anti-carbonation painting
- Replacement of elastomeric bearings and pot bearings, including hydro-demolition works
- Rope access works
- Tailored design for scaffolding and suspended platforms

More details p.79

Bridge repair works on Portugal's busiest highway

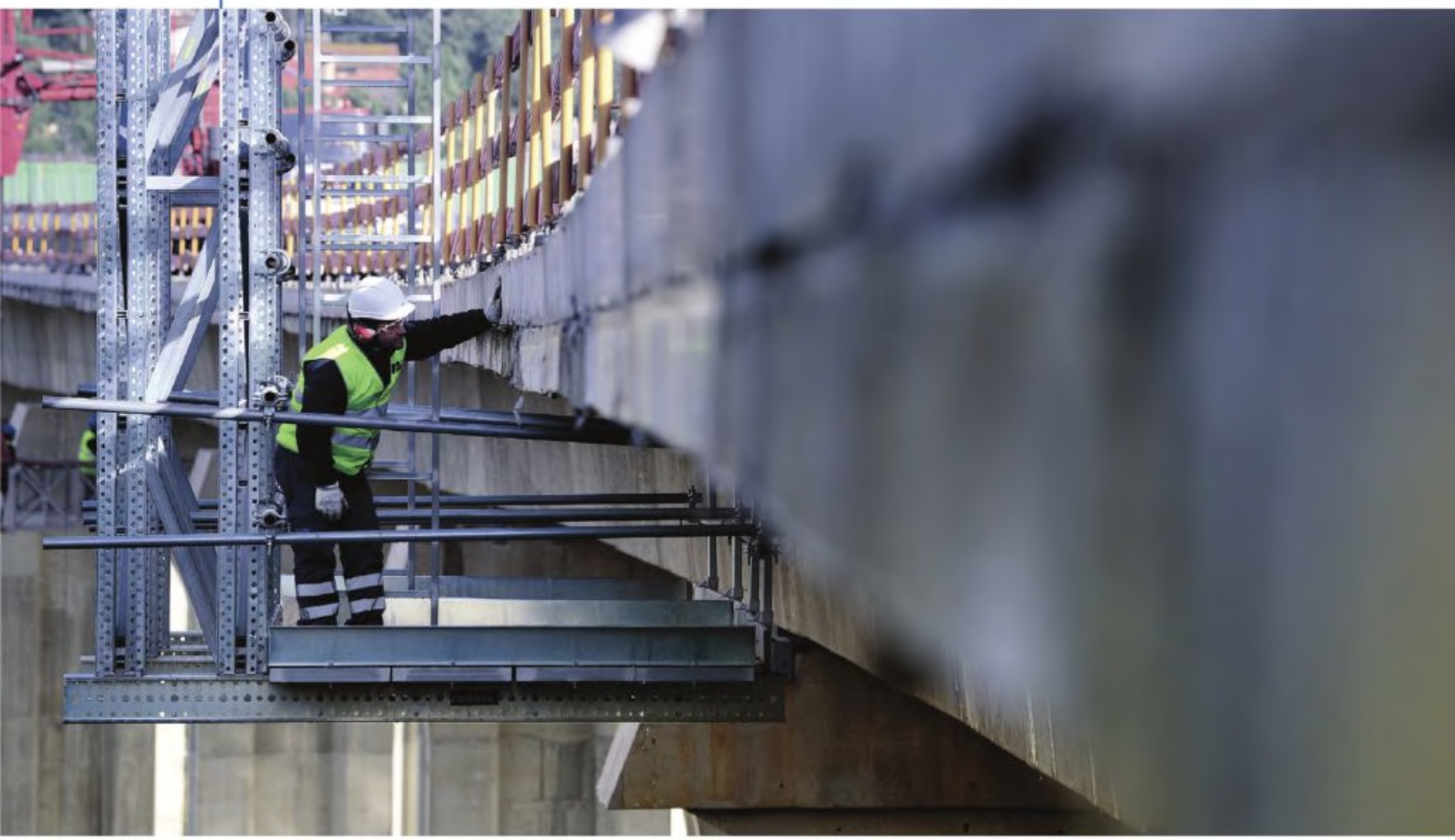
The Agudim Viaduct is a 480m-long structure located on Portugal's most important highway.
VSL carried out repair works as a main contractor. For access, VSL chose to use suspended platforms and an under-bridge platform instead of scaffolding. This solution ensured a highly competitive and effective solution for Brisa which is in charge of the bridges on 17 highways in Portugal.

- Concrete and joint repairs
- Bearing repairs and replacement
- Coating and protection of the concrete surfaces
- Demolishing and rebuilding all the capping beams and safety barriers

More details p.81

PORTUGAL

AGUDIM VIADUCT,
LEIRIA



Strengthening an important bridge in just two months

VSL carried out post-tensioning works and installed carbon-fibre reinforced polymer (CFRP) in Zeehan, Tasmania, to strengthen a key bridge in order to accommodate the increased loads needed for the operation of Higher Productivity Freight Vehicles (HPFV) on this important route.
The project was located over a hard-to-access creek subject to flash flooding. This involved working at height, over water and at varying flood levels.

- Supply and installation of external post-tensioning
- Installation of carbon-fibre reinforced polymer
- Erection of scaffolding
- Traffic management

More details p.83

AUSTRALIA

PINEY CREEK BRIDGE, TASMANIA

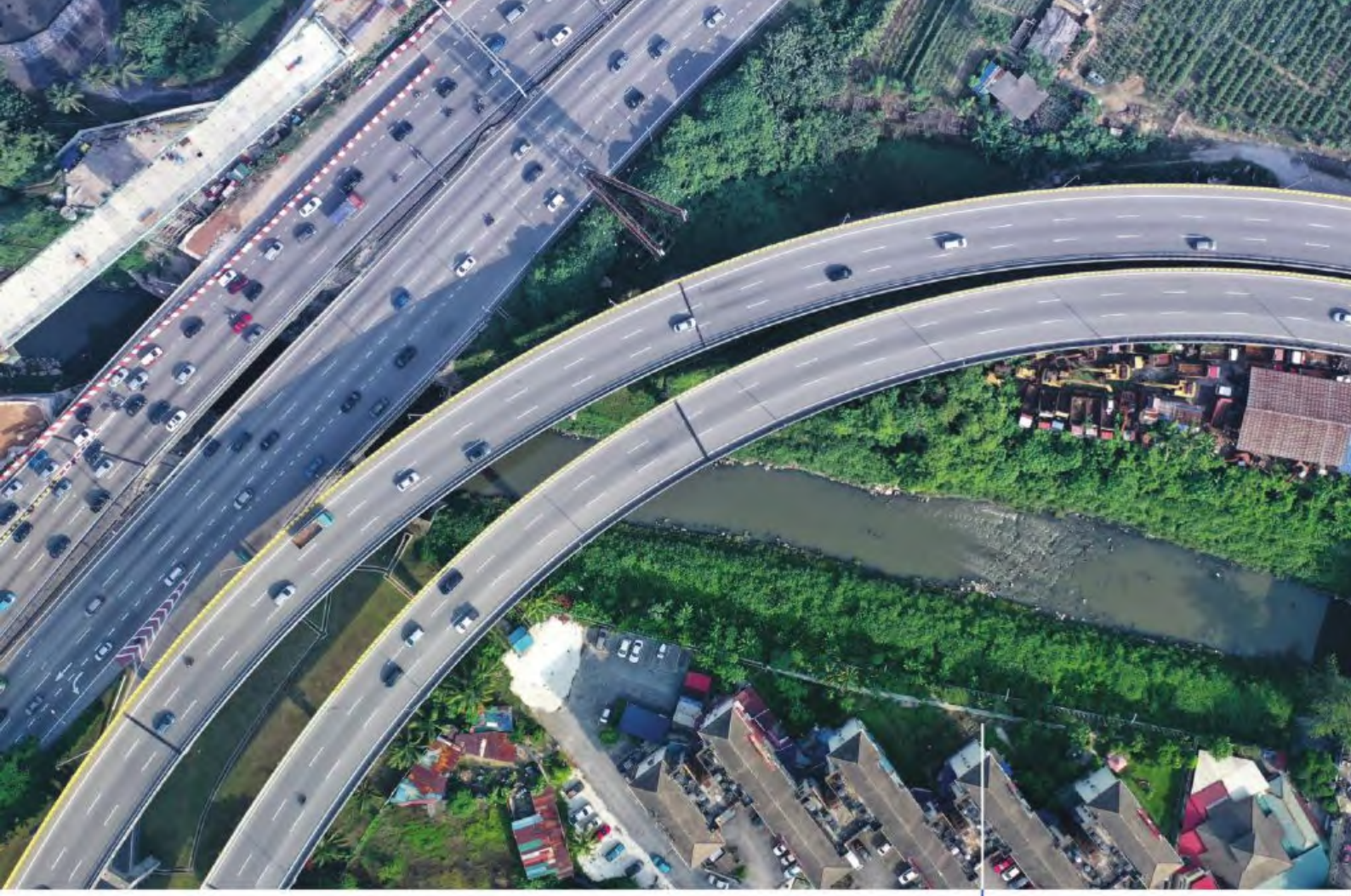
Delivering PT works to strengthen a bridge in Australia

AUSTRALIA
PYKES CREEK,
VICTORIA

As part of structural upgrades to accommodate higher traffic loads, the strengthening of the Pykes Creek Bridge involved the supply and installation of steel braces for crosshead reinforcement, and external post-tensioning works. It included a number of critical tasks such as the scanning and coring of the bridge deck, and the grouting of additional steel bracing to the headstocks.

- Supply and installation of steel braces for crosshead strengthening
- External post-tensioning for beams, deck shear reinforcement and associated road works

More details p.85



Repair and strengthening works on a cracked crosshead

MALAYSIA

MAJU EXPRESSWAY (MEX) NETWORK, KUALA LUMPUR

VSL carried out structural strengthening and repair works on a key crosshead on a major expressway in Kuala Lumpur, Malaysia.

- Design and erection of falsework, access staircase and working platform
- Concrete jacketing works
- Monitoring of the crosshead's deflection

More details p.87

Using new technology for cable replacement on a landmark bridge

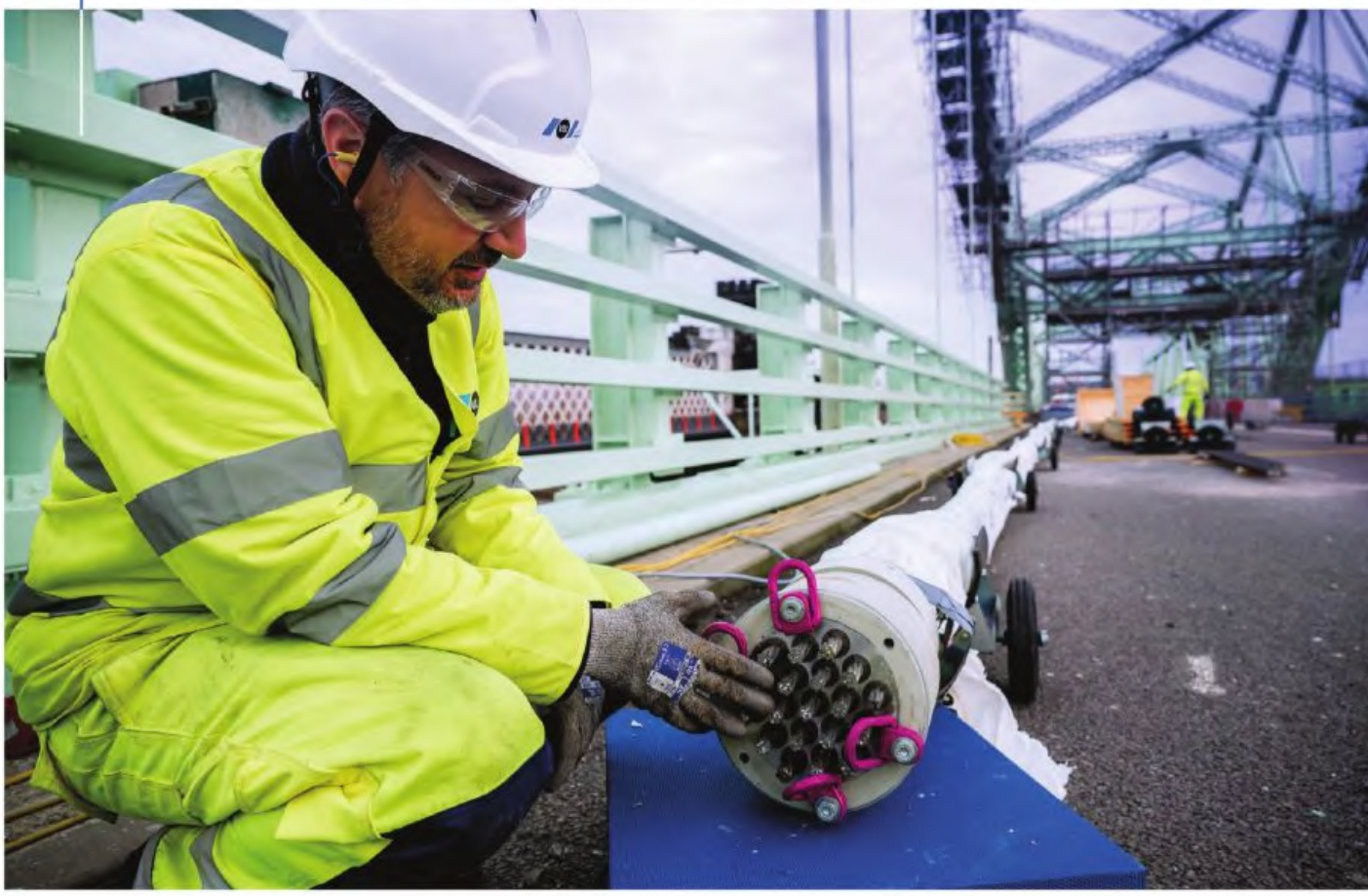
VSL has installed a robust VSL multistrand cable to replace a worn hanger on a landmark arch bridge crossing the River Mersey between Runcorn and Widnes in the United Kingdom.

- Design, supply and installation of the new replacement cable

More details p.89

UK

SILVER JUBILEE
BRIDGE, CHESHIRE



Inspecting PT tendons at a hydroelectric complex by using non-invasive techniques

The Salto Grande hydroelectric complex is one of the largest low-head river plants in the world. It stands on the River Uryguay, which forms the border between Uruguay and Argentina.
VSL was brought in to diagnose the condition of the PT tendons between the trunnion beams, piers and radial gate joints at each of the 20 piers of the spillway structure. It used non-destructive testing and non-invasive techniques, in order to affect the operation of the plant as little as possible.

- Detailed inspection of the concrete structure
- Measurement of tension
- Measurement of corrosion rates
- Modelling the behaviour of the trunnion beam-pier-radial gate joint
- Production of a general diagnostic report
- Proposals for structural remediation

More details p.91

ARGENTINA

SALTO GRANDE
HYDROELECTRIC
POWERPLANT

Upgrading and reinforcing 4,000m² of slabs for the warehouse of an iconic coffee brand

PORTUGAL

DELTA CAFÉS
WAREHOUSE,
CAMPO MAIOR

VSL reinforced the slabs of a coffee warehouse in order to increase its capacity by 40% to 50%.
It was essential to minimise downtime and avoid any impact on the warehouse's use.
VSL offered a design & build service which also includes monitoring of the structure for a period of 20 years.

- Slab reinforcement and upgrading
- Monitoring

More details p.93

One of the key accomplishments for VSL in 2020 will be the Umm Lafina project, in Abu Dhabi, the capital of the United Arab Emirates. This arch-shaped bridge has been designed to improve navigation whilst mitigating construction impact on the mangrove trees and maintaining the flow of water. VSL has designed the arches, supplied and commissioned the arch moulds and carried out the construction works for more than consecutive 60 spans of 21 arches, holding mechanically stabilized earth system walls using the VSoL system. The VSL's scope also included the post-tensioning for some ancillary structures.

INSIGHT

JOB REPORTS 2019

NEW COASTAL ROAD, REUNION ISLAND, INDIAN OCEAN

CARRYING OUT THE PT WORKS FOR A STRATEGIC VIADUCT OVERSEAS

Reunion Island's coastal road is a 12.5km-long route between Saint Denis and its only industrial harbour, Le Port. Connecting the administrative capital city to the economic hub means that this key highway has to carry heavy volumes of traffic.

The original road runs along the cliffs and the sea shore and is vulnerable to landslides and high waves in bad weather. Nets, gabions and other expensive safety measures have been installed in attempts to secure the road, but it still has to be closed frequently, which causes serious traffic disruptions.

The local government decided to build a new coastal road to improve safety and traffic flows between the two cities. The project consists of **three causeways and two viaducts, including the 5.4km-long and 28.9m-wide viaduct between St Denis and La Grande Chaloupe**.

The viaduct is a cantilever structure made from prefabricated concrete segments. It is divided into seven independent 769.3m-long sections, each supported by six intermediate piers and two abutments. The intermediate spans are 120m long and the end spans are 84.6m long. Each viaduct is made of 198 segments, which vary in height between 3.8m and 7.8m.

The construction of the viaduct was entrusted to a joint venture between Bouygues Travaux Publics, Vinci and Demathieu & Bard. The team needed complementary expertise for the post-tensioning (PT) works on the bridge and so awarded the contract to a JV between VSL and Freyssinet, who are affiliated to Bouygues Travaux Publics and Vinci, respectively. Each has extensive experience in France and overseas.

The scope of works included **supply and installation of 1,100t of greased coated strands for transverse PT, using the VSL VSLab S6-4 anchoring system, and 9,000t of bare strands for longitudinal PT, using the Freyssinet system**.

The VSL-Freyssinet JV also supplied and installed 2,500t of grout and 450t of wax, which were injected for the internal PT and external PT, respectively.
In particular, VSL's experience proved

DATE
2015 - 2019

LOCATION
Saint-Denis

OWNER
La Region La Réunion

ENGINEER
EGIS

MAIN CONTRACTOR
JV gathering together Bouygues Travaux Publics, Vinci and Demathieu & Bard

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Supply and installation for transverse PT (VSL system)

Supply and installation for longitudinal PT (Freyssinet system)

Grout injection

Wax injection

KEY FIGURES

- Viaduct length: 5,404 metres
- Viaduct length -long and 28.9-metre-wide viaduct
- 1,100t of greased sheated strands
- 9,000t of strands
- 2,500t of internal PT
- 450t of external PT

crucial for the daunting task of **carrying out the safe installation of two 250m-long PT tendons**. The external tendons were made from 37 strands and their threading proved challenging due to their very small inner diameter (123.4mm) and the high filling rate of >50% needed in the duct. To overcome that difficulty, the VSL-Freyssinet JV used strand caps with different diameters, and decided to change the diameter of the coil following discussion with the supplier. A special pushing machine from specialist manufacturer was also used in the process as it was more powerful than a classic machine.

Grout injection : a key challenge for the project

One of the reasons involved the high quantities that needed to be produced - 1,390m^3 of grout, corresponding to 2,200t of cement. The team also had to take account of the site's hot weather between November and April, which affected the grout properties. Grouts with temperatures above 35°C cannot technically be injected. In addition, the works were carried out in an environmentally protected area.

As a result, the VSL-Freyssinet JV decided to build a fixed insulated factory at the abutment for grout production, and then transport the grout to the injection point in an agitating tank.

The transverse tendons were installed at the segment precasting yard as part of the segment production. The schedule involved producing three segments every day, two pier segments every week and one span or abutment segment every two weeks. In total, 1,386 segments were prefabricated.

The wax was delivered on site in 25t-capacity electrically heated containers to ensure efficient control of the wax temperature and to enable the injection operation. Wax injection also required consideration of the methods to be adopted. A cable could not be fully wax-injected in one go because the process would have taken too long, with the temperature of the wax dropping until it solidified and blocked the duct. The ducts were therefore injected in four stages. Use of the VSLab system enabled the entire operation to be carried out successfully while meeting the schedule.

The project for the VSL- Freyssinet JV began on 15th June 2015 and was completed on 31st July 2019.

Grout injection was a key challenge, because of high quantities that needed to be produced and high temperatures.

SAMUEL DE CHAMPLAIN BRIDGE, MONTREAL, CANADA

CARRYING OUT MAIN SPAN ERECTION FOR A NEW BRIDGE IN CANADA

The route over the St Lawrence River is a major transport corridor in North America, facilitating traffic flows between Canada and the United States. 50 million cars, buses and trucks used to cross the original Champlain Bridge in Montreal each year. This traffic, combined with the damage caused by de-icing salts and other factors, has had a considerable impact on the structure over time. This is why the Government of Canada decided to replace the Champlain Bridge with a new one - the Samuel De Champlain Bridge.

The new bridge, which was fully opened in July 2019, includes two three-lane corridors for vehicular traffic and a two-lane transit corridor capable of accommodating a planned light rail system. The new structure also incorporates a multi-use path for pedestrians and cyclists.

Signature on the Saint Lawrence Group (SSL) awarded the design and construction of the main bridge to the SSLC joint venture (JV) of SNC-Lavalin, Dragados Canada, Flatiron Constructors Canada and EBC Inc.

The initial challenge for the JV was to find an effective way to erect the 240m-long main span over the navigation channel without causing any interruption to shipping. In addition, the work had to be carried out as quickly and safely as possible, to meet the target of erecting one segment every two weeks.

Another major constraint was the need to work around extreme weather conditions. Winter in Montreal is extremely cold, with temperatures dropping to -35°C and high humidity over the water. Therefore, methods that reduced the amount of work taking place on site were preferred to traditional approaches.

VSL was integrated into the JV project team during the tender stage and had a global view of the practical constraints, giving it the opportunity to share advice and provide the most suitable solutions.

VSL suggested an innovative construction method that offered the shortest construction time on the critical path and avoided interference with the shipping navigation channel passing below the main span of the bridge. The

DATE
2015 - 2019

LOCATION
Montreal

OWNER
Government of Canada

ENGINEER / CONSULTANT
Stantec and Ramboll

DESIGNER
SNC-Lavalin, TY Lin International and International Bridge Technology

MAIN CONTRACTOR
Signature on the Saint Lawrence Construction (SSLC) joint venture, comprising: SNC-Lavalin; Dragados Canada; Flatiron Constructors Canada; EBC Inc.

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Supply of experienced engineers integrated into the client's team as well as provision of remote technical assistance from VSL's international Technical Centres

Design, supply & commissioning of specialised equipment (including heavy lifting strand jacks) for the main span erection (over 1,000t of steel and equipment supplied)

Technical assistance for segment erection and equipment operation on site

KEY FIGURES

- Weight of each segment: 850t
- Dimensions of each segment: 60m (w) x 12.6m (l) x 4.2m (h)
- Segment quantity: 15 units, of which 11 were erected using VSL equipment
- Weight of dynamic lifting frame: 735t
- Weight of movable lifting beam: 230t
- Weight of trolley system: 80t

solution offered by VSL also reduced the effect of construction on the environment as well as the impact of the harsh environment on the site, while improving overall safety.

The method deployed by VSL had never been used on any projects before, let alone at such a scale. The solution consisted of full prefabrication and assembly of segments off the critical path, on the ground, in order to minimise the time required to install them in-situ.

Based on its proposal, VSL was hired to provide technical expertise, key staff and equipment for the erection of the main span. The amount of technical expertise provided was extensive, including the supply of experienced engineers - both off site and on site – to support the client's technical and construction teams. VSL also designed and supplied the specialised equipment needed (lifting frames, trolleys, heavy lifting strand jacks) and carried out supervision during the construction.

The segments that comprise the main span are among the heaviest and largest ever lifted anywhere in the world, with individual weights of about 850 tonnes and unusually large dimensions – each 60m wide, 12.6m long and 4.2m high.

The segments were transferred from ground level to their final positions at the tip of the cantilevered deck using the following sequence:

- Each segment was assembled below the deck, next to the pylon, at ground level;
- The segment was lifted up using 'lifting beam' and strand jacking heavy-lifting technology;
- The segment was then transferred to a 'trolley system' that was provided below the completed deck, and then transported to the cantilever tip;
- The lifting frame picked up the segment from the trolley, enabling it to be joined to the already-erected segments with the help of strand jacks.

VSL was asked to incorporate many new features into the design on top of those initially agreed upon, and had to adapt to changes in construction sequences. Nonetheless, VSL's equipment managed to meet the tender target of erecting one segment every two weeks.

VSL also contributed to other scope of works for the new Samuel De Champlain bridge: post-tensioning systems, bearings, and the provision of mechanically stabilised earth walls for the east abutment.

The contract for the main span erection was signed on 15th April 2015 and the bridge was fully opened in July 2019.

CONTRACT CC3, TEMBURONG BRIDGE, BRUNEI

PROVIDING FIRE PROTECTION AND STAY-CABLE SYSTEMS FOR TWO MAJOR BRIDGES

The new, 30km-long Temburong Bridge connects the relatively isolated district of Temburong with the more developed Brunei-Muara region. The bridge enables land commuters to avoid passing through Malaysia and the four immigration checkpoints along the current route, which is frequently congested.

The project has been developed under several different construction contracts, since 2014. Contract CC3 includes the construction of two cable-stayed bridges over navigation channels within Brunei Bay.

The main contractor for CC3 – DAELIM, a South Korean company – was looking for **complementary technical expertise to supply and install a high-quality cable system for the two cable-stayed bridges**.

The owner (JKR) was very aware of the risks associated with potential petrochemical fires on a key national infrastructure link. It commissioned project representative Arup to develop a specification for fire protection of the Main Tensile Element (MTE) i.e. the stay cables. VSL and Arup worked together to develop the specification for the project and VSL successfully supplied and installed one of Asia's first fire-protected cable systems, setting the benchmark for this product in the region.

The project also included other stay-cable features, such as rubber dampers to protect against stay vibrations and an anti-vandalism solution.

Furthermore, VSL proposed the use of a saddle system: this cutting-edge technology allows for the pylon dimensions to be optimised, bringing savings in material costs and maintenance access requirements in comparison to traditional pylon design, including stay anchorages.

DATE
2016 - 2019

LOCATION
Muara

OWNER
The Government of His Majesty of the Sultan and Yang Dipertuan of Brunei Darussalam, represented by The Public Works Department, Ministry of Development

MAIN CONTRACTOR
Daelim

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Supply and supervisory work for the installation of a stay-cable system and a dedicated fire-protection system

Rental of specialist equipment for the construction of two cable-stayed bridges

KEY FIGURES

- Spans of 145m + 145m supported by a single pylon for the Brunei Channel Bridge
- Spans of 130m + 260m + 130m supported by twin pylons for the Eastern Channel Bridge
- 1,127km (approximately 1,400 tonnes) of stay-cable strand
- 80 saddles and saddle frames
- 160 stay pipes and associated accessories
- 160 stay cable anchorages and associated accessories
- 160 rubber dampers and associated accessories

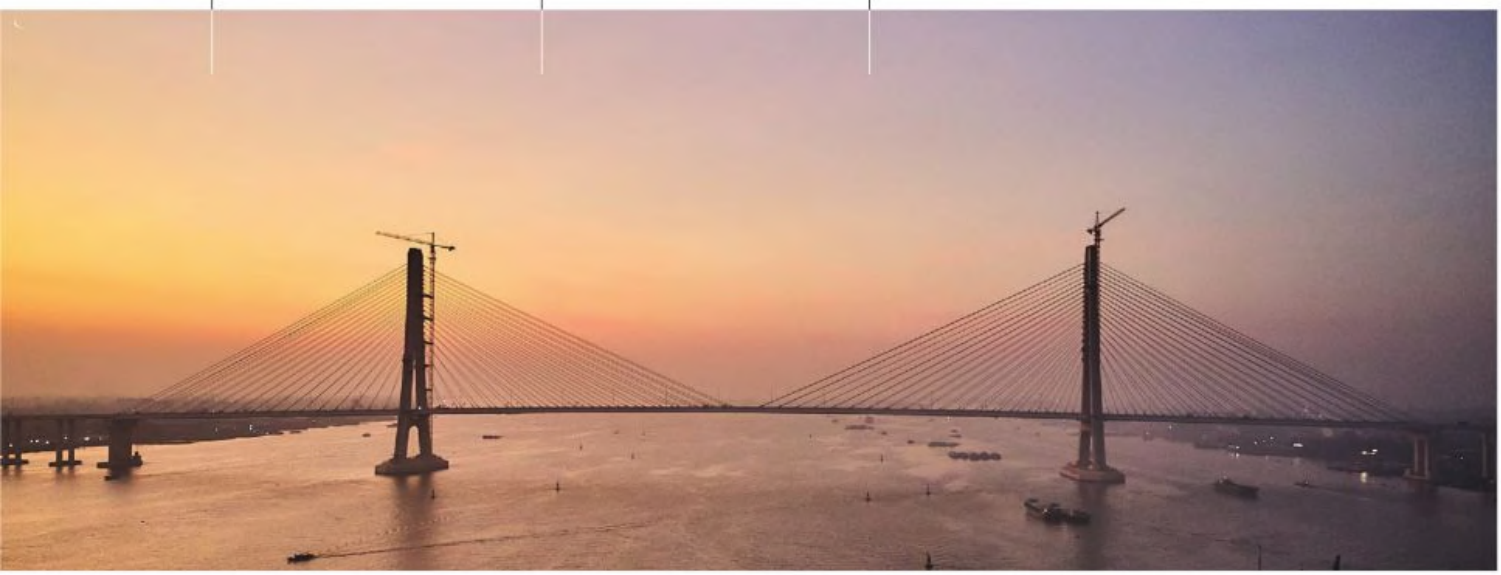
All these solutions proved instrumental in terms of the durability of the system and ensuring both time and cost efficiencies. The client also valued VSL's ability to provide the technical support, experience and guidance necessary to build the two cable-stayed structures simultaneously.

VSL was therefore subcontracted to supply and supervise the installation of a stay-cable system and dedicated fire protection system for each bridge. In addition, it was appointed to provide specialist rental equipment for the construction of the two bridges.

The project included a total of more than 1,127km (approximately 1,400 tonnes) of stay-cable strand, in addition to 80 saddles with their frames, 160 stay-cable anchorages, 160 rubber dampers and all the associated accessories. VSL also supplied and supervised the installation of the anti-vandalism and fire protection systems.

The contract began in October 2016 and was completed in November 2019.

VSL proposed the use of a saddle system: this cutting-edge technology allows for the pylon dimensions to be optimised, saving material costs and maintenance access requirements



VAM CONG CABLE-STAYED BRIDGE, CAN THO CITY, VIETNAM

SAVING TWO MONTHS IN THE CONSTRUCTION OF AN ICONIC BRIDGE IN VIETNAM

The Vam Cong Bridge is the second major bridge spanning the Hau River, a tributary of the Mekong. It links the Lap Vo district of Dong Thap province with the Thot Not district of Can Tho City in southern Vietnam. The project has been co-financed by South Korea and Vietnam.

The new cable-stayed bridge has a total length of nearly three kilometres and carries six vehicle lanes. The main bridge is a symmetrical cable-stayed structure, with two planes of stay cables. Its 450m-long main span is flanked by side spans, each 210m long.

The cable-stayed section has 144 stay cables that are supported by two 144m-tall towers, which are H-shaped for aesthetic reasons. It is expected to become an architectural landmark in the region.

The main contractor, a joint venture of GS Engineering & Construction and Hanshin Engineering & Construction Co., Ltd, needed specialist help to complete the project on time and in line with the approved budget. Furthermore, the Vietnamese Ministry of Transport, which owns the bridge, required a high-end specification for the stay cables.

In Vietnam, VSL had successfully completed many other cable-stayed bridges, such as the Rach Mieu, Tran Thi Ly, Kien and Nga Ba Hue bridges.

VSL's scope of work included the supply and installation of the VSL SSI 2000e stay cable system and the damping devices. To insure the stability of the bridge during its construction, VSL also proposed an alternative scheme that was finally approved. The original scheme envisaged fixing the deck to massive concrete blocks lying on the river bed. **The alternative scheme proposed by VSL included the provision of two temporary wind cables for each**

DATE
2013 - 2019

LOCATION
Cantho City

OWNER
Ministry of Transport – Representative: Cuu Long Corporation for Investment, Development and Project Management of Infrastructure

CONSULTANT
Joint venture of:
- Dasan Consultants Co., Ltd.
- Kunhwa Engineering & Consulting Co., Ltd.
- Pyunghwa Engineering Consultants Ltd.

MAIN CONTRACTOR
Joint venture of:
- GS Engineering & Construction
- Hanshin Engineering & Construction Co., Ltd

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Supply and installation of:

VSL SSI 2000 Stay cable system

VSL Damping devices,

Tie-down cable (VSL SSI 2000 Stay cable system)

Wind cable

KEY FIGURES

- Main span length: 450m
- Deck width: 25m
- Pylon height: 144m
- Size of stay cables: 6-31 to 6-73
- Cable length: 43m to 235m, number of strands: 30 to 73 strands
- 1,300t of strands for stay, tie down and wind cables
- 144 friction dampers

cantilever, fastened between the main girders and the pylon base. VSL's proposal was chosen as it offered the most cost-effective and practical solution for the project.

During the construction of the main bridge, the start date of the stay cable works had been delayed by approximately four months due to late completion of the pier tables. VSL was required to implement double shift works and to mobilise additional equipment and staff within a short time, in order to mitigate the original project delays. As part of the project team, and thanks to these efforts, VSL was able to shorten the construction programme by two months, reducing the standard cycle time to erect a segment and its stay cables from 12 to 10 days generally, and as low as 7 days for some segments.

The stressing methodology that VSL adopted featured force control (at the first stressing – installation stage) and elongation control using a strand marking method (at the second stressing) together with geometrical control of the bridge.

In total, 1,300 tonnes of strands were installed for the project on tie-down and wind cables, together with 144 friction dampers.

The work was completed on time and met the high quality standards required, to the satisfaction of all parties.

Construction works for Vam Cong Bridge began on 10th October 2013 and the bridge opened to traffic on 19th May 2019.

VSL suggested fastening each wind cable from underneath the main girder to the pylon base, instead of fixing it to concrete blocks lying on the bed of the river.

AL GHOUSE ROAD IMPROVEMENTS, MUBARAK AL-KABEER, KUWAIT

DELIVERING A FULL SOLUTION FOR THE DECK CONSTRUCTION OF 13 BRIDGES IN KUWAIT

Kuwait's Ministry of Public Works commissioned **the construction of six flyovers and seven footbridges along Al Ghouse Road to improve traffic** from the Sabah Al Salem area to the 7th Ring Road. The RA 264 project also included maintenance and upgrades to Al Ghouse Road and conversion of existing signalised intersections into wide roundabouts.

The main contractor - Ahmadiah Contracting & Trading Co., a leading civil engineering and building company in Kuwait - needed complementary expertise for the precast of bridge segments, deck erection and post-tensioning works (PT) to help deliver the project on time.

VSL provided a full solution that included the design and supply of segment precasting moulds, the supply of PT material and equipment, supervision at the precasting yard and erection of concrete segments, span by span on falsework.

In addition, VSL developed the geometry control software, calculated the theoretical PT elongations and carried out supervision over a period of 22 months using a team of five engineers and five supervisors.

The 1,036 segments needed for the 66 spans were erected span by span on shoring and specific phasing was devised in

DATE
2017 - 2019

LOCATION
Mubarak Al-Kabeer

OWNER
Ministry of Public Works

ENGINEER / DESIGNER / CONSULTANT
EGIS International & MAZEN Al SANE Engineering Consultant (MSEC)

MAIN CONTRACTOR
Ahmadiah Contracting & Trading Co.

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

A full solution including:

- Design and supply of segment precasting moulds
- Supervision at the precasting yard
- Supervision of deck erection
- Supply of PT material and equipment

KEY FIGURES

— 6 flyovers
— 7 footbridges
— 1,036 segments
— 66 spans

order to keep the traffic working during construction and ensure the overall quality. In total, 4,720 anchorage tendons were needed for the PT works.

The contract began on 20th June 2017 and ended on 31th July 2019.

VSL provided a full solution for the segment precasting and erection of six flyovers and seven footbridges along Al Ghouse Road in Mubarak Al-Kabeer Governorate.

KRAKOW – ZAKOPANE EXPRESSWAY, POLAND

EXECUTION OF PT WORKS FOR VIADUCTS IN POLAND

The 100km-long southern section of the S7 between Krakow and Zakopane is a major tourist and regional road connecting the Tatra Mountains. About 50% of the route was already at expressway standard and the General Directorate for National Roads & Motorways is making steady progress each year to continue the upgrades. The aim is to bring the traffic between Kraków and Nowy Targ onto new dual two-lane carriageways in the next four years.

One of the most difficult segments to build is in the central part of Zakopianka where the route crosses a mountain. The section stretches over 16.7km and includes several high viaducts and a 2km-long tunnel.

Due to the difficulties, the owner divided the central section into three subsections and launched three different tenders. Section I was awarded to IDS (Poland); section II to Astaldi (Italy) and section III to Salini (Italy). Some of the biggest viaducts, such as viaducts 18 and 21, were subcontracted to Porr (Austria), and the curved viaduct 4 at the start of the new section was awarded to Mosty Nowak (Poland).

All the contractors needed complementary expertise to carry out the post-tensioning (PT) works in their respective sections to ensure that the road and bridge works would be completed in line with the project schedule.
VSL was involved at the tender stage and presented the optimal solution to contractors and subcontractors IDS, Astaldi, Mosty Nowak and Porr. VSL was therefore subcontracted the delivery of PT works and the supply of bearings to all three sections.

VSL used its standard VSL Multistrand PT System, including both internal and external PT, and active and passive anchorages. The use of GCK couplers facilitated the staged concreting required for the substantial span lengths involved.

DATE
2017 - 2019

LOCATION
Central part of the expressway between Krakow and Zakopane

OWNER
General Directorate for National Roads & Motorways

MAIN CONTRACTOR
IDS, Astaldi, Salini, depending on the subsection:

- Section I: Lubien – Naprawa (7.6km)
  Main contractor: IDS (Poland)
- Section II: Naprawa – Skomielna (3.0km)
  Main contractor: Astaldi (Italy)
- Section III: Skomielna – Rabka (6.1km)
  Main contractor: Salini (Italy)

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Post-tensioning works

Provision of the VSL Multistrand PT System, including both internal and external PT

Delivery and supply of bearings

Provision of scaffolding and balanced-cantilever formwork

KEY FIGURES

- Delivery of 3,800 tonnes of steel
- Total length of viaducts: 4,000m
- 2,166 active and passive anchorages
- 316 GCK couplers
- 144 friction dampers

The most impressive structure built as a part of the project was Road Bridge 21, a 992m-long box girder viaduct with 10 spans, more than 50m above ground level. The two end sections were built on scaffolding and the central section was erected by cantilever methods, working simultaneously from three piers. VSL carried out the PT works for the entire bridge.

In total, VSL supplied and installed 3,800 tonnes of strand for almost 4,000 metres of viaducts.

VSL managed to maintain a very precise stressing schedule for both the incremental launching and cantilever methods, despite operating in a remote location under challenging winter conditions. Works were carried out on several fronts at the same time.

The contract began on 1st April 2017 and was completed on 31st December 2019.

In total, VSL delivered 3,800 tonnes of steel strand for almost 4,000 metres of viaducts.

I59/20 CBD – BIRMINGHAM, ALABAMA, USA

CARRYING OUT BRIDGE WORKS IN THE USA TO A TIGHT SCHEDULE

The main east/west thoroughfare through Birmingham, Alabama, carries 170,000 vehicles per day. The state of Alabama decided to upgrade the road, which was scheduled to be shut for a year to construct new viaducts.

The I59/20 CBD bridges replacement project involved dismantling two bridges on the westbound and eastbound main carriageways and **replacing them with two segmental bridges, each 2,000 metres long**. The project also encompassed construction of two ramped bridge accesses.

The project included a total of 172 spans, made up of 2,306 segments, all precast in advance of and in conjunction with the demolition and reconstruction of the new viaducts.

The client structured the tender with a very high priority on the achievement of the 12-month deconstruction and reconstruction schedule. Johnson Bros. Corporation, the main contractor (MC), needed a technical proposal that reduced the programme-related risks and enabled the works to finish in nine to ten months, to fit in with other constraints in the contract.

VSL provided the main contractor with a solution that met all the criteria and was awarded the works. Its proposal included a technical solution for the precasting and erection of the segmental bridges.

VSL worked with the contractor to customise the bridge deck construction to accommodate other constraints (traffic, interface with demolition etc.) to optimise the contractor's bid.

The VSL's scope of works included design and supply of casting cells; and design and supply of erection equipment (such as shoring towers, stressing platform), including hydraulic equipment.

DATE
2017 - 2019

LOCATION
Birmimgham, Alabama, USA

OWNER
State of Alabama

ENGINEER
Corven Engineering Inc

DESIGNER
McNary Bergeron & Associates

MAIN CONTRACTOR
Johnson Bros. Corporation

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Design and supply of casting cells

Design and supply of erection equipment (such as shoring towers, stressing platforms), including hydraulic equipment.

KEY FIGURES

- 11 casting cells
- 127 shoring towers (1,800 tonnes, average height 11 metres)
- 8 segment-lifting beams
- 8 stressing platforms (48 tonnes)
- 2 portals (250 tonnes, lengths 43.5 metres and 40 metres)

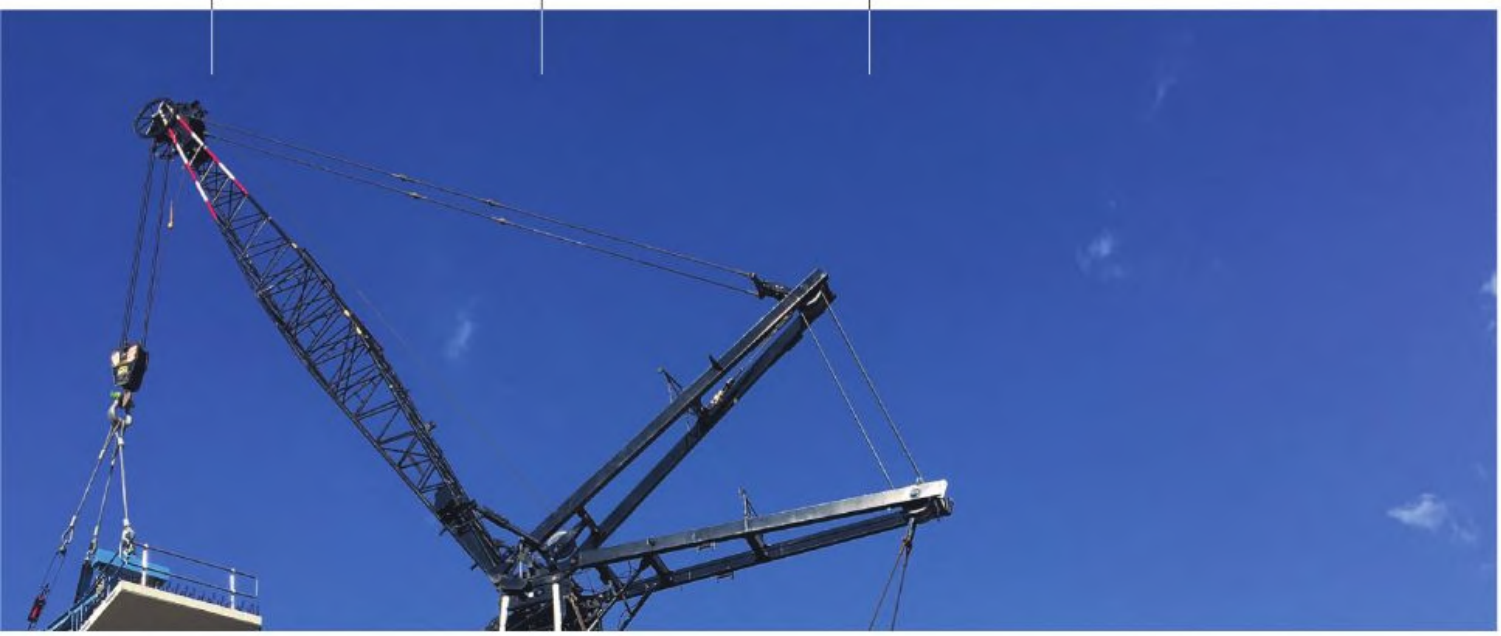
In order to give the main contractor greater assurance and flexibility to achieve the very tight programme requirements, VSL proposed an alternative construction solution for the deck erection. Instead of using launching gantries, VSL proposed to erect the deck segments on a series of customised shoring systems. This solution proved to be economical yet enabled the contractor to erect the bridge in a record time. It therefore became the preferred - and eventually the winning - solution.

In total, 11 casting cells, 127 shoring towers (1,800 tonnes, average height 11 metres), 8 segment-lifting beams, 8 stressing platforms (48 tonnes) and 2 portals (250 tonnes, lengths 43.5 metres and 40 metres) were used in the project.

VSL used its international expertise to liaise between the contractor in the USA, the design and fabrication of the casting cells in Italy, the falsework design in Singapore, the falsework fabrication in China and the project coordination team in Switzerland.

The mission began on 5th May 2017 and ended on 8th November 2019. The scheme that was proposed and implemented by VSL allowed the contractor to complete the erection works in a record time, two months ahead of the contracted completion date.

VSL proposed an alternative solution for the deck erection. Instead of using launching gantries, VSL proposed to erect the deck segments on a series of customized shoring systems.



WESTCONNEX STAGE II - ST PETERS INTERCHANGE, AUSTRALIA

PRECASTING, ERECTION AND POST-TENSIONING WORK FOR NINE BRIDGES IN SYDNEY

The new 33km WestConnex motorway - **the largest transport project in Australia - links Sydney's west and southwest with the central business district, Sydney's Airport and Port Botany**. The aim is to ease traffic flow and to help Sydney's economic growth. The motorway includes bridges, tunnels, cut & cover and retained earth structures. The overall project is being delivered in three stages, with the final stage due to open to traffic in 2023.

One of the key sections of the WestConnex Stage II project is the new St Peters Interchange, which comprises nine bridges made up of 579 precast segments for a total viaduct surface area of 17,600m^2.

The main contractor for this project was a joint venture between Dragados, Samsung and CPB (formerly Leighton), one of VSL's main customer in Australia. VSL had already delivered six match-cast segmental bridge projects with CPB under a partnering contract. VSL's previous experience and know-how about this form of construction was a driving force for the JV engaging VSL again.

VSL worked with CDSJV during the tender stage on **an alternative to the short-span concept design**. Following this, **VSL was appointed to provide the experienced staff, supervision and labour required for the precasting, erection and post-tensioning of the project's segmental bridges. VSL also developed all methods and temporary works designs as well as carrying out fabrication, installation and operation**.

The main reason for using longer spans was to minimise the risks associated with the piling works. The bridges have been constructed on an old tip, where there was a high risk of latent conditions that could have caused problems. Urban design was another big driver.

DATE
2017 - 2020

LOCATION
Sydney

OWNER
WestConnex Delivery Authority

ENGINEER
Arcadis (site independent certifying engineer)

DESIGNER
Aurecon Jacobs Joint Venture, with TGP HK as sub-consultant for Bridge 1

MAIN CONTRACTOR
CPB-Dragados-Samsung Joint Venture (CDSJV)

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Precasting and delivery of 579 segments

Supply of concrete and rebar

Unloading of precast segments at the erection front

Erection of precast segments

Supply and installation of post-tensioning (the PT component supply was managed through a separate VSL supply contract, but remained part of the partnering agreement scope)

Design, supply and operation of all temporary works associated with the operations

Supply and installation of bearings

KEY FIGURES

- Bridges: 9
- Segments: 579
- Overall deck length: 1,584m
- Concrete: 10,696m^3
- Rebar: 1,604 tonnes
- Strand: 598 tonnes

For two of the bridges, VSL executed - for the first time - structures with a constant tapered web with a variable vertical soffit section.

The scope of works comprised precasting and delivery of 579 segments; supply of concrete and rebar; unloading of precast segments at the erection front; erection of the segments; supply and installation of post-tensioning (PT); design, supply and operation of all temporary works associated with the operations; and the supply and installation of bearings.

Precast balanced cantilever construction was chosen as the preferred erection method in order to meet the technical constraints as well as requirements arising from the urban location and from the overall fast-tracked programme.

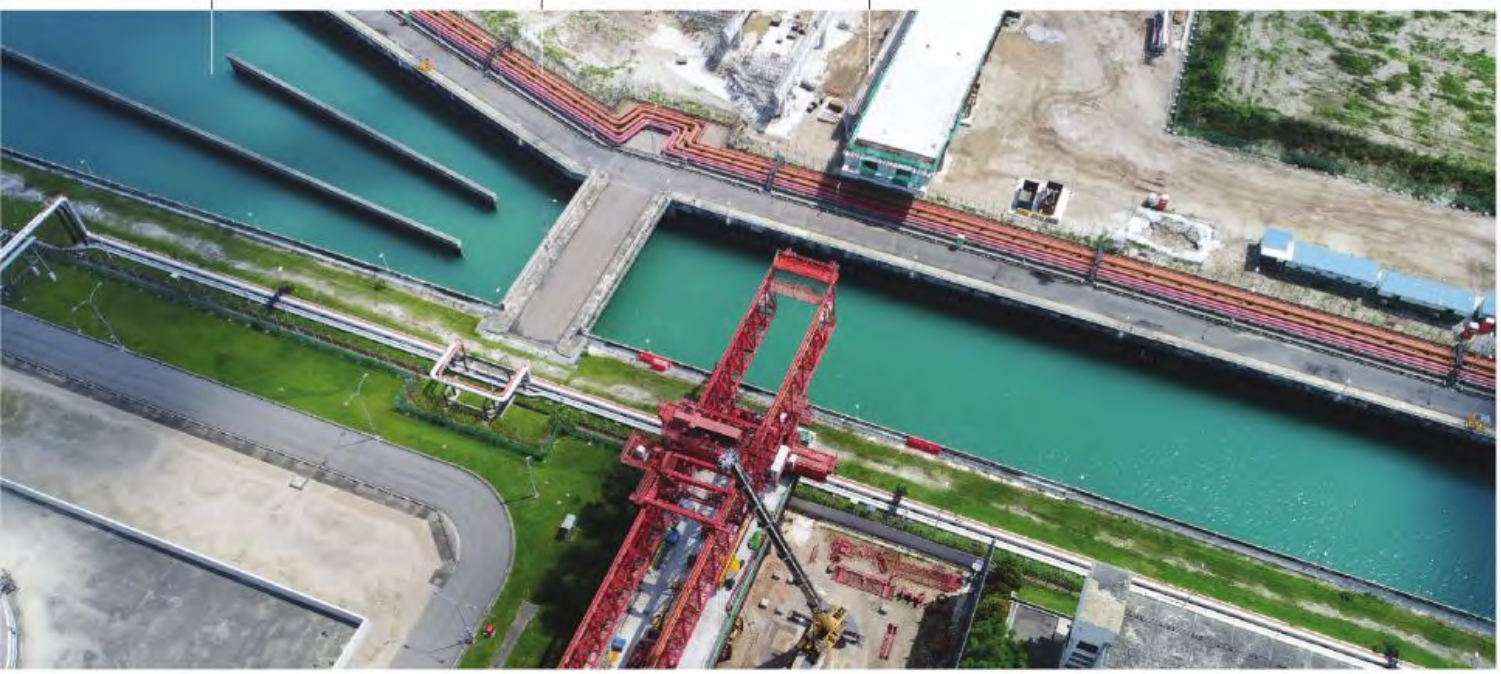
The 579 segments - ranging from 34 tonnes to 89 tonnes - were precast, using three casting moulds in a factory. Cranes were used for the erection of the segments, including 350t and 280t crawler cranes.

The main challenge arose from working in the heart of Sydney on a major interchange made up of multi-layered overlapping viaducts with tight radiuses. Low aviation clearances due to the nearby airport also posed a number of challenges involving the sizing of the erection cranes as well as the construction sequencing.

Works were completed on time and within budget.

Establishment of the precasting yard began in February 2017 and the erection and finishing works at the interchange site were completed in January 2020.

A 350t crawler crane with superlift carried out some of the lifts.



TUAS VIEW BASIN ACCESS BRIDGE, SINGAPORE

GANTRY OPERATION AND PRE-TENSIONING WORKS FOR A NEW BRIDGE IN SINGAPORE

The construction of a new road access at Tuas View Basin in Singapore required the **design and construction of two viaducts** (Route 2 and Route 3) from Tuas South Avenue 9 to Tuas View Basin.

The client - McConnell Dowell (MCD), a major infrastructure construction company in New Zealand - was hired to carry out the works and install seven U-girders weighing up to 283 tonnes for the main spans crossing water.

The water is used for cooling the generator in a nearby power plant and any failure in operation might lead to dramatic power cuts over an extensive area of Singapore. Significant planning, ressources and expertise were required to succesfully carry the U-girder installation operation. The site boundary also presented restrictions and crane operation was not a viable option to lift the U-girders into place.

The client therefore required a solution for the U-girder installation that provided a safe and smooth operation without any interference at the adjacent site boundary.

VSL had been MCD's partner during the tender stage, working to devise a cost-effective and 'buildable' solution to win the tender. Notably, **VSL suggested using a launching gantry instead of a form-traveller to ensure a smooth operation for the erection of the U-girders over the sensitive site**.

VSL's scope of works included the provision, assembly and operation of the gantry for the erection of the seven main-span U-girders for Route-2 and Route-3. The beams had a maximum length of 50.5 metres and weigh up to 283 tonnes. VSL also supplied, installed and stressed pre-tensioned strands for 21 further U-girders and

DATE
2017 - 2018

LOCATION
Singapore

OWNER
National Environmental Agency

ENGINEER / CONSULTANT
Aecom

DESIGNER
Aurecon

MAIN CONTRACTOR
McConnell Dowell

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Design, provision, assembly and operation of the erection gantry used for installation of the main span U-beams

Supply, installation and stressing of pre-tensioned strands for U-girders and I-beams on Route-2 and Route-3

KEY FIGURES

- 7 main span U-beams
- Maximum beam length: 50.5m
- Maximum beam weight: 283 tonnes
- 21 U-girders
- 128 I-beams
- Total strand tonnage: 370 tonnes

128 I-beams. The total weight of the strand installed was 370 tonnes. The launching gantry spanned 75.5 metres between two piers and had a total lifting capacity of 300 tonnes, with 150 tonnes per lifting point.

The reuse of an existing gantry instead of a newly designed and fabricated one helped save costs. It had just been decommissioned from a link road project in Hong Kong, as part of the Hong Kong - Zhuhai - Macau Bridge.

The project presented many technical challenges, such as design checks to enable reuse of the gantry and rechecking of the gantry as the beam weight increased. VSL successfully tackled these challenges as well as logistical difficulties, such as carrying out pre-assembly, packing and unpacking of the gantry 4km away from the first installation site on Route 2. The gantry needed to be commissioned and decommissioned twice for beam installations at two locations, requiring the storage of its parts in 49 standard 40-foot containers, which needed to be transported to the next location.

The mission began on 1st May 2017 and was completed on 15th August 2018.

The launching gantry spanned 75.5 metres between two piers and had a total lifting capacity of 300 tonnes.

KVMRT 2 PACKAGE V203, KUALA LUMPUR, MALAYSIA

CARRYING OUT ERECTION WORKS AND POST-TENSIONING FOR A MAJOR VIADUCT IN MALAYSIA

The Klang Valley Mass Rapid Transit Line 2 (KVMRT 2) is being developed to improve traffic flow from Sungai Buloh to Putrajaya and boost the quality of life in these areas. Contract V203 is one of the 10 packages tendered for the construction of a 40km-long elevated viaduct on the new line.

The main contractor - IJM, a major construction company in Malaysia - had originally purchased its own launching gantries and was initially carrying out the work itself. Some rescheduling on the project and changes in resources meant that measures had to taken to complete the project by the target dates. Consequently, IJM was looking for an experienced specialist to provide support and subcontracted **VSL to supply and operate a VSL launching gantry and erect 32 standard spans for the northbound and southbound structures**.

The overall scope of works included the supply of the VSL launching gantry and the provision of specialised staff to operate it. VSL was responsible for the erection of the 376 segments that make up the 32 spans. Its role also included the installation of external PT ducting and strands, together with stressing, load transfer and span alignment. Each single-track standard span was up to 39.8 metres long and weighed up to 360 tonnes.

In total 4,100m^3 of concrete and 152 tonnes of strand were used over the 6,900m^2 deck area.

DATE
2018 - 2019

LOCATION
Kuala Lumpur

OWNER
MRT Corporation

ENGINEER
MMC-Gamuda JV

DESIGNER
H & T Consultants

CONSULTANT
SMHB

MAIN CONTRACTOR
IJM

SCOPE OF WORKS

Supply and operation of a launching gantry

Erection of 32 standard spans

Installation of external PT

KEY FIGURES

- 76 segments making up 32 spans
- 152 tonnes of strand

The route alignment involved the parallel single-track northbound and southbound viaducts merging into a double-track viaduct at the end. As a result, VSL had to slide the launching gantry from the southbound viaduct to the northbound viaduct.

VSL undertook the design of all the temporary works including hydraulic equipment for the slide. The preparation for the operation took one week after the design approval and the sliding of the launching gantry was completed in a single shift.

VSL provided an optimised solution for the deck erection works that enabled the main contractor to complete the works on schedule.

The contract started on 9th July 2018 and ended on 30th May 2019.

VSL supplied and operated a VSL launching gantry and erected 32 standard spans for the northbound and southbound structures.

EXTENSION OF THE NORTHERN BYPASS - KATZENSEE, ZURICH, SWITZERLAND

PERFORMING PT WORKS FOR A CUT-AND-COVER TUNNEL AND EIGHT BRIDGES IN SWITZERLAND

The Zurich bypass is one of the busiest sections of motorway on the Swiss network. The Federal Roads Office decided to widen the existing dual two-lane northern section to three lanes in each direction.

One of the key projects on the scheme was the building of the new cut-and-cover Katzensee Tunnel, which is more than 600 metres long, together with the construction of eight new bridges.

The main contractor - ARGE Nordring Los 4 joint venture, led by Marti AG Zürich - had a tight construction programme that required the construction of two 25m-long stages per week. **The main contractor needed to bring in additional technical expertise to help it meet the tight contractual deadlines**.

VSL had already worked with the design engineers Gruner AG and DSP, who knew of VSL's multistrand cable system. **VSL became involved at the tender stage and was able to work with the client to develop detailed solutions**.

As a result, VSL was appointed to **supply and install the cable strands using its own post-tensioning system. All work - both for the tunnel cover and for the construction of the eight bridges - had to be carried out to a tight schedule**.

The scope of works included supply, tensioning and grout injection for the cable strands in two six-month stages for the cut-and-cover tunnel - one construction phase for each traffic direction - and over a period of 40 months for the construction of the bridges.

For the cut-and-cover tunnel, VSL used 545 tonnes of 0.6" strands; 1,216 of its GC 6-22 anchorages; 180 of its 6-22 type K couplers; and 190 tonnes of

DATE
2016 - 2019

LOCATION
Zürich

OWNER
Swiss confederation - Federal Roads Office

ENGINEER / DESIGNER / CONSULTANT
Gruner AG, Rothpletz, Lienhard + Cie AG, dsp Ingenieure + Planer AG

MAIN CONTRACTOR
ARGE Nordring Los 4, c/o Marti AG Zürich

SCOPE OF WORKS

Supply of cable strands

Post-tensioning of cable strands

Grout injection for the cable strands for a cut-and-cover tunnel and 8 bridges

KEY FIGURES

- strands 0.6": 545 tonnes
- Anchorages GC 6-22: 1,216 pieces
- Couplings K 6-22: 180 pieces
- HPI grout: 190 tonnes

HPI grout. In addition, VSL installed 178 tonnes of strands for the eight bridges. **For both projects, VSL used the VSL electrically isolated Protection Level 3 multistrand PT system** with K couplers.

VSL developed a system of special openings for the contract, allowing the cables to be threaded through recesses created in sections that had already been concreted. The challenge was to minimise the size of each concrete recess as much as possible while allowing the team to carry out the work, which required the use of cutting-edge technology and expertise. To do so, VSL lined a small 600x600mm opening with a PE pipe, enabling the strands to be threaded through the concrete.

The contract started on 1st June 2016 and ended on 30th May 2019.

VSL used the VSL electrically isolated Protection Level 3 system to protect post-tensioned strands from corrosion on the cut-and-cover tunnel and the eight bridges.

TMCLK LINK'S NORTHERN CONNECTION, HONG KONG

BUILDING THE WORLD'S LONGEST CATERPILLAR TRENCH IN ADVERSE GEOLOGY

The Tuen Mun - Chek Lap Kok (TMCLK) Link's Northern Connection sub-sea tunnel section was built to help expedite travel between the Northwest New Territories and the Hong Kong - Zhuhai - Macao Bridge and to offer an alternative route to the airport from North Lantau. The tunnel is 6km long, including 4.2km below sea level.

The connection starts from the previously built South Ventilation Shafts and ends at the tunnel's South Approach Ramp.

Recent reclamation work for a newly built artificial island meant that the main contractor - a joint venture between Dragages and Bouygues Travaux Publics (DBJV) - had to deal with unstable sea walls and non-consolidated geology before starting its own main scope of work.

DBJV offered alternative technical solutions to the client to overcome the instability of the island and enable the construction of the tunnel's southern landfall. The so-called **Modified Hybrid Scheme (MHS) involved the construction of a strut-free 15-cell 'caterpillar' support structure connected to a tunnel excavated with a Tunnel Boring Machine (TBM). The goal was to speed up the excavation and the construction of the cast-in-situ part of the tunnel, which was being built in adverse geological conditions**.

VSL had partnered with DBJV since the beginning of the TMCLK project. In earlier phases, VSL built the foundations of the **South Ventilation Building (SVB)** together with the diaphragm walls of both **South Ventilation Shafts (SVS)**. At the Northern Landfall, where the tunnelling construction started, VSL had also built a three-cell caterpillar structure for the North Launching Shaft and the water cut-off of the North Approach Ramp.

For the latest project, **VSL was hired to provide the necessary ground improvement for the TBM section and the diaphragm wall for the caterpillar section of the tunnel.**

DATE
2017 - 2018

LOCATION
Hong Kong, on HKBCF reclamation island

OWNER
Highways Department- The Government of the Hong Kong Special Administrative Region

ENGINEER / CONSULTANT
Aecom

DESIGNER
Atkins, Golder

MAIN CONTRACTOR
Dragages Bouygues TP Joint Venture

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Jet grouting for connection between the SVS and the TBM part of the MHS

Jet grouting for remaining SVB foundations

Barrette foundations to guide final TBM drive

CSM curtain wall

Straight D-Wall

15-cell caterpillar D-wall, including a 3-cell receiving shaft for TBM dismantling

CSM for trench stability of Y-panel D-wall

Barrettes for foundation of VSL gantry

A straight D-wall portion at the back of the caterpillar for the open cut excavation of the SAR.

Barrettes for foundation of Satellite Control Building

KEY FIGURES

- Plant: 2 jet grouting (JG) rigs, 2 CSM rigs, 4 cable grabs, 3 cutters and 3 hydraulic grabs
- 200 labourers at peak
- 520,000 man-hours worked
- Around 76,000m³ of CSM for the MHS section of JG
- 39,000m³ of JG
- 150,000m³ of D-wall
- 21,600m³ of barrettes
- 12,300t of steel
- 770,500m of GFRP

Y-Panels: a world-leading technical feat

In order to deal with adverse geological conditions caused by a very deep and thick layer of soft marine deposit, an innovation referred to as Y-panels has been implemented to construct the world's largest caterpillar-shaped cofferdam for a cut-and-cover tunnel. The Y-panels were developed thanks to close collaboration between DBJV and VSL.

The basic principle involves using the arch effect to resist lateral water and earth pressures, thus limiting the effect of vertical bending. Arched wall segments shift the load to the connection panels, in other words the Y-panels, which redistribute the transverse load via reinforced concrete bracing (built during the excavation) and transverse diaphragm walls below the final excavation level.

VSL's scope of works also included:

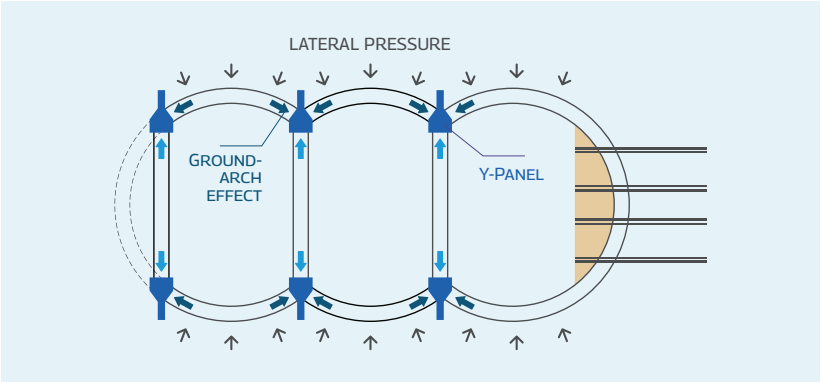
- Jet grouting for the connection between the SVS and the TBM part of the MHS
- Jet grouting for the remaining SVB foundations
- Barrette foundations to guide the TBM's final drive from the SVS to the caterpillar section
- Construction using cutter soil mixing (CSM) of a curtain wall between the SVS and the caterpillar section to provide a TBM maintenance area
- Provision of a CSM 'parking plug' in front of the caterpillar, terminated by a straight diaphragm wall with a soft eye to allow for future TBM breakthrough into the caterpillar section
- Barrettes for the foundation of the VSL gantry mobilised to extract the TBM components during its dismantling at the receiving shaft
- A straight portion of diaphragm wall at the back of the caterpillar section for the open cut excavation of the South Approach Ramp
- Barrettes for the foundation the Satellite Control Building at the future tunnel entrance of the South Approach Ramp

These solutions were chosen and developed because they enabled cost-effective, direct and efficient tunnelling work and excavation and lateral support.

The partnership with VSL allowed completion of all the excavation and lateral support construction before the target date and substantial cost savings.

Two jet grouting rigs, two CSM rigs, up to four cable grabs, three cutters and three hydraulic grabs were used in the project. About 200 labourers were hired at peak, for a cumulative total of 520,000 man-hours worked.

VSL's subcontract agreement started on 9th October 2017, with a finishing date of 30th November 2018. The actual works started on 30th November 2017 and ended on 17th November 2018.



The basic principle of Y-panels involves using the arch effect to resist lateral water and earth pressures, thus limiting the effect of vertical bending.

SAMUEL DE CHAMPLAIN BRIDGE, MONTREAL, CANADA

BUILDING MECHANICALLY STABILISED EARTH RETAINING WALLS WITH CURVED AND INCLINED PANELS

The new 3.4-kilometre Samuel De Champlain bridge in Montreal, which was fully opened in July 2019, includes two three-lane corridors for vehicular traffic and a two-lane transit corridor capable of accommodating a planned light rail system.

The new structure also incorporates a multi-use path for pedestrians and cyclists.
Signature on the Saint Lawrence Group (SSL) awarded the design and construction of the main bridge to the SSLC joint venture (JV) of SNC-Lavalin, Dragados Canada, Flatiron Constructors Canada and EBC Inc.

VSL was hired for several contracts for the bridge's construction, including the erection of the main span and the engineering, supply and on-site technical assistance for complex MSE walls needed for the new bridge's east abutment, which supports the main bridge span.

VSL developed an innovative variant of its VSoL® system, to help ensure the structure's long design life in a cold climate and with aggressive exposure to road salts.

The east abutment was designed to incorporate sandblasted facing elements with architectural grooves to interface with the adjacent electrical building, which features the same pattern.

The arrangement of the panels was particularly innovative. The building of MSE walls usually involves staggering the concrete panels' horizontal joints, to help maintain verticality during erection. However, **VSL deployed a tailor-made solution to enable a world-first in structural engineering: the construction of MSE walls built with non-staggered, curved and inclined panels.**

The walls have been built using VSL's VSoL® system, which combines backfill, soil reinforcement and panels to build cost-effective and attractive retaining walls, ensuring that the project architect's specifications were met.

DATE
2015 - 2019

LOCATION
Montreal

OWNER
Government of Canada

ENGINEER
Arup

DESIGNER
SNC-Lavalin, TY Lin International and International Bridge Technology

CONSULTANT
Fugro

MAIN CONTRACTOR
Joint-Venture of Signature on the Saint Lawrence Construction (SSLC), comprised of: SNC-Lavalin; Dragados Canada; Flatiron Constructors Canada; EBC Inc.

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Works related to MSE Walls, including:

- Design of all structures and their architectural finishes
- Engineering of erection methods and temporary staging
- Supply of system components and concrete panels
- On-site technical assistance during installation

KEY FIGURES

- 600 m² of wing walls built using a two-stage system
- 1,000 m² of 'false' abutment walls built using wire-mesh and concrete facings
- 700 m² of temporary VSoL® Wire-Mesh Facing (WMF) wall up to 20m high to retain the approach of the new bridge until the demolition of the existing one.

VSL provided engineering and technical support from the tender stage by helping the client through every step of the design, notably with detailed 3D models, erection schemes and a study of the moulds required. The complexity of the walls and VSL's demonstrable expertise in the matter made its presence on site mandatory during the erection and the integration with the bridge.

VSL used a two-stage approach. A VSoL® WMF wall was initially – and quickly - erected to generate foundation consolidation and permit adjacent construction activities to continue. Steel ladders and tension elements (turnbuckles) were then used to fasten the concrete panels to the WMF wall, to create an aesthetically pleasing permanent wall-facing.

This solution enabled time savings for the overall project, which was subject to hefty delay penalties. VSL's approach also reduced the risk of architectural defects on the wing walls, which have complex geometry.

A key challenge in the project was the unusually large size of the non-staggered, curved concrete panels – 250 millimetres thick, 6 metres wide and stacked up to 17 metres high.

Another difficulty was phasing the construction of the MSE walls while activity on the existing bridge was still ongoing. The old structure could only be demolished once the new bridge was finished, in order not to hinder traffic in the area.
Almost all the new bridge structures and road alignments overlapped with the old ones, and this significantly increased the amount work for VSL, which had to develop an expanded design package. This including providing additional wall drawings, and closely coordinating supply and logistics by optimising schedules and predicting requirements.

Phasing for the east abutment was critical, as it supports the main bridge span. The southern portion could not be built until the existing bridge was demolished. VSL had to tackle similar phasing challenges when building a further 15,000m2 of MSE walls for the structure's approaches - one of the many other missions VSL performed as part of the overall project.

A final complication came from working in extreme weather conditions. Winter in Montreal is exceptionally cold, with temperatures dropping to -35°C, and work shifts had to be organised accordingly, which VSL managed successfully.

These factors significantly extended the duration of the new bridge project's overall construction, but VSL met all its targets and successfully delivered on all fronts.

The new bridge's east abutment contract was awarded to VSL on 15th September 2015 and construction was completed on 30th November 2019, following demolition of the old bridge's approach.

VSL developed an innovative variant of its VSoL® system, to help ensure a long design life in a cold climate with aggressive exposure to road salts.

NEW TERMINAL BUILDING, CLARK INTERNATIONAL AIRPORT, THE PHILIPPINES

PRECASTING AND PT WORKS FOR A NEW AIRPORT TERMINAL BUILDING IN THE PHILIPPINES

Clark International Airport has completed a terminal upgrade to improve the passenger experience: improvements included the renovation of domestic arrivals hallways and the introduction of measures to reduce passenger congestion in the pre-departure area. An extension of the gangway linking domestic and international pre-departure areas has improved passenger transfer flows between the two areas.

The Philippines Bases Conversion & Development Authority awarded the building project to MGC JVI, a joint venture between Megawide Construction Corporation - a local construction company - and Indian construction company GMR.

VSL had worked with the JV during the construction of Mactan Cebu International Airport, which was completed five months ahead of schedule. The JV decided to hire VSL again, to carry out work at Clark International Airport with the same level of quality and safety to a tight schedule.

VSL was responsible for the design, supply, delivery and installation of 116 AASHTO Type IV girders - including post-tensioning (PT) works - for the elevated road in front of the new terminal (108 girders) and Dolores Bridge (eight girders), which is located two kilometres away.

The project also required about 1,900m^3 of concrete, 310t of rebars and 120t of post-tensioned strands.

DATE
2019

LOCATION
Clark, Angeles City, the Philippines

OWNER
Bases Conversion & Development Authority (BCDA)

PROJECT ARCHITECT
Integrated Design Associates Ltd

DESIGNER / CONSULTANT
Meinhardt Philippines

MAIN CONTRACTOR
Megawide-GMR Construction JV, Inc (MGC JVI)

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Design, supply, delivery and installation of 116 girders

Post-tensioning

KEY FIGURES

- 116 AASHTO Type IV girders
- 310 tonnes of reinforcing bars
- 120 tonnes of post-tensioned strands

The successful experience at Mactan Cebu International Airport and its similarity with the Clark International project made for smooth cooperation between the client and VSL. VSL completed its works in a timely manner.

The contract started on 14th January 2019 and was completed on 18th June 2019.

VSL was responsible for the design, supply, delivery and installation of 116 girders for the elevated road in front of the new terminal and Dolores Bridge.

AEON MALL, HA DONG, HANOI CITY, VIETNAM

DESIGN, SUPPLY & CONSTRUCTION OF PT SLABS AND BEAMS FOR A MAJOR SHOPPING MALL

AEON is Japan's largest retail group, with about 10 business lines, including AEON MALL, a core enterprise that focuses on commercial real estate development. The company's first shopping mall project in Hanoi was completed in the Long Bien District in 2015. The second, which is nearing completion in the district of Ha Dong, involves a total investment of approximately US$190 million and is expected to become the biggest retail centre in the area – as well as being a place of fun and leisure for everyone's enjoyment. AEON MALL Ha Dong consists of a basement level for parking and three floors for shopping, with a total area of approximately 150,000m^2. The gross leasable area is approximately 74,000m^2 including an AEON supermarket.

In order to build the shopping centre's concrete structure, the main contractor needed to bring in complementary expertise to carry out the specialist post-tensioning works for the project.

VSL had already worked successfully with Kajima Vietnam in the past and provided the JV with extensive support during the tender stage in order to produce an optimised design for the slabs and beams.

As a result, **VSL was awarded the design, supply and installation of the post-tensioned slabs and beams**. The project used the VSLab system, VSL's new PT system designed for concrete slabs, particularly in building projects. The mall's PT beams used 128 multi-tendons of type 6-12.

VSL was responsible for maintaining good coordination with the other contractors to reduce the construction period as the start date for the PT works had been pushed back by two months, due to the late completion of the foundation works. The expertise of VSL's team ensured that the PT works were carried out safely, on time and in line with the approved budget.

DATE
2018 - 2019

LOCATION
Ha Dong District
Hanoi City

OWNER
AEONMALL Vietnam Co. Ltd

ENGINEER
CICI - International Construction & Investment Consultant Co., Ltd

CONSULTANT
Coninco 3C Joint Stock Company

MAIN CONTRACTOR
Kajima - Hoabinh Joint Venture

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Design, supply and installation of post-tensioned slab and beam

KEY FIGURES

- Total floor area: 150,000m²
- Gross leasable area: 74,000m²
- Net quantity of PC strand: 517.1t

Schedule optimisation

Due to its size - the total slab area is approximately 113,000m² - each floor's slab needed to be divided into three zones, in which several subzones were constructed simultaneously. A pour strip was provided in between each subzone in order to accelerate the construction progress and allow a reasonable concreting time for each pour. This solution enabled the concreting work for each subzone to be carried out in four to five hours, instead of pouring a huge quantity in one go.

A challenge when building such a huge slab in different zones and subzones is that the PT works must typically be carried out simultaneously at multiple locations. This demands close management of the manpower schedule and optimal monitoring of the organisational chart for the PT works - two requirements that VSL met successfully.
All PT tendons were prefabricated on top of the concrete slabs, in close coordination with the builders at each subzone. This minimised the need for tower crane usage when lifting prefabricated tendons and also reduced the time needed for loading and unloading the prefabricated tendons into the strand lifting frames.

Design evolution that occurred throughout slab construction proved another challenge, which VSL successfully overcame by making adaptations to the design and the loadings on the slab.

The contract began on 1st August 2018 and ended on 25th January 2019. The grand opening of the mall took place on 6th December 2019.

On such a huge slab, the PT works were carried out simultaneously at multiple locations.

The project used the VSLab system, VSL's new PT system designed for concrete slabs, particularly in building projects.

SAN GABRIEL WIND FARM, RENAICO, CHILE

BUILDING CHILE'S FIRST WIND FARM WITH PRECAST CONCRETE TOWERS

San Gabriel Wind Farm is located in Renaico in the Araucanía region of southern Chile. The wind farm comprises **61 precast concrete towers** - each 120m high and made up of 22 concrete segments - and will produce a total output of more than 180MW.

It is the first in Chile to use precast concrete for the construction of the towers. The project's main contractor, Nordex Acciona Wind Power (NAWP), was looking for complementary expertise in precast works in order to ensure that construction of the wind farm was completed by September 2019.

The contract was awarded to a joint venture (JV) between VSL and Windtechnic, which had the original contact with the client but no previous experience in Chile. VSL's local presence and the method it offered for the precasting and installation works convinced the client to award the contract to VSL and Windtechnic JV. The scope of works included establishing the full precasting yard as well as setting up the formwork, tying in the rebar and placing concrete, together with finishing, handling and storing the 1,342 precast elements that were produced.

VSL provided the infrastructure for the erection of all the precast elements close to the construction site, which minimised the time and distance required for deliveries by truck. The precast plant and stock yard spread over an area of 29,900m^2.

A major challenge on the project was that seismic design parameters in Chile require 50% more reinforcing steel for the concrete elements than in non-earthquake regions. VSL had to hire double the standard workforce and optimise its organisational skills to meet the requirements. It took 400 staff and workers,

DATE
2018 - 2019

LOCATION
Renaico

OWNER
Acciona Energy

DESIGNER
Nordex Acciona Wind Power (NAWP)

MAIN CONTRACTOR
Nordex Acciona Wind Power (NAWP)

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Full precast yard erection

Full concrete precasting of 1,342 elements including:

- forming
- pouring
- finishing
- handling
- storage

Precast yard dismantling

KEY FIGURES

- 61 concrete towers, each 120m high
- 22 concrete segments
- 26,000m³ surface
- 5,600t of steel reinforcement
- Precast plant + stock area: 29.900m²

working around the clock to deliver the work on time. In total 5,600t of reinforcing steel were required for the project.

Good relationships with the JV and with the client led to the successful execution of the operations. Right after completing the work at San Gabriel Wind Farm, VSL was appointed by NAWP to prefabricate another 28 concrete precast towers for the Tolpán Park project, using the existing operational precast yard.

The works for San Gabriel Wind Farm started in August 2018, and the final towers were supplied in June 2019.

A major challenge on the project was that seismic design parameters in Chile require 50% more steel reinforcement for concrete towers than in non-earthquake regions.

VSL provided the infrastructure for the erection of all the precast pieces close to the construction site of the wind farm.

BIM 2 SOLAR FARM, NINH THUAN, VIETNAM

CARRYING OUT MECHANICAL WORKS FOR A SOLAR POWER PLANT

The BIM 2 solar power plant in Quan The, a village in Vietnam's Ninh Thuan province, will become the largest of its kind in Southeast Asia, with an expected production capacity of over 250MWp. BIM 2 is part of a major clean energy network that is expected to have a capacity of 1,000MWp in 2025, according to owner BIM & AC Renewable Energy Ltd.

The project was the first in Vietnam for main contractor Bouygues Energies & Services (BYES), a subsidiary of Bouygues Construction. A key goal for BYES was to ensure power delivery before the project deadline, in order for the scheme to secure a profitable 9.35 cents per kW tariff and cement the company's reputation as well as generating further work from this or other potential clients.

The project's scale required a huge amount of labour and BYES needed to hire multiple subcontractors. **VSL Vietnam had already been in contact with BYES about a year before, assisting BYES in preparing the construction budget, which included the full scope of civil, mechanical and electrical works. It soon became apparent that bringing in VSL – which has 20+ years' experience in the country - was the best solution. VSL was appointed to carry out a third of the mechanical works for the BIM 2 solar farm**.

In total, VSL's third of the mechanical package involved the installation of 31,144 screws for the foundations, 3,893 mounting structures and 233,580 photovoltaic (PV) modules.

VSL worked as a partner, well integrated into the BYES site team. Its role in carrying out the mechanical engineering works included providing the necessary staff, supervisors, labour and machinery to meet the project requirements.

DATE
2018 - 2019

LOCATION
Ninh Thuan

OWNER
BIM & AC Renewable Energy Ltd

DESIGNER
Civil part: Aurecon ; Electrical part: Vatec

CONSULTANT
Fichtner

MAIN CONTRACTOR
Bouygues Energies & Services

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

A third of the mechanical package, including:

- installation of screws;
- mounting structures;
- and photovoltaic modules.

KEY FIGURES

- Surface occupied: 193ha
- Nominal power of power plant: 201 MWp
- Approximately 610,000 solar panels
- 31,144 screws
- 3,893 mounting structures
- 233,580 photovoltaic modules

Cost-effective solutions

The plant is located in an area where the geotechnical conditions are suitable for the use of galvanised screws in the foundations instead of needing cast-in-situ foundations. This saved money, by significantly reducing construction time.

The decision was taken to assemble the blocks of 60 PV modules using table frames with a 4x15 row configuration, rather than the more typical 2x30. This meant that the system was easier to assemble and adjust. It also expedited construction and boosted cost-effectiveness.

A successful first

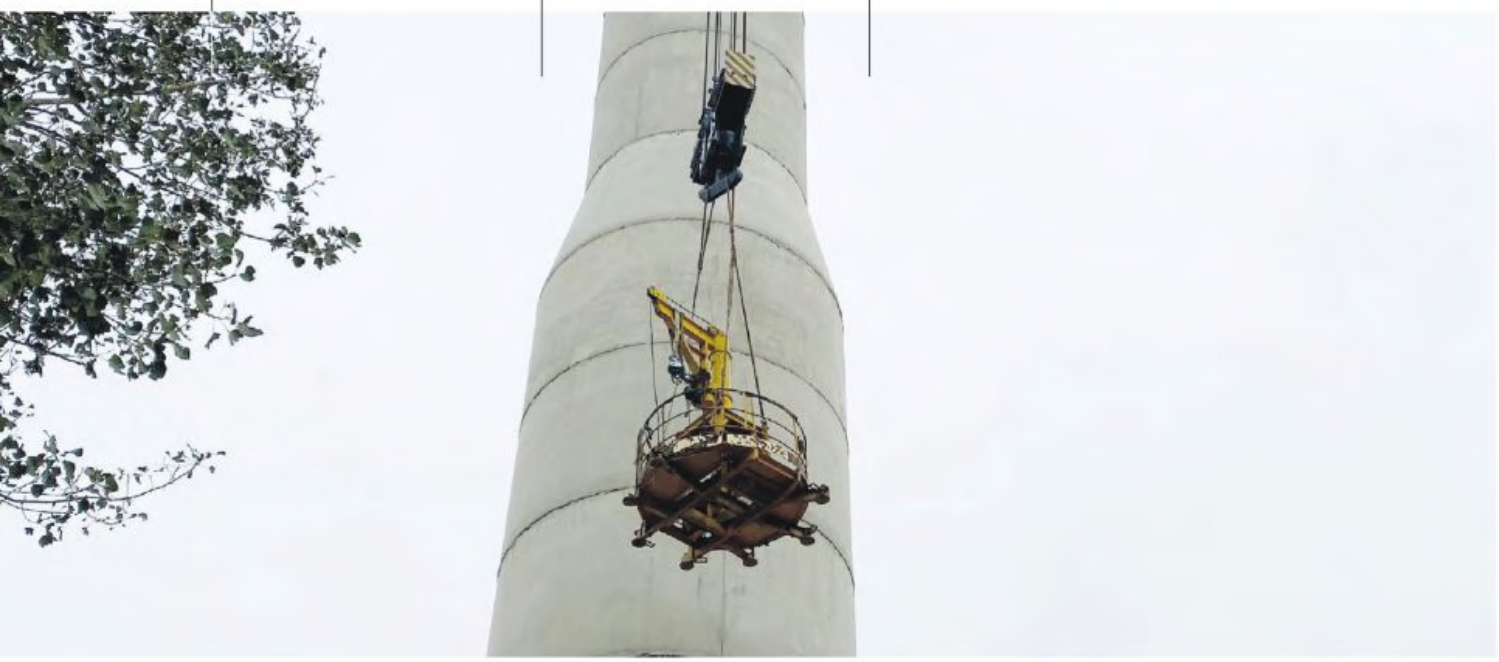
VSL was able to deliver the daily installation target of 400 foundation screws, 50 mounting structures and 3,000 PV modules from the outset.

VSL's success in its first mechanical project for a solar farm was achieved by strict adherence to the procedures in terms of quality and safety, hiring a large amount of labour and working in close cooperation with BYES. These measures allowed site progress to be maintained despite a short mobilisation time and bad weather.

The achievements at BIM2 have convinced BYES to keep on working with VSL on further projects with a similar design.

The work for the BIM 2 solar power plant began on 29th August 2018 and was completed on 28th March 2019.

VSL delivered the construction of 31,144 screws, 3,893 mounting structures and 233,580 photovoltaic modules.



HENAN WIND TOWERS, HENAN PROVINCE, CHINA

CARRYING OUT POST-TENSIONING WORKS FOR CHINA'S FIRST HYBRID CONCRETE-STEEL WIND FARMS

China's first-ever wind farms of hybrid construction are being built in Henan Province. These hybrid towers earn their name because they are constructed **using an 80m-high section of reinforced concrete, which is then topped with a further 40m of steel structure**.

The site ownership of the wind farms is split between China Resources Power Holdings and China Datang Corporation Renewable Power, which jointly own the 150 towers that are being constructed across multiple sites.

Twelve external vertical PT tendons are located around the inside of each circular tower and run the full height of the concrete section, to pre-tension and stabilise the structure.

The main contractor - Golden Ocean Company - and the engineering and design consultant - Wind Tower Technologies - needed complementary expertise to install these tendons.

VSL is one of the key players in the field of post-tensioning in China. Its strong international network and renowned support make it a reliable partner for international design offices and contractors.

As a result, VSL was hired as a specialist contractor for a two-year period to **carry out the supply of PT materials and the installation of external unbonded tendons for the wind towers**.

VSL is using its **VSL Multistrand Post-Tensioning System Type EWT, which is an efficient method of strand installation that involves installing the tendons from bottom to top as a full bundle**.

VSL also recommended using a specialist tendon lifting frame and winch: this

DATE
2018 - 2019

LOCATION
Henan Province

OWNER / ENGINEER
China Resources Power Holdings Co., Ltd. / China Datang Corporation Renewable Power Co., Ltd.

ENGINEER / DESIGNER
Wind Tower Technologies, United States

MAIN CONTRACTOR
Golden Ocean Company Ltd.

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Technical/design support on post-tensioning works

Supply of post-tensioning materials, including monostrand, anchor heads, wedges, protection caps and load cells

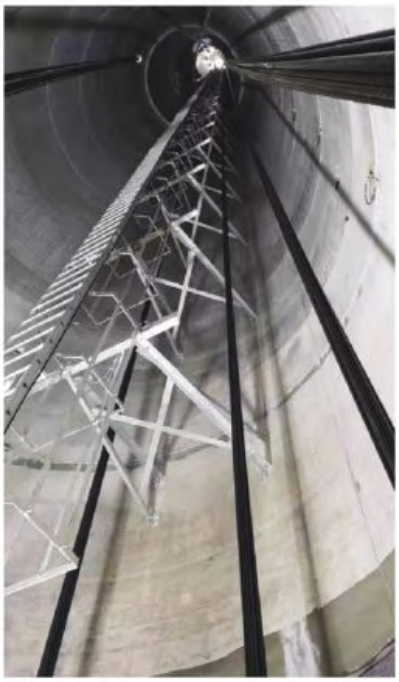
Installation of the PT works, including:
- tendon prefabrication,
- lifting the tendons using winches,
- stressing ,
- installation of protection caps,
- installation of external tendons

KEY FIGURES
— 150 wind towers
— 9 tendons per tower, each with 19 x 0.6" strands

method enables much faster installation of the tendons, as each can be installed in just an hour. Following the first wind tower prototype, VSL was required to install and stress the nine tendons, each with 19 strands, within a two-day period.

Post-tensioning is on the critical path during erection of the tall precast concrete sections. VSL chose a full strand bundle installation method over strand-by-strand installation, after prototype testing demonstrated that 3.5 working shifts were required for strand-by-strand, compared to just 2.0 for successful full-bundle installation. Full-bundle installation also means improved tidiness, safety and efficiency.

The project began for VSL in October 2018 and was completed in October 2019.



External tendons are fitted inside the precast segment of each tower.

Post-tensioning is on the critical path during erection of the tall precast concrete sections.

CABLE LANDING FOR HKT ULTRA EXPRESS, HONG KONG

INSTALLING A 573M-LONG SUBSEA STEEL CONDUIT TO CARRY A FIBRE-OPTIC CABLE

Hong Kong Telecommunications Ltd (HKT), one of the largest telecommunications companies in Hong Kong, operates data centres in Tseung Kwan O. It decided to **install a submarine fibre-optic cable to facilitate high-speed data connections for key clients in the central business district and stay at the edge of what is a competitive business. The 2.5km-long submarine cable needed to be installed between Tseung Kwan O and Siu Sai Wan across the seabed of the Tathong Channel**.

Most of the route could run on the seabed but work was needed to bring it ashore at Siu Sai Wan, where obstacles included a seawall.

There was already a cable landing station in Tseung Kwan O but not in Siu Sai Wan and so the operation required the installation of a product pipe to carry the cable beneath the seawall. A marine cable contractor was appointed to install the cable on the seabed and then pull it through the new conduit so that HKT could connect it to the network.

VSL, through its sister company Intrafor, had already carried out a similar project for one of HKT's competitors in 2017.

VSL was hired to **provide the means and method to install the conduit to take the fibre-optic cable beneath the seawall**.

The scope of works comprised the installation from land to sea of a 573m-long internally-flush steel conduit of 152mm-diameter and the construction of a beach manhole.

To do so, **VSL used Horizontal Directional Drilling (HDD)**, an appropriate technique when obstructions prevent a cable being landed by conventional dredging or trenching methods. HDD enabled the

DATE
2019

LOCATION
Siu Sai Wan

OWNER
Hong Kong Telecommunications Ltd

ENGINEER / DESIGNER
N/A

CONSULTANT
SMEC

MAIN CONTRACTOR
Intrafor

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Installation of a 573m pipe from land to sea

Construction of beach manhole

KEY FIGURES

- Steel conduit – final length 573m
- Beach manhole – 5.3m (L) x 3.5m (W) x 3.2m (D)

product pipe to be installed from land to sea with a punch-out on the seabed, **without disturbing either the seawall with its 30m-deep foundations or the offshore coral**.

The presence of the seawall meant that HDD was the only viable solution for the cable landing in Siu Sai Wan, which was itself the only suitable location in the area.
VSL had to face site constraints caused by trees and a small working area as well as various challenges such as drilling through deep-fill materials, including rock fill, and the need to maintain a connection with the down-the-hole guidance tools.

VSL successfully overcame these difficulties and completed all key stages on time and within budget.

The mission began on 15th April 2019 with site mobilisation and ended on 20th September 2019, with the completion of the civil works for the beach manhole and the site handover. HKT's entire project was completed when the end-to-end fibre-optic cable went live in December 2019.

VSL had to face site constraints caused by trees and a small working area as well as various challenges such as drilling through deep-fill materials, including rock fill.

SANTA MARÍA DE GUÍA-EL PAGADOR, GRAN CANARIA, SPAIN

CARRYING OUT ALL REPAIR AND MAINTENANCE WORKS ON 13 BRIDGES IN THE CANARY ISLANDS

The Canary Islands government decided to carry out refurbishment and maintenance works on a section of Road GC-2, which connects Las Palmas in Gran Canaria to La Aldea de San Nicolás, and is the only access from the north of the island to the capital.

The section from Santa María de Guia to El Pagador was a two-lane road that was inaugurated in 1976. In 2010, the road was widened to a dual carriageway to increase its capacity. This section contains 13 bridges, mainly of double T-Beam construction with neoprene bearings. The typical spans are between 35m and 40m. The two main structures are the Cuesta de Silva Viaduct I and Viaduct II, which were built in 1979 and 2010, respectively.

Viaduct I was one of the highest concrete bridges in Spain upon its completion. It has a central pier of 106m and a span configuration of 58m + 90m + 120m + 90m + 58m, for a total length of 416 metres. The deck is 11.6m wide. It has fixed pot bearings (15,000kN) on piers 2 and 4, and guided, free bearings at the abutments.

The 2010 viaduct has a central pier of 110m and a span configuration of 50.15m + 108.8m + 114.5m + 108.8m + 50.15m for a total length of 432.4 metres. The deck is 15.5m wide. The viaduct is curved in plan with a radius of just 390 metres and a gradient slope of 6%. All the piers are fixed to the deck and the only bearings are pot bearings at the abutments.

The client - Obrascón Huarte Lain (OHL) - needed complementary expertise to carry out the repairs, coatings and bearing replacements with the highest quality and safety possible. The main requirement from the authorities was to minimise traffic disturbance by using only temporary lane closures instead of closing any lanes permanently.

DATE
2018 - 2020

LOCATION
Santa María de Guía, Las Palmas, Gran Canaria

OWNER
Government of the Canary Islands

ENGINEER
José Luis Martínez Cocero (Head of Projects and Works, Government of the Canary Islands)

DESIGNER
Ingeniería Torroja and Jose Antonio Llombart

CONSULTANT
Angel Carriazo (Ingeniería Torroja) and Jose Antonio Llombart

MAIN CONTRACTOR
OHL

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Concrete repair

Anti-carbonation paint

Replacement of elastomeric bearings using synchronised equipment (19 synchronised 100-tonne jacks)

Replacement of 1,500t-capacity pot bearings using 6x 670-tonne jacks

Hydro-demolition works for bearing replacement

Rope access works

Tailored design for scaffolding and suspended platforms

Underbridge units

KEY FIGURES

- 1,000m² of concrete repair
- 122,000m² of anti-carbonation paint
- 221 elastomeric bearings installed in 21 lifting operations
- 8 pot bearings replaced in 4 lifting operations

VSL had previously worked with OHL on new bridge works and offered a full solution for the project.

VSL was therefore hired as a package subcontractor to **carry out all repair and maintenance works on the bridges**, excluding the lane closures and road signage.

These works included the supply of 100 tonnes of grout, mortar and resin, 60 tonnes of anti-carbonation coating and neoprene bearings. VSL designed and manufactured tailor-made pot bearings; modifications to the structure was reduced by using a custom anchoring solution that incorporated new dowels.

VSL also carried out all the engineering, safety, quality and supervision works on site, and developed the method statement for all of its in-house works and safety procedures.

In addition, **VSL provided all the specialist labour and all auxiliary facilities, including a rope-access team, synchronised jacking and hydro-demolition equipment**.

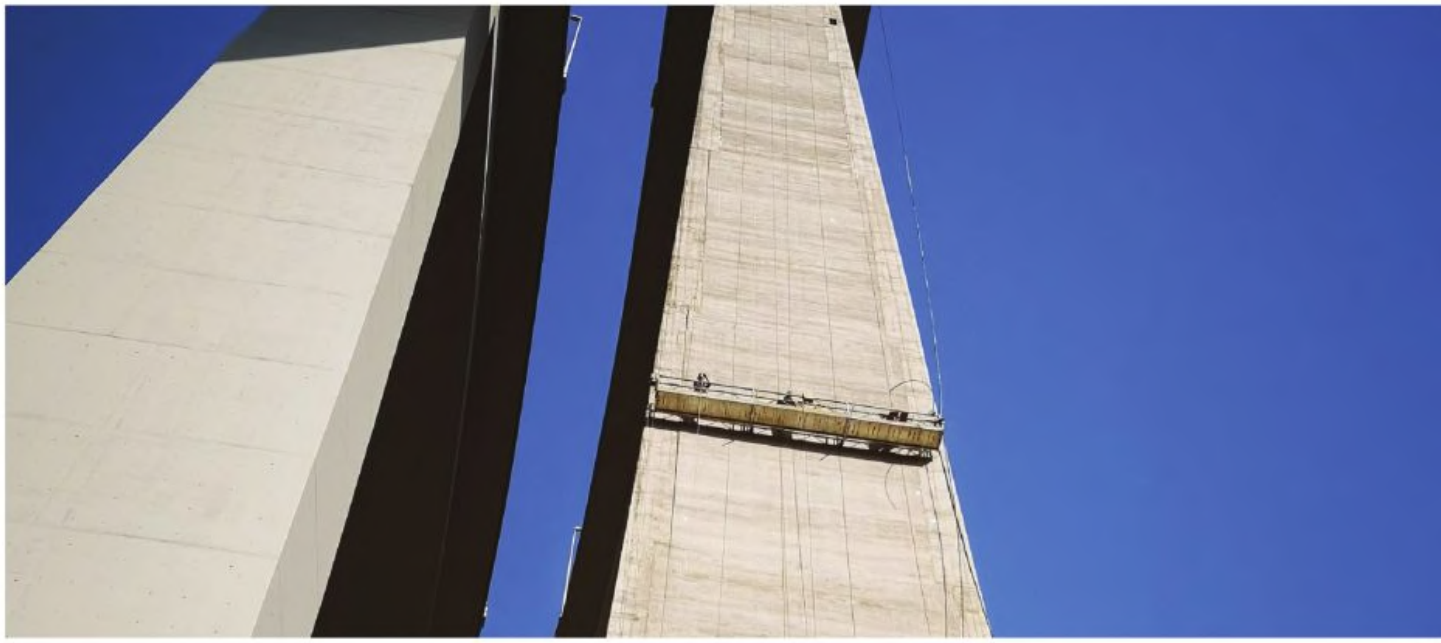
VSL repaired 1,000m² of concrete and applied 122,000m² of anti-carbonation paint. Most of the tasks took place on structures more than 25m high and required the use of an underbridge unit, hanging scaffolds or a rope access team.

The 221 elastomeric bearings were replaced in **21 lifting operations**, using synchronised jacking equipment; up to 18 flat jacks of 100 tonnes were operated simultaneously.

The project also included the replacement of eight pot bearings - each of 1,500-tonne capacity - using six 670-tonne jacks in four lifting operations. Some customised temporary structures were designed for the task of replacing 800kg bearings at a height of 105 metres. It was necessary to use hydro-demolition equipment to remove the existing dowels.

Thanks to this project, VSL has started working with OHL on other bearing replacement missions all around the world.

The works started on 8th January 2018 and ended on 31st January 2020.



VSL repaired 1,000m² of concrete and applied 122,000m² of anti-carbonation paint.

AGUDIM VIADUCT, LEIRIA, PORTUGAL

BRIDGE REPAIR WORKS ON PORTUGAL'S BUSIEST HIGHWAY

The Agudim Viaduct is a 480m-long structure located in Leiria on the A1, Portugal's most important highway. The twin-deck crossing of the Agudim River is managed by BRISA, which is the country's largest private road operator and is responsible for repair and retrofit works on all the bridges on 17 highways.

The renovation works needed on the Agudim Viaduct had to be carried out without hampering traffic or safety on the key transport route.

VSL began performing repair projects in Portugal over 15 years ago and has established a strong track record on specialist work packages, in particular for the replacement of bearings and joints. It has become a reliable main contractor for repairs in the region and an established partner for BRISA.

As a result, VSL was hired as a main contractor for the Agudim Viaduct work to help BRISA achieve the best results without any compromises in terms of safety or quality.

The scope of works included concrete and joint repairs; bearing repairs and replacement; coating and protection of the concrete surfaces; and demolishing and rebuilding all the capping beams and safety barriers.

For access below the bridge, VSL chose to use suspended platforms and an under-bridge platform instead of scaffolding. This solution reduced costs and above all, it ensured a high level of safety for our workers.

DATE
2018 - 2019

LOCATION
Leiria

OWNER / ENGINEER
BRISA

DESIGNER / CONSULTANT
Armando Rito

MAIN CONTRACTOR
VSL Portugal

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Concrete and joints repairs

Bearing repairs and replacement

Coating and protection of the concrete surfaces

Demolishing and rebuilding all the capping beams and safety barriers

KEY FIGURES

- 35,000m² of concrete
- 1,400m of crack repairs
- 400m² of concrete repairs
- 980m of concrete kerb to be demolished and rebuilt
- 19,800 holes to fix and install new rebar
- 52 bearings to be replaced
- 62m of expansion joints to be replaced

VSL cleaned and coated 35,000m² of concrete and carried out more than 1,400m of crack repairs and 400m² of concrete repairs. Its scope also included the demolition and re-building of 980m of concrete kerb, a challenging operation at the edges of the bridge that also required the drilling of 19,800 holes to fix and install new rebar.

The safety barriers envisaged in the original design were not suitable but VSL solved the problem by working with BRISA and the supplier to reach a solution that satisfied all involved parties by meeting technical, practical and economic requirements.

In total, 35t of steel structures were used to protect the capping beams, 52 bearings were replaced using heavy lifting operations and 62m of expansion joints were replaced.

Works for the Agudim Viaduct began in June 2018 and were completed successfully just a year later.

The renovation works needed on the Agudim Viaduct had to be carried out without hampering traffic or safety on the key transport route.

PINEY CREEK BRIDGE STRENGTHENING, TASMANIA, AUSTRALIA

STRENGTHENING AN IMPORTANT BRIDGE IN JUST TWO MONTHS

The Piney Creek Bridge on Heemskirk Road in western Tasmania is on a key route connecting ports, transport hubs and major industries. The owner, the Department of State Growth, required the strengthening of the bridge in 2018 to accommodate the increased loads imposed by the operation of Higher Productivity Freight Vehicles (HPFV) on this important route.

VSL was appointed by the Department of State Growth to **supply and install external post-tensioning to strengthen a pier crosshead and to install carbon-fibre reinforced polymer (CFRP) fabric on the bridge**.

VSL was awarded the project thanks to its ability to mobilise design and operational resources in a really short time frame. The client contacted VSL at end of October 2018 and required to have the job finished by Christmas the same year. VSL managed to deliver a quick turnaround, achieving the deadline ahead of this tight schedule.

Another challenge was that the project was located in a particularly remote part of the state, over a 'hard to access' creek subject to flash flooding. **The project involved working at height, over water and at varying flood levels** - constraints that are similar to those on a number of bridge tenders in which VSL is currently involved.

A particular feature of Piney Creek was the alternative chosen for the external post-tensioning strengthening to the pier headstocks. The use of VSL's elec-

DATE
2019

LOCATION
Zeehan (Tasmania)

OWNER
Department of State Growth

DESIGNER
GHD

MAIN CONTRACTOR
VSL Australia

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Supply and installation of external post-tensioning

Installation of carbon-fibre reinforced polymer (CFRP)

Erection of scaffolding

Traffic management on the bridge.

KEY FIGURES

- Installation of 4 EIT tendons
- Wrapping of the headstocks with carbon fabrics 25m^2

trically isolated GC 6-3 tendons and prefabricated galvanised reaction beams provided a cost-effective solution while delivering the required enhanced durability.

The works required the erection of scaffolding and the traffic management for the project. VSL installed four electrically isolated tendons and wrapped the headstocks with 25m^2 of the carbon fabric.

The mission began on 2nd November 2018, with the mobilisation on site starting on 19th November and the work completed on 19th December 2018.

PYKES CREEK, VICTORIA, AUSTRALIA

DELIVERING PT WORKS TO STRENGTHEN A BRIDGE IN AUSTRALIA

Pykes Creek Bridge is located on the Melbourne-bound carriageway of the Western Freeway and crosses an existing water reservoir. The bridge comprises two parallel structures each carrying two lanes and made up of five spans of typical length 26 metres. The works carried out by VSL were part of structural upgrades to accommodate higher traffic loads.

The strengthening of the bridge involved the supply and installation of steel braces for crosshead strengthening, external post-tensioning for beams, deck shear reinforcement and associated road works.

The main contractor was Ace Contractors Group Pty Ltd, an Australian company specialising in civil, infrastructure, landscape, water and environmental works. It needed complementary expertise to undertake the deck and girder strengthening works, which were carried out using external monostrand tendons to match the design requirements.

VSL is one of the leading specialists worldwide in the supply and installation of external monostrand PT. As a result, it was awarded a subcontract to carry out the task, using the VSL External Monostrand PT system.

The scope of works included a number of critical tasks such as the scanning and coring of the bridge deck, and the grouting of additional steel bracing to the headstocks. VSL supplied, cored and installed 1,280 N16 dowels to improve the shear performance. In addition, it carried out scanning using ground-penetrating radar (GPR) to detect embedded steel to enable the coring of 208 holes (40mm diameter, 500mm long) in the

DATE
2018

LOCATION
Ballan

OWNER
Vic Roads

DESIGNER
GHD

MAIN CONTRACTOR
Ace Contractors Group Pty Ltd

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Supply and installation of steel braces for crosshead strengthening

External post-tensioning for beams, deck shear reinforcement and associated road works.

KEY FIGURES

- 1,280 N16 dowels to improve the shear performance
- 208 holes

post-tensioned precast girders. VSL also supplied, installed and stressed 208 PT brackets; installed external monostrand in the form of 104 galvanised, greased and sheathed tendons of 15.7mm diameter; and supplied and installed 40 permanent external deviators.

VSL developed and installed a monostrand bracket system exclusively for the project.

The contract began on 2nd April 2018 and ended on 15th August 2018, all the while working over water and in winter conditions.

The scope of works included a number of critical tasks such as the scanning and coring of the bridge deck, and the grouting of additional steel bracing to the headstocks.

MEX – P44A STRENGTHENING, KUALA LUMPUR, MALAYSIA

REPAIR AND STRENGTHENING WORKS ON A CRACKED CROSSHEAD

The MAJU Expressway (MEX) network in Klang Valley, Malaysia, is a 26km-long route that links Kuala Lumpur city centre with the international airport in Sepang. The MEX is a backbone of the Multimedia Super Corridor, connecting areas of the capital.

The MEX - P44a crosshead is located along the route adjacent to the Kerayong River. Multiple cracks were discovered in 2012, with materials testing and repair works carried out the following year. However, a visual inspection in 2017 showed that severe cracks had started forming at the surface of the crosshead.

MAJU Expressway Sdn Bhd holds the government concession that has spanned from the design and construction of the MEX through to maintenance, operation and management. It needed to identify the origin of the cracks and fix them, while minimising the impact on road users.

VSL's previous work as a consultant to MAJU Expressway for post-tensioning issues on other projects led to it being hired to carry out the crosshead's strengthening work.

It was involved right from the beginning until the end of project in order to **deliver a bespoke engineering solution, which used a concrete jacketing method** that was designed by Tony Gee Perunding Sdn Bhd.

The scope of works comprised the design and erection of the falsework, access staircase and working platform; concrete jacketing work including roughening the concrete, installing the rebar and formwork and placing self-compacting concrete; and monitoring the crosshead's deflection.

Heavy-duty modular scaffolding, plastic formwork and pre-bagged self-compacting concrete were chosen for the project. The concrete had a maximum aggre-

DATE
2018 - 2019

LOCATION
Kuala Lumpur

OWNER
Maju Expressway Sdn Bhd

ENGINEER / DESIGNER / CONSULTANT
Tony Gee Perunding Sdn Bhd

MAIN CONTRACTOR
VSL Engineers (M) Sdn Bhd

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Design and erection of falsework, access staircase and working platform.

Concrete jacketing work including concrete roughening, rebar, formwork and Self-Compacting Concrete (SCC) placement.

Crosshead's deflection monitoring.

KEY FIGURES

- Formwork, 90m^2
- Scaffold, 850m^3
- Sika Microcrete 217, 1,750 bags
- Steel bar, 6t

gate size of 6mm, which was chosen due to the difficulty of fully filling the soffit part of the crosshead with normal concrete. The jacketing required continuous pouring without cold joints and the supporting scaffold and formwork needed to be sufficiently rigid to prevent movement and bulging.

VSL used a 90m^2 formwork system, 850m^3 of scaffolding, 1,750 bags of Sika Microcrete 217 and six tonnes of steel bar for the project.

VSL completed the mission successfully and within schedule, in spite of challenges such as keeping road traffic flowing and the requirement for a continuous pour of the whole volume of concrete in one operation.

The works began on 28th November 2018 and were completed on 16th February 2019.

VSL carried out the crosshead's strengthening work with bespoke engineering solution, making use of concrete jacketing method that was designed by Tony Gee Perunding Sdn Bhd.

SILVER JUBILEE BRIDGE HANGER REPLACEMENT, CHESHIRE, UK

USING NEW TECHNOLOGY FOR CABLE REPLACEMENT ON A LANDMARK BRIDGE

The Silver Jubilee Bridge crosses the River Mersey between Runcorn and Widnes in Cheshire in north-west England. The structure is a through arch bridge with a main arch span of 330m. It was opened in 1961 and widened between 1975 and 1977 – the year of the Queen's Silver Jubilee, after which it was renamed to mark the occasion.

It is one of the few crossings of the River Mersey between Manchester and Liverpool, and traffic grew exponentially to the point that a new crossing, the Mersey Gateway, had to be built. VSL supplied and installed the stay-cable and post-tensioning systems for the new bridge, which was completed in September 2017.

Following completion of the Mersey Gateway, the Silver Jubilee Bridge was closed to traffic to allow essential maintenance. It is expected to reopen by the middle of 2020. During this time, Halton Borough Council, the bridge's owner, decided to investigate the possible replacement of hanger cables, after inspections showed that some wires had broken on one of them.

Both the old and new bridges are owned by Halton Borough Council; VSL's work on the new bridge had already demonstrated its capabilities in installing stay cables in a very controlled and safe manner.

VSL was therefore asked to study the possibility of replacing a hanger cable on the Silver Jubilee Bridge, in case urgent replacement was needed in the future. VSL convinced the owner and its engineer, Mott MacDonald, of the benefits of using a modern MSI cable, which is based on well-proven and robust multi-parallel-strand technology and features multiple anti-corrosion barriers. The alternative would have been to replace the existing locked coil cable with the same design.

DATE
2018 - 2019

LOCATION
Between Runcorn and Widnes

OWNER
Halton Borough Council

ENGINEER
Mott MacDonald

DESIGNER
VSL (directly for all temporary works and subcontracted to Tony Gee & Partners for permanent works connections)

CONSULTANT
Tony Gee and Partners and COWI (independent checker of the work)

MAIN CONTRACTOR
Balvac

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

Design and supply of the new replacement cable (MSI6-15)

Design and supply of the new connecting steelwork to fix the new cable to the arch and deck structure

Transfer of the load from the existing cable to a temporary cable

Lowering of the existing cable down to deck level for detailed analysis

Hoisting the new replacement cable

Transfer of the load from the temporary cable to the new permanent cable

KEY FIGURES

— Main arch span of 330m

Putting in a new hanger cable required the design and provision of complex access systems and temporary works, as well as new permanent structural connections. VSL was able to provide a full package solution combining three key pillars of its approach: engineering, products from its own factories and the execution of the work in a safe and efficient manner.

As a result, VSL was hired to execute the design of all the equipment and the methodology to replace the cable, as well as to perform the actual replacement work.
The scope included developing the concept for the replacement methods, the design and supply of all the temporary works and special equipment, and specific tasks:

- the design and supply of the new replacement cable (MSI6-15);
- the design and supply of the new connecting steelwork to fix the new cable to the arch and deck structure;
- transfer of the load from the existing cable to a temporary cable;
- lowering and removal of the existing cable down to deck level for detailed analysis;
- hoisting the new replacement cable;
- transfer of the load from the temporary cable to the new permanent cable.

VSL made use of temporary cables and hydraulic equipment to transfer the load smoothly from the existing cable to the new one, without ever leaving the deck unsupported.

The adopted solution avoided overloading the remaining adjacent cables. This was essential due to the absence of redundancy in the original design.

Preparations for the hanger cable replacement works on the Silver Jubilee Bridge began in 2018 with the design, method development and fabrication of the special equipment required. The actual works began on 16th September 2019 and were completed on 13th October the same year.

VSL made use of temporary cables and hydraulic equipment to transfer the load smoothly from the existing cable to the new one, without ever leaving the deck unsupported.

SALTO GRANDE TRUNNION BEAMS, ARGENTINA

INSPECTION OF PT TENDONS AT A HYDROELECTRIC COMPLEX

The Salto Grande Hydroelectric Complex is located on the River Uruguay about 18km upstream of the Uruguayan town of Salto and the Argentinian town of Concordia. The river makes the border between the two countries, which run the plant through a joint technical commission. When completed in late 1980, the complex's two powerhouses contained 14 Kaplan turbines with a total output of 1,890MW, making Salto Grande one of the largest low-head river plant in the world.

The spillway structure consists of 20 concrete piers at 19m centres. Each pier features a trunnion beam of prestressed concrete, against which the supports of the 19 radial spillway gates bear.

In extreme cases - when one gate is closed and the neighbouring gate is open - the trunnion beams are subjected to an unbalanced water pressure force of 15MN that acts at a distance of 2.6m from the centreline of the piers. **To enable this force to be transferred to the pier, the trunnion beams are anchored into the piers by means of post-tensioned (PT) cables**, which were installed by VSL in 1978.

In 2019, **VSL was asked to perform a diagnosis of the current status of the PT tendons of two trunnion beams**, after the technical commission detected some leaks in the active anchors of the tendons.

The client wanted to ensure the safe operation of the hydroelectric complex for the next 50 years.

VSL was appointed to diagnose the actual condition of the PT tendons between the trunnion beams, piers and radial gate joints, using non-destructive testing and non-invasive techniques, in order not to affect the operation of the plant.

DATE
2019

LOCATION
Concordia

OWNER
Argentina and Uruguay

MAIN CONTRACTOR
Salto Grande Joint Technical Commission

SCOPE OF WORKS

Detailed inspection of the concrete structure:
- Visual inspection of the structure
- Visual inspection of the PT tendons
- Carbonation testing
- Reinforcement mapping
- Chloride tests
- Compressive strength tests
- Testing to determine the modulus of elasticity

Measurement of tension:
- Hole-drilling tests - precompression
- In-service monitoring

Measurement of corrosion rates

Modelling the behaviour of the trunnion beam-pier-radial gate joint using a 3D finite element model (FEM)

Production of a general diagnostic report

Proposals for structural remediation

KEY FIGURES

— 20 concrete piers featuring a trunnion beam of prestressed concrete

The VSL's scope of works included:
- detailed inspection of the concrete structure;
- measurement of tension;
- determination of the rate of corrosion;
- modelling of the behaviour of the trunnion beam-pier-radial gate joint using a 3D finite element model;
- production of a general diagnostic report;
- and proposing the structural remediation needed.

An engineer and a supervisor from VSL carried out in-situ tests and an initial pre-inspection using rope access techniques. VSL then installed a cloud monitoring service to measure strain, displacement, temperature and cracks for a month, so that all the data could be analysed.

VSL had to research old drawings and information and carry out detailed investigations – including gathering anecdotes, memories, pictures and any other useful information - to understand the problem at hand.

The contract for the inspection of the PT tendons took place throughout August 2019.

VSL diagnosed the condition of the PT tendons between the trunnion beams, piers and radial gate joints, using non-destructive testing and non-invasive techniques, in order to affect the operation of the plant as little as possible.

DELTA CAFÉS WAREHOUSE REINFORCEMENT, CAMPO MAIOR, PORTUGAL

UPGRADING AND REINFORCING 4,000M² OF SLABS FOR AN ICONIC COFFEE BRAND

VSL has recently completed the second phase of a long-term project to increase storage capacity in a major coffee warehouse in Portugal.

Delta Cafés is Portugal's biggest coffee producer and distributor. The first blend was made in 1962 in a 50m² plant in Campo Maior in the Alentejo province. As the brand grew bigger, so too did its storage requirements and so an elevated slab was built in the 1990s for the purpose of storing 'green' coffee.

The capacity at the time amounted to over 4,000m² across three levels, but the client soon required five or six levels to store its coffee. It was looking for **a solution to reinforce the slabs and increase the capacity by 40% to 50%, while minimising downtime and any impact on the warehouse's use**.

VSL is a major repair contractor in Portugal and was contacted by Delta Cafés to develop a solution to improve the capacity. **VSL offered a full service comprising inspection of the existing installation; design and delivery of a reliable solution based on the expertise of specialists in concrete reinforcement; and execution of all the works, including all preparations in the warehouse. This full-service approach and VSL's experience in repairs convinced the client to award the work to VSL**.

The first phase of works was carried out in 2006. The second and most important phase started in May 2018 and was completed in September the same year.

VSL's scope of works has included CFRP slab reinforcement, elimination of expansion joints and the coating of

DATE
2006 - 2026

LOCATION
Campo Maior

OWNER / ENGINEER
Delta Cafés

DESIGNER
VSL/LEB

MAIN CONTRACTOR
VSL Portugal

BACK TO THE PROJECT OVERVIEW | JOB REPORTS SUMMARY

SCOPE OF WORKS

CFRP slab reinforcement

Expansion joint elimination

Slab surface coating with epoxy mortar

Slab shoring

Monitoring for 20 years after reinforcement.

KEY FIGURES

- 14.4km of CFRP cut-In laminates
- 5km of CFRP laminates
- 4,000m² slab coating with epoxy mortar

the slab surface with epoxy mortar, along with shoring of the slabs. **The contract also involves monitoring for a period of 20 years**, which began after the initial work in 2006 and will continue to 2026.

VSL applied CFRP laminates to the underside of the slabs and cut-in laminates to the top surfaces in order to facilitate and expedite the installation procedure. VSL and its co-designer LEB chose this solution, which uses technology developed by S&P Clever Reinforcement, as steel plate reinforcement would have taken too long.

For the top surface reinforcement, several concrete cutting machines were used and epoxy resin was applied to insert cut-in laminates within the concrete slab.
In total, the work used 14.4km of CFRP cut-in laminates, 5km of CFRP laminates and 4,000m² of slab coatings with epoxy mortar.

In order to limit the impact on coffee production, VSL organised shift working to reduce the duration of the project. **Protection systems were implemented to avoid dust contamination of the coffee.** Dust produced in preparing the concrete could have been a particular issue but VSL avoided any problems by installing suction turbines.

The client wanted to reinforce the slabs of its coffee warehouse and increase the capacity by 40% to 50%, while minimising downtime and any impact on the warehouse's use.

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