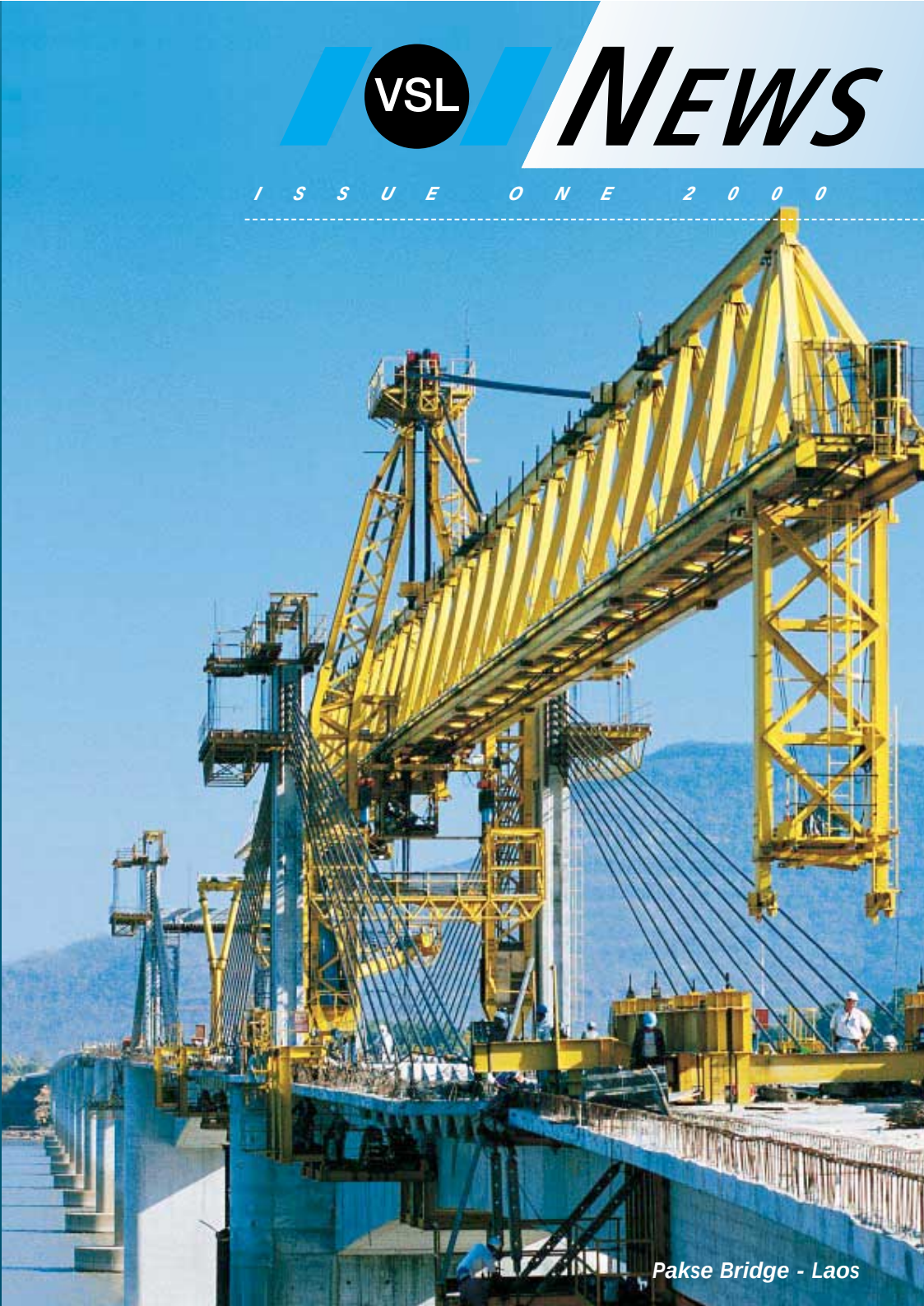
VSL NEWS

ISSUE ONE 2000



Pakse Bridge - Laos

HIGHLIGHTS

An example to follow!

The present issue of VSL News contains an article concerning the Pakse Bridge on the Mekong River in Laos. This project represents a good example of our strategy based on providing customers with enlarged work packages that incorporate many of VSL's specialised techniques.

Our responsibilities on the Pakse Project included all superstructure works:

- design, construction and dismantling of the precast segment casting yard;
- production and erection of precast segments, including the design, supply and commissioning of the erection gantry;
- construction of the cast in-situ upper part of the piers and pier-heads as well as the two central span pylons;
- installation of post-tensioning and stay cables.

By providing our customers with a package integrating all interfaces between the different technical activities, we are able to save them both time and money.

We are proud to announce that the bridge was completed 4 month ahead of schedule and to the full satisfaction of our client. We can do the same for you - anytime, anywhere.

Alain le Pivert
CEO and Chairman of the Board

PUBLISHED BY

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- HONG KONG -

Completion of the Olympic Station

Olympic Station Development Site C is the third phase of a new residential and commercial programme located on the Kowloon Peninsula overlooking Hong Kong harbour. The programme comprised ten residential towers as well as a retail and transport centre, both already completed. For its last phase - construction of the 32-storey MTRC and Hong Kong Bank office building- the developer, Sino Land, required a faster construction schedule than originally planned to catch up with the overall programme.
Initially tendered for construction using traditional formwork methods, VSL proposed speeding up construction by using a combination of VSL Climbform system for the large central core and Mivan system formwork for the beams and slabs as well as for the columns and lift lobby / staircase areas.

Due to the large number of angled secondary beams and reductions in core wall and column thicknesses, table formwork could not be used or would have resulted in excessive table-form modifications.
The typical core area formed per floor was 940 m² using VSL Climbform and 2,400 m² with Mivan formwork.

After only a 3-floor learning curve, the building progressed regularly on a 4-day per floor cycle including some modification works on certain floor levels. The structural frame was successfully completed just after the Chinese Lunar New Year. ■

Stuart Pearson
VSL Hong Kong

VSL Climbform and Mivan Formwork were used to speed up construction of this 32-storey office Building.

- CHILE -

PT Slabs for the Boulevard Kennedy Complex

Located in Santiago next to a shopping centre, the Boulevard Kennedy Project will introduce a new business services concept in Chile by grouping together a hotel, office areas, conference rooms and other services in a single complex.

Owned by Inmobiliaria Calle, the complex comprises a 42-storey main tower incorporating the Marriott Hotel, two 18-storey twin office towers and a four-level underground carpark.
The main contractor, Constructora ACS, awarded VSL the design, supply and installation of the post-tensioning slabs for the twin towers and the underground levels, representing a 58,000-m² area.
While the main tower was designed using traditional reinforced concrete, post-tensioning was the only solution for the construction of the twin towers given the need to provide for a 4.5-m cantilever and increased distances between columns. PT was also the best solution for the underground levels, as it allowed excavation works to be considerably reduced. ■

Andres Avendaño
VSL Chile

- FRANCE -

LIFTING THE VETROTEX FACTORY USING VERSO™

On January 1, 2000, VSL celebrated the new millennium by jacking up the 50 columns supporting the steel structure of the Vetrotex Factory by 340 mm. This factory is a multi-storey industrial building manufacturing glass fibre.

As it does not require cable connections, the VeRSO™ system is very simple to install and can independently control the movements of up to one hundred jacks.

A VeRSO™ System lifting unit

In order to modernise its Chambery factory (south-east France), Vetrotex, a Saint-Gobain subsidiary, decided to increase the floor to ceiling height of a manufacturing bay by 340 mm to install new equipment.
VSL successfully met the challenge and carried out the jacking works on 1 January without the slightest problem.

The 30 x 40-m and 15-m high manufacturing bay is a 900-t steel structure resting on 50 columns.
The lifting process was carried out by simultaneously jacking up the 50 columns with a maximum allowable tolerance of 1 mm between any two jacking points.
VSL installed 70 hydraulic jacks (with capacities ranging from 10 to 100 t) under the steel brackets welded to the columns. The jack mounting system was designed to withstand wind stresses of up to 160 km per hour on the bay.

The project's reduced jacking tolerance was achieved using VSL France's new lifting equipment: the VeRSO™ jacking system.

VeRSO™ - Shared intelligence computer-aided jacking system
The VeRSO™ system comprises a central control station and a number of individually computer-aided jacking units, each contributing to the general jacking process. All jacking units are radio controlled by a central processor. Each jacking unit is equipped with a process computer, a high pressure hydraulic pump (700 bars), a digital displacement sensor, an electronically regulated oil flow valve, an oil tank and ancillaries, two-way radio command and a 24 Ah electric battery.

In addition to fully designing the jacking operation, including computer analysis of the frame, wind calculations, steel brackets design and shop drawings, VSL supplied and assembled the steel brackets, dismantled and refitted all pipe-work and external wall cladding, carried out the 340 mm jacking and installed the new concrete bases for all the columns. ■

Alain Stamm
VSL France

VSL Technical Centre Europe (TCEU) carried out the engineering studies required to jack up the Vetrotex Factory's steel structure by 340 mm.

TCEU's scope of works comprised:

- modelling of the structure, using ROBOT finite elements software, both for the jacking and for the new permanent configuration. The goal was to define the loads to be supported and check structural stability during all stages, taking climatic conditions (winds up to 44.7 m/s, snow...) and the seismic environment into account.
- definition of all temporary works needed to transmit jacking loads to the columns. These temporary works were analysed and defined to optimise VSL's scope of works, both economically and in terms of completion times.
- definition of all new final column connections in their new positions as well as structural strengthening due to changed wind conditions on completion of the building jacking operation.
- technical assistance during the lifting process.

Vanessa Buchin
and Christophe Candolfi
VSL TCEU

- CHINA -

Nanjing Yangtze River Second Crossing Project

Located some 11-km downstream from the existing Nanjing First Yangtze River Bridge, the Nanjing Yangtze River Second Crossing consists of two bridges (north and south) and a road section repressenting a total length of 12,517 m.

The North Bridge is a conventional post-tensioned cast in-situ concrete bridge constructed using the balanced cantilever method with travelling formwork. Its 2,212-m overall length is divided in three 165-m main spans.
The South Bridge is a prefabricated steel segment cable-stayed bridge. With a main span of 628 m and a total length of 1,238 m, it is ranked as the longest cable-stayed span in China and the third longest in the world.
In December 1998, VSL was awarded a contract for the design, commissioning and supervision of the segment erection system and rental of the heavy lifting equipment for the South Bridge. This marked the start of VSL's proactive involvement in the introduction of advanced construction methods into Mainland China.

Segment erection
A standard segment weighs 272 t, and is 38 m wide, 15 m long and 3.5 m high. For the segment lifting operation (approx. 40 m above sea level), VSL used two SLU lifting units mounted on self-launching cantilever lifting frames. Lifting rates are set at a maximum of 19 m/h and an automated driven coiler enables the lifting spreader beams to be rapidly lowered to hook up the segments.
The 69 segments are lifted from a barge positioned below the bridge deck and handled in space by adjusting the SLU jacks and the lifting points on the spreader beams.
The segment erection requires a simultaneous lift on both ends of the cantilevering bridge deck with the out of balance load limited to 10%.

The segments are welded to the existing deck, rope stays installed and tensioned. The lifting frames are then launched out and the process repeated.

Simultaneous lift of two 272-t segments

Cycle times are anticipated to be one pair of segments every seven days per pylon. As erection is scheduled to take place on both pylons over the same period, a total of four lifting frames is needed.

The close collaboration between VSL's Heavy Lifting department in Singapore and VSL's Special Projects division in China resulted in an impressive project that incorporates the highest levels of construction safety, quality and performance. ■

Ronald Lee (VSL China) and David Trayner (VSL Singapore)

The South Bridge under construction.

- SWITZERLAND -

Spectacular assembly of the Dreirosen Bridge

Second truss in lifted position and being moved into bridge axes.

The Dreirosen Bridge crosses the river Rhine in the centre of Basle, Switzerland. However, the existing 65-year old bridge no longer meets today's traffic requirements and it was decided to replace the old structure by two parallel 3-span double deck bridges. These will eventually link the Swiss motorway system with German and French motorways.

In late January 2000, VSL placed the two 540-t and 128-m long steel trusses for the first bridge. The trusses, fabricated 4 km further down the river Rhine on the French side, were transported to the site on two barges. Each barge was equipped with 2 lifting towers, each supporting one SMU-330 lifting/lowering unit. As the barges had to pass under an existing bridge, the lifting towers were split into two so that each half could be pivoted backwards.

Once the lifting towers were repositioned at the bridge site, VSL lifted the truss by 10 m, and after the barges were properly positioned, lowered the structure onto piers and abutments.

Once the first new bridge is commissioned in 2001, the old superstructure will be dismantled and in January 2002, VSL will repeat the same operation for the second bridge. ■

Ferdinand Trenkler
VSL Switzerland

- CHILE -

El Portezuelo Retained Earth Wall

El Portezuelo Retained Earth Wall - Phase 1

Owned by Inmobiliaria Auco S.A., the Portezuelo Condominium is currently one of the largest building projects being constructed in a new residential area of Santiago City. The first stage was the construction of two 17-storey buildings and this will be followed by the completion of eight new buildings over the next five years.

One of the most difficult problems to resolve was the design of the access ramp to these two buildings. This essentially consists of a 450-m long ramp with access from both sides, sloping up from 0.60 m to 18 m. Among the different proposed solutions, the VSL Retained Earth Wall system was chosen as the most economical and aesthetic alternative proposal.

The 6,000-m² total surface area is divided into two phases. While the second phase is expected to begin at the end of the year, VSL was awarded the design of the wall, the supply of materials (square panels, mesh and accessories) and the supervision of the installation works for the first phase by the main contractor, Constructora Manquehue Tres S.A.

The first phase (3,500 m²) leads up from one side up to a reinforced concrete ornamental arc shape located at the centre of the ramp. The architect divided the wall into three similar height sections in order to create two garden terraces between them.

This project represents an important retained earth reference for VSL Chile as it is the highest RE wall constructed in an urban area in the country. ■

Andres Avendaño
VSL Chile

- SWITZERLAND -

Electrically isolated anchors for the Seelisberg Motorway Tunnel

The 9.3-km long twin tunnel is part of the A2 motorway running from Basle to the Italian border.
It crosses a 450-m long marl stratum, which, despite the prestressed VSL anchors installed in 1979, continues to swell and raise the concrete road pavement. To contain the uplift and extend the service life of the existing anchors, the owner, the Canton of Nidwalden, decided to install additional anchors.

VSL supplied and stressed 376 electrically isolated permanent and regroutable 5-12 type anchors, each with a working load of 1,310 kN.

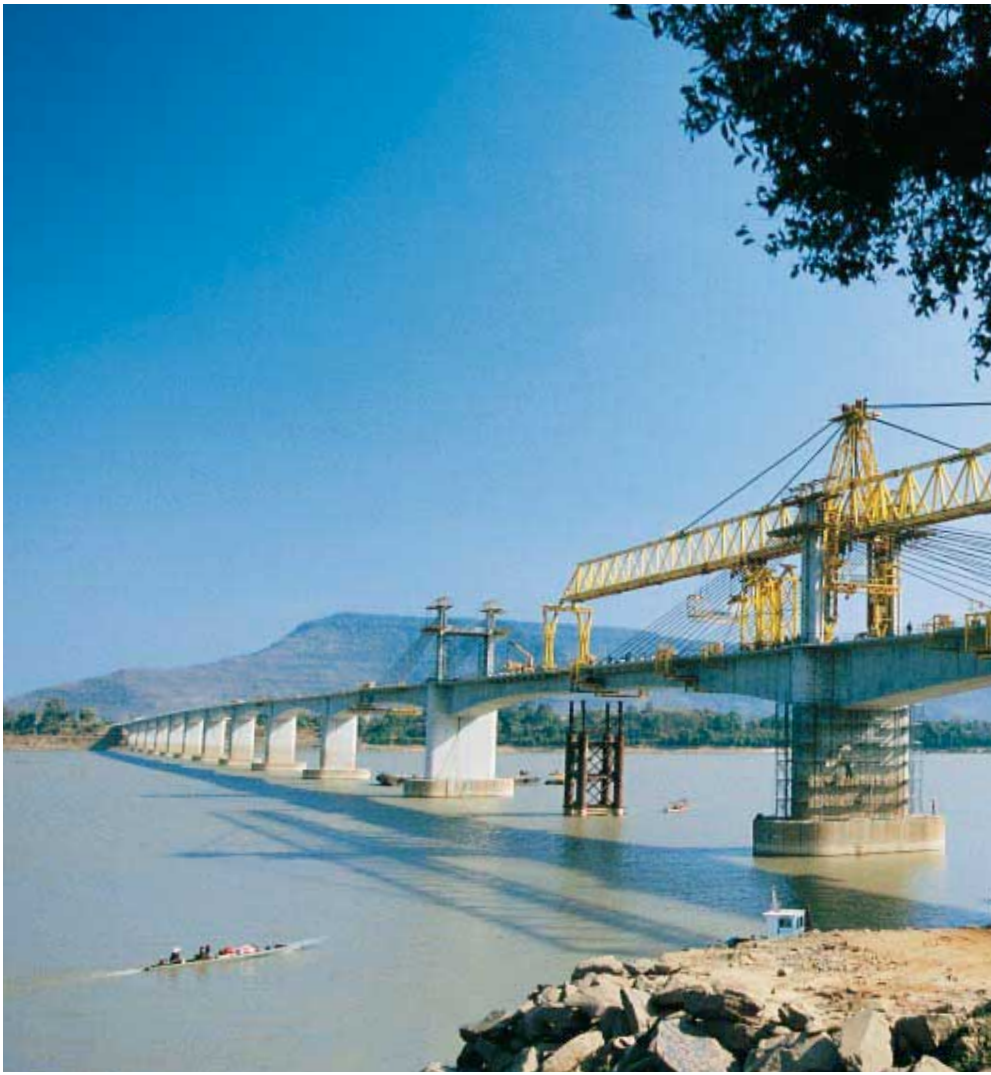
Based on the results of test anchors, the free length was set at 12 and 14 m with an 8-m bond length. All anchors have threaded anchor heads for subsequent load adjustments.
A total of 16 surveillance anchors, each with a load cell and an electrical resistance measuring installation, were installed, enabling forces and the integrity of the corrosion protection encapsulation to be continuously monitored. Works were carried out between November 1999 and mid-February 2000. ■

Franz Fischli
VSL Switzerland

- PEOPLE'S DEMOCRATIC

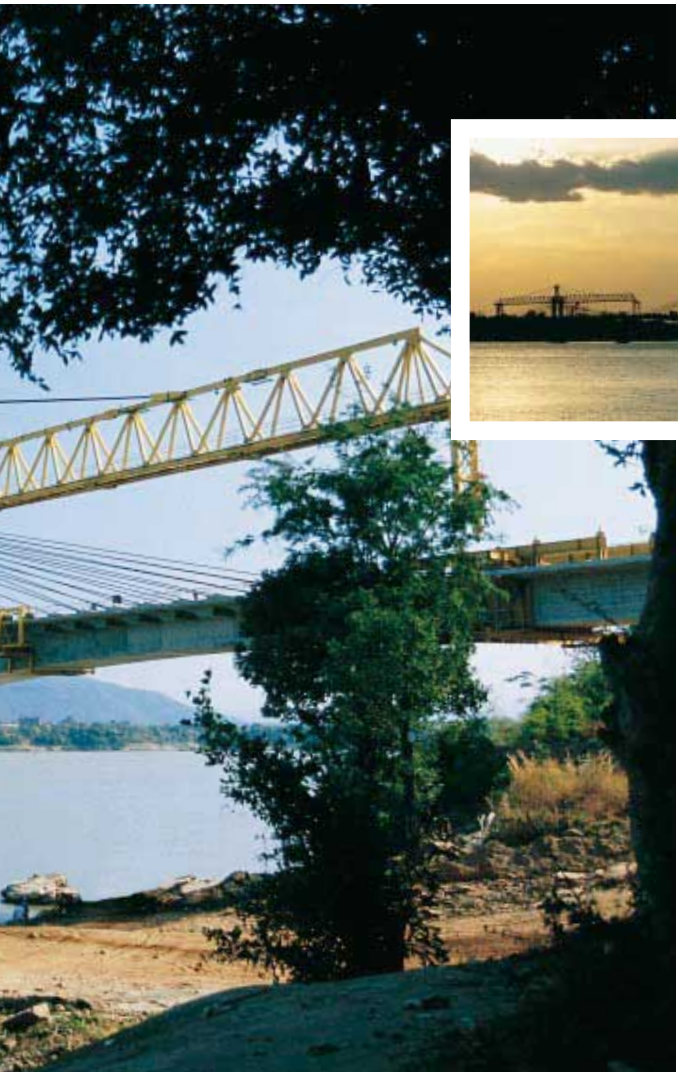
COMPLETION OF THE

VSL expertise helps open



REPUBLIC OF LAOS -
PAKSE BRIDGE

up South-East Asia



The deck assembly of the Pakse Bridge in Champasak, the southern province of Laos, was completed in February 2000, four month ahead of schedule. The opening of the 1,380-m long precast segmental bridge later this year will be a key factor in the development of this region as it will ease travel and trade between Thailand, Vietnam and Cambodia.

The 1,380-m long Pakse Bridge and its launching gantry after finishing deck erection.

VSL Heavy Lifting equipment installed for lowering of stay stressing platform

The People's Democratic Republic of Laos is a landlocked country in the centre of the Indochinese peninsula, and shares a common border with Thailand, Vietnam, Cambodia, Burma and China. Pakse, the most southern regional capital of Laos, is the transit point for traffic in the southern area of the country: Vientiane, the capital, lies to the north, Vietnam to the east, Cambodia to the south and Thailand to the west. The area is rich in natural resources and the new bridge, one of two crossing the Mekong, is an integral part of a regional infrastructure upgrade currently being undertaken to allow the Laotian people to more fully develop these resources by providing access to trade ports in neighbouring countries.

A 1,380-m segmental bridge

Lying a few kilometres south of the existing ferry route, the Pakse Bridge stretches 1,380 m from the Phonthong to the Pakse side. The bridge is a precast segmental bridge with an extra-dosed main span erected using the balanced cantilever method and supported by a total of 13 piers. This continuous rigid frame post-tensioned concrete box girder consists of four bridges, separated by hinges at mid-span. The standard span length is 102 m with a main span of 143 m.

- Bridge 1, including A1 abutment:
  70 - 102 - 102 - 51 = 325 m.
- Bridges 2 and 3:
  51 - 102 - 102 - 51 = 306 m each.
- Bridge 4, including the main span and A2 abutment:
  51 - 123 - 143 - 91.5 - 34.5 = 443 m.

The main span segments are wider than the standard segments to accommodate the stay blisters.

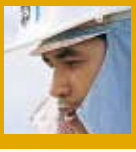
Although the pier heads are cast in-situ, the 384 segments are cast in moulds in the precast segment production yard on site.
The segments are installed with internal and external prestressing, and incorporate the stay cables for the main span segments.
The weight of a segment varies between 60 and 105 t, with a length of 2.5 or 3.5 m, a width of 11.5 m for normal segments and 14.5 m for main span segments. The height varies from 6.5 to 3 m at mid-span.

A total of 975 t of strands and stressbars were used on the Project.

VSL's Package

VSL's substantial scope of works for the Pakse Bridge includes:

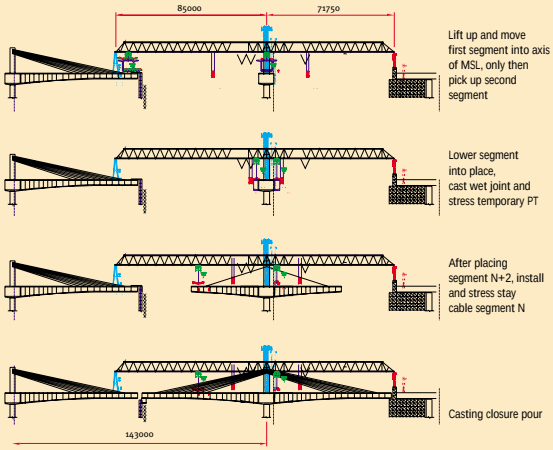
- construction and dismantling of the precast segment casting yard;
- production of 384 precast segments;
- erection of precast segments, including design, supply and commissioning of the erection gantry;
- geometry control;
- construction of the cast in-situ portion of the deck including the installation of bearings and expansion joints;
- construction of pylons;
- installation of stay cables (50 t);
- construction of the top 11.5-m of piers 1 to 12;
- Post-tensioning: 930 t.



Segment erection of the Pakse

384 segments had had to be precast for Pakse Bridge, each using 25-40 m³ of concrete.

Segment erection **Main span**



8 nationalities were involved in the construction of the Pakse Bridge.

Construction Schedule

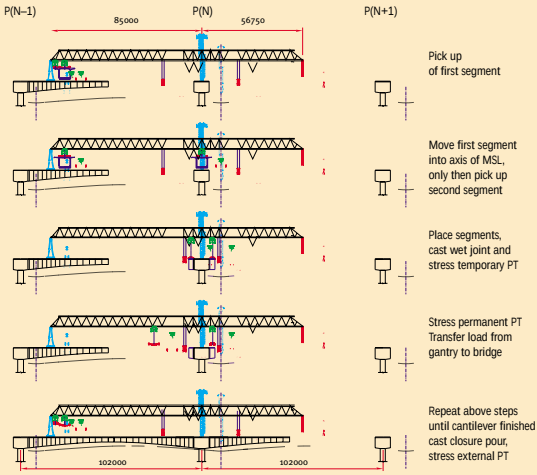
The climate in southern Laos is clearly divided into two seasons: the rainy season from May to October, and the dry season from November to April. During the year, the water level of the Mekong varies by more than 10 m and the strong currents during the rainy season can make access by boat and barges very difficult and time-consuming.

On the other hand, access during the dry or low water level season is difficult because of the many sandbanks that become exposed in the Mekong. Pakse's physical isolation also meant that the VSL team had to carefully programme their work as most of the construction materials, i.e. consumables, machines, equipment and others, had to be imported from Thailand or from overseas.
These extreme conditions had an impact on the construction schedule but the careful planning and good management by the capable and dedicated VSL Project Team led to the segment erection being completed in February 2000, 4 month ahead of schedule. ■

Peter Mahar
VSL Thailand

Bridge

Segment erection **Approach span**



Main participants:

- Grant aid: The Government of Japan, Japan International Cooperation Agency (JICA)
- Client: Ministry of Communications Transportation, Post and Construction
- Supervising Agency: Communications Department, MCTPC
- Consultant: Nippon Koei Co., Ltd., Japan in association with Construction Project Consultants Inc., Japan
- Contractor: Shimizu Corporation - Hazama Corporation Joint Venture, Japan
- Principal Sub-Contractor: VSL (Thailand) Co., Ltd. (segment production, pier head, deck)

- JAPAN -

Takamatu Bridge

The Takamatu Bridge has the longest concrete arch span ever built in Japan.

This reinforced concrete fixed arch bridge is located in the northern part of Miyazaki Prefecture in Kyushu. Owned by Nishiusuki Branch Agency, Miyazaki Prefecture, it is built by the Taisei Corporation and Kawada Construction Co. Ltd Joint Venture.

With a length of 463.2 m and a width of 6.25 m (roadway) plus 1.5 m (sidewalk), the Takamatu Bridge has a 260-m long arch span, making it the longest concrete arched bridge span in Japan and the 10th in the world.
For the first time in Japan, the erection of the arch rib was executed by combining Truss and Melan methods.

VSL's method was adopted for the installation of external cables at the arch rib, as well as for the upper deck slab back stay cables, diagonal suspension cables and main cables, and the transverse prestressing cables at deck level.
The arch rib is already completed and the upper part is under construction. The overall project, for which construction works began in March 1999, is schedule for completion by October 2000. ■

Motoharu Kono
VSL Japan

- USA -

Maysville Stay Cable Bridge - Kentucky

VSL recently completed the first half of a cable-stayed bridge in Maysville, Kentucky. The 710-m long bridge (2,330-ft) spans the Ohio River and uses VSL's Monostrand System 200. The Maysville bridge is the first cable-stayed bridge in the United States to use co-extruded stay pipe and strand-by-strand installation.

VSL's scope of works included stay testing, design and manufacturing, and shop prefabrication of anchors. VSL also provided stay installation equipment, stressing equipment, and technical assistance for the stay installation.

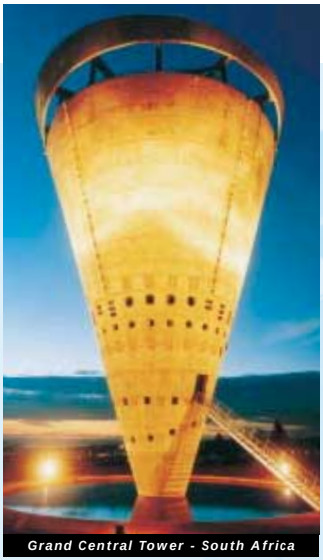
Consisting of steel edge girders, transverse floor beams and precast deck panels, the 320-m long main span superstructure (1,050 ft.) was erected using the balanced cantilever method.

The bridge consists of 2 cast-in-place pylons rising 93 m (305 ft.) above the water line.
There are a total of 80 stays ranging in size from 24 to 43 strands.

The anchor piers and approach spans were constructed concurrently with the pylons. The structural steel edge girders are 167 cm and 213 cm (66 inch and 84 inch) in height and the floor beams are spaced at 4.8-m centres (16 ft.). The main span grid structural steel sections are 15 m long by 16.7 m wide (50-ft. x 55-ft.) and weigh approximately 41 t. Overall roadway width is 14.6 m (48 ft.). ■

John Crigler
VStructural Llc.

The first US stay cable bridge using co-extruded pipe and strand-by-strand installation



Grand Central Tower - South Africa

Horizontal PT for this 40-m high unusual cone-shaped structure.

Without post-tensioning, many special structures could not be built. VSL has adapted post-tensioning principles to a wide range of civil engineering structures such as LNG/LPG tanks, water reservoirs, wastewater plant digesters, underground tunnels, off-shore platforms, concrete floating barges and dams.

For these types of structures, requiring strict quality control and flawless performance, post-tensioning provides cost savings, speeds up construction, improves durability and is virtually maintenance-free.

Over the years, VSL has been involved in a number of highly prestigious and complex concrete structures. These include the world's largest concrete barge (the NKossa barge in France), one of the largest concrete multi-cell rectangular reservoirs (the Warragamba waste water plant in Australia), the first catenary moored floating platform (the Troll Oil Production platform in Norway), one of the longest pre-assembled concrete immersed tunnels (the MTR 502 in Hong Kong) and the first egg-shape digesters in Singapore (the Kranji Egg).

- SPAIN -

LNG Tank at Cartagena

The 135,000-m³ LNG tank requires 1,000 t of vertical and horizontal tendons.

Located in Cartagena, on Spain's eastern coast, this LNG tank is an extension to the plant owned by Enagas, the Spanish Gas Company.

The tank, designed to store a total volume of 135,000 m³ of liquefied natural gas, is a 40-m high concrete cylinder with an internal diameter of 67 m and 6 vertical buttresses.

The main contractor, Ferrovial-Agroman (one of Spain's major contractors) sub-contracted all the transversal and horizontal PT to VSL.
The horizontal cables are anchored in three alternate buttresses placed at 120° from one another. The 57 units (VSL E6-31 tendons) are stressed simultaneously using three 1,000-t capacity jacks.

This allows each tendon to be stressed in one operation to its final load configuration. The Stronghold G3-1000 jacks were adapted in CTT's factory in Barcelona to fit the VSL Anchorages. The 270 vertical tendons (VSL E6-19) are anchored at the top of the tank. A total of 540 anchorages will be stressed and 54 additional vertical tendons (9 per buttress) installed. Galvanised steel U tubes and thermo-retractable duct couplers have been placed in order to ease the strand threading and assure the water tightness of the galvanised duct.
VSL's works started at the end of 1998. Up to now, 42 (out of 57) horizontal tendons have been installed, stressed and grouted. The last horizontal tendons and all the vertical tendons will be installed, stressed and grouted in the last quarter of 2000 and the first quarter of 2001. ■

Pedro Ferrer
CTT Stronghold

- AUSTRALIA -

Dungowan Dam

Dungowan Dam is located 60 km Southeast of Tamworth, in central New South Wales (NSW). The dam is owned by the Tamworth City Council and supplies a significant proportion of the city's water requirement.
The project represents a world first for the installation of special permanent anchors.

In 1996, a wedge failure occurred on the eastern ridge of the dam which supports the fuse-plug. The NSW Department of Public Works & Services (DPWS), on behalf of the Tamworth Council, designed the remedial works to be carried out and was also engaged as the Project Manager.
In 1998, the DPWS contracted one of VSL's competitors to carry out the excavations and anchoring for the remedial works. In early 1999 the DPWS went into dispute with the contractor who was unable to complete an extremely complicated part of the works. By the end of July 1999 the DPWS had terminated the contract and engaged VSL to carry out the remainder of the works.

The project entailed VSL taking on the role of main contractor and establishing a full site compound in this remote area. The remedial works involved stabilisation with rock bolts and mesh, the grouting up of the previous contractor's failed anchor systems, the installation of five rock anchors and the construction of five large reinforced concrete reaction pads.

The DPWS design was unusual, as the design parameter required that, on completion, the anchors formed a single continuous bond length. This ensured that no rock mass movement could take place due to cable extension. This requirement was met by the secondary grouting of the free anchor length on completion of the stressing works.

The permanent anchors (8 x 15.2 mm and 58 m long) with a 8.0-m bond length and a 50-m free length have the particularity of only being inclined at 20 degrees below the horizontal.
The drilling works required a 200-mm diameter hole to be accurately drilled to 62.5 m in highly fractured ground and at this flat inclination. This was achieved using a customised "fatboy" directly behind the down-the-hole hammer and large diameter stabilised drill rods.
On completion of the anchor hole, the next challenge was to successfully clean the hole of all drilling debris. Standard industry practice techniques could not be used due to the flatness of these long anchors. VSL constructed an air-lift system small enough to fit inside the 200-mm diameter hole but also capable of travelling the 62.5-m depth of hole. The airlift basically vacuumed the drill hole clean.
Due to the secondary grouting requirement of these anchors and the plunging effect needed to successfully install such flat long anchors, VSL decided to pre-grout the bond length prior to installation. This was achieved by building a project specific fabrication bed and using a special steel transportation/installation cradle.
After completion of the stressing and monitoring requirements, the anchors had to receive secondary grouting. Again, due to the length and flatness of the anchors, the DPWS specified a grout flow of 5 litres per minute. Once the inner annulus was full, a constant pressure of 100 kPa had to be maintained on the grout column for a 45-minute period to ensure that trapped air and water were forced out of the sheathing corrugations.
These permanent anchors are a world first for such a low inclination at this length. ■

Mick Holland
VSL Australia

- VIETNAM -

NGHISON CEMENT PLANT

The Nghison Cement Plant Project in Vietnam's Thanh Hoa Province was completed in April 2000 by the Shimizu / Vinaconex / Hacc J.V.

VSL was awarded the contract for an alternative design using post-tensioning for the Plant's seven silos. VSL's Technical Centre in Singapore designed the 7 prestressed concrete silos in co-operation with the Shimizu Head Office Technical department. Slipforming and heavy lifting methods were proposed as economical solutions to lift the assembled roof at the same time as the slipform operations, reducing the construction time for each silo to an average of one month.

Under the leadership of Project Manager Geoff Mc Kinnirey, VSL installed 430 t of PT strands for two 60-m high cement silos (22-m and 28-m diameter), two 44-m high clinker silos (23-m diameter), two 46-m high blending silos (18-m diameter) and one 37-m high limestone silo (24-m diameter).
Along with the Morning Star cement plant, completed in 1997, and the Hoang Mai cement plant, currently under construction, Nghison represents VSL's third reference in Vietnam.
Benefiting from the VSL Group's network and experience, VSL Vietnam confirmed its ability to locally provide its customers with top quality engineering solutions and high quality works. ■

Laurent PEGURET
VSL Vietnam

- INDIA -

DABHOL, PHASE 2 LNG TANK

Three 200,000-m³ gas-fuelled power production LNG tanks are currently under construction in Dabhol, about 500 km south of Mumbai.
Owned by the Dabhol Power Company, this type of tank is the first of its kind in India. LNG Tanks are considered as highly critical and sensitive structures, and VSL PT systems were able to meet the stringent requirements.
The 80-m diameter and 40-m high tanks have a 600-mm wall thickness throughout and a 900-mm thick ring beam at the top. The walls are horizontally and vertically stressed with VSL6-19S tendons, representing a total of 166 horizontal tendons (125-m long) and 64 vertical tendons (40-m high). The PT tonnage per tank is approximately 600 metric tonnes. Each tank is cast in 11 lifts and each casting height lift is restricted to 3.75 m. Strand installation and stressing operations are scheduled to begin once the tank walls are completed and will strictly comply with the main contractor's works schedule.

In addition to the supply of PT materials, including anchorages, corrugated steel ducts for horizontal and vertical U-shaped tendons, VSL is also providing all PT equipment (hydraulic jacks, pumps, strand pushing machine, strand decoilers and grout mixers) and technical assistance including site supervision during duct installation and PT operations. ■

R. M. Ganesh
VSL India

- AUSTRALIA -

Cronulla Sewerage Treatment Plant

Following the Lend Lease Projects (LLP) award for upgrading the Cronulla Sewerage Treatment Plant, discussions were held with members of the infrastructure project team towards the end of 1998 to investigate alternatives to their conventionally reinforced concrete design for water retaining structures.
This led to VSL submitting an alternative PT design for four 5.7 million-litre circular clarifier tanks and a 4-cell 17.3 million-litre rectangular bioreactor structure.
Given that alternative PT structures are technically superior as they require fewer joints and offer overall cost savings, LLP was receptive to VSL's design and construct structures package.
An alliance was formed between Hornick Constructions -a local specialist tank builder who has extensive experience in the construction of water retaining structures- and VSL to offer a "total solution".
The contract was secured at the end of the 1st quarter of 1999 with site works beginning simultaneously mid-June 99 on both the clarifier and bioreactor structures.
The clarifier and bioreactor base slabs are designed with two-way post-tensioning, while the walls only have horizontal post-tensioning.

Aerial view of Cronulla Sewerage Treatment Plant.

All the walls are cast in-situ with the exception of the internal bioreactor baffle walls which are precast on the slab.
Once works had begun on site and after the slab was poured, the decision was taken to increase the bioreactor structure to five cells, providing a total of 21.6 million litres. The final size was 50 m by 60 m with 7.2-m high walls, and with 36-m diameter and 5.6-m high clarifiers.
Works are progressing according to the schedule thanks to the co-ordination between VSL's on-site Project Manager and the design team. As a result of its high performance level, VSL's scope of works has been extended to include the design and construction of a 78.5-m long x 34-m wide biosolids structure, comprising two-way post-tensioned base slabs and 2.4-m high horizontally post-tensioned walls.
VSL expects to have a portion of the site works completed by June 2000. ■

Ross Ioakim
VSL Australia

- MOZAMBIQUE -

Mozal Alumina Silo

The Mozambique Aluminum (Mozal) Smelter project is situated in Maputo, Mozambique. Owned by Mozambique Aluminum Ltd, it will provide much needed export revenue for the country.

The 45,000-t capacity aluminium oxide storage silo, built by Group Five Civils and Conform J.V, is post-tensioned using VSL's multistrand bonded system. The 40-m high silo has an internal diameter of 40.6 m and a wall thickness of 400 mm.
It is post-tensioned with 98 horizontal rings of 21 Ø and 12.9-mm strand tendons alternating over 180 degrees, i.e. 4 buttresses.

The walls of the silo were slipformed over a 15-day period. This was followed by the casting of a ring beam to support the cast in-situ dome roof. Strands (130 t) were then pushed into the cast-in ducts.

VSL supplied the materials and carried out the threading, stressing and grouting operations from August to November 1999. ■

Brian Cox
VSL South Africa

- SINGAPORE -

Ulu Pandan Sewage Treatment Works

Owned by Singapore's Ministry of the Environment, the Ulu Pandan Sewage Treatment Works is the third of its kind to be built in Singapore. It is intended to meet the expected increase in wastewater generated by the rapid residential, commercial and industrial development of the area.
The main Contractor, Sembcorp Construction Pte Ltd., awarded VSL the design, supply and installation of the PT Plus System for the 8 egg-shaped sludge digesters. Each digester has a maximum diameter of 21 m and is supported on twelve 1.3-m diameter in-situ bored reinforced concrete piles. Although its height is approximately 30.7 m, only 11 m will extend above ground level once it is completed.
The digester walls vary in thickness from 600 mm near the base to 500 mm near the top and are constructed using a 35-grade concrete with a 40-mm cover. The wall thickness was determined to ensure a simple to build and watertight structure that would allow the concrete to be easily poured and vibrated.

The post-tensioning uses VSL's bonded multistrand system. This is encased inside VSL PT-Plus plastic ducts to provide an additional corrosion barrier. Because of its lower friction characteristics, the use of VSL's PT-Plus plastic ducts meant that the number of horizontal tendon anchorages could be reduced by 50%. Due to the egg-like shape of the digesters, the hydrostatic pressure from the sludge creates tensile membrane forces in the walls in both horizontal and median directions. These are balanced by VSL PT strands. While normal Ec type anchorages have been used for the median cables, the 3,600 horizontal cables are individually anchored and stressed using Z-type anchorages. This solution is well adapted to egg-shaped digesters as no external blisters are required and the number of stressing pockets in the wall is minimised. In all, approximately 350 t of strands were used for each digester. The project began in December 1998 and construction will take 18 months. ■

Patrick Woo
VSL Singapore

- USA -

Erie Zone 3 tank

VSL recently completed construction of the 5.7 million-litre Erie Reservoir (1.5 million-gallon) in Colorado.
The overall dimensions of the state-of-art, fully encapsulated structure are 34-m (110-ft.) in diameter by 7-m high (23-ft.).
The project engineer, Denver-based Bates Engineering Incorporated, required enhanced corrosion protection of the post-tensioning systems to maximise the service life of the structure. VSL provided this through the use of the VSL S-6 monostrand system in the floor and roof slabs, circular PT-Plus duct with 5-12 strand tendons horizontally in the wall, and flat PT-Plus duct with SO6-4 anchorages vertically in the wall. A special grout containing microsilica was used.

The wall was cast in eight individual full-height segments, including 4 pilaster segments, and the floor and roof slabs were each cast in a single pour to eliminate the maintenance problems associated with horizontal construction joints.

The scope of VSL's works included placing the post-tensioning systems and mild reinforcement, as well as friction testing and providing the post-tensioning systems. ■

Dan Harger
VStructural Llc.

VSL Sistemas Portugal

Since 1985, VSL has continued to develop as a strong and successful post-tensioning sub-contractor in Portugal.

The presence of VSL in the Portuguese market goes back to the early seventies, when it was introduced through an important local company, Novobra S.A., which acted as an exclusive licensee.

Following Novobra's bankruptcy in 1984, a new company, Prequipe S.A., took over the VSL license and rapidly developed as a small dynamic structure specialised in post-tensioning activities.

Given Prequipe's strong position in its specialised market and the gradual growth of the Portuguese public works sector, VSL International Ltd. acquired a majority holding in the company in 1990, and subsequently acquired a 100% holding in 1995.

● ***Combóio Viaduct in Madeira Island: PT and stay cables (1999/2000)***

The Combóio Viaduct is the first Portuguese bridge to be equipped with VSL Stay Cables. Owned by the Madeira Regional Government and built by Soares da Costa, this viaduct is located in a rather densely populated area of Funchal city and forms part of the Funchal ring road programme currently under construction.

The viaduct, designed as a stay cable bridge, has a 92-m long main span and two 25-m high pylons above the deck, each supporting 2 x 7 stays in the deck axis. The 21.5-m wide deck is a single post-tensioned box beam and will carry two traffic lanes in each direction.

In addition to the post-tensioning and stay cable works (replaceable strand-by-strand stay cables), VSL Sistemas Portugal will also supply the bearings and joints.

VSL for the installation of external post-tensioning bars using high density of polyethylene ducts.
Post-tensioning bars were designed along both sides of the beams and the anchorages were incorporated into concrete blocks.
Using internal bars, these blocks were transversal post-tensioned into beam's web.

● ***Fonte Nova Viaduct in Lisbon: structural repairs and strengthening (1999)***

The Fonte Nova Viaduct, owned by the Lisbon Municipal Council, forms part of one of the most important roads around Lisbon, linking the International Airport to major Portuguese highways.

Although the structure was highly damaged, it could not be demolished due to the unacceptable traffic disruption this would cause. The main contractor, Soproel, responsible for the structural repairs and strengthening of the bridge, sub-contracted

The new subsidiary, called "VSL Prequipe S.A.", went through continuous growth over this period and, in 1997, its turnover attained a peak of USD 12 million.
At the same time, the VSL Group was also the 50% shareholder of another Portuguese company, Stronghold Portugal S.A. In August 1998, the Group decided to amalgamate Stronghold Portugal and VSL Prequipe. This merger between the two entities led to the creation of "VSL Sistemas Portugal S.A.".

Following the slump of Portuguese civil works market in 1998 and 1999 which seriously affected the company's activity (USD 6.3 million), VSL Sistemas should now benefit from a major 5-year infrastructures investment programme.
This includes new projects such as private motorway concessions, sports infrastructures for Euro 2004, the expansion of the Lisbon metro, the construction of the Porto metro, railway rehabilitation and preparations for high speed train tracks.

A second phase is programmed from 2004/5 to 2010 with more private motorway concessions, and large-scale projects such as the new Lisbon airport, a high speed railway programme, as well as one or even two new bridges across the river Tagus.
In order to prepare for this construction boom, VSL Sistemas Portugal increased its staff level at the end of 1999 and now has a total of 79 employees.

A part from maintaining a leading position in its core business and related activities (post-tensioning, bearings and joints, retained earth and geotechnical services, heavy lifting, special equipment, etc...) the company also wishes to increase its stay cable activity and diversify its services and products, especially in the structural repairs sector.

In addition to its corporate vision, recent developments based on modern tools (internet and intranet solutions), and specialised contractor qualifications, VSL Sistemas is also committed to a quality policy and should very soon become the first post-tensioning sub-contractor to obtain ISO 9002 Certification in Portugal.

This will be the result of a policy of confidence and continuous investment by the VSL Group in Portugal over the last ten years. ■

Carlos Moniz & Zenóbia Q. Martins
VSL Sistemas Portugal

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