VSL NEWS

THE VSL NEWS MAGAZINE • ISSUE TWO 2009

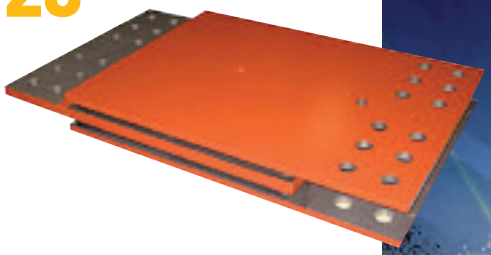
Intrafor, an underground partner

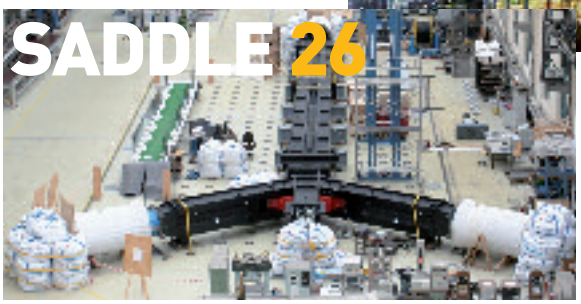
VSL Dampers for buildings

Gautrain in South Africa

highlights

DAMPERS 28





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Cover photo: Foundation works in Hong Kong at Central Reclamation

EDITORIAL

Building on innovative solutions

The economic turmoil of the last year has influenced markets all over the world. But the infrastructure packages launched by all major countries in terms of civil works brought economies and the construction business back on the track. VSL has continued its active marketing policy and can announce the signature of several important projects, such as two large projects for foundations: the Central Reclamation Phase III as well as HATS project, important contracts for VSL-Intrafor in Hong Kong. Another major project is the design and build contract for the Hodariyat Bridge in Abu Dhabi which represents an excellent opportunity to emphasize VSL's role as leader in the stay-cable business and in line with our No. 1 Bridge Partner strategy.

VSL is also building this year on another important area of competences and signed a contract for the post-tensioning works in a nuclear power plant in Saint-Petersburg, Russia. This will be a major reference for VSL and opens new possibilities on the ever growing nuclear market worldwide.

VSL's staff throughout the world has made considerable efforts to continue to offer optimised services to clients, to propose innovative solutions and to see what is best, for the engineers, the main contractor and the owner, as well as for the project. VSL's well known commitment to quality and innovation will strengthen VSL's position as market leader and as No. 1 construction partner.

Jean-Philippe TRIN, former CEO & Daniel RIGOUT, CEO as of Nov. 2009

Small efforts – big savings

VSL's Actitudes programme is now three years old. VSL's approach to sustainable development, is *'Improving our attitudes through the way we act'*. It has 42 specific action points in seven key areas: client relationship, risk management, leadership in health and safety, employee skills and opportunities, supplier relationship, respecting the environment, community support. Review of some recent efforts.

Good practice on site

Video site inspections

A new initiative was launched in 2009, with site inspections being recorded on video. The inspections are then annotated to identify both hazards and good practice with the results published as training aids. The plan is to record an inspection for each type of work and each type of project.

Better living for site labour

VSL Brunei is in the process of upgrading its labourers' living conditions by providing better accommodation and amenities in the camp, in line with VSL's ideology to "lead by example".

Recognising safe performance

VSL-Intrafor Hong Kong was involved in organising and judging the Lighthouse Club (Hong Kong Branch) Safe Subcontractor Awards 2009. The awards were presented in front of 300 people, including senior representatives from the Government and other major employers.

Certification

Triple certification
VSL has been making great strides in developing and implementing more effective management systems and conforming to international standards. ISO 9001:2008 is client-focused, with the primary aim of ensuring 'Quality' – that is that the requirements of clients are identified, understood and met. The ISO 14001:2004 standard focuses on ensuring that VSL activities are conducted in an environmentally-friendly way, while OHSAS 18001 makes sure that works are carried out without undue risk, either to VSL employees or to those working with and around VSL.

VSL Australia was recently recommended for triple certification for quality, safety and environmental management (ISO 9001, OHSAS 18001 and ISO 14001). This achievement builds on a long history of quality management and significantly increases the proportion of the VSL Group covered by triple certification.

VSL Switzerland
VSL's Swiss operations achieved triple certification to ISO 9001, ISO 14001 and OHSAS 18001:2007 in June 2009. The scope covered by the certification includes post-tensioning, structural strengthening, stay cables, bearings, dampers, ground anchors and geotechnics.
At the same time, Special Projects, Heavy Lifting, and the European Technical Centre achieved certification to ISO 9001 and OHSAS 18001.

VSL Middle East
VSL-ME satisfied the system requirements of all three standards when audited in September and was recommended for the triple certification of its Integrated Management System (IMS). The certification covers the full range of work, including design, supply, installation, construction and consulting services in relation to specialist construction methods and structural engineering projects using VSL post-tensioning systems, segmental erection, stay cables, VSoL® and stressbars. ■

Take the lead in sustainability

Recycling materials

VSL in New Zealand is taking a lead in sustainability and recycling by finding companies who can reuse materials arising from the demolition of a 700m-long viaduct. Other initiatives include reducing carbon footprints by working with key suppliers to minimise the number of deliveries.

Cleaning concrete waste naturally

VSL Brunei has set up a series of ponds at its yard to treat the water that washes out its concrete mixer trucks. Settlement removes the sediment and ultraviolet radiation treats the water before discharge, with promising initial results.

Reduce pollution

Vehicle fleet

• VSL Thailand recently replaced an older diesel truck with one that combines use of compressed natural gas and diesel. The investment has an expected payback period of three years or 250,000km.

• In Switzerland, VSL is reducing the environmental impact of its vehicle fleet: vehicles coming up for renewal are replaced with ones that are leaders in environmental performance to ensure continual improvements in the fleet's emission and fuel performances.

Environmentally-friendly paint

VSL Thailand has identified that the use of high-quality paint and strict painting standards has many advantages including reduced maintenance and lifetime paint costs, extended equipment life and improved productivity.
The approach is being used initially on hydraulic jacks.

Charity bike ride

Office organisation

Stay right where you are

As a global organization, VSL needs to communicate across borders and as a result staff members have spent considerable time travelling by air to attend meetings, creating a significant 'air travel footprint'. In an effort to reduce this footprint by 25%*, VSL is upgrading its video-conferencing capabilities. These upgrades will be completed by the end of 2009 and will introduce systems in Thailand, India, Dubai, Hanoi, Melbourne and possibly Brisbane, to supplement existing systems in Paris, Switzerland, Hong Kong and Singapore.

Developing a new culture and changing old customs

• Use less paper

Paper production and related activities have a strong environmental impact, requiring up to 60m^3 of water to produce a ton of paper. Throughout the network, offices are implementing many recycling and paper-saving routines including printing documents on both sides, use of recycled paper as well as scrap paper where possible, thinking before printing and recycling printer cartridges and paper. Adoption of the guidelines achieves significant energy and cost savings without affecting the quality of work.

• Save energy

Timers have been fitted to all printers and photocopiers in VSL's Hong Kong offices to shut off the power overnight and at weekends.

There are also more local initiatives, such as developing enthusiasm for cycling to work and supporting charity bike rides.

** The actual amount of travel depends on activity levels and locations.*

Community actions

Members of staff around the world carry out corporate and individual community activities. For instance, VSL Australia is now a sponsor and partner of the international foundation Emergency Architects, which works alongside other organisations to rebuild devastated areas in a sustainable way.

emergency architects australia
www.emergencyarchitects.org.au

VSL Taiwan staff sacrificed their holidays to help in a refuge camp after Typhoon Morakot caused severe damage and the loss of hundreds of lives in August.
Staff members from VSL India have been making regular presentations to college students about employment and sustainable development.

Network
Office in Qatar

→ **The opening of the VSL Middle East Qatar branch office** was attended by many contractors, consultants, developers, suppliers and important business representatives from all over the state of Qatar. There is a construction boom in both infrastructure and property developments and VSL ME is setting up a team locally to better serve its clients, and is currently following a number of major projects. ■ *Contact: a.rossetto@vslme.ae*

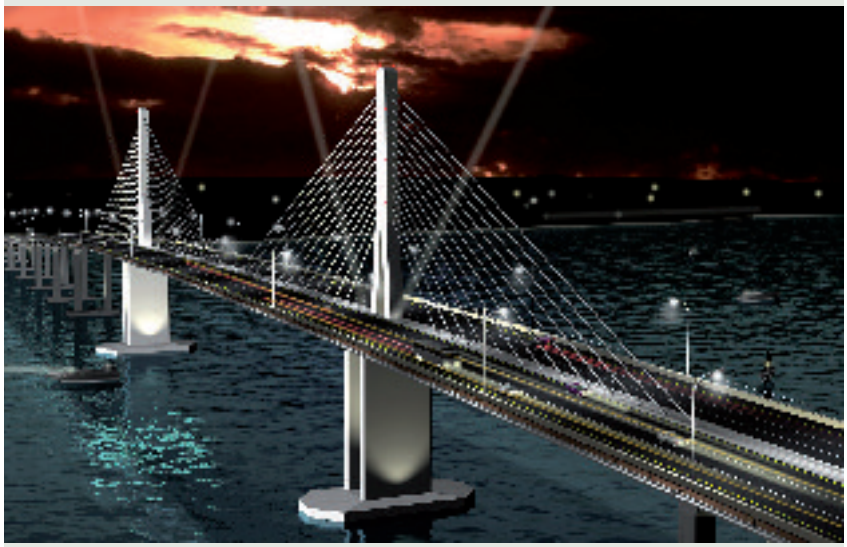
Dampers
Calming effect

→ **Testing has shown that the Friction and Gensui dampers** installed by VSL Korea and HK JV on the Incheon Bridge have achieved a high reduction in the amplitude of cable vibration. Contractor Samsung awarded VSL the contract and the dampers were supplied by CTT Stronghold and SRI Group. ■ *Contact: thomas.cheung@vsl.com*

Tanks
First in Algeria

→ **VSL (Switzerland) Ltd has been awarded the post-tensioning supply** and installation works sub-contract for 4 concrete tanks in Arzew, North-West Algeria. The tanks are for the storage of LPG (capacity 12'000m^3 & 56'000m^3) and LNG (capacity 2 x 160'000m^3). Italian contractor Bentini was awarded the local contracting works due to their experience on similar projects in Algeria and Europe by EPC contractor Saipem. Slip-forming of the first LNG tank walls is scheduled to commence early 2010 with the completion of all civil works planned for end of 2011. ■ *Contact: felix.blumschein@vsl.com*

Expertise
Hodariyat challenge



→ **VSL Middle East has been appointed as the Hodariyat Bridge's main contractor** in joint venture with AST. The cable-stayed bridge will link Abu Dhabi Island and Hodariyat Island across a 1km-wide channel. It is VSL Middle East's largest single project and is based on an alternative design proposed by VSL and developed by IBT. The project encompasses almost every aspect of VSL's expertise, including precasting and balanced cantilever erection for the main span and incremental launching of the side spans. The project also requires post-tensioning, bar systems and soil walls. ■ *Contact: a.dodds@vslme.ae*

EIT
Isolated first

→ **The Eggraben Bridge in Großarl** features VSL's first Austrian bridge application of electrically-isolated tendons. The deck of the 50m-long arch bridge is built without reinforcing steel and the post-tensioning is designed for exceptional durability. The 30 longitudinal tendons are electrically isolated to permit future monitoring. Work began in June for completion in November. ■ *Contact: josef.simader@gps.bau.com*

Testing
Minimum curvature

→ **Upon request of the client, the Vienna University of Technology,** Institute of Structural engineering, tests have been carried out to determine the highest stresses that can be applied for a range of tendon curvatures. The tests on 24 tendons covered six different sizes at four alignments - straight and with a radius of 0.5m, 1m and 3m. Each was successively stressed to failure in the tests. ■ *Contact: josef.simader@gps.bau.com*

PT-Plus®
Beach access

→ **VSL Middle East has recently completed work on 21 bridges** providing access to Abu Dhabi's Al Raha Beach Development. Post-tensioning was supplied and installed under four separate contracts for ALOR. The bridges incorporate a total of 1,900t of PT strand and most feature PT-Plus® ducting for enhanced corrosion protection. ■ *Contact: a.dodds@vslme.ae*

Nuclear
Double first

→ **VSL Switzerland has been awarded its first nuclear power plant contract** with a Russian contractor. The project involves the supply of the post-tensioning and monitoring systems for the 67.7m-high inner shells of two nuclear containment structures designed to meet the latest safety requirements. Atomenergoprojekt Saint Petersburg is the designer and general contractor for the 1,100MW LAES-2 power plant at Sosnovyi Bor near St Petersburg and the civil works have been sublet to Metrostroy. Installation of the embedded elements for the first structure's PT system will begin in December. ■ *Contact: sebastien.elias@vsl.com*

Strengthening
Join forces

→ **For the first time, VSL Middle East and Structural Preservation Middle East** have joined forces to carry out a major strengthening operation on a high rise building in Abu Dhabi. The work is in preparation for the addition of five new levels to each of five towers, which range from 36 to 50 storeys and sit on an eight-storey podium. The six-month contract involves enlarging more than 550 beams and columns together with the strengthening of nearly 650 beams using a combination of CFRP and Near Surface Mounted Carbon Fiber (NSM) rods. Challenges have included training a labour-force of over 150 workers and performing the installation in temperatures in excess of 40°C. ■ *Contact: mmerchant@structural.net*

GROUND ENGINEERING

Intrafor, an undergro

With its extensive experience in soil engineering techniques, VSL-Intrafor provides clients with a comprehensive package of professional services ranging

As part of some advance works, Intrafor had successfully completed in 2008 the construction of large diameter bored piles, barrettes and diaphragm walls for the Central Reclamation Phase III project in Hong Kong. The scope of CRIII includes the reclamation of 18 hectares of land in front of the Star Ferry Pier between Central Reclamation Phase I to Lung King Street along with the construction of public transportation interchanges, stormwater culverts, drains and sewers, pumping stations for cooling main of future developments, public ferry piers, etc. The waterfront is located in front of the new HK Government Headquarters and the Legislative Council, which is currently under construction and due for completion by 2011.

und partner

from feasibility studies and design development to complete construction. Such know-how has been noticed: turnover is expected to have grown almost two-fold since 2008.

Intrafor, VSL's ground engineering and foundations specialist subsidiary, is happy today: an additional cutter is on the way to help it extend its services and offer the best to clients. With investments like this brand new high-tech monster, Intrafor-VSL's growing fleet offers the latest tools, designed to increase safety, production rates, durability and savings.
This acquisition gives Intrafor more technical capacity to surf the wave of success and take advantage of a resurgence in the market. The foundations business within VSL is expecting a dramatic increase of turnover in the coming years. Figures for diaphragm walls and barrettes doubled between 2006 and 2008.

At the heart of the business

The diaphragm wall market is again becoming very active, particularly in Hong Kong and Singapore.

A new wave of projects launched in 2007 by the Government in Hong Kong, where Intrafor is based, means that work volumes are increasing significantly, particularly on railway construction projects. MTR has five major projects in the pipeline in Hong Kong. The 56km of track and 17 stations are equivalent to about a quarter of the current Paris Metro and will cost between €10 billion and €15 billion. MTR is considering increasing its project management team from about 1,000 staff to 2,400 over a three-year period*.
The 26km of the Hong Kong section of the Guangzhou-Shenzhen-Hong Kong Express Rail Link will be the first high-speed line there, operating at 200km/hour and carrying 10,000 passengers per hour in each direction by 2015. The 'all underground' works - including a 140 000m² terminus - mean that it is expected to be the world's most expensive high speed link, costing US$190 million per kilometre. Other strategic rail projects include the West Island Line, a 3.2km underground extension to

Hong Kong Echo, Automn 2009, page 26.

Heading to the deepest shaft on HATS

The Harbour Area Treatment Scheme (HATS) is targeting to improve water quality of Vitoria Harbour. The main works consist of a series of sewage collection tunnels, drop shafts and pumping stations around the northern coastline of Hong Kong Island and to a treatment plant at Stonecutters Island. In August 2009, Intrafor as part of a consortium was awarded the subcontract to construct 8 shafts. Intrafor will be responsible for constructing 3 of them including the deepest & the most challenging Sai Ying Pun Shaft which is 13m radius, 1500mm thick and 91m deep.

Intrafor's deepest stop end at Lai Chi Kok, Hong Kong

Intrafor has mobilised its Bauer BG40 cutter from Dubai for the excavation of a major shaft for the Drainage Services Department of the Hong Kong Government. The 58.5m-deep shaft has a 12m internal diameter with a 1.5m-thick wall and the project also includes a slurry wall, which is 84m long, 1m thick and 30m deep. Six large panels were constructed, with 49m-deep WSI joints in between them. This is the deepest stop end installed by Intrafor to date. Such a deep installation required an extremely high degree of supervision and good workmanship. The 84m slurry wall, which is located along the existing sea wall, has been excavated using traditional cable grab and chisel equipment. Once the excavation was completed, Type IV sheet piles were inserted into the trench to form a cofferdam for later deep excavation. Work was completed in October 2009.


Lifting the large size cages

the existing Island Line from Sheung Wan to Kennedy Town that opens in 2014. Another line will run through multiple districts from Shatin to Central, with one section from Tai Wai to the West Rail line and a second bringing East Rail across the harbour to Hong Kong Island. Two other projects are the Kwun Tong Line Extension and the South Island Line (East).

Network springboard

Intrafor was originally founded in France in 1850 and has developed into a well-established and recognised construction partner for developers, consultants and contractors worldwide. The company has been present in Hong Kong since the 1960s. Over the years, Intrafor has participated in many of the major projects that have shaped Hong Kong, including the foundations of the ICC tower, Hang Hau station and tunnels on the MTRC TKO line, Tsuen Wan station and tunnels on KCRC's West Line and overall ground engineering work on the Spur Line, for KCRC.

Among other current projects, Intrafor is now constructing the Central Wanchai Bypass right on the harbour front (see box p.12). Hong Kong is now acting as the main regional office and serves as the central platform for Intrafor's activities in the rest of the world.

Expanding out of Hong Kong

Intrafor is expanding its presence outside of Hong Kong, taking advantage of VSL's worldwide network. Its subsidiaries and licensees are organised into closely co-operating regional units to provide clients with customised solutions using cost-effective construction technologies. All foundation works can be executed using Intrafor personnel and equipment. VSL-Intrafor offers the full range of ground engineering techniques that are applicable to retaining structures, soil improvement and environmental protection as part of civil engineering or building projects. Applications include metro stations, tunnels, roads and bridges, reclamation work, dams, deep basements, car parks and

Diaphragm Walls in permeable Nile river sands for Attaba Metro Station in Cairo, Egypt

The bulk excavation depth of some 39m at Cairo Metro Line 3 Attaba Station means that it is one of the deepest - if not the deepest - of its kind ever built with a non-circular diaphragm wall and strutting. Intrafor successfully completed this 1,500mm-thick diaphragm wall, which is 85m-90m deep, as well as another of the same thickness and depth for a TBM exit shaft next to the station. The total amount of diaphragm walls was 61,000m^2.

Ground conditions in Cairo have a reputation for being extremely difficult, particularly from the point of view of groundwater control. This is due to the extreme permeability of the Nile River sands, which extend to great depths and require the provision of a flawless groundwater cut-off to avoid piping and flooding of the excavation.

The original design included a 78m-deep diaphragm wall with an 11m-thick grout plug extending to the 78m depth. However, a clayey layer was identified a few metres below the proposed diaphragm wall toe and the design was revised after further investigation using soil samples from a depth of about 82m to 84m. The redesign involved a deeper diaphragm wall, to be keyed in the clayey layer without the need for a grout plug.

The station box was split into three sub-boxes using intermediate slurry walls so that pumping tests could be carried out in each separate box. The first box was built using the original grout plug scheme, while the feasibility of the revised design was investigated. Both remaining boxes were built using the deeper diaphragm wall scheme. It was difficult to ascertain whether the clayey layer would be sufficiently continuous to provide the water cut-off required to achieve the very tight specified seepage of about 12m^3/h/box. Proper keying of the diaphragm wall into a good clay material was essential and this was carefully checked for each panel. The pumping tests proved successful in all three boxes and bulk excavation within the station box could proceed.

high-rise buildings. Intrafor's internal design capabilities enable it to target full involvement in projects from the earliest stages and offer turnkey solutions tailored to customer needs. This involvement includes appropriate technical consultancy and support during the planning and construction phases. And as with all of VSL, Intrafor is keen to work in partnership with clients right from the conceptual stage, and to have its design and method engineers working closely with the client's estimating teams during the tender stage. In Australia, alliance-type contracts are also developing.

Resources - key criteria

Who are Intrafor's clients today? Firstly, there are main contractors – from middle-sized to large, local to international. Developers are also clients where large foundation packages are separated from other works. Intrafor also provides services to contractors who do not have specialist know-how in diaphragm walling. In addition to Intrafor's ability to carry out the work, clients pick the company on the basis of price and resource availability. A particularly strong point is Intrafor's ability to bring in additional teams immediately from elsewhere if an increase of resources is required. This can include Hong Kong nationals currently working outside Hong Kong as well as staff hired for projects in the Middle East. Such an option may be the deciding factor for clients wanting to get their project under way quickly without suffering any delays at the start, where the efficiency of the foundation works is a major issue.

In ground engineering more than elsewhere, providing resources also includes ensuring the availability of appropriate equipment: a state-of-the-art cutter can reduce time by up to 40% when properly deployed with a trained operator. The purchase of new equipment with the latest options *(see box)* will definitely give an edge to Intrafor once it comes into action early in 2010. *(Cont. p.15)*

Ronan Hasle, business development manager, in front of the cutter

Deep Diaphragm-Walls at Central Reclamation Phase III – Hong Kong

The third phase of Hong Kong's Central Reclamation project (CRIII) incorporates a 1km section of a new underground road, the Central-Wan Chai Bypass. This section is being built as advance works to avoid future disruption and allow the early release of significant areas for the harbour-front development. The section of trunk road within CRIII comprises a dual three-lane underground tunnel and the advance works include construction of the walls and the top slab along the future alignment.

The subcontract for the diaphragm walling and barrettes is being undertaken by Intrafor in a fully-integrated JV. The work comprises 1km of 1.2m-thick diaphragm walls to be constructed into the granite bedrock and around 107 1.2m barrette piles for foundations to the tunnels. Pre-treatment of a pell mell rubble mound will be required to a depth of about 22m to ensure that trench stability is maintained. There are various sensitive structures around the works, including stormwater culverts, cooling mains and power cables that are close to or crossing the tunnel alignment and so demand very special care. Peak operations will require three cutters and nine excavation cranes. In addition, 10 services cranes of up to 280t capacity will be deployed on site to place the 25,500t of reinforcement cages into the diaphragm wall and barrettes. Cages will be fabricated in single lengths of up to 38m and 50t using vertical couplers.

Operating outside Hong Kong relying on VSL network

For the Chinatown Station, part of the Singapore underground railway network, VSL Singapore has built a total of 1.25 km of diaphragm wall corresponding to 25,000 m^3 of excavation and concrete. VSL-Intrafor deployed up to four excavation rigs and one mini-cutter capable of working in restricted space and reduced height. Some constraints of this high profile project were particularly challenging: the site is located on one of Singapore's main commercial and tourist areas; working space was limited to a strip of 8 to 10 m wide; 80 meters of a 20 m deep diaphragm wall is built under a bridge with a clearance of 6 m; ground condition is a combination of the very soft Singapore marine clay and the hard rock formation.
The project also illustrates the synergy and benefit of operating outside of Hong Kong relying on VSL local network. VSL-Intrafor team completed the project without any incident resulting in more than 350,000 safe man-hours. VSL-Intrafor team has also been rewarded through the project by receiving numerous "Monthly Best Safety Conscious Sub-Contractor" and the rank of Best Safety Sub-Contractor in the whole of Gammon Singapore Projects.
The diaphragm wall was completed in July 2009. Station is to be completed in 2013.

K. M. Chum, deputy project manager, checking bentonite properties

Using a risk management approach in deep cofferdam construction

Intrafor was awarded the subcontract to design and construct a four storey basement in the heart of Kwun Tong town centre adjacent to an MTRC mass transit station and considered to be one of the deepest cofferdams of a private sector development in Hong Kong. Construction has involved demolition of the existing basement, diaphragm wall installation, excavation and lateral support for the diaphragm wall and footing construction works. Low working headroom within the old basement made it difficult to demolish the existing pile cap to form slots along the existing perimeter to facilitate diaphragm wall work. Diaphragm wall installation has demanded very high levels of technical skills during excavation because of the presence of the existing concrete piles and the adjacent MTRC station and commercial buildings.

There were five layers of steel H-section struts and walings (900Te) acting as lateral support to provide shoring to the installed diaphragm walls and preloading during excavation. The excavation work was very complex and proceeded slowly, especially while removing the existing basement structures. Intrafor was the first contractor in Hong Kong to use the approach described in CIRIA Report C580 for the design of excavations and lateral support. The approach requires the analysis of a progressive failure of struts, unless a risk management plan is implemented to reduce the risk of strut damage. The project is the first private development scheme of its kind in which the risk management approach has been adopted as an alternative to strut failure analysis. It has been found to be much more cost-effective than using more and heavier struts to prevent progressive failure.

Founding on safety

Foundation construction has become more heavily mechanised over the last 40 years to improve productivity and, more importantly, safety. However, the switch to using heavy equipment has brought new hazards that need to be carefully managed. VSL-Intrafor has more than 50 years' experience in foundations (particularly diaphragm walls) and mechanised its operations relatively early on. It is therefore well versed in safe working methods and makes safety a top priority, as demonstrated by gaining OHSAS 18001 certification in 2003.

Typically the main hazards on a diaphragm wall construction site are:

1) Movements of heavy vehicles such as dump trucks and concrete trucks

A large construction site can have hundreds of truck movements each day. These movements are often in relatively congested areas where cranes are also operating. Public footpaths may need to be crossed and the trucks may enter and exit via public roads. To minimise risks, VSL-Intrafor:

- selects vehicle operators based on their performance standards
- provides guards at all vehicle entrances to guide movements
- checks the condition of vehicles as they arrive on site, and weekly if they remain on site
- insists on CCTV at the rear of all heavy vehicles
- provides spotters to supervise any reversing manoeuvres on site

2) Crane and lifting failures

There's usually something moving overhead on a foundations site, such as excavation grabs, chisels, reinforcement cages and tremie pipes. The risk of loads passing over personnel or colliding with other equipment or structures needs to be managed.

To control these risks VSL-Intrafor:

- carefully checks ground conditions
- carefully checks all cranes on site and ensures that they are regularly maintained
- assesses the competence of operators
- assigns trained banksmen/riggers to each crane to monitor loads and movements

3) Ground collapse

The problem with working underground is that you can never be exactly sure what is there or how it will respond. That is why specialist contractors are required. Ground collapses can be an issue if works are not properly planned, supervised or monitored. Close monitoring of ground conditions during critical stages of the works helps ensure that collapses are rare. As a backup, VSL-Intrafor maintains the capability to stabilise a collapse quickly by backfilling the excavation rapidly with bentonite-cement, lean mix concrete or gravel.

4) Major health issues

Mixing bentonite or cement slurry without control measures creates dust that can be harmful, particularly if breathed in regularly over a prolonged period. Much of the equipment on site produces relatively high levels of noise particularly if working within 2m of it, which can cause hearing damage. VSL-Intrafor sets up its equipment to minimise these hazards, and strictly enforces the use of personal protective equipment.

Multicultural staff

Last but not least, Intrafor's strength lies in the quality of its multicultural staff. Training is a must, for safety and for technical knowledge, whether in design, methods or construction on site. Ideas about best practices are exchanged through the VSL network with one common goal: to deliver the best possible quality to clients, wherever the client is as mobility is not an obstacle. *"Moving around? We don't mind at all,"* says Ronan Hasle, business development manager at Intrafor. *"We are flexible. We've been from Hong Kong to Egypt, to South Africa, to Dubai... In fact, it's in our culture!"* ■

Good teeth to be at the cutting edge

"It takes three to six months of testing to make sure our operator is a good one!" says Alain Deletang, site superintendant. *"What they need first is excellent experience on grab equipment. You need to "feel the soils" such as sand alluviums, decomposed granites, rock... and know how to face different types!"* Only then are they allowed to take over a cutter. One of the major differences from a grab is the use of electronics and automatic controls: a cutter has cameras, screens and digital buttons to press. You can go straight down 60m non-stop without changing tools, as the built-in inclinometer 6m from the bottom and the two lateral flaps keep you on track, always nice and vertical. The level of precision is high: to a tolerance of 300mm at 60m depth. *"We kept it to 30mm,"* comments Alain casually, as if it is no big deal to achieve such remarkable accuracy on such a challenge. On the Package 7 project in Hong Kong, Intrafor achieved 20mm of maximum deviation... at a depth of 104m. Central Reclamation III involved 7m of hard rock - even with the help of chisels to loosen the ground in front, the monster cutter still needed new teeth every metre... at HK$350 a piece and with 150 units in a set! Thanks to this expensive dental work, production speeds can reach up to 15mm per minute.

INTERVIEW
Brian Gillon, Client on Central Reclamation Project, Hong Kong

Let's finish early

What were your main concerns when putting the tender together?
We were asking for the best in delivery and costs. We want to meet our construction programme for one kilometre of cut and cover tunnel. And time is very critical on this project with 700 people on site!

What was at stake when choosing a foundation sub-contractor?
We have three drivers: time, cost and safety.

What about management?
It comes back to time! And it had to be someone located in Hong Kong, because the best chance of getting the equipment on site is how close it is. It's often in Europe or Middle East. The rest tends to get sorted out... We also need the works complete in a particular order; we monitor progress very closely through sequences of work. For instance,

at a particular culvert: there's a concentration of work in there. We prioritise the work.

To what extent do you interfere with production?
Not directly. There might be the odd panel here and there. It also depends on ground conditions. What controls production more than anything else is the machines themselves. We have three cutters from different groups on site. And it became necessary to change the cutting tips to suit the ground conditions. So we meet to see how to address the matter.

What to you think of using these new cutting tips?
It increases production by up to 40%. Of course, it's a balance between what it's going to cost and how efficient it is. We – our group– place a lot of emphasis on time. It's a kind of philosophy of ours to always deliver ahead of time - even if it costs more. I've never got into trouble for finishing a project early.

What about safety?
The approach has been proactive: separate walkways, barricades round the machines... and we've achieved safety rates on this project that are better than other projects I've worked on. Movement of plant which are large and heavy is a concern: workers are far more fragile!

UAE

Easy ducts

→ **Works are fully under way for the construction of five LPG tanks** on the Persian Gulf islands of Sirri and Kharg. The post-tensioning is provided by VSL and the overall requirements for the wall prestressing add up to more than 2,000 CS 2000 anchorages, 72,000m of PT-Plus® ducting and 1,000t of strand. The client has been particularly satisfied with the ducting's ease of handling and its impressive friction values. The main contractor is Panahsaz Engineering. ■ *Contact: fabian.persch@vsl.com*

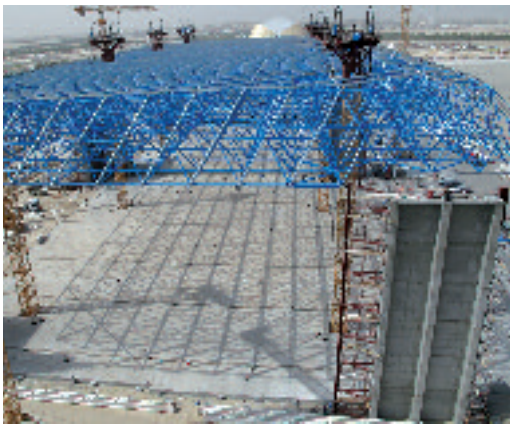
Dubai

Top end

→ **VSL carried out the lift that secured Burj Dubai** its place in the record books as the world's tallest structure. Burj Dubai reached its final height of 818m in 2009 with the lifting of the steel pinnacle that tops the tower. Eversendai was in charge of the top steel structure and VSL Heavy Lifting participated as subcontractor to raise the 450t pinnacle into position. The pinnacle consists of a 2.1m-diameter rolled steel pipe. Its height is 143m, with 30% remaining inside the building for the connection. The segments were successively brought up by crane and assembled inside the tower itself, starting at level 156 (585m above ground). Temporary slab openings in levels 157 to 162 allowed the lift to take place. VSL's three SLU 220/550 hydraulic strand jacks were installed at a height of 695m. The entire process went very smoothly and a lifting speed of 10m/hour was achieved. ■ *Contact: david.gratteau@vsl.com*

Kuwait

Raising the roof



→ **The complete 1,500t steel roof structure** for a new Airbus A380 hangar in Kuwait has been successfully raised into position by VSL on behalf of client Ahmadiah Contracting & Trading Company. The roof, which measures 175m by 85m by 9.2m, was prefabricated at ground level and raised by ten SLU 220/550 jacks and six SLU 120/550 units fitted to the column tops. The lift was executed in a single, computer-controlled operation. ■ *Contact: david.gratteau@vsl.com*

Abu Dhabi
Waterfront towers

→ **VSL Middle East has recently been awarded two contracts** for the post-tensioning works for towers being developed at the prestigious City of Lights development on the waterfront at Al Reem Island in Abu Dhabi. One of the projects is being built by China State Hong Kong and comprises two towers of 57 and 38 floors, requiring 250,000m² of post-tensioned flat slabs and approximately 1,000t of strand.

SKEC-NK Joint Venture is building five further towers, two of which were awarded to VSL, with 42 and 22 storeys and total of 150,000m² of post-tensioned slabs, requiring more than 600t of strand. Both projects will use the VSL bonded slab post-tensioning system with S5-5 anchorages and 12.9mm strand. VSL's design works are well advanced and the site teams have been mobilised. ■ *Contact: a.dodds@vslme.ae*

Dubai
VIP bridges

→ **VSL is playing a major role with Dutco Balfour Beatty** on two Dubai bridge projects. The first, Nad Al Sheba VIP Bridge will provide access to a new camel and horse race course. It includes both conventional and post-tensioned sections. A total of 140t of strand is being installed with VSL 6-37 anchorages for a main span

of almost 80m. The second is improving access to the new Midriff City Centre shopping mall requiring cast-in-situ spans of up to 55m, using 400t of strand threaded through more than 20km of corrugated ducts and anchored with 382 sets of VSL anchorages. VSL's works also include 4,000m² of VSol® walls. ■ *Contact: a.dodds@vslme.ae*

USA
Kanawha closure

→ **The closure segment of Kanawha River Bridge's 231m main span** was cast in June. Overall completion of the 900m-long multi-span bridge in Charleston is scheduled for October 2010. The bridge's main span is the longest for a concrete box girder in the USA and was built by the cast-in-situ balanced cantilever method. VSL has supplied Brayman Construction Company with post-tensioning materials, including 984t of 0.6" diameter (15mm) post-tensioning steel and the PT-Plus® plastic duct system, which was chosen to meet enhanced durability requirements. ■ *Contact: kblack@vsl.net*

Belgium

Identical twins

→ **VSL licensee Heijmans has provided the post-tensioning for two identical bridges** on the first phase of the extension and redesign of a road junction near Lummen. The bridges are each 123m long and they have been reinforced with a total of 200t of post-tensioned steel. Heijmans used the VSL E6-27 system in accordance with the ETA. ■

Contact: MPronk@heijmans.nl

Czech Republic

Inclination for VSL

→ **VSL is carrying out a range of post-tensioning works on a bridge over the Lochkov Valley,** which is being built as part of Bögl a Krysl, Hochtief and Strabag's extension of the Prague south-ring road. The steel superstructure is 260m long, supported on two inclined piers. It is being launched over temporary supports at 50m height, while the permanent inclined piers are constructed simultaneously. The concrete deck will be poured once the main structure is in its final position. VSL's works include post-tensioning of the inclined pier footing and pier heads, transverse post-tensioning of the deck and temporary stays for the inclined pier erection. ■ *Contact: psevcik@vsl.cz*

Equatorial Guinea

Double challenge

→ **VSL Ceme and VSL Ipsala are supporting BBGE,** the subsidiary of Bouygues Bâtiment International and DTP Terrassement in Equatorial Guinea for the construction of two new stay cable bridges in what will be a major city in the country. The bridges have a main span of 80 meters, and are supported by 2 pylons with H shape, of about 30 meters of height. The scope includes the design of the bridges, the development of the methods of erection, the supply of the specialised equipment and materials, as well as the management of the entire construction works. These include the setting up and the running of a new camp specifically built of the project for expatriates and local workers. The works on the site are scheduled to start early 2010 and to complete first half of 2012. ■

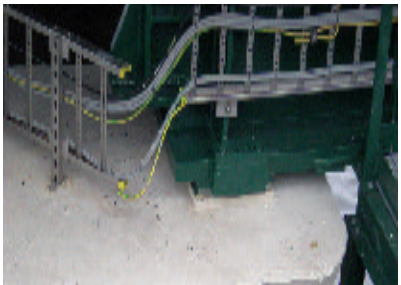
Contact: jeanmarie.laurens@vsl.com

Netherlands

Bridge elevation

→ **The old bridge over the River Zaan** near Amsterdam has been replaced. The new bridge is 200m long. Its northern section includes a steel bascule span for which VSL licensee Heijmans has provided special VSL pot bearings. The deck had already been placed and so it was necessary to lift the 400t bridge in order to install the bearings. ■

Contact: MPronk@heijmans.nl



Russia

Towering trio

→ **Murom, one of the oldest cities in Russia,** now has its first fixed bridge over the River Oka. Previously, the only access was across a pontoon bridge, which opened whenever a vessel had to pass through. The new 1,394m-long bridge has three A-shaped pylons, supporting two main spans of 231m and two side spans of 63m. VSL's works involved the supply and installation of the SSI 2000 stay cable system and 28 friction dampers, together with erection of the 130t bridge segments. Four SLU-70 jacks lifted a total of 32 segments by 33m in an operation that took each time little over two hours. ■ *Contact: rdenk@vsl.cz*

Slovakia

Multiple strands

→ **VSL is installing nearly 500t of strands** in bridges being built by Bögl a Krysl on the Sverepec-Vrtizer II section of the D1 highway. VSL CZ has supplied the PT system for two major ramps and is currently finishing PT installation for a five-span bridge. The ramps use the VSL CS 6-19 system with K couplers for their longitudinal PT and VSL SO 6-4 in the transverse direction. The bridge over the River Vah has a main span of 96m, built by the free-cantilever method. It uses VSL CS 6-19 with fixed couplers and VSL E 6-22. ■ *Contact: pvanek@vsl.cz*

Germany

Power lifting

→ **VSL lifted more than 6,000t of components** in its contract at the 100m-high boiler house of the Walsum power plant. The VSL strand lifting system shortened the construction period considerably and achieved significant cost savings. Work began in November 2007 with the erection of the 1,100t heavy suspension grillages in a closely-monitored operation. The flexibility and size of VSL's equipment, which had a capacity of 3,560t, enabled installation to take place anywhere within the boiler house. The procedure was that components were always lifted up out of the assembly area, keeping it free for the next parts to arrive and simplifying the delivery logistics. ■ *Contact: robert.monger@vsl.com*

NOTE PAD

Opening. *On 09/09/09, the first section of Dubai Metro was officially opened by HH Sheik Mohammed bin Rashid Al Maktoum, vice president and prime minister of the UAE and ruler of Dubai. VSL's joint venture scope of works included casting and erection of over 16,000 segment units stretching for 58 km of the elevated sections of the superstructure. Precasting works started late 2005 and erection was completed early 2009 on the green line, the second section of the metro, scheduled to open in 2010.*

Circling Eindhoven. *Heijmans, VSL's licensee for the Netherlands, has built 12 in-situ concrete bridges for the widened Eindhoven ring road, all with VSL post-tensioning system. Use of VSL's type-K coupler anchorage allowed the 31-strand post-tensioning cables to be extended through all six sections of a 600m-long flyover. CTT Stronghold (VSL in Spain) supplied the project's elastomer bearings.*

Astana arch. *VSL Switzerland Special Projects Department has successfully completed the M3 Arch Bridge in Kazakhstan's capital Astana for Turkish licensee Mega Yapi. The 151m long composite deck is suspended from four steel arches using 128 stay cables. Stay installation was completed two weeks ahead of schedule in just six weeks.*

Cycle crossing. *A cable-stayed bridge was built to provide a new cycle crossing above the new southern ring road in Franeker. Heijmans installed the 10 four-strand front cables which are connected to the pylon at a forked mortise-and-tenon joint. The two 24-strand rear cables have VSL SSI 2000 anchorages with deviators. The stressing ends of the rear cables are located in the top of the pylon.*

Malaysia

Extended success

→ **VSL has been closely involved in the erection of segments** for two bridges and four ramps for Seremban Middle Ring Road Phase 2. The elevated highway was built using the match-cast segmental and precast U-beam methods. The span lengths for the main viaducts vary between 39.1m and 62.2m while span lengths for the ramp viaducts range from 27m to 44.4m. In total, 481 segments were cast by VSL's joint venture partner, Projalma. They were erected on site by a combination of crane and the MX50 segment lifter. The segment lifter was used at locations where crane erection was not possible, including two river crossings and the crossing of an existing bridge. VSL's wide-ranging scope of works included supply and installation of post–tensioning; design and provision of the segment erection equipment and temporary falsework for pier unit erection; provision and installation of bearings and movement joints; as well as construction engineering services. ■ *Contact: ckchong@vsl.com.my*

Australia

Wall flowers

→ **The new 14.3km Bundaberg Ring Road improves safety,** traffic flows and port access. Bellero Constructions was awarded both stages of the works and VSL was contracted to design and supply VSoL® Retained Earth Walls. Stage 1 required one abutment to be constructed with a floral pattern, which was achieved using specially-developed form-liners. The wall consists of 306m^2 of panels up to 9.8m high, which were then painted to suit architectural requirements. Stage 2 consisted of two abutment walls forming an overpass crossing a road and the north coast rail line. These walls consist of 589m^2 of panels up to 8.9m high. ■ *Contact: s.mills@vsl-australia.com.au*

Australia

Permanent fix

→ **The RXR Alliance Project** involves the lowering of a 1.4 km section of the Brisbane to Sydney freight rail corridor by about 10m and building a new 140 metre long overpass including three traffic lanes in each direction. VSL was sub-contracted to supply and install 90 VSL Permanent Anchors for the bridge abutments. Installation of six test anchors showed that ground conditions were different in the abutment areas and so drill hole diameters had to be increased to attain the required bond capacity. All permanent anchors are designed to be restressed, as the excavation to final cut will continue over a protracted period. VSL has also been awarded the installation of a further 43 permanent anchors at one abutment as a remedial measure to deficiencies in the pile capacity. ■ ***Contact: s.mills@vsl-australia.com.au***

Hong Kong

Strengthening a school

→ **For the expansion of St. Louis School,** that requires the construction of additional floors, VSL has carried out design and strengthening works of the cover of the spectator's stands. The solution involved adding post-tensioned beams both above and below the concrete slab cover. VSL has undertaken the full scope including concrete hacking, drilling to insert reinforcement and fixings, form-working, concreting and installation of the mono-strand post-tensioning system and stressing. The works schedule was extremely tight and all works were completed within the 1.5 month window before the start of the school term. ■ ***Contact: alice.lin@vsl-intrafor.com***

NOTE PAD

Lift-off. *Madison Square Garden in New York is undergoing major renovations and the project team needed accurate information about current loading in the complex roof support cables. VSL was hired to verify the forces non-destructively using a lift-off technique. Extensive pre-planning, including a full-scale mock-up, ensured successful completion of the test in just a week. Result analysis provided engineers with sufficient information to proceed confidently with the landmark renovation project.*

Delicate manoeuvre. *VSL has moved three bridges from temporary to final position on Germany's A1 motorway for Donges Steeltec. The most delicate operation involved a slide over a railway, with just five hours available. The largest bridge measured 241m and weighed 9,000t and was moved on four axes in a computer-controlled operation.*

Tunisian tensioning. *More than 80,000m of post-tensioning strands have now been installed on the Z4 Interchange in Tunis. Two of the six bridge decks are complete and another is close behind. VSL is supplying post-tensioning materials, technical assistance and elastomeric bearings for the 825m-long viaduct, built by main contractor Chaabane et Cie.*

Armoured progress. *VSL in the USA is progressing very well with the USA's armour initiative for major cable-supported bridges. The projects involve the shielding of cable elements and other critical members from malicious attacks, accidents and disasters both man-made and natural. The second project is nearing completion and four others are at various stages.*

Pakistan

Efficient lifting

→ **VSL Heavy Lifting successfully lifted the 365t top-structure** of a 28m-diameter prilling tower to a level of 124m as part of the expansion of the Engro fertilizer plant in Daharki. The strand jacking equipment, consisting of eight SLU-70 and two pump units, was lifted by client Tahtan's winch-driven derricks to the installation position at 140m above ground.

All equipment was delivered in a single 20-foot (6m) container, proving the efficiency of VSL's Heavy Lifting system – an SLU-70 can lift up to 190 times its own weight. An inclinometer with a remote display was used to monitor the level of the structure at all times during the long lift in the inaccessible concrete tower. ■ *Contact: wolfgang.schroeppel@vsl.com*

Thailand

Overpass overdrive

→ **Thailand's Department of Highways is carrying out an extension project** for Route 9 from the Thap Chang interchange to Bang Pa-In to support the increasing levels of traffic. The project, known as the extension of the Outer Bangkok Ring Road, includes twelve overpasses of box girder construction with external post-tensioning. VSL Thailand was awarded post-tensioning works by Siam Bridge Company for three overpass projects - Sukhapiban 2-3, Ramindhra and Thanyaburi - as well as the Lamlukka overpass for Krungton Engineering Company. In total, the 12 bridges involve 3,500t of external post-tensioning works. The projects began in January 2009 for completion in mid-2010. ■ *Contact: tendering.th@vsl.com*

Thailand

Top shop

→ **VSL has completed work on the "mega" Central department store** in Khon Kaen in central north-east Thailand. Main contractor Construction Line Company awarded post-tensioning works to VSL Thailand. The store consists of five floors, each separated into 26 zones of between 800m² and 900m², giving a total area of approximately 160,000m², which required 650t of PT. Good co-operation with the main contractor and a seven-day cycle for post-tensioning works in each zone meant that the post-tensioning could be completed within six months. At peak, 38,000m² of PT was installed in one month, a record speed for VSL Thailand. ■

Contact: tendering.th@vsl.com

Thailand

Transport building

→ **Thailand's SEAFCO Construction Company** has awarded VSL the post-tensioning works of the Mass Rapid Transport Authority's new office building in Bangkok, involving nine floors with 15,000m² and a total strand requirement of more than 40t. The programme involves a 10-day cycle, and the works are scheduled for completion in April 2010. ■

Contact: tendering.th@vsl.com

Vietnam

Complex development

→ **VSL Vietnam is working with the main contractor Bouygues Bâtiment International** on the PT design, supply and installation for a 40-storey complex in Ho Chi Minh city, Vietnam. Sai Gon M&C Real Estate Joint Stock Company is investing in the development, which includes an international commercial centre, an office block and an apartment block with a total of 100,000m² of PT floors. The slabs and beams make use of a variety of VSL anchorage types - S5-5, Sc5-7, Sc5-12 and Sc5-19 - to accommodate the different floor designs. VSL's works began in September for completion in March 2011. ■ *Contact: lan.tranduc@vsl.com*

Spain

Twin challenges for Cristalia

→ **VSL has been appointed for the post-tensioning sub-contract** in two innovative office buildings being developed by Bouygues Immobilier in Madrid.
Constructora San Jose and Peyber are main contractors for the Cristalia development, which involves a total post-tensioned area of 23,000m² with typical spans of 16m. Architect Rafael de la Hoz, supported by structural consultant Pondio Ingenieros, designed both a "cable-stayed building" for Cristalia 4A and a second structure that uses a major transfer slab with cantilevers up to 14m for Cristalia 4B. Accommodating the required PT inside the cable-stayed concrete façades of Cristalia 4A required special development work by VSL. Diagonal tension elements support the seven floors and dramatic 20m cantilevers. The stay cables, up to 31x0.6", have a unique "rectangular" shape, running inside a rectangular concrete section of 30x50cm. The buildings feature flat slabs with a combination of Bondtech® and multistrand post-tensioning. ■ *Contact: posso@vslsp.com*

Argentina

Optima slabs

→ **The Optima Business Park is a multi-use office building** located in an expanding area in Vicente Lopez, near Buenos Aires. VSL Argentina has provided the engineering for the PT slabs, with the supply and installation of almost 160t of VSL's unbonded slab system. The project has a total surface area of 37,000m², split into two buildings, each with seven upper levels and two underground. Optima Business Park has been developed by Belgravia Land & Development to a project design by architect Mario Roberto Alvarez and engineering consultant Estudio Guitelman.
VSL Argentina had already worked with main contractor Caputo on several projects and they are currently working together on the construction of a 90,000m² shopping mall in Tortuguitas. ■ *Contact: aloguercio@vslarg.com.ar*

Argentina

Mega mall

→ **VSL Argentina took part in the design, supply and installation** of post-tensioning slabs for Buenos Aires' largest mall, the newly-opened Dot Baires Shopping. The mall is strategically located at the intersection of the country's two busiest motorways and has a total area of 173,000m². It incorporates 125,000m² of post-tensioned slabs using Bondtech®, VSL's bonded monostrand system. Use of post-tensioning allowed the designers to produce a structure of great aesthetic impact. The spans range from 8m to 11m for which 600t of strands have been installed.
VSL Argentina has also been awarded the installation of 16,000m² of post-tensioned slabs in an adjacent building for the same owner, IRSA, and main contractor, Constructora San José Argentina. The engineering consultant is AHF. ■ *Contact: aloguercio@vslarg.com.ar*

Mexico

Speedy storeys

→ **VSL Corporation Mexico has completed the post-tensioning works** on a 26-storey building at Monterrey in Mexico. The structural design of the building included a post-tensioned foundation, which was developed by VSL. The project involved about 37,000m² of 390mm-thick post-tensioned slabs, including the installation of 86t of bonded post-tensioning. The commercial and residential buildings were constructed in just 10 months, reaching a construction rate of almost three slabs per month. ■

Contact: mmartinez@vslmex.com.mx

Spain

Motorway move

→ **CTT Stronghold (VSL in Spain)** has transported an existing 400t bridge to a new position 550m along the los Viñedos motorway. The bridge, which has a 51m span, was moved to its new placement during a single night shift. The manoeuvre has been carried out without any additional jacking equipment. The entire operation was achieved with the hydraulic suspension provided by the two self-propelled modular trailers supplied by VSL. The client for the project was UTE Ronda Suroeste Toledo (San José – Rayet Construcción) and the project's owner was Junta de Comunidades de Castilla – La Mancha. The engineering was by Siegrist y Moreno. ■ *Contact: jmmartinez@vslsp.com*

Spain

Flexible launch

→ **CTT Stronghold (VSL in Spain) has completed the launching of the La Cabrilla Bridge in Córdoba.** The slender and flexible bridge is made up of four 50m spans, with a total steel weight of just under 300t. A hydraulic strand holding unit was installed at the launching abutment to prevent the bridge from moving on its own and a double lateral guidance system was used at the skidding supports. There was no need for a launching nose. Instead, the 2m-long steel in the front section was used to support two vertical hydraulic jacks to overcome the deflection. The client is Dragados, the owner is Acuavir and engineering was by ACL, Diseño y Cálculo de Estructuras. ■

Contact: jmmartinez@vslsp.com

Mexico

Mobile slabs

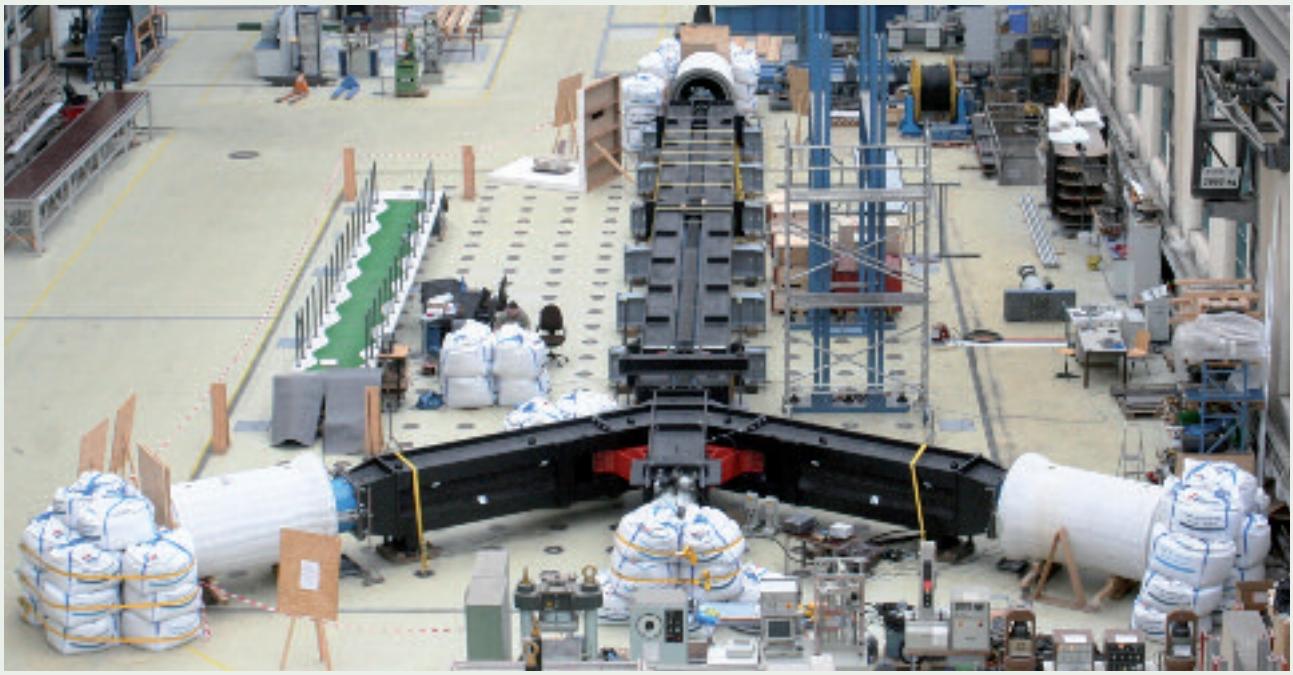
→ **A 150mm-thick slab on grade was built by VSL Corporation Mexico** in six weeks for Mexico's main mobile phone company, Telcel. The 3,300m² of slab on grade required installation of 6t of bonded post-tensioning. VSL's scope on the project included design, supply and placing of the base coat; supply and placing of concrete; supply and installation of post-tensioning and movement joints. The largest pour for the slab on grade was about 650m², governed by the geometry and the wall layout of the project. ■

Contact: mmartinez@vslmex.com.mx

TESTING

Full-scale success for VSL Saddle

The VSL SSI Saddle system demonstrated impressively its high level performance in passing the *fib* fatigue and tensile test in Berlin.



fib fatigue and tensile test set-up, with the VSL 6-55 SSI saddle

The VSL SSI Saddle system achieved great success in July in passing the *fib* fatigue and tensile test at Technische Universität Berlin's laboratory. The system behaved impressively and fulfilled all of the test's fatigue and static criteria to demonstrate the saddle's high level of performance. This was the first full-scale test of the SSI Saddle following initial small-scale testing that had been carried out to validate the design principles.

The test was carried out in accordance with the latest *fib* recommendations, which define the fatigue testing criteria that needed to be met for the system to qualify for application on cable-stayed bridges. It is believed to be the first stay cable saddle on the market that has succeeded in passing this *fib* test.

The specimen consisted of a complete stay cable assembly, including a saddle with a cable capacity of 15MN (55 strands). The saddle, which had an opening angle of 60°, was initially mounted so that a cable deviation of 10 milliradian occurred at the saddle entrance. The specimen was subjected to fatigue loading of two million cycles with a 200MPa stress range and an upper load of 45% of the strand nominal capacity (GUTS). Completion of the fatigue cycles was followed by determination of the ultimate capacity of the system in order to validate the saddle performance against *fib* criteria: required ultimate capacity of 95% of the nominal and 92% of the actual initial performance.

The specimen was made up of an SSI Saddle produced in VSL's

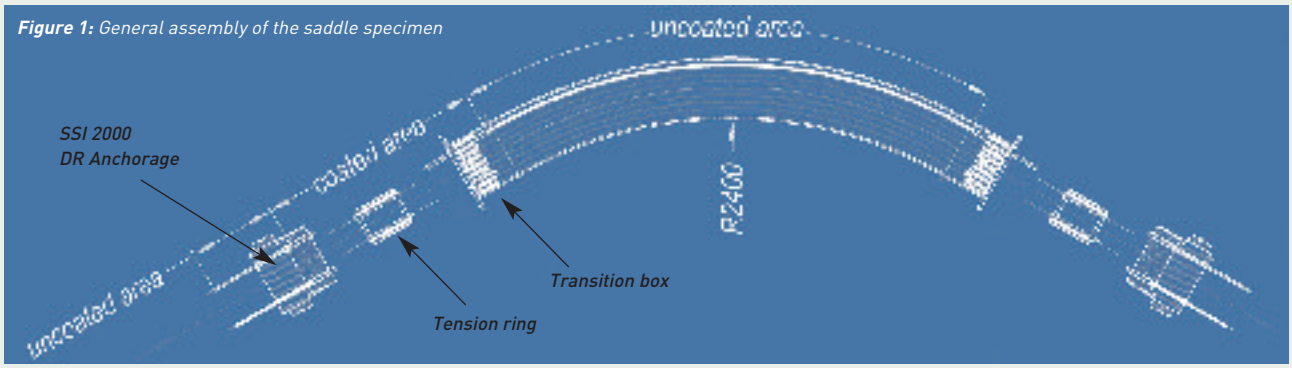


Figure 1: *General assembly of the saddle specimen*

Barcelona factory and two transition boxes developed and prototyped in the VSL workshop in Subingen. Two SSI 2000 6-55 DR anchorages and two tension rings completed the test sample. The test used standard 1860 Mpa grade waxed and sheathed stay cable strand. The saddle had a radius of 2,400mm and a deviation angle of 60° as recommended in the *fib* specification.

The very high forces involved in such a test could only be applied through careful engineering of a test frame specifically designed for this application. No reaction forces could be transferred to the laboratory floor or structure.
The limited capacity of the dynamic jack used for application of the two million cycles led to a decision to split the application of the static and dynamic components. The static component was applied by a spring device made of a 24m-long 6-55 Dyform strand cable.

The saddle was "suspended", connected by cables on three sides *(see figure 2)*. The saddle position and the tension on each of the three sides were carefully recorded during the entire fatigue test period.
The two million cycles were carried out at a frequency of 1Hz. No wire breakage occurred during the fatigue test. After completion of the two million cycles, the saddle returned exactly to its initial position, with the cable forces restored to their initial values. This proved that no creep or any kind of relaxation had occurred in the saddle set-up during the course of the fatigue test.

On completion of the fatigue test, 19 strands of the specimen were individually tensioned to ultimate force using a mono-jack system. The remaining 37 strands of the specimen were loaded simultaneously to ultimate force. The capacities measured during these operations were significantly above the *fib* criteria, once again highlighting the high performance of the VSL SSI Saddle system. ■

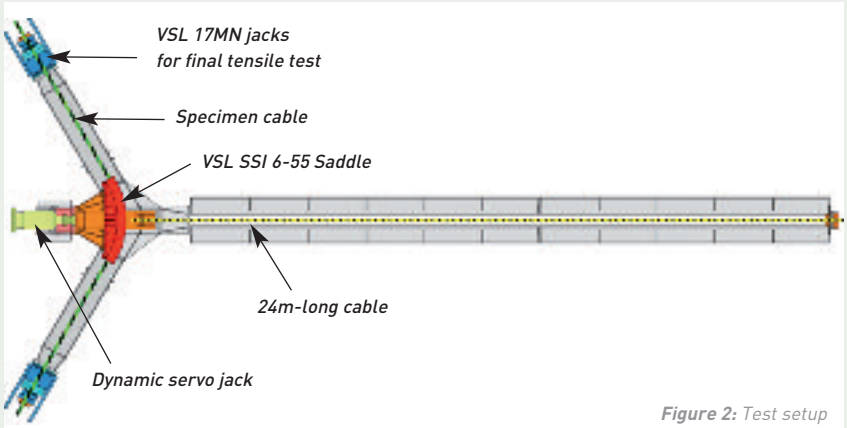


Figure 2: *Test setup*

The new bridge over the Catumbela River, in Angola built by the consortium Soares da Costa-Mota Engil, has just been inaugurated as an important landmark. Armando Rito Lda designed the cable-stayed bridge, which is 438m long with a main span of 160m. Anchoring the 10 stay cables at each side of the H-shaped pylons was a particular consideration and resulted in a special saddle design by VSL. The bottom three cables use standard anchorages, while the remaining above cables cross the pylon through individual new developed SSI 2000 Saddles. VSL Portugal's responsibilities included the supply and installation of stay cables and saddles, the post-tensioning by high-strength bars and strand, as well as the supply of all pot bearings and dampers.
Contact: ralmeida@vslsistemas.pt

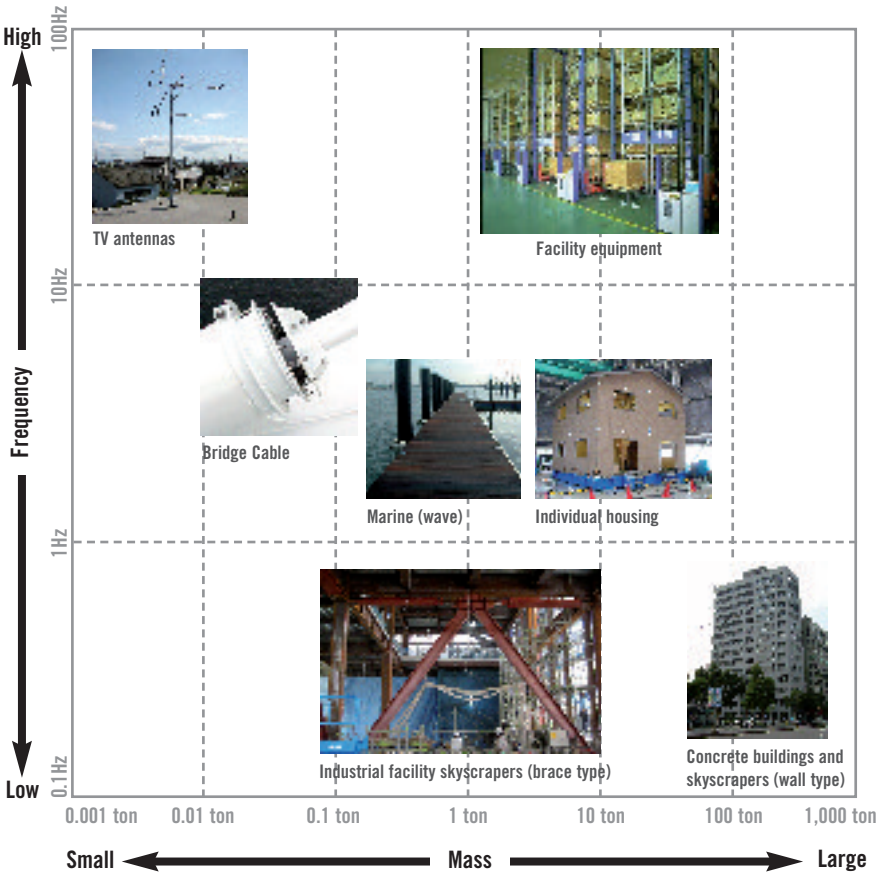
How to mitigate movem

An efficient and cost-effective VSL damping solution for all vibration amplitudes and frequencies.

VSL started working with vibration control technology some 15 years ago with the aim of developing solutions to the problems caused by stay cable vibrations. Backed by the strength of that experience and with many projects around the world, VSL is offering an extensive range of efficient and cost-effective damping solutions for bridges and now for buildings.

Successful partnership

Gensui dampers were launched in 1994 by Japan's Sumitomo Rubber Industries Ltd., a world-leading developer of industrial rubber components. The initial use was to control wind-rain induced vibration of stay cables in bridges in Japan. The range of applications for this high-damping technology has since been extended to include buildings, marine structures, utility towers, transmitter masts, houses and pedestrian bridges. VSL and Sumitomo Rubber Industries Ltd. have been in partnership since 2000 distributing the technology to the rest of the world.



The application range of the VSL Gensui Damper

Sumitomo Rubber Industries Technical Centre in Kobe, Japan, equipped with brace damper.

Exceptional energy absorption

The VSL Gensui Damper is a visco-elastic damper composed of steel plates and super-high-damping rubber pads. Damping is provided through the instant conversion of shear movement (kinetic energy) of the rubber pads into heat energy. Unlike other visco-elastic dampers, the Gensui damper has the unique characteristic of being able to maintain its high damping performance in a wide range of design conditions. It can cater for anything from the very small movements of floor vibrations to the very large movements that occur in major seismic events. It is equally useful for low frequency movements due to wind and for very high frequency movements due to earthquakes. It works in ambient temperatures ranging from -20°C to +40°C. The damping characteristics of the Gensui Damper remain stable for more

ent in buildings?

than 60 years. These abilities confirm it as very effective and suitable for all types of applications, particularly as it is a very durable damper that requires little or no maintenance.

Extreme adhesion
The joints between the steel plates and flanges of the high-damping rubber pads are created through a special heated and pressurised vulcanisation process, which forms an extremely robust bond between the two materials. This ensures that ultimate failure will occur within the rubber material and not by delaminating the steel plate-rubber pad interface.

A standard 400mm x 400mm VSL Gensui damper unit with two 15mm layers.

Environment, health and safety
The materials and chemical substances used in manufacturing the high-damping rubber are safe and conform to the chemical substance control laws of Japan, the USA and Europe. In the event of a fire, the VSL Gensui Damper does not emit any toxic fumes, and the building's structural integrity is not compromised, even if the dampers are damaged. The dampers can be easily and quickly replaced.

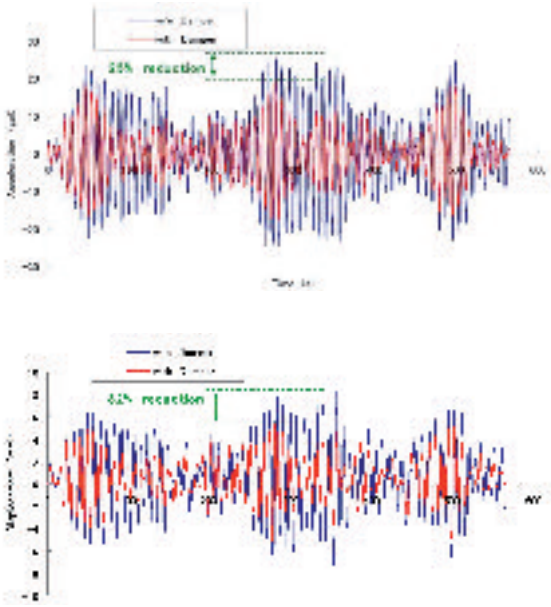
Flexibility for optimum layout
The main design advantages of the VSL Gensui Damper System are compactness and flexibility of use.

Gensui Wall-Panel and Brace-type Damper

VSL Gensui Dampers can be installed as a single unit, as multiple units in series or in parallel. Various structural damping configurations may be brace type, wall-panel type, hinges or part of a VSL Damped Outrigger System (patents pending). This flexibility means that the design can be optimised to provide the most efficient damping performance while ensuring minimum impact on floor usage or other non-structural members. For example, a single wall panel consisting of one, two or three standard VSL Gensui Damper units, arranged either in series or in parallel, can handle up to 50t, 100t or 150t of shear force respectively.

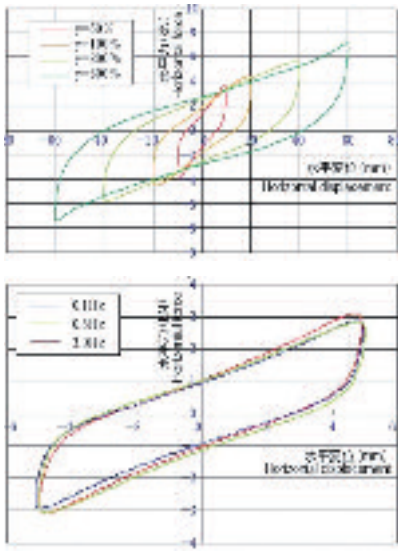
High capacity to deform
VSL Gensui Dampers can be strategically placed where the building structure experiences maximum deformation due to the dynamic effects from wind or earthquake. At these locations, the dampers are subjected to shear deformation, whereby the kinetic energy of the building is converted into heat energy. This damping of the dynamic response of the building results in a reduction in the lateral sway and acceleration of the building.
VSL can provide assistance to designers in the modelling of structures using building analysis and design software such ETAB, SAP and Midas.

Reducing the lateral sway and acceleration

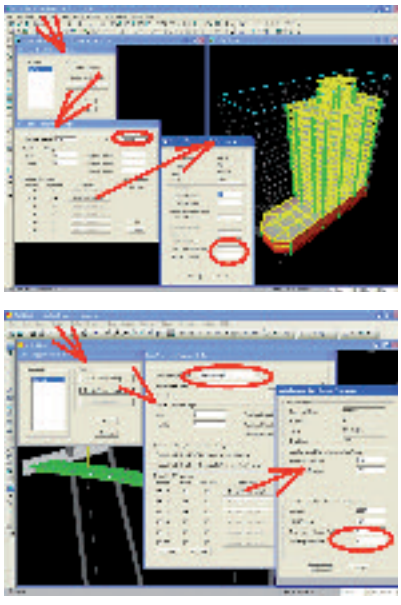


Evaluation of building response displacement and acceleration under earthquake loading

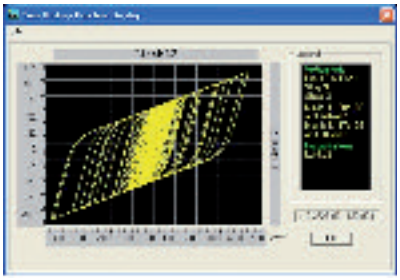
Computer modelling
The hysteresis loop of the VSL Gensui Damper complies with a modified bi-linear model as used in commercially-available computer software. Compared with other damping materials, it has exceptionally low dependencies on vibration frequency, amplitude and ambient temperature, which means that it provides constant and effective damping force under varying vibration conditions. This special characteristic allows engineers to perform accurate analysis and design of building structures to withstand wind and earthquake.



Hysteresis loop shows low dependencies on strain amplitude and frequency



Modeling VSL Gensui Damper in commonly used software ETABS and SAP



Analytical hysteresis loop in software is compatible with test results

Tall building design
Historically, the control of the building's sway has been done by increasing the stiffness of the building by drastically increasing the member sizes in excess of what is normally required for strength. In seismic countries, increasing the member sizes has an additional disadvantage as it increases the mass of the building, leading to higher seismic loads due to ground acceleration. In such a situation, it is usually more cost-effective to increase the damping rather than the building's stiffness.

Providing additional damping to a building lessens the reliance on the low and less predictable natural damping of the building. The performance of supplementary damping can be accurately predicted and its amount and location can be finely tuned to suit the dynamic response. With increased damping, it is possible to reduce the stiffness while at the same time improving the building's dynamic response.

In some tall buildings, tuned mass (liquid or solid) dampers have been used to control sway and acceleration arising from wind-induced vibration. Tuned mass dampers provide damping by moving a mass in opposition to the oscillating frequency of the structure. This type of damping system has major drawbacks. The dampers are bulky, heavy and must be placed at the top of the building, which is the most expensive part of the structure. They must also be correctly tuned to the first fundamental mode of vibration, which is difficult to ascertain in a concrete structure because of its time-dependent material characteristics. The size and cost of this type of system means that there will only be one such damping system per building and hence there is no back-up to provide supplementary damping in the event of failure. The relatively slow response of the damping system means that it is ineffective for major seismic events. In view of these limitations, tuned mass

The 46-storey Namba Tower in Osaka, Japan

dampers are not used for strength but only for improving the comfort of occupants.

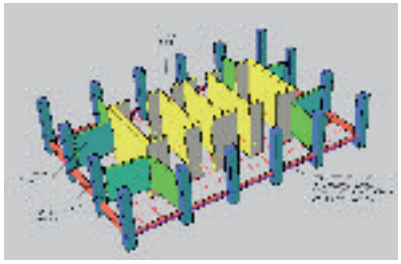
All other means of providing supplementary damping in a building have severe limitations either in the range of application, stability of the damping properties under different working environments, long-term durability, ease of installation or cost.

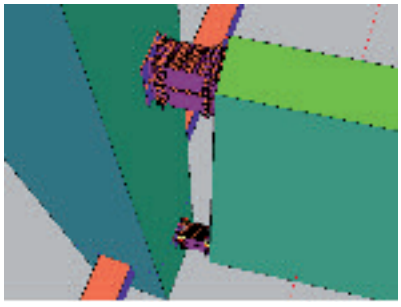
Redundancy not an issue

VSL has recently developed a new damping concept, the VSL Damped Outrigger System (patents pending). This system can be used in medium and tall buildings to control the dynamic response under wind and earthquakes, improving design strength and occupants' comfort.

The VSL Damped Outrigger System is used to achieve the desired supplementary damping economically by providing damper units in the outrigger or refuge floors. Damping is provided by multiple arrays of VSL Gensui Damper units and so redundancy is not an issue. The damping system is robust, well-engineered and can cater for small wind-induced deformations as well as large deformations caused by a major seismic event. The VSL Damped Outrigger system has many advantages:

- well-engineered and reliable supplementary damping;
- effective damping is provided bi-axially at each connection between the outrigger wing wall and the external column, providing high supplementary damping;
- independent of mode or frequency of building vibration and does not require any fine tuning;
- the dampers are compact and are placed only in the outrigger/refuge floors, avoiding interference with typical floor usage;
- the system does not occupy premium floor space at the top of a building, unlike tuned mass dampers;
- reduced wind and earthquake loads can be used in design for both serviceability and ultimate limit states of all structural elements and foundations;
- overall cost savings.





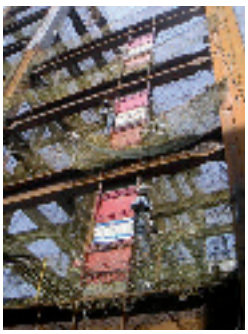
VSL Damper Outrigger concept (3D graphic representation)

Efficient vibration reduction

The VSL Gensui Dampers can either be installed floor-by-floor during construction or once the entire building frame has been completed.

The VSL Gensui Panel Type Damper consists of three main sections: the upper and lower steel supports, with the damper units in the middle. In a typical floor-by-floor installation, the lower section of the VSL Gensui Wall Panel Damper is placed on top of the beam reinforcement cage (see picture). After the concrete is poured, the upper steel sections and VSL Gensui Damper units are aligned and fixed to the lower section to form a complete panel unit. The damper panel is temporarily propped to avoid any movement during construction of the upper floor. After concreting of the upper storey, the damper installation works can be finished. The total height of damper system is designed to fit the clear height of each storey.

Storey-by-storey installation



Post-construction installation

Steel structures usually adopt the post-construction installation method as the VSL Gensui Damper assembly is bolted to the main structure. The preassembled wall panel or brace damper is delivered to site, lifted into position and then bolted to preinstalled welded steel brackets.

For reinforced concrete buildings, sleeves are provided in the reinforced concrete beams. The preassembled wall panel or brace damper is lifted to its final position, aligned, shimmed and propped. Stress bars are inserted through the damper support brackets and through voids formed by sleeves within the reinforced concrete beams. High-strength self-levelling grout is then poured at the top and bottom of the damper assembly to form uniform bearing plinths. The stress bars are stressed to the required loads once the grout has reached the required load transfer strength. ■

GAUTRAIN

For people on the move

Span construction: nine viaducts, six VSL 460t jacks stressed a total of 2,300t of PT (all supplied by VSL); 3,208 precast segments; 177 spans; three under-slung girders/trusses.

South Africa's new state-of-the-art rapid rail network, Gautrain, is the biggest construction and PPP project in Africa. VSL is playing a key role, providing a wide range of expert services including segmental erection by under-slung girders, elevated station erection and viaduct finishing works. Follow the steps...

1 ***Take up diverse challenges***

Gautrain is one of the first projects in Africa to use span-by-span erection methods with under-slung gantries. There were constant reviews of site preparation and methods to cater for the project's diversity, which included 177 spans varying in length from 22m to 56m and in weight from 390t to 1,100t, with a minimum span radius of just 250m. Viaduct erection took place in densely populated areas over busy roads and railways. Close co-ordination was required to put in place all the necessary road and railway closures, height restrictions and safety measures.

2 ***Prop and launch***

Temporary propping was necessary to build spans of up to 56m using launching girders designed for a maximum of 45m or 50m.
The heaviest of the 28 over-long spans weighs 1,100t and required prop columns with a 450t capacity. Since the oval-shaped piers of one viaduct could not accommodate the standard bracket for girder support, a special propping system was developed for the launch.

Temporary propping: 28 spans propped; 3,000m of stress bars supplied by VSL in Melbourne; 450t capacity per prop column.

3 ***Use a loader***

Segments were normally loaded using a mobile crane positioned alongside the span to be erected but an 80t segment loader had to be used for the many road crossings of Viaduct 15, as well as for the spans located near the airport station in Johannesburg. The loader consists of a self-launch sliding system, a tie-down system for stability and an arrangement that allows segment placement with precision. The operation required a fully-grouted span on bearings. Where this was not feasible, transverse and longitudinal restraints were provided by pier bracket clamps and shear cones with stress bars.

Segment loader: 60t segment lifting capacity; self-launching loader; 30 minutes segment loading cycle.

Relocations: eight operations; three-week programme saving per relocation; shorter girder re-commissioning time; longest single girder transported: 77m without nose sections; maximum girder weight for the transport: 150t.

4 ***Turn around swiftly***

Nine viaducts were spread along 80km of rail track, providing technical and logistical challenges in moving the launching girders and trusses to successive sites. To save time and costs, the girders were transported in sections that were as complete as possible. Use of multi-axle trailers enabled the main sections of the trusses to be relocated in one piece. The operation usually involved a tandem crane lift from the pier brackets onto the trailers, transport along public roads with special escort, and a second tandem lift onto the new piers.

5 ***Finish on tracks***

Parapet installation followed span erection. A tight schedule meant that deck finishing works had to run simultaneously on up to 5 viaducts at one time, which brought logistical challenges in providing access for cranes, concrete and asphalt. A customised slip-form machine was able to cast up to 300m of cable tray per day.

Finishing works: 3,900 parapets; 75,572m² of deck waterproofing; 4,500t of asphalt; 15,908m of cable tray; 8km of deck drainage; 177 expansion joints.

6 ***Elevate station plaforms***

VSL's scope also included the erection of three elevated stations, the longest of them being up to 170m. Temporary steel structures (design by VSL) enabled the simultaneous installation of 12 struts. These were fixed using strands running transversely through a tendon cast into the deck slab to connect two struts. Ballast walls and parapets required precise setting out to take account of future deflection changes arising from loadings applied once the rail track was laid. Platforms were set using adjustment jacks to meet tight tolerances.

Elevated station platform erection: 200 precast struts; 100 precast fixed platforms; 96 precast infill platforms; 216 parapets.

7 ***Approach airport with shortened nose***

The girder used to build the station span linking Gautrain to O.R. Tambo International Airport (ORTIA) had its front nose shortened to facilitate the launch into the airport building. Work was only possible overnight when traffic lanes could be closed. Tight clearances between the girder and the roof and columns demanded precision at all stages. The increased span weight meant that the girder had to be back-propped, with half of the span weight supported on a special structure resting on the pile cap. With the span complete, the girders were reinstated to their full length so that they could be launched back to a suitable location for demobilisation. The noses and tails were then removed and a tandem of cranes lifted the 65m-long sections onto multi-axle trailers waiting on the completed deck. The sections were then transported along the viaduct to a location where they could be lifted off onto other trailers at ground level to continue their journey to the next site by public roads.

The project

The rail network comprises two sections - a line between Tshwane (Pretoria) and Johannesburg and a line between O.R. Tambo International Airport and Sandton. Three main anchor stations and seven other stations will be linked by approximately 80km of rail.
It is the biggest public-private partnership and the largest construction project in Africa.

- 80km overall
- 15km of tunnels
- 10.5km of viaducts
- 55 bridges
- 6.7 million cubic metres of earth moved
- 9,000 parking places
- 44 months of civil works
- 1 million cubic metres of concrete poured
- 10 stations, including three underground and three elevated
- 63,200 jobs created (11,700 direct and 51,500 indirect)

Preparing the pier bracket lift-off.

**"The story of Gautrain is not about a train
It's about how far we've come
The faces we meet, the places we see,
And our everyday life's journey (...)"**

Source: www.gautrain.co.za

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