VSL NEWS

THE VSL NEWS MAGAZINE • ISSUE ONE 2007

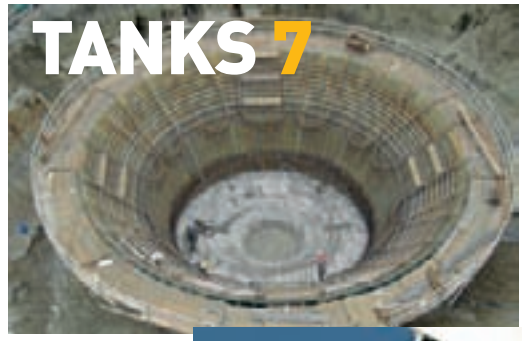
DUBAI & THE UAE

VSL success story

Leak tightness tests

Heavy lifting in CERN

highlights



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Cover photo: Heavy lifting of the CERN's particle detector, courtesy CERN

EDITORIAL

Safety first!

While construction companies have to face ever increasing activity throughout the world, VSL's main objective remains to develop for its clients innovative technical solutions that comply with the strictest possible demands in terms of preservation of the environment and, above all, in terms of safety.

By doing this we are looking forward to initiate trustful relationships and to create long term partnerships. Within these partnerships, the safety issue on our construction sites is of utmost importance. Our executive committee has decided that from now on every meeting on site or visit to a profit centre should start with a safety review in order to increase even further awareness of the topic within the whole group.

From the very beginning of a project, our engineers have to integrate construction methods of the highest possible safety standards and permanently aim zero accident. We also cooperate closely with our clients to optimise preventive measures.

VSL is a company composed of men and women for whom construction is a passion and it is our responsibility to protect them: Our people are our most valuable resource.

Jean-Philippe Trin, Chairman & CEO

SAFETY

VSL Major Equipme Operation Permit

The VSL permit system "MEOP" is now becoming compulsory for the operation of all major equipment on VSL projects to improve safety and efficiency

VSL's bridge and structure construction projects involve the operation of major items of machinery, which are usually designed or adapted to meet the specific conditions and constraints of the particular project. In consequence, VSL's equipment is usually one-of-a-kind, complex and controlled by multiple operators. It therefore requires a high level of engineering, coordination and skill in order to ensure safe and efficient operation. Additionally, VSL must ensure that nothing goes wrong with its structural operation as the consequences could be catastrophic due to the number of people on site, the size of the equipment, the working heights and the energy and loads involved.

Complex equipment requiring a high level of engineering, coordination and skill

VSL launched the Major Equipment Operation Permit (MEOP) in September 2006 to improve the safety and efficiency of major equipment such as launching gantries and form-travellers. Upon successful implementation on several pilot projects, the permit system is now becoming compulsory for the operation of all major equipment on VSL projects.

The implementation of the permit requires project staff to assemble and operate major equipment in accordance with strict requirements. A permit is only granted if the project can demonstrate to a panel of independent expert auditors that all aspects of the equipment are clear and have been checked so that it can be operated safely, properly and effectively. The auditing team that reviews the documentation and visits the site consists of three experienced staff members from the relevant parts of the organisation - Technical, Operations, and Quality/Safety/Environment. Areas covered include design, fabrication, assembly and commissioning, as well as the on-site preparations

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such as clarity and quality of the procedures, kinematics, chains of command and the skills and level of training of the operating staff.

A permit is issued for a maximum of six months, during which no significant changes can be made without approval. Prior to expiry of the permit, the process to issue a new permit is initiated.
All requirements and conditions are thoroughly reviewed to confirm that they are up-to-date and still satisfactory (e.g. taking account of newly acquired information). This review usually includes revisiting the project site.

The initial implementation cycle has resulted in a significant improvement in the planning and coordination of projects, with many more site issues being resolved before they become problems. Site safety has improved, as has project feedback, particularly of technical aspects.

The MEOP system is proving to be very valuable and has improved still further the already high level of confidence that VSL has in its major operations. The system is providing additional assurance to VSL and its clients that projects can be delivered safely, efficiently and on-time. ■

QSE MANAGEMENT
Aiming for the highest

The regional QSE Audit programme, launched in Asia at the end of 2005, is now about to enter its third cycle. The programme is proving to be very successful, achieving significant improvements. The ultimate aim is that all VSL operations are of a comparable standard that is at the highest level in the industry. The current focus of the audits is on site safety and quality control. This will gradually shift to system issues as general standards improve, helping drive 'continual improvement'. ■

COMMUNITIES
Make their day

In March, VSL Singapore participated in a community services project called 'Make Their Day'. This involved helping a family renovate its home to make it a better place to live. Singapore Contractors Association Ltd asked all its members to volunteer their expertise to achieve the project's aims. Who Hup Pte and VSL Singapore answered the call for help and repaired the spalling concrete of the ceiling, walls and floor. ■

SAFETY
Award for T3 project team

Shatin T3 bridge project team has been recently awarded two safety awards from the government in Hong Kong: "Best sub-contractor" (Meritorious award) and "Best Hazard Identification Activity" (Meritorious Award). ■

TRAINING
Project Management Excellence programme

December 2006 saw the completion of the first VSL Project Management Excellence (PMX) programme in Hong Kong. The programme brought together a team of project managers to develop project management capabilities, share experience, reinforce and review procedures, and improve project capabilities - and ultimately group performance. The programme is based loosely on the framework set out by the Association of Project Managers, and, more specifically, on VSL's own requirements. The sessions are conducted by a team comprising experienced senior managers from inside the group and external consultants. ■

Durability
EIT protects Prague bridge

→ **VSL's EIT (Electrically Isolated Tendons) technology** has been introduced on the Sluncova railway bridge, as part of the Nove spojeni project in Prague, Czech Republic. The EIT technology being used is designed to protect the tendons against the stray currents that can occur around electrified railways. Such currents can significantly affect the durability of the post-tensioning system. Another key advantage is the ability to monitor the status of corrosion protection of EIT tendons any time. Skanska's bridge division is building the structure, which was designed by Pontex. The internal post-tensioning is scheduled for completion this year using VSL CS 6-19 Super. Installation of external tendons will then take place in 2008. ■ *Contact: jbesta@vsl.cz*

Bridges
First for Equatorial Guinea

→ **VSL has recently started its second project in Equatorial Guinea** for Belgian contractor Besix. The project consists of two parallel bridges along a new ring road around Malabo in Bioko Island. The client is the Ministry of Infrastructure and Forests. The engineer is Tremblet from Switzerland whereas the client's representative is BCEOM from France. The scope of works of VSL includes the design, supply and operation of form travellers as well as post-tensioning. Form travellers are of the VSL modular type and were manufactured by VSL Taiwan. Each bridge consists of a single span of 90m that will be built by 2 form travellers, each one starting from one abutment, by free cantilever method. Each cantilever consists of 9 segments of 3.5m, 4m and 5m plus a closure pour of 3m. The heaviest segment is 180 ton. The deck width is 18m and the top slab is post-tensioned transversally using the Bondtec system offering a high degree of corrosion protection thanks to its plastic duct. Under the direction of Besix project manager Xavier Debruche, segment casting began in May and completion is due in early 2008. ■ *Contact: jmenchaca@vslsp.com*

Dampers
Gensui first

→ **Taiwan's first building vibration control project for Gensui dampers** was secured in March 2007. A total of 19 wall-type dampers with 100t shear capacity will be installed in a 14-storey luxury residential building in Taipei. The dampers are designed to protect the building from damage during earthquakes and to improve its serviceability during high winds. Construction is due to start in October 2007 and VSL Taiwan will supply and install the Gensui dampers. A damper panel is on display to potential buyers in the development's show home to demonstrate the benefits of the solution provided by the system. ■ *Contact: haining@vsl-tw.com*

Nuclear
Full-scale mock-up

→ **VSL is building a 3m-high full-scale mock-up** of a nuclear containment vessel to demonstrate the efficiency of its solutions for the latest reactor designs, which require enhanced post-tensioning. The construction in central France will be completed by the end of 2007, with tests and client presentations starting in 2008. VSL has four ongoing contracts and has been active in the civil nuclear industry since 1974, with 58 containment projects involving the complete VSL anchorage system or the use of its stressing equipment. The mock-up is a major R&D investment and will enable VSL to participate in the market's forthcoming boom and to apply its extensive experience to ensure maximum safety and durability. ■ *Contact: jeanbaptiste.domage@vsl.com*

Showcase

CTT attends Construmat

→ **CTT Stronghold had a high-profile presence** at the Construmat international construction show, which took place in May in Barcelona, Spain. Many products were on show, including VSL SSI 2000, CS 2000 anchorages and CTT Stronghold's hydraulic stressing jacks, pumps and pot bearings.
■ *Contact: csuch@vslsp.com*

Foundations

Mini cutter

→ **Intrafor Hong Kong is now completing its latest diaphragm-wall project** for Sun Hung Kai. The project in Kowloon's Ng Chi Wan sub-district involved several important firsts, including allowing Intrafor to demonstrate to this high profile developer its capacity for handling sensitive construction. In a first for Hong Kong diaphragm walling, Intrafor deployed an MBC30 mini cutter, which was able to work within the restricted areas available for the excavation. Intrafor also employed a new type of heavy cable grab, whose capacity considerably exceeded traditional cable grabs in the dense, decomposed granite soil. The work was carried out within a five-month period despite complex geology.
■ *Contact: anthony.mak@hk.vsl-intrafor.com*

Tanks

Z-Anchorage brings savings

→ **Four huge 30m-high egg-shaped concrete digester tanks** are the eye-catching focus of a new wastewater treatment plant near Zagreb. A concession consortium of WTE Wassertechnik, RWE aqua and Vodo priveda Zagreb is developing the plant, with Zueblin Hrvatska building the structures. VSL's German subsidiary was awarded a contract that included supplying the entire PT system and supervising its installation. Substantial savings were achieved by using the VSL Z-Anchorage for all ring-tendons, avoiding the need for stressing blisters along the tank surface. Each tank has 69 ring tendons of

up to 78.5m, varying from Z6-04 to Z6-12, and 14 loop tendons (E6-07) of up to 60m. All four tanks have been tested successfully for water tightness, with final hand-over due in October 2007. ■ *Contact: hd.reuter@vsl-germany.com*

Monitoring

Easy GIS

→ **VSL International subsidiary FT Laboratories** has completed a software development project to create an on-line application for monitoring structural and geotechnical instrumentation. The enhanced Deformation Monitoring system (DeMon) presents the client with an easy-to-use GIS (Geographical Information System) interface, which can be accessed from any internet-connected computer. Clear visualisation of the site or structure highlights any instruments where response values have been exceeded, indicating that further investigation is needed. The system is compatible with FT's real-time and wireless sensors, and automated alerts can also be sent by email or SMS. Reports can be designed and generated on demand and data can be easily exported.
■ *Contact: david.clayton@ft.com.hk*

NOTE PAD

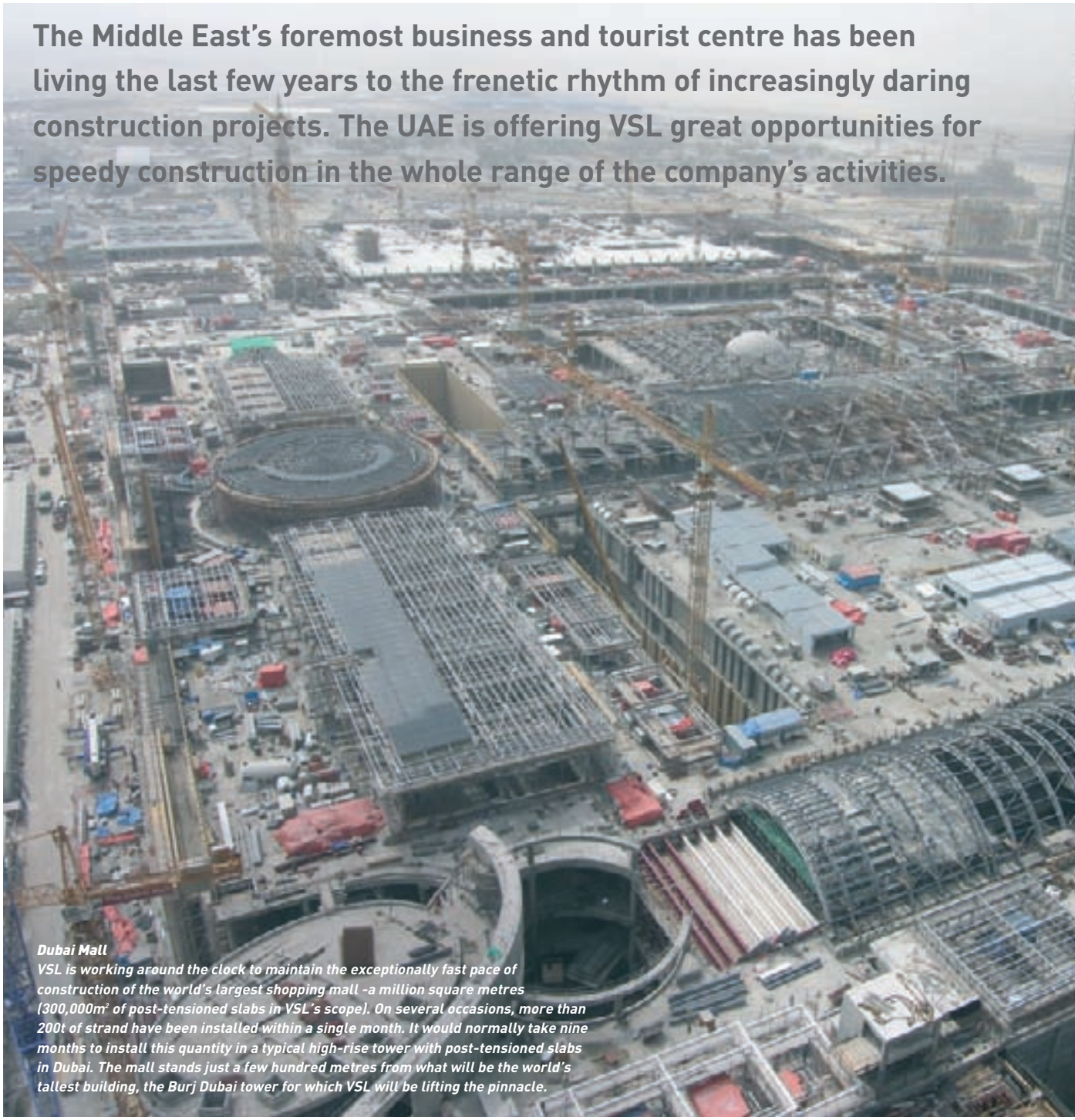
VSoL® first. *In 2006, VSL was awarded its first VSoL® contract in Switzerland. The system was chosen for its economical and environmental benefits. VSL's responsibilities included all works related to the supply and installation of the VSoL® materials together with the earthmoving and backfill works as well as reinstatement of the earth slopes around the walls. The wall is 45m long.*

Scott Greenhaus, *president of VStructural LLC, was recently sworn-in as the president of the Post-Tensioning Institute for a two-year term. Greenhaus is the author of numerous papers related to concrete repair and strengthening, has served on the Board of Directors of PTI and the International Concrete Repair Institute (ICRI) and is a member of the American Concrete Institute (ACI) and the American Segmental Bridge Institute (ASBI).*

SUCCESS STORY IN DUBAI AND THE UAE

Vertical and horizontal

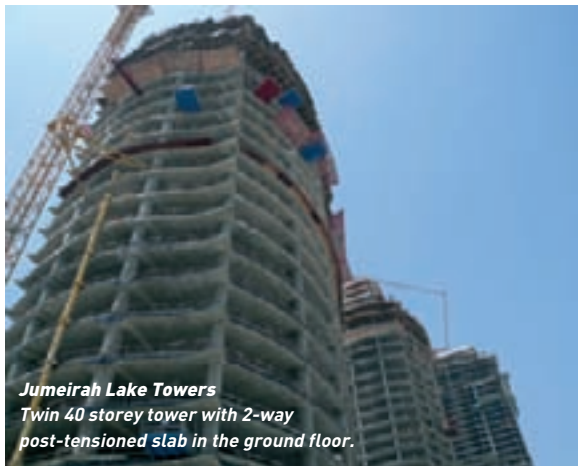
The Middle East's foremost business and tourist centre has been living the last few years to the frenetic rhythm of increasingly daring construction projects. The UAE is offering VSL great opportunities for speedy construction in the whole range of the company's activities.



Dubai Mall
VSL is working around the clock to maintain the exceptionally fast pace of construction of the world's largest shopping mall -a million square metres (300,000m² of post-tensioned slabs in VSL's scope). On several occasions, more than 200t of strand have been installed within a single month. It would normally take nine months to install this quantity in a typical high-rise tower with post-tensioned slabs in Dubai. The mall stands just a few hundred metres from what will be the world's tallest building, the Burj Dubai tower for which VSL will be lifting the pinnacle.

LRT (Light Rail Transit system)
This historic contract for VSL includes precasting and erecting the 60 km-long segmental viaducts of the Dubai metro Red and Green Lines over a period of 33 months, as specialised contractor in a joint venture with Freyssinet and Rizzani de Eccher. Client is the JT Metro JV (Obayashi, Kajima, Yapi Merkesi). Precasting of 17,000 segments is being carried out on a 40-hectar plant. Erection has begun, using 10 launching girders, heavy cranes and lifting frames, to be completed mid 2009. The Dubai LRT, a mostly elevated rapid transit rail system will cross the city from East to West.

To date, the construction continues in Dubai at a breathtaking pace with more cranes operating per square meter than anywhere else in the world... This flourishing market for VSL, which has been established in this booming town for over ten years, has now offered the company with two international partners the biggest contract in its history: to build 60 km of viaducts for the Red and the Green Lines, a mostly elevated rapid transit rail system which will cross the city from East to West.



Jumeirah Lake Towers
Twin 40 storey tower with 2-way post-tensioned slab in the ground floor.

Keeping to scale

The VSL projects carried out in Dubai are shared between major civil engineering works (post-

Ras Al Khor and Al Garhoud Bridges
The Al Garhoud Bridge (back) is a 35,4m-wide and 520m-long post-tensioned twin deck bridge, each providing 7 lanes.
The Ras Al Khor is a post-tensioned cast in situ multi-span bridge.

tensioning of bridges and inter-changes), post-tensioning of large buildings (shopping malls, high-rise residential blocks, car parks), construction of VSoL® soil walls, lifting operations, and ground engineering works.
VSL is currently involved in many projects such as the Al Garhoud Bridge widening, the Cultural Village Bridge, the Business Bay Bridge, the Interchange 5.5 Sheikh Zayed Road, the Ras Al Khor Contract 6, the Interchange 1 Sheikh Zayed Road, the double decking of Doha Road, the Jebel Ali Airport Bridge, the widening of Emirates Road, the Dubai tower, the Gold & Silver Tower, the Dubai Mall.
The latter gives the scale: 1 km²!
VSL's scope of work covers as wide as the post-tensioning of 300 000m² of what will be the world's largest shopping mall. VSL has lifted the longest footbridge in the world between two towers of the Marriott Hotel.

VSL will also climb up new heights to provide heavy lifting services for the pinnacle of the world's highest building to be completed in 2008, the Burj tower.

Palm Jumeirah Bridge
VSL participated in the construction of the main access bridge to the artificial island of Palm Jumeirah, one of the most ambitious real estate developments in terms of size and designed in the shape of a palm tree.

Interview

Simon Buttery, Operations director for the Dubai Festival City project.

"Here is not like elsewhere..."

Dubai Festival City
Post-tensioning in buildings on 5 structures in 2 zones with a total post-tensioned area of 250,000m². Dubai Festival City is 6 million square metres of land divided into 15 lots along the famous Dubai Creek. Forty VSL employees are carrying out post-tensioning work in areas 1,2b and 8B.

How do you perceive VSL?
Simon Buttery: In a way, in a fairly short period of time with the site team, it has turned from VSL being just another tenderer in the market to being what we like to call a preferred supplier. This is through working closely on the first projects they secured.

You have finished two projects with VSL. Why did you pick VSL in the first place?
SB: First, the bid was compliant, which is definitely a rarity in Dubai! Everyone is in such a rush that they don't really look at what clients actually are asking for when they're asking for a contractor to price. Basically on the quality of the bid. And price. And we liked the look of the team that they were putting forward. Then they completed two large projects with us here at Dubai Festival City and that really set the scene for how we want to develop the relationship from here on. You've got to bring people together and co-locate the project team. It wasn't just paying lip service, VSL was constantly through the project, before actually starting the work.

Why is this attitude so important to you?
SB: One of the biggest challenges that we all have in this market is client changes! And when you get a change here, it's not like elsewhere. On the commercial building, we were at level 18 of a 27 storey building but the client asked us to add 10 more storeys on the building! And we were asked to provide a technical brief as to whether this could be done, and a price, within 14 days... We did that and we only did that because we had the likes of VSL actually based on the site. The client got the information he needed to be able to make the decision within 14 days as to whether he went for the variation. He decided to go ahead.

What is so different here about building in Dubai?
SB: Speed of construction, scale of construction. Also from our point of view as the main contractor, we are much more involved in the construction process. We have our own direct resources, we construct the reinforced concrete frame and a lot of the wet trades. In the UK we would just manage the process. We have 18 000 of our own operatives. You have to think of the logistics of moving and looking after this number of men, bussing them to work, feeding the guys. It's huge logistics. You only get 66 men on a bus! ■

Simon Buttery, Operations director for the Dubai Festival City project, Al-Futtaim Carillion

Plot 44, Burj Residence - Dubai

Westside Marina
3km-long wall for VSoL®, erected by VSL for Carillion in the Dubai Marina district.

VSL's successful approach of the Dubai boom has a lot to do with the need for speedy and safe solutions. Business is running at high speed, clients are eager to go for fast delivery. Innovation and cutting edge technology is something VSL is always pushing together with networking internally to have worldwide resources and assistance. Post-tensioning technology, providing the PT Plus® Plastic duct system and electrically isolated tendons, are useful innovations to service the mushrooming city of Dubai which is building so many skyscrapers at one time and an airport to be eight times larger than the current Dubai International Airport and Dubai Cargo Village combined. As an example of new technologies, VSL and its JV

Dubai Tower
A 46 storey building, totaling approximately 42,000m² of post-tensioned floor area.

King Abdul Aziz Bridge, Sharjah.

Foundations of the Burjuman and Saeediya stations
By the end of the year 2007, the Intrafor team in Dubai should have completed 123 000m³ of diaphragm walling excavation, thus representing one of the largest achievements of the ground engineering department of VSL-Intrafor in the recent years. Scope of works included diaphragm walls, excavation works, cut and cover tunnels for the Burjuman station and the Saeediya station of the Dubai Metro project. Two cutter rigs and three mechanical grabs were used. Works take place around the clock, 6 days a week, with 260 persons at peak.

Dualisation of Sohar Buraimi Road – Sohar, Oman

partners are currently involved in the Dubai LRT superstructure works using launching girders with a pre-cast concrete segmental system which is a first in Dubai.

Increasing commitment

Another strong point in VSL's development in Dubai is staying close to clients. The opening of a VSL subsidiary in Dubai dates back to 1996. Since 2002, business has boomed again. VSL always developed relations with local customers, allowing building up the resources and experience which was needed to tackle large-scale projects in Dubai, Abu Dhabi and in the surrounding Emirates and in Qatar, Bahrein, Oman, as well as in Saudi Arabia.

Willing to be the customer's first choice, and a "partner" rather than a "sub-contractor", especially for civil engineering projects, VSL's approach is to fully integrate with the main contractor's team and to go the extra mile for the client, aiming to exceed his expectations. The goal is to ensure that upstream planning and programming is implemented with respect to resources, equipment and materials on the site front and liaison with the VSL technical team based in the local branch office so that the shop drawings and calculations are submitted and approved ahead of the works. VSL also have their own manufacturing facilities within the network, which helps with planning and supply.

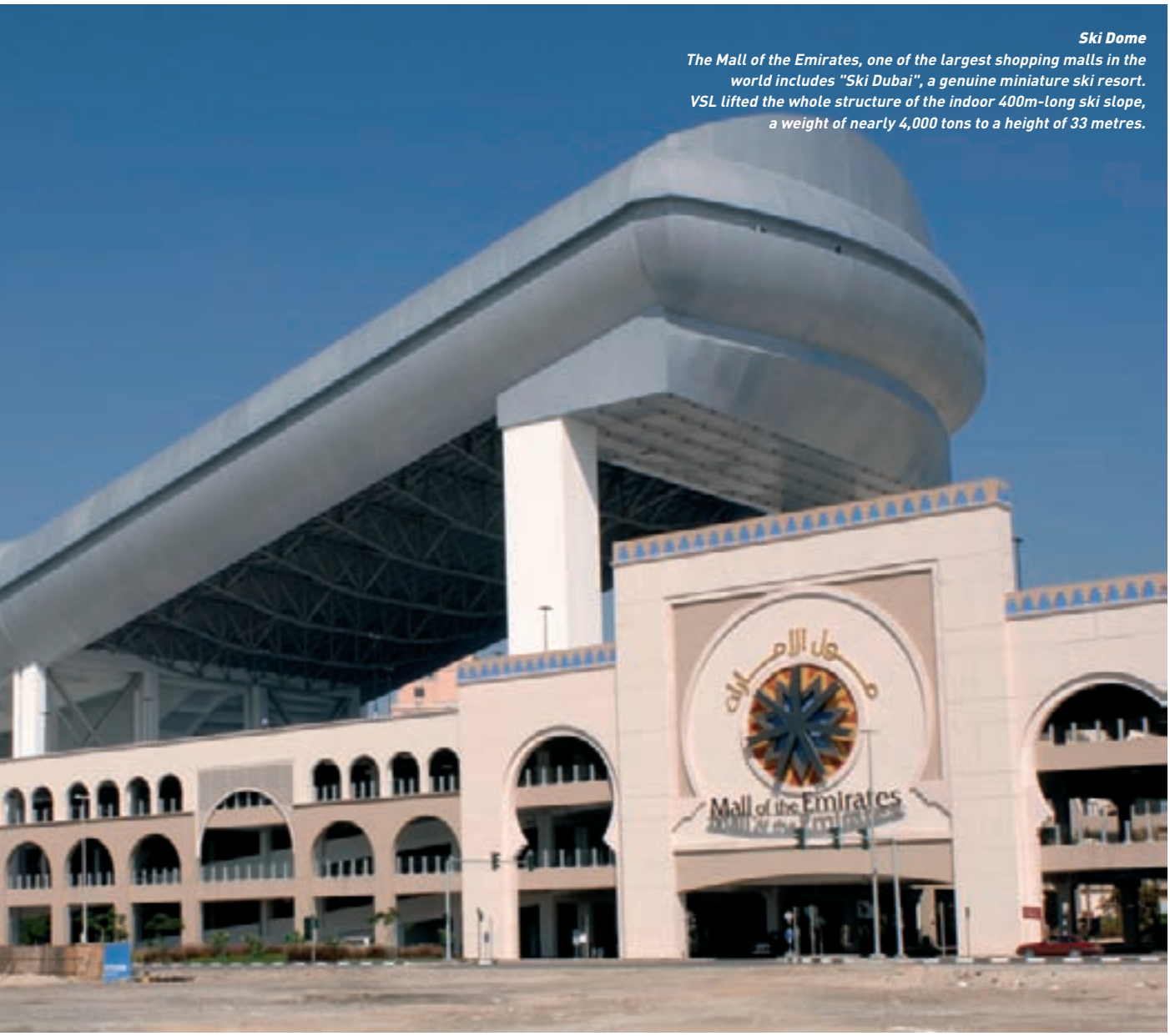
Multicultural team

Today, VSL Middle East employs 200 people, including designers, engineers, technicians and supervisors. This multicultural team (including English, Chinese, Turkish, French, Chileans, Indians, Egyptians, Filipinos and other Arab nationals) reflects Dubai itself, whose population includes more than 80% expatriates and construction sites where post-tensioning jacks and VSoL® panels are handled by workers hailing from India, Pakistan, the Philippines, Indonesia, Thailand, Egypt, China, and others.

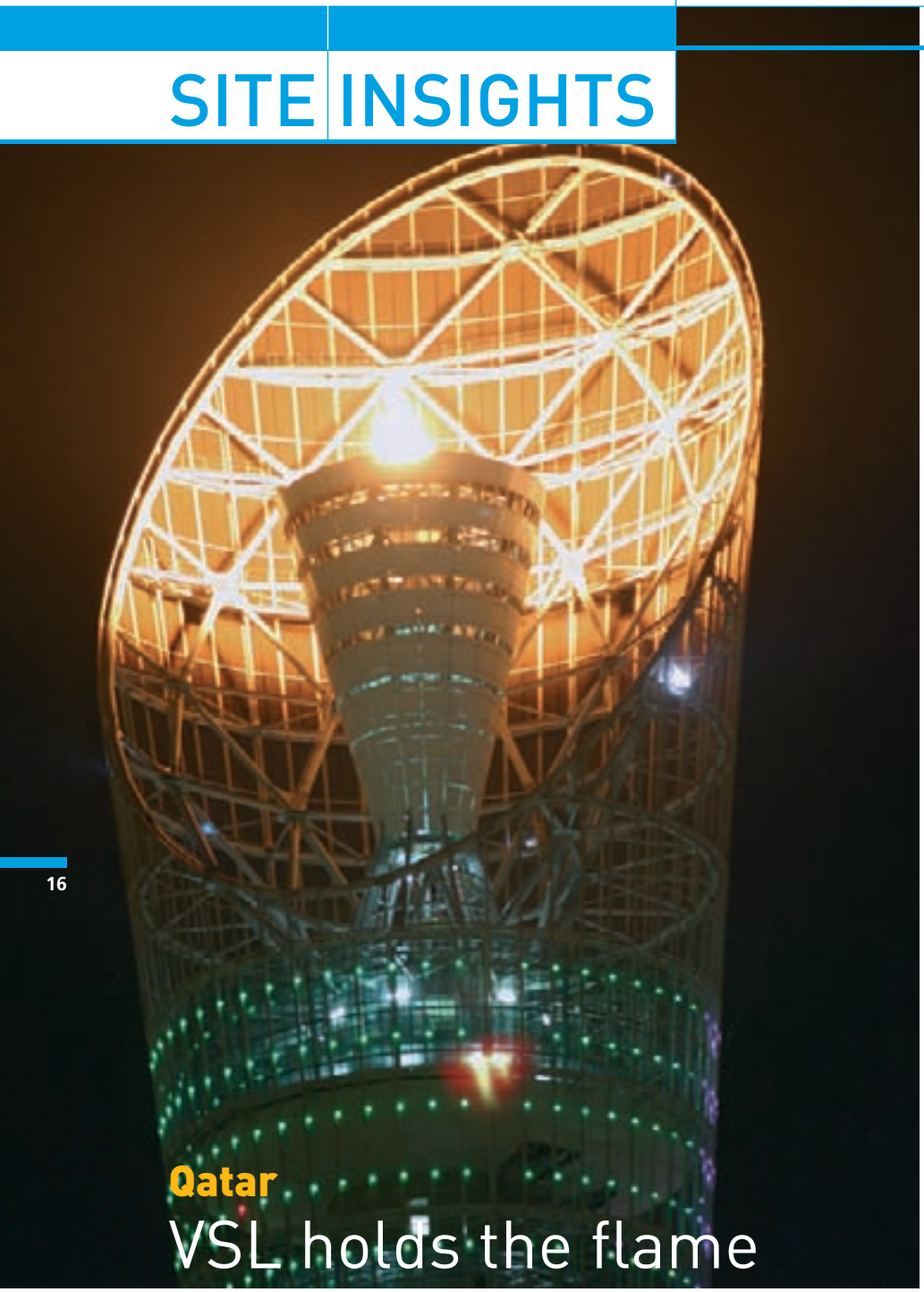
VSL is now selecting more high-profile and prestigious large-scale projects for which general contractors choose their subcontractors. *"At VSL we rise to challenges and there are plenty of*

those at the moment" says Steve Burke, in charge of VSL's development in the ME. There has been an increased demand over the last 12 to 18 months and the company is endeavouring to be selective when tendering. In a hot market like the UAE it would be easy to over-extend. *"A lot of thought has to go into the type, size and timing of upcoming projects"*, says Steve Burke. Abu Dhabi is now very much on the bridge and building radar and VSL is gearing up accordingly... ■

Burj Al Arab, Dubai's unique 7-star hotel. VSL lifted the whole skeleton in 1997.



Ski Dome
The Mall of the Emirates, one of the largest shopping malls in the world includes "Ski Dubai", a genuine miniature ski resort. VSL lifted the whole structure of the indoor 400m-long ski slope, a weight of nearly 4,000 tons to a height of 33 metres.



Qatar

VSL holds the flame

→ **VSL ME has completed the supply and post-tensioning of bars and strands** for the Qatar Sports City Tower in Doha. The 320m-tall tower stands alongside the Khalifa Stadium, which in December 2006 was the main venue of the 15th Asian Games, where some 10,000 athletes from 45 countries competed in 39 sports. VSL used Y1050 grade bars from Stahlwerk Annahütte, VSL's JV partner for bars in Middle East. The bars are in five different diameters, ranging from 18mm to 75mm. The tower is topped by 44 bars of 75mm diameter, which are stressed where a "petal" weighing 600t held the Games' flame. Stressing was carried out using a ZPE-460/31 jack. The project also involved the supply of 300mm-thick plate, and the arms to hold the petal were welded to the support plate. A single section of the top plate and arms weighs 3.6t. Holding the circular structure also involved the stressing of 20 unbonded 15mm (0.6") diameter strands using the CTT Stronghold (DD Type) connector. ■

Contact: shemi@vslme.ae

Saudi Arabia

Super bowl

→ **The Dammam Water Tower** provides a majestic and decorative sight at the Sea Front project in Dammam Al-Khobar city, close to the spectacular bridge leading to Bahrain. The 90m-high water tower, which stands at the centre of an artificial island, contains a viewing deck and restaurant as well as the 5000m³-capacity tank with an outer diameter of 46m. The 8100t concrete bowl and cupola, with its intricate shapes, was constructed in situ around the shaft at ground level. Steps of 200mm were used to lift the bowl almost 60 meters, where it was fixed to the shaft with a series of shear keys.
VSL lifted the tank with 20 SLU 330 units, which were installed at the top of the shaft and equipped with compacted strands. The tower's base will be turned into a major commercial centre with more than 350 shops.
■ *Contact: david.gratteau@vsl.com*

Saudi Arabia

Ready for the Hajj

→ **The first floor slab of the unique Jamarat Bridge structure at Mecca** has been completed, following eleven months of intense activity. VSL has been involved in the construction by providing the geometry control and associated engineering, technical assistance for the erection works, some of the post-tensioning components for the structure and technical assistance for the post-tensioning works. The first slab was completed in time for the 2006 Hajj and erection of the second floor slab is ongoing. All four slabs are scheduled for completion by the end of 2008. ■

Contact: christophe.petrel@vsl.com

Jordan

Saddle solution

→ **Wadi Abdoun Bridge,** the focus of the newly-built Amman Ring Road, opened in mid-December 2006. The outstanding structure consists of three Y-shaped towers, which rise up to 71m above ground level and carry the load of a 425m-long bridge deck on 60 stay cables over two main-spans of 132m and two side-spans of 63m. The S-shaped bridge gradient was a challenge in terms of geometric control. Larsen & Toubro, in joint venture with Arab Technical Construction as main contractor, appointed VSL for technical assistance on all aspects of bridge deck erection, stay cable engineering and related PT works. The stay cables, which range from 17.5m to 76m in length, are fixed at the tower with a specially-designed saddle pipe with partitions for each layer of strand. ■ *Contact: christophe.petrel@vsl.com*

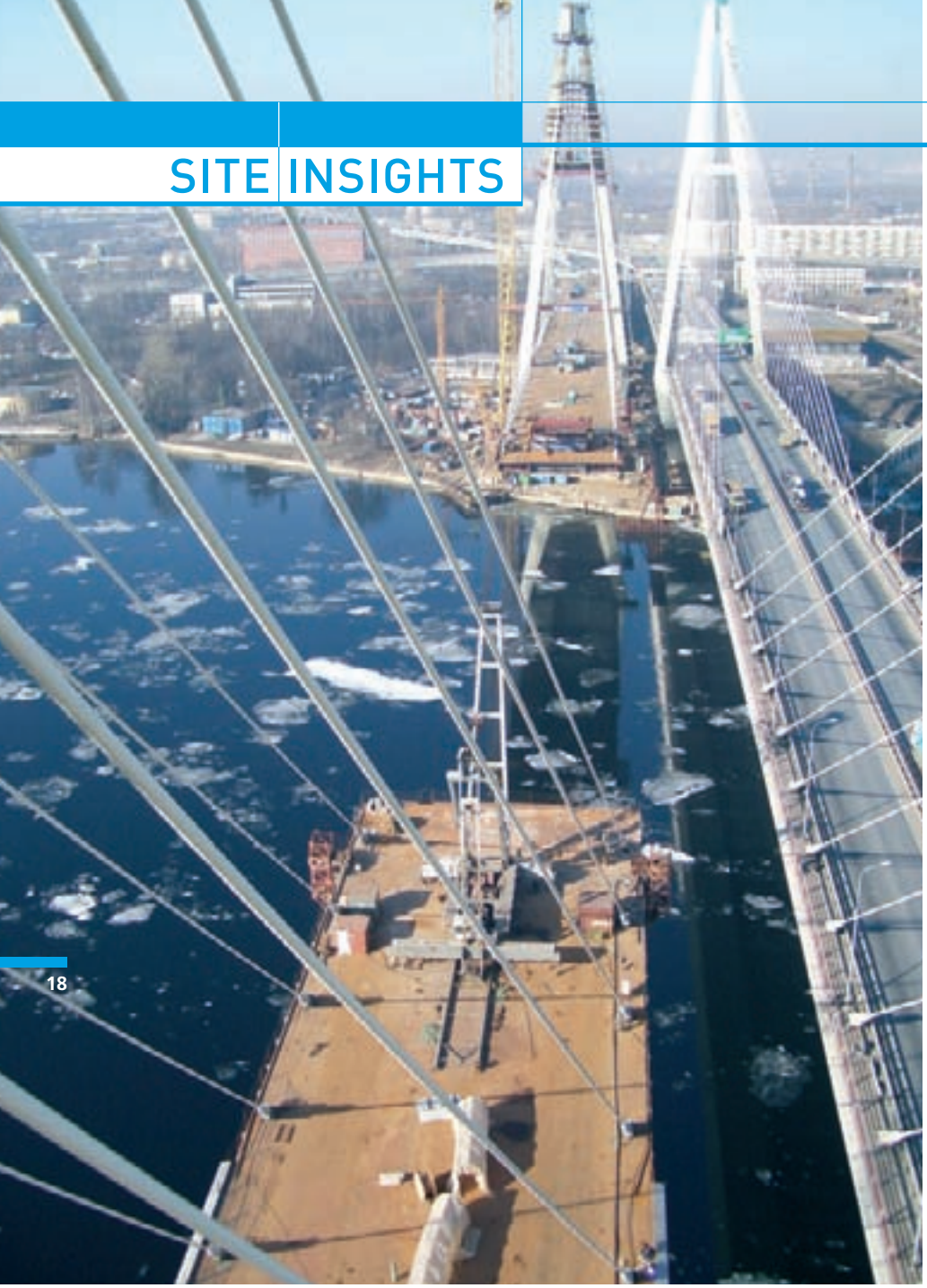
NOTE PAD

Alliance progress. *VSL Australia, in alliance with Abigroup Contractors and Leighton Contractors, is constructing the 260m-span New Gateway Bridge in Brisbane. The work already underway on this iconic bridge includes the establishment of a precast facility, construction of access islands in the Brisbane River, completion of a test-pile programme and fabrication of major equipment components.*

Two months gained. *VSL-Abigroup Alliance has completed the 1500m-long Bridge Over South Creek two months ahead of schedule. The bridge - part of the Windsor Flood Evacuation Route Project near Sydney - was built using the segmental match-cast method with an under-slung erection system. VSL Australia personnel was responsible for procuring, erecting and operating the gantry system. It also managed the post-tensioning.*

Crossing the Hérault. *VSL France is carrying out the post-tensioning works for the new Gignac arch bridge in southern France, including the longitudinal post-tensioning of the two outer deck segments, the post-tensioning of the arch's base on the east bank, reinforcement of the foundations and the inclined legs on the west bank. The deck will be post-tensioned transversally and longitudinally using a combination of VSL systems.*

No buttresses. *VSL's Dallas office, working for Massman Construction, is supplying and installing 101t of 0.6 inch (15mm) diameter strand on the Huey Long Bridge Widening Project in Louisiana. Work includes provision of circumferential reinforcement for the existing piers and horizontal tendons to reinforce the pier ends. Use of VSL's intermediate Z-anchorage eliminates the need for stressing buttresses.*



Russia

Neva second

→ **The 2nd Neva stay-cable Bridge** forms an important link on the newly-opened ring road in St Petersburg. Lifting of the closure segment occurred on schedule in May 2007. The VSL site team, together with main contractor Mostootryad 19 and its bridge subcontractors, managed to construct the bridge in less than half the time needed for the 1st Neva stay-cable Bridge. It took less than six months for the latest project, which included installation of 600t of galvanized strand in 112 stay cables. All the staff contributed to the successful completion of the demanding project and maintained a professional attitude and a commitment to quality. Mostootryad 19 is a leader in bridge construction in the Russian market, and once again successfully completed a major bridge to a very tight schedule. Giprostroymost Saint Petersburg has designed both Neva bridges, as well as other major bridges in Russia.

■ *Contact: christophe.petrel@vsl.com*

USA

Silo record for Holcim Cement's plant

→ **VSL's Denver office is supplying a bonded post-tensioning system** for 10 silos that are being built at Holcim Cement's new Missouri production plant, which is expected to be the largest of its kind in the USA. The joint venture team of MC Industrial and TE Ibberson selected VSL to provide the ECI 6-19 system. Two clinker silos - which at 46m in diameter and 63m high are believed to be the largest in the world - are currently under construction, together with two "four-pack" cement silos, each 24m in diameter and 84m tall. Each clinker silo requires 23,462m of strand, 12,927m of duct and 344 anchorages. For each of the "four-packs", all four silos will be poured simultaneously with more than 100 workers per shift working around the clock to install 7t of rebar per hour and the associated post-tensioning ducts, anchorages, set-backs and embeds. In total, 1,264,462m of strand, 65,420m of duct and 3,168 anchorages are needed for each "four-pack".

■ *Contact: janderson@structural.net*

Latvia

Flyovers for Riga

→ **Construction of a new bridge over the River Daugava in Riga,** Latvia, will improve traffic congestion in the city. VSL is supplying its CS 2000 (6-19) post-tensioning system for the six flyovers which make up the bridge over the river. Construction of the 1,791m of flyovers was begun by BMGS in February 2006 for completion in June 2008. ■ ***Contact: jbesta@vsl.cz***

Czech Republic

Speedy footbridge

→ **VSL has installed its SSI 2000 stay cable system** on the new Zizkova footbridge in Usti nad Labem, Czech Republic. The scope of VSL's work also included the post-tensioning of the deck. Installation of 28 stays, including final tuning took just two weeks. The main contractor for the footbridge was Chladek & Tintera and it was designed by VPU Deco Praha. Construction was completed in April 2007. ■ ***Contact: jbesta@vsl.cz***

USA

After Katrina

→ **Construction of a new US 90 Bridge in Biloxi, Mississippi,** will help regenerate the local economy, as the original bridge was washed away during Hurricane Katrina. VSL's Dallas office is working with GC Constructors - a joint venture of Massman Construction, Kiewit Southern and Traylor Brothers - and has been involved closely with the design and build team throughout the project. The post-tensioning requires installation of 44 tendons, each 198m long, using VSL's ECI 6-19 system, which will allow for a longer span to enable the uninterrupted flow of both road and water traffic. VSL's work is on the main span, 30m above the water in the middle of the bay. Crews have to use boats to reach the support barges below the span and the working platforms can only by accessed by crane and man-basket. The work began in April 2007 and is scheduled for completion in January 2008. ■ ***Contact: jmctaggart@structural.net***

Switzerland

EIT on Roeti

→ **The first Roeti Bridge over Solothurn's Aare River** was built in 1924, then widened and strengthened in 1965 and again in 1995, but now needs to be replaced by a new structure. Some 25,000 vehicles cross the bridge every day and so an auxiliary crossing had to be built before the old bridge could be demolished. The Canton of Solothurn appointed as contractor JV Roeti Bridge, which is made up of Batigroup of Solothurn and Zurich, Meier & Jaeggi of Zofingen. The new structure was designed with a total length of 140m, made up of spans of 46.2m, 56.3m and 35.5m, and was concreted in three stages. The cross-section consists of two robust edge-beams, which contain longitudinal post-tensioning cables 6-37. Strands were pushed through individually before concreting and coupled to the previously-installed tendon. All tendons are electrically isolated. Post-tensioning work started in spring 2006 and was completed by the end of the year.

■ *Contact: franz.fischli@vsl.com*

Austria

Waterproof pits

→ **The H4 project is part of a new railway line** between Munich and Verona designed to reduce environmental damage by encouraging the carriage of freight by rail. It combines classic tunnel construction methods, using the Austrian Tunnelling Method where the line passes under highways, railways or small villages and difficult open cut construction in other sections. The main challenge is the economical design and construction of the deep excavation pits for the open cut construction. Groundwater is only 3m below the surface and thus requiring the pits to be absolutely watertight. VSL's Austrian licensee GPS provided the solution, which uses sheet pile walls, anchored underwater concrete slabs and temporary strand anchors. GPS managers and designers optimised the anchors to transfer forces of up to 1,300kN in the loose sand and gravel. In total, 1,700 bar (57.5mm diameter) anchors and 1,700 prestressed strand anchors will be installed by the completion in 2008.

■ *Contact: Klaus.Breit@gps-bau.com*

France

Carbon concept

→ **An innovative concept proposed by VSL France** led to the award of a contract to reinforce a building's slabs for the French Air Force. The proposal saved both time and money as it minimised the reinforcement zones by taking into account the additional loading on the upper slab. The structure was composed of primary beams of 6.2m span, secondary beams spanning 4.5m and a 3m-span slab. Flexion reinforcement was used for the slabs and beams. This required the application of carbon plates along their entire lengths. U-shaped carbon sheets were used as shear force reinforcement underneath both primary and secondary beams. In total, 850m plates and 100m^2 of sheets were installed. The use of carbon fibres is particularly suited to this type of reinforcement, offering an alternative to traditional steel plates. VSL expects a growth in its use on ageing assets in France and elsewhere. ■ *Contact: fabien.cousteil@vsl-france.fr*

France

Replacing external PT cables

→ **The 1,103m-long Saint Cloud bridge,** which is on a major motorway between Paris and Normandy, consists of two concrete viaducts separated by a central cantilever joint. The viaduct was built in 1974 then reinforced in 1980 using additional external PT cables but corrosion caused one of these to break in 1998. The DIRIF (Direction Interdépartementale des Routes Île-de-France - French Civil Department) decided that the others were also vulnerable.
The replacement process involves fitting each side of the deviator with a shock-absorber safety device, developed by LCPC and EC Nantes and designed to absorb energy when the cable is cut or fails. The two-part system comprises a 2m-long stainless steel sheet in contact with the concrete deviator and a rectangular element known as a "hammer" bolted onto the cable. The existing external PT is cut using remote control equipment. The anchorages are then removed or adapted and the PT is replaced. ■ *Contacts: v.buchin@bouygues-construction.com, f.crozat@vsl-france.fr*

Switzerland

Transfer solution

→ **The resort of Hameau les Crosets** has experienced a rise in tourism in recent years and construction of much-needed new accommodation started in March 2006, i.e. 15 buildings. VSL was invited to provide a load transfer solution for the slabs of the three main buildings' car parks.
The scope of works included design, supply, installation, tensioning and grouting of the cables. Construction of the 17m by 35m, 400mm-thick concrete transfer slabs required VSL to install 81 VSL SO-H 6-4 post-tensioning cables, totalling 7t of prestressing steel for each slab. Tendons were tensioned in two stages, firstly to allow removal of the formwork and then once the framework and principal loads were in place. Despite delays caused by unfavourable weather, VSL's solution substantially reduced construction times and allowed the owner and the main contractor to complete the buildings on schedule. ■ *Contact: fabrice.vouilloz@vsl.com*

Australia

VSoL® for Queensland upgrades

→ **VSL Australia has recently completed two VSoL® projects** for FRH Group as part of a major road upgrading programme being undertaken in South East Queensland. VSL was awarded contracts for the design and supply of VSoL® Retained Earth Walls in December 2006, continuing a working relationship established on the Linkfield Connection Road project. The Hamilton Road Upgrade involved three walls, totalling 1,330m² of Forest Finish panels with a maximum height of 10.3m. The walls were designed to withstand crash barrier loading. Two walls were built on the Maroochydore Road Upgrade project, with smooth grey panels totalling 1,220m². ■ *Contact: smills@vsl-australia.com.au*

Malaysia

Giant lift for A380s

→ **Malaysia Airlines System's order for six Airbus A380 aircraft** meant a new hangar was needed at Kuala Lumpur International Airport, Sepang, big enough to accommodate the XXL-aircraft. The Zelan -Marubeni-Tokyu Construction Consortium was appointed to design, build, test and commission the new hangar. The structural steel building boasts a 231m span and is 92m wide. It has a clear height of 32m and will be the longest column-free span hangar in the world upon completion. VSL worked for steelwork subcontractor Zelan-WEPE Joint Venture and raised the 5,100t hangar roof in April

2007, using 22 SLU 330 jacks located at nine lifting points, maintaining a lifting speed of 2.5 – 3m per hour until reaching the final height of 27m. Throughout the lifting procedure, the camber tolerance of 9mm was respected. ■ *Contact: ckchong@vsl.com.my*

China

Back to Pu Dong

→ **Tokyo Gas Engineering Company has awarded VSL Hong Kong a contract** for two 50,000m³ tanks for the expansion of the Shanghai LNG Peak Shaving Project at Pu Dong, Shanghai. The site's existing tank was built in 1999 with post-tensioning by VSL France and VSL Hong Kong. Each of the new tanks is a 30.5m-high cylinder of 56.1m diameter with a 0.65m-thick concrete wall. In total, the new tanks require the installation of 389t of strand. Their main structural reinforcing elements are horizontal tendons and vertical U-tendons made up of 6-12 units. Use of VSL GC Type F anchorages ensures compliance with the project's cryogenic requirements. ■ *Contact: alice.lin@vsl-intrafor.com*

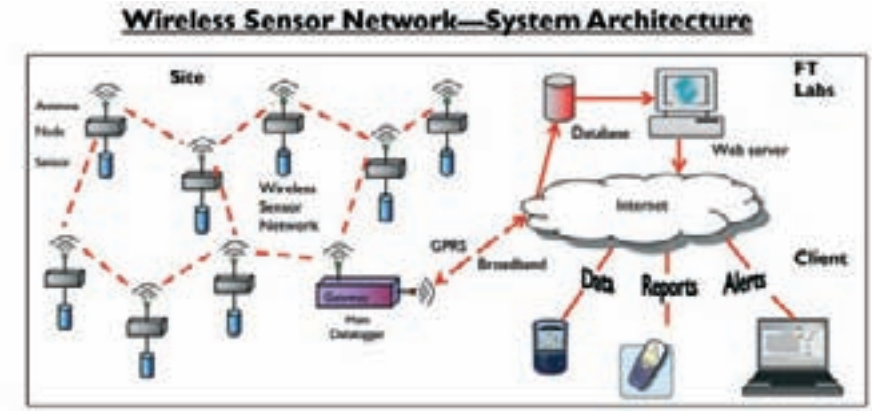
Malaysia

Balanced approach

→ **The combination of a specially-designed segment launcher** and a lifting crane has successfully constructed the superstructure of two bridges at Rasah Interchange, Seremban. The first bridge has 135 segments across nine spans and the second has 128 segments across eight spans. Segment weights range from 41t to 61t. VSL's MX50 Segment Launcher working with a mobile crane proved to be the ideal combination, particularly for the challenging 62m spans across the Linggi River. ■ *Contact: ckchong@vsl.com.my*

Hong Kong

Real-time sensor monitoring



'Over the Air' Programming is a key feature of the system.

→ **FT Laboratories has completed** a development project to implement wireless sensor networks (WSN) for remote real-time monitoring of geotechnical instruments. This provides a self-forming / self-healing data transmission network between instruments. Data transmission is no longer limited to easily-damaged single-route wire connections – these can now be replaced by multi-hop ad hoc wireless networks that use the most efficient routing from point A to B. Instrument readings are received at the site's 'gateway', from where they are transmitted to FT's data centre for uploading to the secure DeMon website. One of the driving forces for FT's adoption of the system was 'Over the air' programming, which allows great flexibility in data acquisition. The monitoring frequency for any instrument can be changed remotely over the internet. This can either be done manually by the engineer or can be event-driven through FT's DeMon website.
In Hong Kong, the principle application of the system is for the monitoring of piezometers on remote and unstable hillsides. The system is designed for low power consumption and nodes can operate for a full year on just two AA batteries.
The current design of the WSN system is primarily geared towards geotechnical sensors. However it could be expanded to structural instruments. ■
Contact: david.clayton@ft.com.hk

Australia

Staying correct

→ **VSL's scope of work on the Albury Bypass's Dean Street Pedestrian Bridge** included the supply, installation and post-tensioning of 28 stay bars, ranging in length from 28m to 74m. The stays were manufactured by VSL in Melbourne, transported to the painting contractor and then to site where they were lifted into position by crane. Calculations completed prior to the start proved to be invaluable. The final bars needed to be threaded precisely through the abutment and the clevis connection and the process was eased by having the bars sitting at the correct angle. ■ *Contact: istuart@vsl-australia.com.au*

Australia

Tasmanian double

→ **A project for Norske Skog Newsprint Mill in Southern Tasmania** involves construction of a new wastewater treatment plant, consisting of an outer 40m-diameter post-tensioned concrete tank with a 16m-diameter one within. Materials supply and stressing has been carried out by VSL (Tasmania). The 11m-high, 300mm-thick precast wall panels are cast off-site and are stressed vertically before removal from the precast bed. The walls are delivered to site by conventional road trucks and placed into a ring-

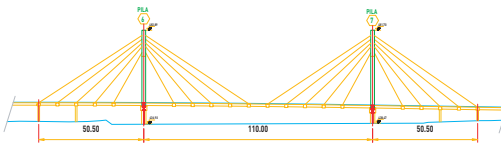
beam, with the joints between the panels poured in-situ. The tank is then stressed horizontally and the ducts are fully grouted following final stressing. ■ *Contact: istuart@vsl-australia.com.au*

Tunisia
Cable-stay first

→ VSL is playing a key role on what will be North Africa's first cable-stayed bridge. The first segment of the Rades-la-Goulette project's principal bridge was cast in early June 2007. Work is progressing on each of the two piers, which stand on either side of the Canal de Tunis Port. VSL is providing the main contractor Tasei Corporation with extensive equipment and services, including the supply, installation and supervision of two sets of pier table structures and two pairs of form travellers; the supply and installation of 1,000t of post-tensioning and 16 SSI 2000 6-37 stay cables, as well as the construction engineering. Completion of the bridge deck is scheduled for late November 2007.
■ *Contact: k.doghri@bouygues-construction.com*

Argentina
Stays for Córdoba

→ VSL Argentina was awarded the contract in April 2007 the supply and installation of stays for a cable-stayed bridge at Rio Cuarto in Córdoba Province, Argentina. The bridge consists of a 110m main span and two 51.2m side spans, all with concrete decks. Installation of the VSL SSI 2000 System stay cables is scheduled for completion at the end of 2007 and includes cables up to 43-06 in size.
■ *Contact: aloguercio@vslarg.com.ar*



Mexico
Baluarte record

→ A consortium of Mexico's Tradeco, Idinsa and Corey, together with VSL México, began construction of the new Baluarte Bridge in June 2007. At nearly 1,200m long, it is Mexico's longest cable-stayed bridge and will be one of the most important bridges in Latin America. It forms part of the Mazatlan-Durango highway. The bridge comprises two approach viaducts, built by the free cantilever method, and a main cable-stayed bridge, which has a

520m span flanked by two pylons. The main span, 400m above the bottom of the ravine, has a steel deck while the approaches will be concrete. The 68 stay cables, weighing a total of 1,000t, require nearly twice the cabling of the earlier Uddevalla stay cable bridge built in 1998. VSL's scope of works includes the supply and installation of PT, four pairs of form travellers and the stay cables. This project is due for completion in 30 months. Together with Puente la Unidad in 2003, Baluarte Bridge puts VSL México at the top of the Mexican stay cable market. ■
Contact: mmartinez@vslmex.com.mx

Portugal

New Tagus crossing

→ **Portuguese motorway operator "Brisa - Auto-Estradas de Portugal"** has just opened to traffic the new crossing over the River Tagus, completing the main road accesses to the metropolitan area of Lisbon. The construction of this 11,670m long project was carried out by TACE - Construção da Travessia Rodoviária do Tejo, ACE. It consists of two approach viaducts, 1.700m and 9.160m long, and a 970m long main bridge, composed of six 130m spans and two 95m spans, and features a single box girder deck built by free cantilever method. A joint venture between VSL and Freyssinet began work in January 2007 on the installation of 1,614t of post-tensioning for the main bridge, including 1,167t of internal PT using 6-22 longitudinal cables and 188t of transversal 6-4 cables. The works were concluded in June with the installation of 290t of external cables inside the deck girder during this last month, using a replaceable and re-tensionable system developed for this job with 31 unbonded and grouted strands.

■ *Contact: ralmeida@vslsistemas.pl*

Morocco

Waffle wall

→ **VSL has been awarded the design, supply and erection** of more than 23,000m² of VSoL® walls at Tanger Mediterranée, a new port for Tangiers in northern Morocco. VSL and its licensee in Morocco, Renfor-Bat, joined forces to supply the VSoL® components as well as carrying out the prefabrication and erection of the wall. The VSoL® panels are 2.25m by 1.5m and the precasting plant can produce 300m² per day.
The project is in a seismic zone. The use of polymeric reinforcement as well as waffle panel which optimises concrete quantities were the key to secure this project. Wall erection started in May and is expected to be completed in September 2007.

■ *Contact: jpinelli@vslsp.com*

Spain

Giant umbrella

→ **VSL recently completed the lifting of the new Pantadome® roof** that covers the bull-fighting arena in Xativa. This unusual structure was conceived by Japanese engineer Mamoru Kawaguchi - known for his designs of the Sant Jordi dome and Singapore stadium - and designed in conjunction with Spain's CMD engineers. It is a very light structure with a 42m span that unfolds umbrella-like from the ground and required a simultaneous lift using 44 of VSL's SLU 70 jacks. The structure is composed of 22 trusses connected radially to a central drum and to hinged articulations on the outer steelwork. Two jacks per truss were used to shorten two radial tendons, creating a lifting force that raised the whole structure. As the whole structure is extremely flexible, checks needed to be made every 500mm of the lift. The central ring was lifted 17m into position, within 5mm tolerances, in just two days to the satisfaction of all involved.

■ *Contact: jmartinez@vslsp.com*

Stay cables

Successful leak tightness tests for the SSI 2000

Two different units of the SSI 2000 anchorage successfully passed the 2 leak tightness tests as defined in the PTI and *fib* stay cable recommendations. The VSL SSI 2000 anchorage is thus the first and only stay cable anchorage to successfully pass both levels of tests with sheathed strand cables. Again, VSL is setting a new level of protection and high durability up to 100 years...

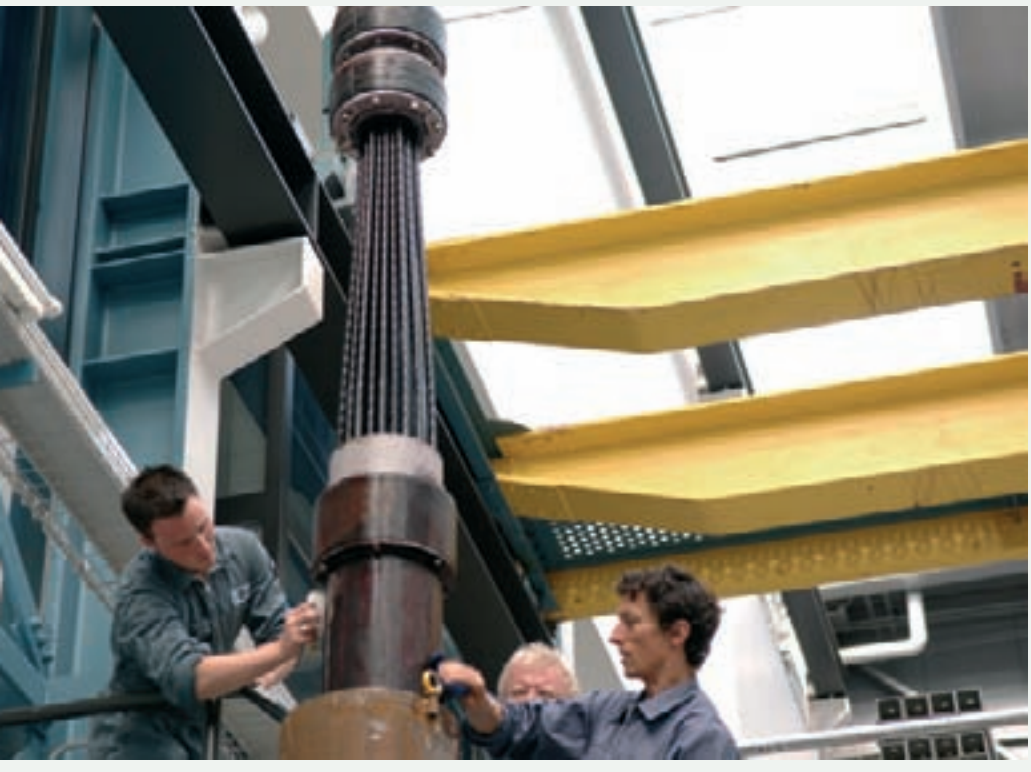
During the maintenance operations on cable-stayed bridges equipped with different stay cable systems, the presence of water collected within the protection cap covering the cable end has been observed on some deck anchorages. These observations led the working groups of the PTI, CIP and *fib* to define a new type of test: the leak tightness test.

Enhancing leak tightness

The principle of this test is twofold. First, the stay cable anchorage and particularly its sealing system are submitted to some mechanical and environmental constraints. Then, this anchorage (with its cable) is placed into a chamber with 3m-head of dye solution to check there is no ingress of water into the anchorage. The principles of the leak tightness tests as defined in the CIP, PTI and *fib* documents are similar but the testing conditions are somewhat different. This leak test is a new test and the usual testing laboratories have not yet the equipments to carry out this type of test. VSL thus decided to build the necessary equipment and to submit its SSI 2000 anchorages to the *fib* and PTI tests which are representative of the different testing conditions.

PTI test at EMPA lab

Before being submitted to the leak test, the anchorage type VSL DS 6-37 and its cable composed of 37 strands was installed on the testing bench of the EMPA laboratory (Switzerland) and submitted to a fatigue tensile test of 2 million cycles, with a maximum tension of 56% of the cable breaking load and a stress



***1 -** After 96 hours of immersion, the anchorage and its cable are lifted out from the pipe filled-in with 3m-head of dye solution.*

2 - *First inspection of the anchorage, covered by the red dye solution, before dissection.*

range of 140MPa. The objective of this test is to create a fatigue and mechanical ageing of the sealing system of the anchorage. Then, the fully assembled anchorage with its cable is immersed during 96 hours into a dyed water tank composed of a vertical steel pipe to create a pressure corresponding to a 3m head of water *(picture 1)* on the anchorage components.
At the end, all the parts of the cable within the anchorage were examined *(picture 2)*. They did not show signs of corrosion that could be due to penetration of dyed water within the anchorage.

fib test at VSL lab

The test conditions defined in the *fib* recommendations require more complex equipment which does not exist in the laboratories. VSL thus decided to design and install new testing equipment in its laboratory located in Subingen (Switzerland). A cable of 31 strands equipped with its stay cable anchorage was placed into a special testing bench designed by VSL and installed in its laboratory *(picture 3)*. The testing installation, execution of the test and final investigation were under the control of independent experts.

As for the PTI test, the sealing system of the anchorage is submitted to some constraints to simulate a certain ageing of the system. The anchorage is not submitted to a mechanical fatigue test, as in the PTI recommendations, but to a combination of variable tensile loads (with 440MPa stress range) and angular cable deviations of 1.4° at the anchorage.
Additionally to these mechanical constraints, the anchorage and its cable were placed within a water tank with a water temperature varying from 16°C to 56°C, to accelerate the ageing of the sealing system. After a total duration of 8 days, each of the 31 strands was removed and carefully examined. No presence of moisture nor dyed water inside the anchorage and in particular on the surface of the strand was recorded.

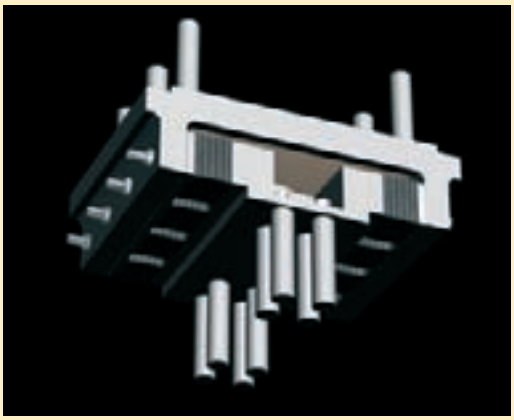
Higher protection

The technologies developed by VSL for the protection system of its SSI 2000 stay cable anchorage contribute to define a new level of protection and high durability. With regards to corrosion protection of the steel components of its anchorage, VSL has designed a new system which offers the best protection in the most aggressive environments: up to 100 years without maintenance on the non-accessible components.
As of today, the VSL SSI 2000 anchorage is the only stay cable anchorage to successfully pass the PTI and *fib* leak tightness tests with sheathed strand cables.
Its experience allows VSL to offer a stay cable system with a high level of durability. Through permanent development and research efforts, VSL is anticipating to develop a system with even higher levels of corrosion protection and with controlled durability. ■

3 - *Test installation*

Equipment

Preloaded bearings offer versatility



Special preloaded bearings, which are fixed under service loads and offer limited movement if the load is exceeded, were designed and manufactured by VSL in Spain for the Ankara-Istanbul railway line rehabilitation in Turkey.

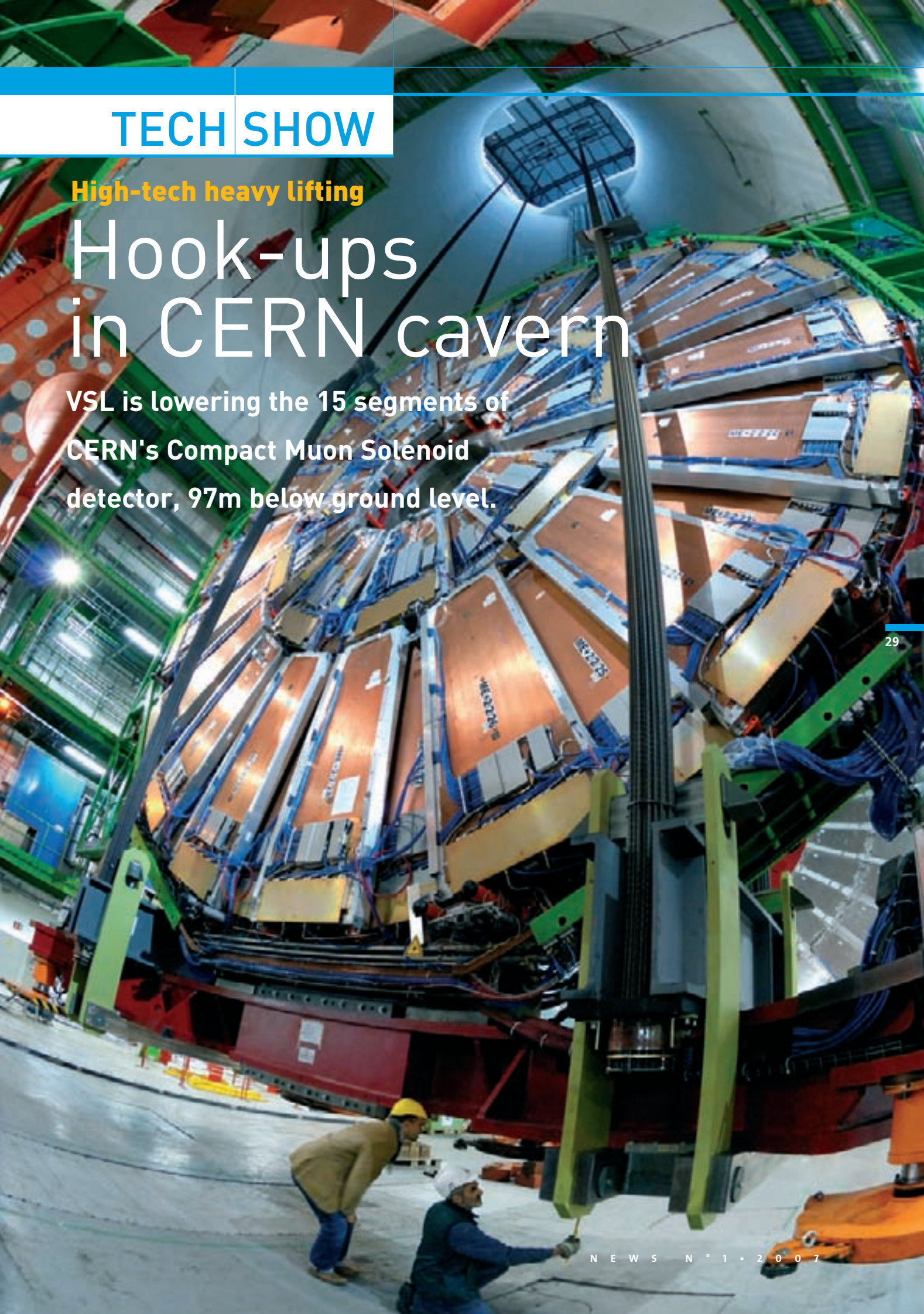
VSL has recently completed the supply of 1,900 bearings to Spanish contractor OHL for Viaduct 4 of the Ankara-Istanbul railway line rehabilitation in Turkey. The deck of the viaduct consists of 34m-long simply-supported spans, with 12 precast beams per span, each with one fixed end and one free end. Ideam was the designer of the 2.2km-long viaduct, which is located in a highly seismic zone. All bearings must be able to resist vertical loads of 140t. However, the four central bearings at the fixed ends also need to withstand horizontal loads of up to 60t during service and up to 216t from seismic loads. In addition, the designer specified that even if the four central bearings were to be considered as fixed under service loads, they should also be able to accommodate small movements (10mm) during a seismic event.
CTT Stronghold (VSL in Spain) proposed the use of special preloaded pot bearings for the four central bearings. These are similar to the ones used for roof applications and others structures with high wind or seismic loads. Preloaded pot bearings can be considered as fixed bearings up to a certain load and, if this load is exceeded, they are capable of limited movement. The four central bearings were preloaded to resist up to 60t during service without movement and up to 216t during seismic loading.
With this solution, there would be no need to replace any fuses after a seismic event and there is also provision to monitor the loads at any time and re-load if required. All bearings are fully replaceable at any time. Design of the preloaded bearings was not straightforward. CTT Stronghold had to carry out internal tests at its factory to verify the actual compression movements of the bearings rather than rely on theoretical values from tables. These tables give lineal deformation, but practical experience shows that this is not the case for these loads and these bearing dimensions. The high loads involved meant that special tests had to be carried out before the design of the bearing could be completed.
Up to 15 different types of bearing arrangements were tested in order to develop an efficient design. Variables included factors such as the dimensions of the piers and beams, the total weight of bearings and the costs. Great attention was paid to quality control for the bearings. In addition to the 4 central bearings on the fixed end, standard PL pot bearings (free bearings) were used on the remaining bearings (8 on the fixed end and 12 on the free end). Lateral buffers were also required at each pier to limit transverse movements of the deck. Due to the large movement on the free end due to seismic loads, the buffers on the free end were FL type whereas the buffers at the fixed end were B-Bs type.
Thanks to the good collaboration of OHL, Ideam and VSL the project was completed on time and to the satisfaction of the client TCDD, the Turkish Railways Authority. ■

CTT Stronghold holds ISO 9001 and can certify the quality of the materials and the manufacturing process for the entire bearing. The company has its own quality control for the neoprene, while the other raw materials used in the process all come with the quality assurance of their suppliers. CTT Stronghold has more than 30 years experience in bearing fabrication, with more than 20,000 bearings installed worldwide. Although CTT Stronghold manufactures in Barcelona, Spain, the company is also very familiar with AASHTO, BS, German and EN standards because of VSL's presence in Latin America, Africa, Europe and Asia, where many bearings have been supplied in recent years.

High-tech heavy lifting

Hook-ups in CERN cavern

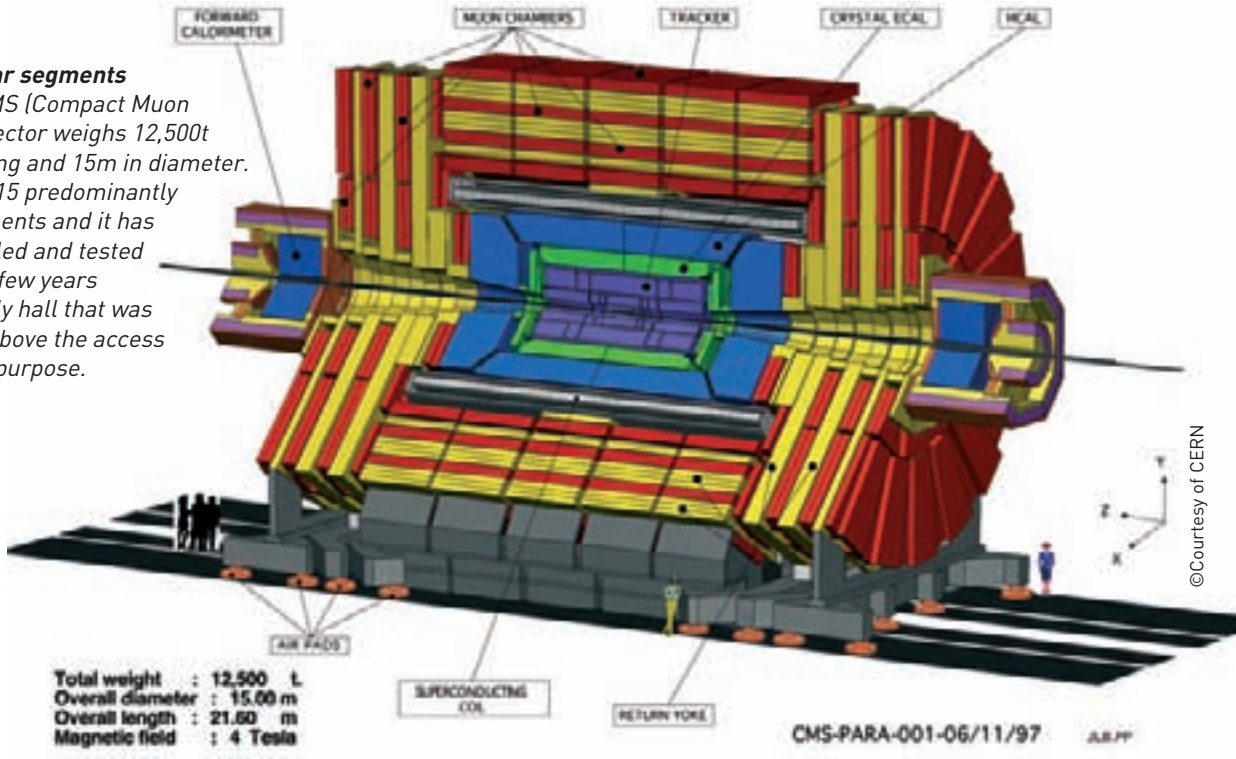
VSL is lowering the 15 segments of CERN's Compact Muon Solenoid detector, 97m below ground level.



VSL detected for high energy lifting

The Large Hadron Collider is a superconducting particle accelerator, which is being built in a 27km-long circular underground tunnel straddling the Swiss and French borders on the outskirts of Geneva. Its experiments will involve smashing protons into each other to recreate the conditions of a fraction of a second after the big bang. The high-energy protons will collide at four points where detectors will observe the results. One of the four is the CMS, or Compact Muon Solenoid, detector. The cavern 97m below ground level and its 20m-diameter vertical access shaft have been built near Cessy to accommodate the CMS detector.

The CMS consists of 15 segments weighing between 250t and 1,920t. The tender scope included the concept, detailed design and provision on a rental basis of the portal crane, including erection, operation and disassembly. The work also included the design and fabrication of all the custom-built accessories (called ancillaries) needed to hook-up the 15 loads. Five companies were prequalified. The contract was signed in late 2004 with VSL.



©Courtesy of CERN

1 ***Circular segments***

The CMS (Compact Muon Solenoid) detector weighs 12,500t and is 22m long and 15m in diameter. It consists of 15 predominantly circular segments and it has been assembled and tested over the past few years in an assembly hall that was constructed above the access shaft for this purpose.

2 ***VSL gantry, girders and towers***

CERN had decided that the lowering would be by means of a fixed gantry crane, to be installed outside and on top of the assembly hall. The assembly of VSL's gantry started in late 2005. In January 2006, VSL erected the two interconnected welded steel girders, 3.4m deep and each weighing 63t. The beams are interconnected with bracings and stand on two pairs of lattice towers, which VSL had used previously for other lifting work, mainly overseas.

3 Horizontal jacking in two directions

A comparison of the features of several possible approaches led CERN to specify hydraulic strand lifting/lowering units as the only acceptable type of equipment for installation on the supporting gantry crane. VSL's portal crane has a 28m span and 25m free height under the main beams. The CMS segments have hook-up geometries which vary by several meters in plan and so the position of the four lowering units had to be adjustable by horizontal jacking in two directions. This is achieved by two main platforms with weather houses which sit on the main girders and which can be jacked longitudinally. On each platform, there are also two secondary platforms to allow lateral adjustment.

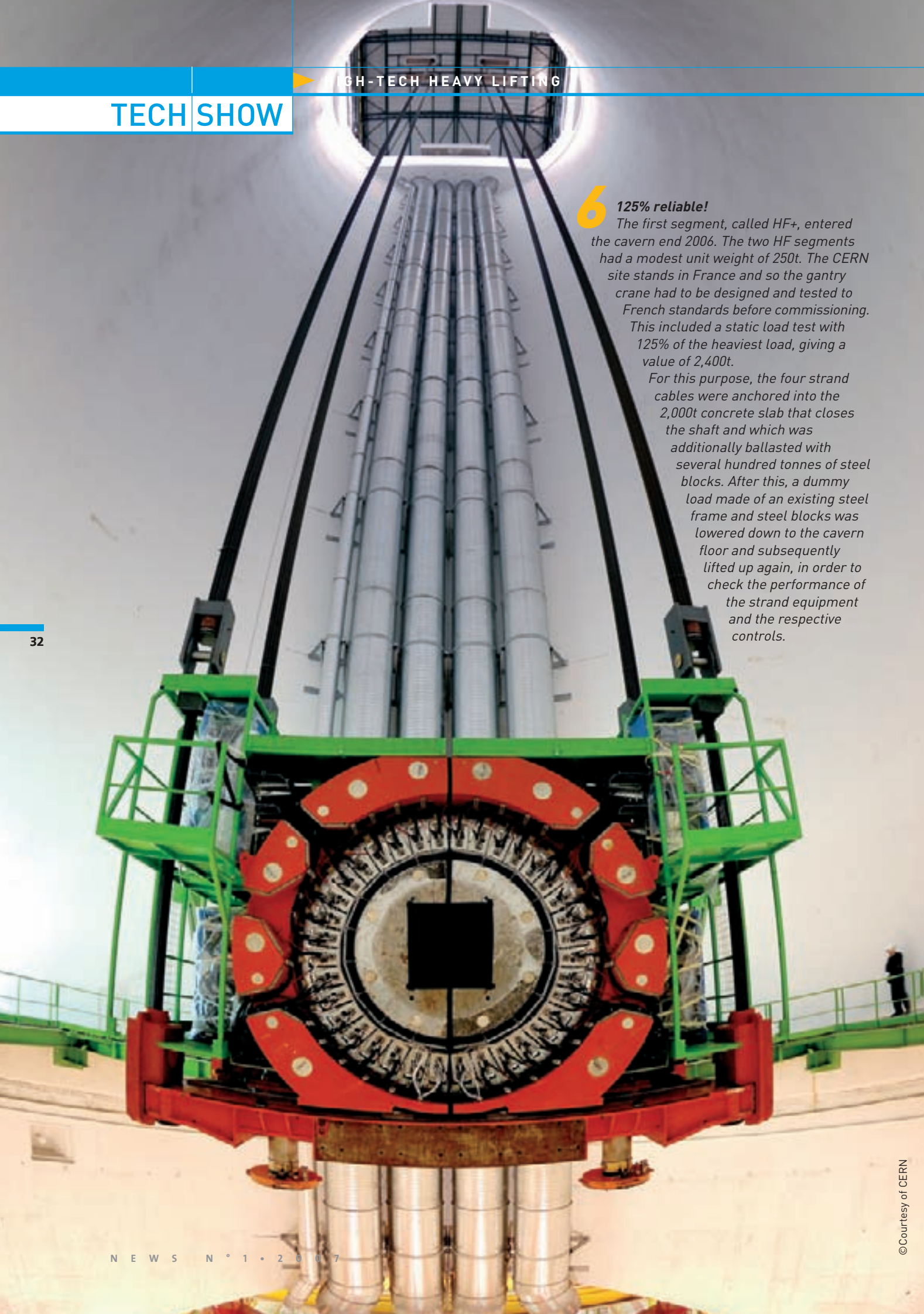
4 No inclination, no rain, no snow

The control and monitoring equipment is installed in a small housing on the main girders, between the weather houses. The forces in the four strand cables are controlled via the hydraulic pressure in the jacks. This does not give any information about whether the load is hanging horizontally - as it should - or is slightly inclined. Therefore, the orientation of each segment being lowered is monitored by means of two inclinometers (the second for redundancy reasons) which are fixed onto the segment itself. The strand cables pass through four large existing openings in the assembly hall roof.

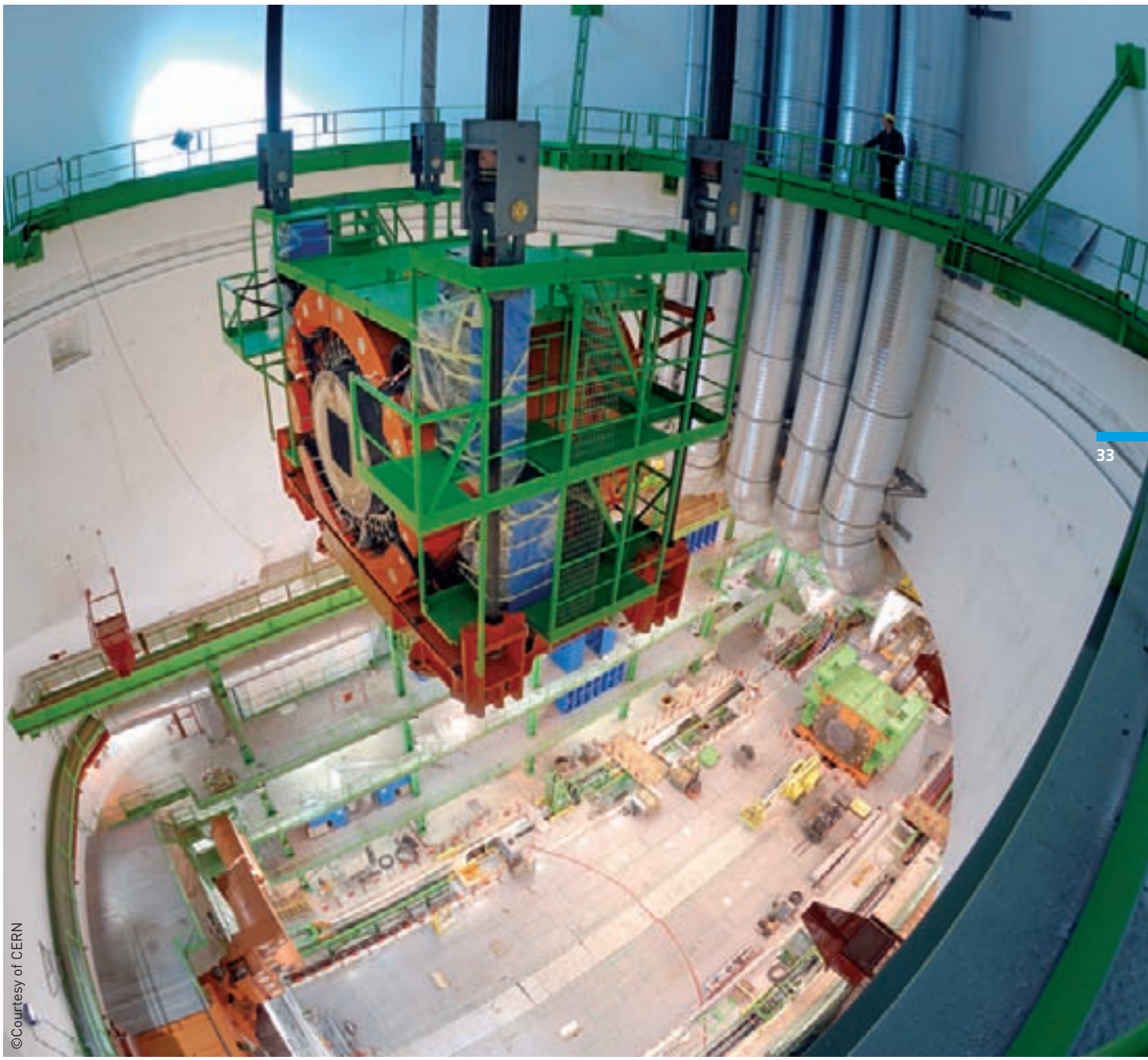
CERN's requirement that no rain or snow should penetrate into the hall is being satisfied by two measures: storm-proof weather houses enclose the equipment platforms; sealing of the space between the movable platforms and the roof is achieved with four mobile frames and square mantles.

5 Coiler drums allowing controlled storage of strand

Each movable, secondary platform supports a VSL strand unit SMU-580 and its motor-driven strand coiler drum. The SMU-580s have a 550mm piston stroke and work with 55 seven-wire strands of 15.7mm diameter and an ultimate capacity of 28t each. Each strand bundle is 130m long and weighs 10t, which gave rise to questions about storage. The motor-driven coiler drums developed by VSL allow a controlled storage of the strands under limited space conditions.

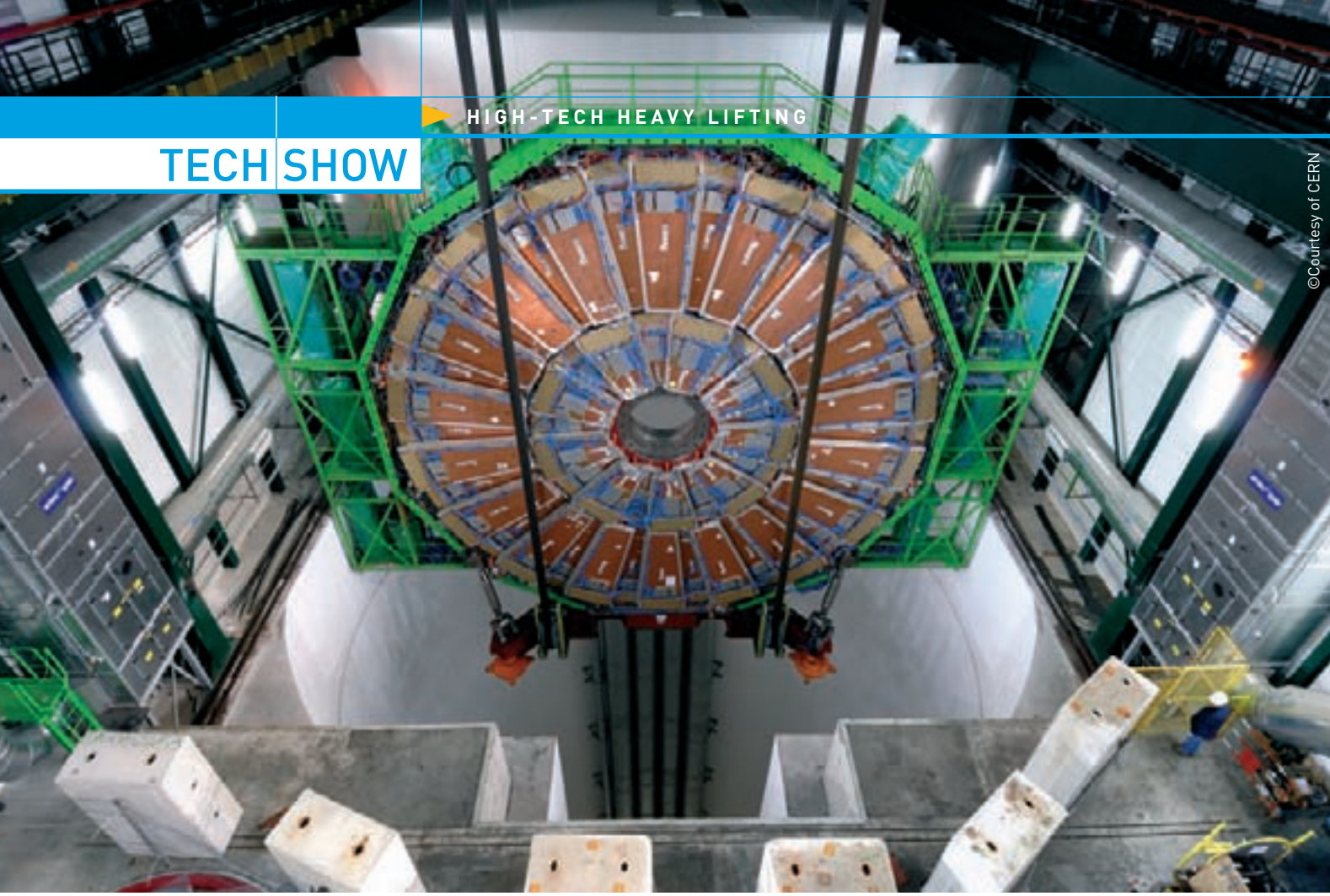


6 ***125% reliable!***
The first segment, called HF+, entered the cavern end 2006. The two HF segments had a modest unit weight of 250t. The CERN site stands in France and so the gantry crane had to be designed and tested to French standards before commissioning. This included a static load test with 125% of the heaviest load, giving a value of 2,400t.
For this purpose, the four strand cables were anchored into the 2,000t concrete slab that closes the shaft and which was additionally ballasted with several hundred tonnes of steel blocks. After this, a dummy load made of an existing steel frame and steel blocks was lowered down to the cavern floor and subsequently lifted up again, in order to check the performance of the strand equipment and the respective controls.



©Courtesy of CERN

7 ***310t before touch down***
Following the two HF segments came the lowering of the YE+3 end disk, weighing 310t. The cavern has the size of a cathedral, with a length of 52m, a height of 26m and a width of 25m.



©Courtesy of CERN

8 ***Hook-up at 7m below centre of gravity***

YE+2, the 880t second end disk, was lowered into the cavern end 2006. Six other segments were then lowered by mid-March 2007, including the central barrel, known as YBO.

The concept and design of the ancillaries for the six YE end disks turned out to be a genuine challenge. Each of these tall, slender segments stands on a substantial steel cart. The hook-up is only possible at a level about 7m below the centre of gravity and so the suspended loads are unstable. CERN had provided two pairs of massive tube sections in the upper part of each disk, to serve as attachment for devices which embrace the lowering strands and stabilise the suspended segment.

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9 ***One full step takes three minutes***

The heaviest of the 15 segments, the 1,920t central barrel YBO, was lowered into the cavern on February 28, 2007. Once the ancillaries are properly fixed and the cables hooked up, the opening of the shaft and the subsequent lowering of a segment takes about 10 hours, irrespective of its weight. One full lowering step of 500mm takes three minutes; the actual lowering speed is of the order of 10mm per second. At this relatively low speed, dynamic effects such as a sudden emergency stop would be barely measurable and are only a fraction of the 15% impact loading which had to be allowed. The last segment, an end disk of 310t, is due to touch the cavern floor in late 2007.

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