

DYWIDAG-SYSTEMS INTERNATIONAL



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Dear Readers,

On behalf the management team, it is my pleasure to make this introduction to the 16th edition of our DSI-Info. Please join us on a journey through our truly global world of construction, tunneling and mining systems and concrete accessories.

As a management team we are proud of our heritage, reputation and brands. This pride has been hard earned and is built on a passion for serving customers. I would like to take this opportunity to thank you for your trust and renew our pledge to do all we can to find even smarter solutions tailored to your needs and requirements.

Last year was an exciting one in the DSI group. We continued to grow profitably both organically and by acquisition. DSI today is a truly global business with a group turnover of close to 700 million Euros. We are #1 or #2 in most of our chosen market segments and applications. In October 2007, the group was acquired by CVC capital partners, a leading Private equity investor. CVC have a reputation of investing and supporting the quality businesses that make up the core of their portfolio. We look forward to their participation as we strive to ever improve our performance and deliver on our growth strategies.

Against this background of positive financial support, a well established leadership team, great people, products and systems and a culture of customer focus, it was easy for me, earlier this year to accept the position of Group CEO. The board chairman, Howard Poulson, myself and the Group CFO, Paul Taaffe look forward to a long and successful association with the DSI group, our customers and partners.

2008 is clearly going to be a challenging year, dominated as it is by inflation and supply issues in most commodities including steel as well as sluggish demand in some of our end markets. I have every confidence that through the ingenuity and dedication of our employees, supplier partners and customers, we will emerge stronger and better able to compete and service our customers.

The management team and I very much appreciate your interest and hope you will enjoy looking at what we do and share in our excitement about the Industry we serve.

Yours sincerely

Alan Bate



**DSI Management, from left to right and top to bottom:
Alan Henderson, Franz Schnagl, Peter Mossmann,
Jim Marianski, Karl Boehm, Derek Hird, Kerry Allen,
Alan Bate, Howard Poulson, Paul Taaffe**



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First Utilization of *GEWI*[®] Piles in India

Bangalore Metro, India

■ The city of Bangalore, in the southern part of India, is considered to be the world's largest and fastest growing location for IT support and solutions. It has a population of more than six million inhabitants, and a tendency for strong growth. Up to now, all vehicle traffic moves on roads that are completely overloaded. This frequently results in stoppages that extend over several kilometers. In order to support its future economic development, the ever expanding city is in urgent need of an efficient public transportation system. A milestone for this development was reached in December 2006 with the beginning of the construction of a subway & elevated rail system (The Bangalore Metro).

As a first step, two sections are being built that cross the city from North to South and East to West. The two sections cross directly in the center of the city, not far from Mahatma Gandhi Road and the popular Commercial Street. All in all, nearly 40km of track and 35 stations are being built. The completion of the first section is planned for the end of 2011.

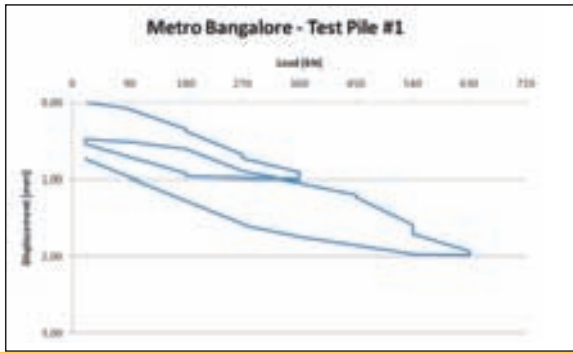
In the East-West corridor, the elevated portion of the Metro passes over a complex crossroad structure being built by the Bangalore Development Authority as part of the radial highway network. Since high groundwater levels are to be expected from time to time, the entire crossroads structure and the approaches have to be stabilized in order to prevent upward movement of the Metro Foundations from buoyancy forces.

In the initial stage, 182 40mm Ø double corrosion protected *GEWI*[®] Piles were planned for stabilization against uplift forces. Since this is the first utilization of *GEWI*[®] Piles in India, the owner required comprehensive technical presentations as well as the practical installation of test piles with subsequent pile testing. Test piles were assembled, pre-mounted and installed on site by DSI's associate company (GRIPS INDIA). The entire procedure was constantly monitored by the owners and drew great public interest. Subsequent pile testing proved to be a complete success.



Once launched on the market, the use of *GEWI*[®] Piles will continue to grow as they demonstrate their technical performance and economy to the people in India. The path has now been cleared

to install approximately 200 building piles at the crossroads in Bangalore and for using *GEWI*[®] Piles for further projects in the booming Indian construction industry.



INFO

Owners Bangalore Metro Rail Corporation Ltd., Bangalore, India ; Bangalore Development Authority, Bangalore, India +++
Consultants STUP Consultants Pvt. Ltd., Bangalore, India +++ **General Contractor** ECCI Ltd., Bangalore, India +++
Subcontractor GRIPS INDIA, Bangalore, India

DSI Unit DSI Group Headquarter Operations, Munich, Germany
DSI Scope Supply of 182 Ø 40mm double corrosion protected GEWI® Piles; supply and installation of 3 test piles with increased steel tendons; rental of equipment; technical assistance



DYWIDAG Post Tensioning Systems Used for Extra Thin Main Girder

Riverside Senshu Overpass, Senshu, Nagaoka-shi, Niigata Prefecture, Japan

■ With its length of 367km, the Shinano River is the longest river in Japan. On its way through Niigata Prefecture, the Shinano runs through the city of Nagaoka. The city council of Nagaoka has hosted a number of development projects in recent years: most notably new large-scale commercial facilities in Seshugahara District. Part of this project was the construction of a shopping center with a cinema complex divided into two buildings on both sides of a highly frequented road that is several lanes wide.

A pedestrian overpass was constructed in order to link these two buildings. The provisionally-named Riverside Senshu Overpass is a three-span continuous prestressed concrete (PC) structure with a length of 30.5m and a width of 3.5m. The fact that the bridge had to cross a highly frequented road and the need for earthquake-proof anchorages of the bridge at both buildings called for a special technical design.

Consequently, external prestressing and the application of SUQCEM, an ultra-high-strength fiber-reinforced concrete characterized by compressive strength five times that of regular

concrete, made it possible to minimize the depth of the main girder. The shallow depth was also made possible by the use of steel fiber instead of steel bars for reinforcement. For the external prestressing, Sumitomo (SEI) Steel Wire Corp., DSI's licensee in Japan, supplied high quality type MA 19x0.6" DYWIDAG Tendons.

Another special solution was the use of HiFleD (i.e. high flexibility and damping) piers, the sheet metal dampers of which increase resistance against seismic motion, simplify the sub-structure and facilitate recovery work in the event of seismic damage.



The SM (Sumitomo Monostrand) method was used for vertical PC steel members to ensure rigid frame construction. In this method, each steel element extends from the top of the bridge pier down through a support cross girder to the top of the floor slab for anchorage.

As a last step, the bridge was fitted with a membrane structure roof to protect pedestrians from rain and snow. Since August 2007, the bridge allows visitors to the shopping center and cinema complex a safe crossing between the two buildings. With its decorative nighttime lighting, the bridge may soon become a popular landmark of Nagaoka.



INFO

Owner UNY Co. Ltd., Yokohama-shi, Kanagawa Prefecture, Japan +++ **General Contractor** Chotetsu Kogyo Co., Ltd., Nagaoka-shi, Niigata Prefecture, Japan +++ **Contractor** Kajima Corporation, Japan +++ **Consulting Engineers** Kajima Corporation, Minato-ku, Tokyo, Japan +++ **Subcontractor** Sumitomo Mitsui Construction Co., Ltd., Nakano-ku, Tokyo, Japan

DSI Unit Sumitomo Electric Industries Ltd., Tokyo, Japan

DSI Scope Supply of type MA 19x0.6" DYWIDAG Tendons



A Bridge Leading the Way into the Future: The Gajo Arch Bridge, South Korea

DSI supplies DYNA Grip® Stay Cable Anchorages for an Arch Bridge in South Korea

■ **Its large number of coastal islands characterizes the southern part of the Republic of Korea. As population density is particularly high along the coast, a large number of these islands are inhabited. Nevertheless, in many cases, connections to the mainland are insufficient. This results in problems with the local economies. Because the affected regions do not have adequate infrastructures, they have been unable to keep up with the economic growth of the rest of South Korea.**

This was also the case for Gajodo Island, an island with a total area of 5.86km² located in the south of Korea. Crossing to the mainland used to be tedious and time consuming for the approximately 5,000 inhabitants living on the island.

To correct this infrastructure problem, a decision was made to build a bridge to the island. Cabletek was chosen to build the Gajo Arch Bridge, a project scheduled to be completed in December 2008. The bridge strengthens opportunities for economic growth on Gajodo Island, thus improving the quality of life for the island's inhabitants.

The Gajo Arch Bridge is a high quality arch bridge whose architectural design allows it to blend in well with the local environment. It consists of approach ramps on both sides and includes three steel arches as the main bridge apertures. Both of the exterior arches have spans of 90m each while the principal arch has a span of 150m. Both the arches and the floor beams were constructed on shore and assembled using DYWIDAG DYNA Grip® stay cables functioning as hangers. The stay cable system was also preassembled. Subsequently, each arch was transported to the erection point using a floating crane and placed onto the bridge bearings. The bridge deck was constructed later. The lengths of the stay cables were precisely determined such that they were prestressed to their required load by dead weight of the bridge.

For this important infrastructure project, DSI supplied a total of 160 DYNA Grip® DG-P12 anchorages that were perfectly suited for the fabrication of preassembled stay cables used as hangers for this important arch bridge.





INFO

Owner Cabletek, Seoul, Korea +++ **General Contractor** Hanjin Heavy Industries & Construction Co. Ltd., Korea
DSI Units DSI Group Headquarter Operations, Munich, Germany / DSI Korea Co. Ltd., Seoul, Korea
DSI Scope Supply of 160 DYNA Grip® DG-P12 anchorages



DYWIDAG Post-Tensioning Systems Secure LNG Tanks

Construction of numerous LNG Tanks in South Korea



■ **At the beginning of the 1990s, South Korea began to take measures to reduce its dependence on imported coal and oil and to make use of low-emission energy sources. The Korean Gas Corporation, KOGAS, which was founded for this purpose, began constructing the first import terminal for natural gas in 1993. Since then, numerous other import terminals have been built, all of them featuring tanks for interim storage of natural gas, which is delivered as LNG (Liquefied Natural Gas).**

Natural gas liquefies at minus 165°C. When liquefying, its volume is reduced by a factor of 600, which allows space saving storage in purpose-built and secured tanks.

These tanks are often constructed as “full containment systems”. LNG is stored in an interior tank made from 9% nickel steel which is further protected by an exterior tank constructed out of prestressed concrete.

The first tanks, which were constructed in the mid 1990s, had a capacity of about 100,000m³ of liquid gas. 10 years later, the tanks’ capacity

has doubled thanks to a continuous development of technical design and advancements in construction materials. In 2007, construction began on two LNG tanks that are to have a storage volume of 200,000m³ of liquid gas each.

The specific physical properties of LNG pose extremely high requirements on the materials used. Low-temperature impact resistance is of extreme importance. That is why the cryogenic suitability of DYWIDAG Post-Tensioning systems has been and continues to be successfully proved in regular tests and controlled within DSI’s internal quality management system.

Photos reprinted by courtesy of DYWIDAG International GmbH, Munich, Germany

INFO

Owner Korean Gas Corporation, Seoul, South Korea +++ **General Contractor** Samsung, Hyundai, Daelim and others, Seoul, South Korea +++ **Subcontractor for tank design and reinforcement** DYWIDAG International GmbH, Munich, Germany

DSI Unit DSI Korea Co. Ltd., Seoul, Korea

DSI Scope Supply of DYWIDAG Post-Tensioning Systems with anchorages and accessories, cryogenic GEWI® bars; rental of technical equipment; technical assistance

DSI Korea has delivered high quality DYWIDAG Strand Tendons for more than a decade, including anchorages and accessories as well as cryogenic GEWI® bars in different diameters and sizes. The prestressing jacks required for installation as well as other technical equipment are also supplied by DSI Korea. Furthermore,

DSI Korea offers comprehensive counselling and technical assistance during installation on site.

DYWIDAG's Post-Tensioning System has been successfully employed in more than 20 LNG tanks in Korea. This development indicates that

DSI Korea will continue to operate as a reliable supplier of Post-Tensioning Systems for the new LNG tanks that have been planned within the scope of the country's national resource strategy.





DYWIDAG Tendons Secure Viaduct in Singapore

LTA Contract 1280, Boon Lay MRT Extension, Singapore



■ The multi million dollar project “Boon Lay MRT Extension” extends the existing Singapore Mass Rapid Transit (SMRT) East-West line. Starting from what used to be the last stop, Boon Lay in the West, a new 3.8km long viaduct and two new passenger stations are being built for this extension line. After its scheduled completion in 2009, bus transfers will become unnecessary for both the residents in this rapidly growing south-western region and for employees of the surrounding industries.

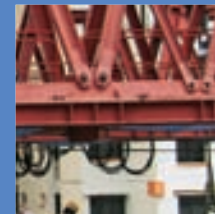
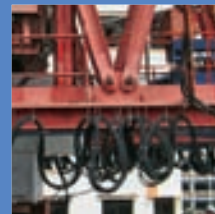
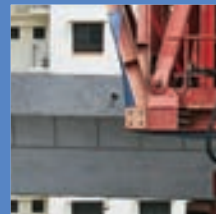
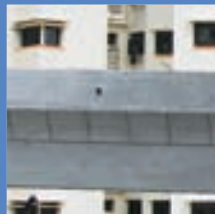
Utracon Structural Systems Pte Ltd (USS), previously known as UTRACO, DSI's licensee in Singapore, was awarded the sub-contract for the post-tensioning and precast beam installation works for the new viaduct. One of the main challenges of the construction was the transportation and launching of the precast beams, which weigh up to 270t. As the contract forbade the transportation of precast beams on the existing roads, Utracon made the innovative proposal to transport the precast beams on the completed viaducts to the final launching site, where the beams were erected using Utracon's self launching steel truss.

The construction cycle began with the casting of beams at the precast yard located adjacent to the elevated viaduct. Here, four DYWIDAG Multistrand Tendons, types 22x0.6" to 26x0.6" with anchorages were installed into each of the 238 precast beams. Subsequently, Utracon post-tensioned the DYWIDAG Tendons at the precast yard.

After removal from the forms, each post-tensioned precast beam was pulled towards Utracon's loading facility (made up of 2 steel portal frames with 2 strand lifting units) and lifted onto the viaduct's temporary rail tracks by Utracon personnel. Each beam was then transported on a locomotive all the way to the rear of the self-launching truss, which was parked just behind the span where the beam was to be launched. After anchoring the precast beam onto the auxiliary beam of the launcher, the launcher was then pushed forward by the

locomotive so that the beam could be slid towards its final position and lowered to the required final position. There, the beam is supported on temporary jacks where grouting of permanent bearings will then take place.

For the permanent post-tensioning of the crossheads on site, Utracon used 31x0.6" DYWIDAG Multistrand Tendons and post-tensioned them successfully. Utracon is proud to have contributed to this prestigious project in Singapore.



INFO

Owner Land Transport Authority, Singapore +++ **Architects and Consultation** Land Transport Authority, Singapore +++
General Contractor Sato Kogyo (Singapore) Pte Ltd, Singapore

DSI Unit Utracon Structural Systems Pte Ltd, Singapore

DSI Scope Supply, installation and post-tensioning of DYWIDAG Multistrand Tendons, type 22x0.6" – 26x0.6" and 31x0.6"; technical assistance; rental of equipment



DYWIDAG Post-Tensioning System Secures Bridge over Interchange in Singapore

LTA Contract ER 141, Upgrading of the Braddell Interchange, Singapore

■ **Upgrading of the Braddell Interchange in Singapore is part of the Land Transport Authority's extensive Outer Ring Road System designed to divert traffic away from the city as commuters travel across the island. This project involves the widening of the existing road interchange at Braddell / Thomson / Lornie Road, and the construction of a new dual two-lane vehicular bridge over the existing MacRitchie Flyover.**

Utracon Structural Systems Pte Ltd (USS) is the specialist contractor engaged to supply post-tensioning material and to erect and prestress the precast segments that make up the new overpass.

As construction of the new bridge took place over heavily traveled roads, the free cantilever construction method was used by the contractor, with road closures at night for safety reasons and to facilitate the transportation and installation of precast segments.

For the production of the 10.8m wide and 2.1m deep single cell precast segments, Utracon delivered types 7x0.6" and 12x0.6" DYWIDAG external tendons. Type 19x0.6" DYWIDAG Post-Tensioning Tendons were used for permanent external Post-Tensioning. The precast segments were delivered to the launching site by heavy duty hydraulic trailer.

After positioning the precast elements, epoxy glue was applied by Utracon personnel on the match-cast surfaces of the precast segments. The precast segments, which weigh approximately 50t each, were then hoisted into position by either a 500t capacity mobile crane, or by a mechanical winch mounted on Utracon's lifter frame.

As soon as the precast segments were aligned both horizontally and longitudinally with the aid of positioning hydraulic jacks, the precast segments were stressed against the previously installed segments using 36mm dia. DYWIDAG prestressing bars. Once the prestressing bars were fully stressed, the crane and winch respectively were disengaged from the precast segment, and the stressing of all DYWIDAG permanent internal tendons was carried out by Utracon personnel.

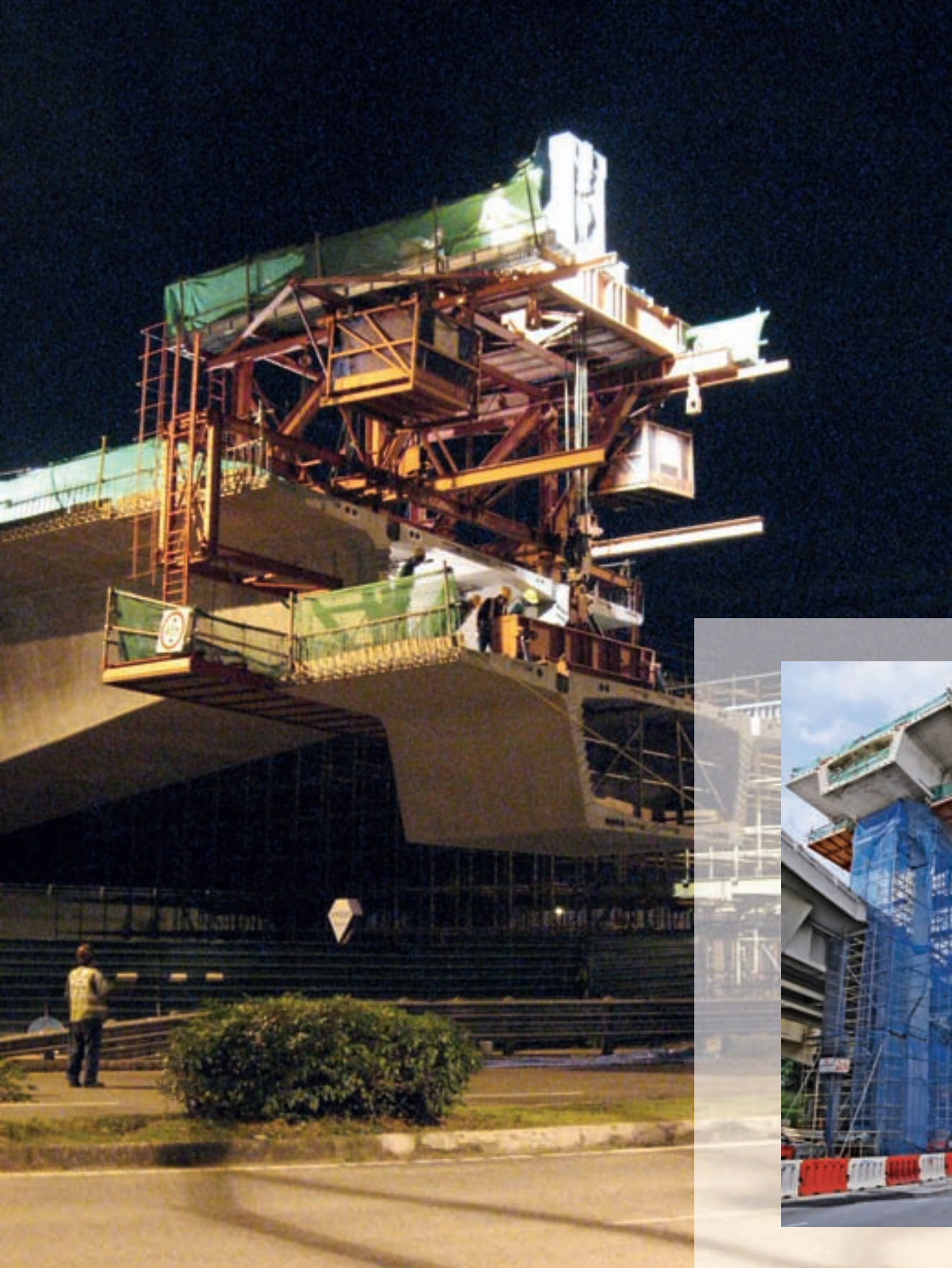


INFO

Owner Land Transport Authority, Singapore +++ **Architects** Land Transport Authority, Singapore +++ **Consulting Engineers** Land Transport Authority, Singapore and TY Lin International Pte Ltd., Singapore +++ **General Contractor** Sato Kogyo (Singapore) Pte Ltd

DSI Unit Utracon Structural Systems Pte Ltd, Singapore

DSI Scope Supply, installation and post-tensioning of DYWIDAG Post-Tensioning Tendons type 7x0.6", 12x0.6", 19x0.6" and DYWIDAG prestressing bars \varnothing 36mm; technical assistance; rental of equipment





Highway Bridge in Sri Lanka Stabilized using DYWIDAG Post-Tensioning System

Peace Bridge between Polonnaruwa and Manampitiya, Sri Lanka

■ The newly constructed Peace Bridge, which crosses the Mahaweli River, is the only connection between the North-Central Province and the Eastern Province of Sri Lanka. The existing steel bridge, which was opened in 1922, can only be used for traffic in one direction at a time due to its narrow width of merely five meters. Since trains also used the bridge, traffic jams at both ends of the bridge were exacerbated every time cars had to make way when a train crossed the bridge. In addition, heavy truck traffic over the years had overstressed the bridge structure. Consequently, in 2006, the Sri Lankan government decided to eliminate this bottleneck by building a new concrete bridge.

The feasibility study conducted by the financing agency JICA (Japan International Cooperation Agency) concluded that the Incremental Launching Method (ILM) with preassembled box girders was the best method for constructing this bridge. The method was preferred in view of the bridge's geometry and long span over the Mahaweli River, which carries a great amount of water during the monsoon season.

Utracon Overseas Pte Ltd, a foreign subsidiary of DSI licensee Utracon Structural Systems Pte Ltd in Singapore, was the specialist contractor engaged to carry out the entire construction of the bridge superstructure, including incremental launching, formwork, post-tensioning, etc.

After a detailed study of site conditions, a precast bed was set up adjacent to one of the

bridge abutments located near the river bank. Here, 25 concrete box girder segments with a width of 10.4m and a height of 3.6m each were produced, with lengths varying from 6.15m to 14m.



INFO

Owner Road Development Authority, Sri Lanka +++ **General Contractor** Hazama Corporation, Tokyo, Japan +++ **Architects** Road Development Authority, Sri Lanka +++ **Consulting** Oriental Consultants Company Limited and Nippon Koei Co., Ltd., Tokyo, Japan

DSI Unit Utracon Structural Systems Pte Ltd., Singapore

DSI Scope Supply, installation and tensioning of DYWIDAG THREADBAR®s \varnothing 32mm and DYWIDAG Post-Tensioning Tendons 2x0.5" and 12x0.5"; technical assistance; rental of equipment



The entire post-tensioning works of the concrete box girders were carried out using the easy-to-install high quality DYWIDAG Post-Tensioning Systems:

- DYWIDAG \varnothing 32 mm THREADBAR®s, for the longitudinal tensioning of the bottom and top deck slabs
- DYWIDAG 2x0.5" strand Post-Tensioning Tendons with flat anchorages for the transverse tensioning of the top deck slab
- DYWIDAG 12x0.5" strand Post-Tensioning Tendons for the longitudinal tensioning of the entire bridge

Having been designed to stabilize extremely thin post-tensioned concrete slabs, DYWIDAG flat anchorages were best suited for transverse tensioning.

Utracon supplied all the post-tensioning materials required and carried out the complete post-tensioning works. The precast and preassembled segments were launched using a steel launching nose with a length of 39m and two hydraulic jacks with a pulling force of 480t each. Thanks to the combination of high quality construction systems, technical know how and equipment with sophisticated logistics and a highly skilled and competent workforce, the production and installation cycle for each segment could be achieved within 7 to 9 days depending on the length of each box girder segment.

The bridge was inaugurated in October 2007 during a festive ceremony at which both the Sri Lankan president and the Japanese ambassador were present.





Cantilever Segmental Bridge Erected with DYWIDAG Form Travellers, Taiwan

Nantou Section, National Expressway No. 6

■ Due to geographical obstructions created by the Central Mountain Range, outward traffic towards Eastern Taiwan has been inconvenient, and the development of the eastern area has been, for a long period of time, slower than much of the western Taiwan area. To promote the development of the eastern Taiwan area, it is necessary to build a rapid and safe highway transportation system between eastern and western Taiwan.

That is why the government instructed the Taiwan Area National Expressway Engineering Bureau (TANEEB) to investigate the feasibility of a Central Cross-Island Rapid Highway. After nearly a decade of studies, the project, now known as National Expressway No. 6, was proposed. It is divided into two sections: the Nantou section, from Wufeng to Puli, and the Central Crossing section, from Puli to Hualien. The current infrastructure plan calls for constructing the first section from Wufeng to Puli immediately, while the Central Crossing section will be evaluated further once the first section has been completed.

The township of Puli is located in Nantou County, where a major earthquake measuring 7.3 on the Richter scale hit in 1999, causing more than 2,300 deaths and 6,500 people to suffer injuries. Puli is also the gateway into Taiwan's famous Central Mountain Range. During weekends and holidays, flocks of tourists travel through Puli on their way to the scenic Central Mountain area. Currently, the only major road connecting Wufeng and Puli is the four lane surface carriageway Provincial Route No.14 traversing through various small towns within Nantou County. Horrendous traffic jams often occur on Route No. 14 during the weekends and holidays. In addition, Nantou County is also a major source of quarry rock. As Route No. 14 also serves as a major quarry truck transport route, heavily loaded trucks increase the risk of accidents with tourist vehicles and worsen the traffic along the way. One of the main purposes of the six-lane Expressway No. 6 project is to alleviate traffic congestion and to improve traveling safety in this region.

Lot C601



Lot C605



Lot C607





The Nantou Section of the National Expressway No. 6 is 38 km long, starting with a connection to the Second Expressway at Wufeng in Taichung County, and extends along the River Wu eastwards into the mountainous Nantou County. The Expressway crosses the River Wu at several junctions and follows the treacherous terrain along the valley of the River Wu. Elevated structures make up more than 65% of the Nantou Section, while tunnels and roadworks comprise the other 35%. Among the nearly 25km of elevated structure, almost 18km is to be constructed by the free cantilever segmental method.

The 38 km project is divided into 10 civil contracts, and construction started in March 2004.

As one of the largest free cantilever bridge specialists in Taiwan, DYWIDAG has been chosen by several Contractors to cope with the difficult working terrain and tight construction schedule. In Taiwan and overseas, DYWIDAG has accumulated more than 17 years of experience with cantilever bridge construction and has completed over 40 projects as well as designing and supplying over 200 sets of form travellers. Currently, DYWIDAG is participating with a varying scope of work in 4 of the civil contracts – C601, C605, C607, and C608, which covers around 8km of the free cantilever bridges, or 45% of the total free cantilever viaduct length on the Expressway No. 6 Project.



Lot C608

INFO

Scope of work on the different contracts:

Lot C601: **Owner** Taiwan Area National Expressway Engineering Bureau (TANEEB) +++ **General Contractor** Pan Asia Corporation +++ **Engineer** Sinotech Engineering Consultants Ltd +++
Duration November, 2004 - April, 2008

DYWIDAG Scope Design and supply of four pairs of DYWIDAG Form Travellers; Assembly, relocation and final dismantling of the Form Travellers on 20 piers; launching operation work of Form Travellers for 400 segments; supply of DYWIDAG THREADBAR® system for permanent and temporary applications

Lot C605: **Owner** Taiwan Area National Expressway Engineering Bureau (TANEEB) +++ **General Contractor** Kung Sing Engineering Corporation +++ **Engineer** Sinotech Engineering Consultants Ltd +++
Duration October, 2005 - July, 2008

DYWIDAG Scope Design and supply of fourteen pairs of DYWIDAG Form Travellers; assembly, relocation and final dismantling of the Form Travellers; launching operation work of Form Travellers for 200 segments; work commenced October, 2005

Lot C607: **Owner** Taiwan Area National Expressway Engineering Bureau (TANEEB) +++ **General Contractor** Evergreen Construction Corporation +++ **Engineer** Sinotech Engineering Consultants Ltd +++
Duration October, 2005 - July, 2008

DYWIDAG Scope Design and supply of six pairs of DYWIDAG Form Travellers; assembly, relocation and final dismantling of the Form Travellers; design and supply of the pier table shoring and formwork system; construction engineering of superstructure; post-tensioning detailing and engineering; superstructure construction of eleven pier tables; superstructure construction of 382 cantilever segments; superstructure construction of all closure side spans

Lot C608: **Owner** Taiwan Area National Expressway Engineering Bureau (TANEEB) +++ **General Contractor** Raito Engineering Corporation +++ **Engineer** Sinotech Engineering Consultants Ltd +++
Duration May, 2005 - October, 2007

DYWIDAG Scope Design and supply of two pairs of DYWIDAG Form Travellers for Taiwan's first extradosed cable bridge; assembly, relocation and final dismantling of the Form Travellers; supply of DYWIDAG THREADBAR® system for permanent and temporary applications



A Case for DYNA Grip®: Trois Bassins Bridge on La Réunion Island

DSI supplies DYNA Grip® Stay Cables for Bridge on La Réunion Island, France



■ **The French island La Réunion, situated in the Indian Ocean, is noted for its many steep gorges. At one time, the island's jagged structure made the construction of a modern road network seem almost impossible. However, in 2002, a decision was made to substantially improve the island's poor coastal road network in order to attract more tourism.**

The ambitious construction project "La route des Tamarins" includes the construction of a 33.7km long expressway. The route is to lead through the island's fissured and mountainous regions, traversing more than 120 canyons along the way.

Due to difficult geological conditions, the route will include three tunnels and a total of 23 bridges. The project is exceedingly challenging because of climate conditions and the need for environmental protection.

The project's total cost is estimated to be more than 970 Million Euro and construction works

are scheduled to be finished at the beginning of 2009. DSI contributed to one of three sub-projects classified as exceptionally artful structures: the bridge crossing the broad Trois Bassins gorge. Construction work was executed by a consortium consisting of Eiffage TP, Groupe Razel and Matière. Trois Bassins is an extradosed bridge.

Extradosed post-tensioning (French "extra-dossée", literally "out from the back") is



characterized by the fact that the tendons of a hyperstatic structure are “lifted out” from the bridge deck and deviated over an intermediate compression member, thus increasing the lever arm. The vertical reaction is directly transferred into the bridge pier below. Like stay cables, extradosed tendons can withstand long-term atmospheric influences including sunlight.

The bridge has a total length of 375m and a width of 22m. The impressive sub-project required a total of 14,000m³ of concrete, 1,800t of steel and 400t of prestressing steel.

DSI supplied 352 DYWIDAG Post-Tensioning anchorages, types MA 6812 and MA 6819 as well as 36 VC 6819 anchorages for external Post-Tensioning. In addition, DSI supplied 34 DYNA Grip® DG-P37 anchorages, tendon sheathing and approximately 105t of galvanized, waxed and PE-sheathed strands.

A special feature of these stay cables is the fire protection that was applied over their entire length. According to specifications, the strands are designed to reach a maximum temperature of 100°C with a fire temperature of 1,100°C. This is achieved by enveloping the installed strand bundle into a double-layered fire protection mat.

Subsequently, PE half shells are assembled on top of the double-layered mats. Due to the small inclination of the stay cables and the small diameter of the pylons, cradles, which were also included in the delivery, were installed in the pylon instead of individual anchorages.

One of DSI’s experienced installation engineers was at hand during installation.

The installation of the DYNA Grip® stay cables with fire protection was successfully completed in spring 2008.



INFO

Contracting Authority Région Réunion-Direction d’Opération Route des Tamarins, Saint Denis, La Réunion +++
Prime Contractor ARCADIS ESG, Sèvres, France; Cotéba, La Plaine Saint-Denis, France +++ **Architect** Strates/ Berlotier Architectes, Bourg-en-Bresse, France +++ **General Contractor** Eiffage TP, Neuilly sur Marne, France ; Matière, Groupe Razel SA, France
DSI Units DSI Group Headquarter Operations, Munich, Germany; DSI-Artéon, BU Post-Tensioning, Dagneux, France
DSI Scope Supply of 34 pieces of DYNA Grip® DG-P37 anchorages; supply of 352 DYWIDAG Post-Tensioning anchorages types MA 6812 and MA 6819 and 36 anchorages VC 6819 for external Post-Tensioning



Slope Stabilization using Permanent DYWIDAG Multistrand Anchors

Lots 22 and 23, S35 Expressway, from Bruck an der Mur to Graz, Austria

■ **The S35 Expressway in the Austrian province of Steiermark runs along the river Mur, connecting the industrial city of Bruck an der Mur with the regional capital Graz. In order to close what used to be a gap between these two cities, the northern 7km lot from Mautstätt in the direction of Bruck an der Mur is currently under construction.**

Road works of the northern lot, which are estimated to cost around 190 Million Euros, are to be finished in spring 2010. Construction measures include a comprehensive slope anchorage program as well as the permanent stabilization of a 900m long retaining wall.

Lot 22 includes the two double tube tunnels Kaltenbach and Kirchdorf, the interchanges Zlatten and Kirchdorf and several cross-country passages where a great number of slopes had to be stabilized by tie back walls.

To build the tie back walls, the slopes were first sealed with shotcrete and then nailed with approximately 10,000m of R32L+N DYWI® Drill Hollow Bar Anchors.

Precast concrete ribs with consoles were then placed on top at a spacing of 4m each and permanently anchored with 1,300 DYWIDAG 2x0.6", 3x0.6" and 6x0.62" Multistrand Anchors, in lengths between 13 and 40m. Afterwards, these areas were concreted similar to arches. As a last step, concrete troughs were put into the cantilevers and then backfilled and planted with vegetation.

A total of six tie back walls are to be built in this manner. The 300m long tie back wall 1 between the two tunnels is especially impressive. It includes about 450 DYWIDAG Multistrand Anchors, which were installed in up to 9 layers.

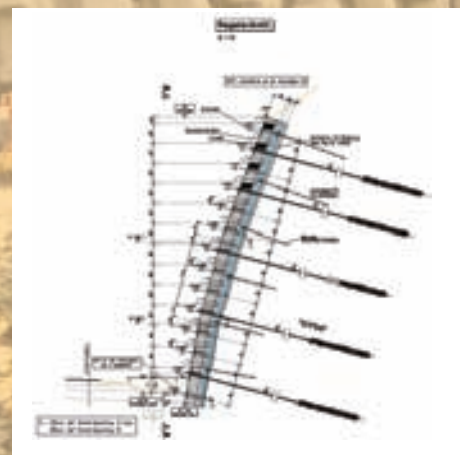
Lot 23 includes the construction of a shore bridge on 370 bored piles with a length of about 900 m near Zlatten reservoir. Because space was restricted in the shore area, the shore bridge had to be designed as a supporting structure.



Finished anchor heads



Partially stressed anchor



Plan of the shore bridge profile

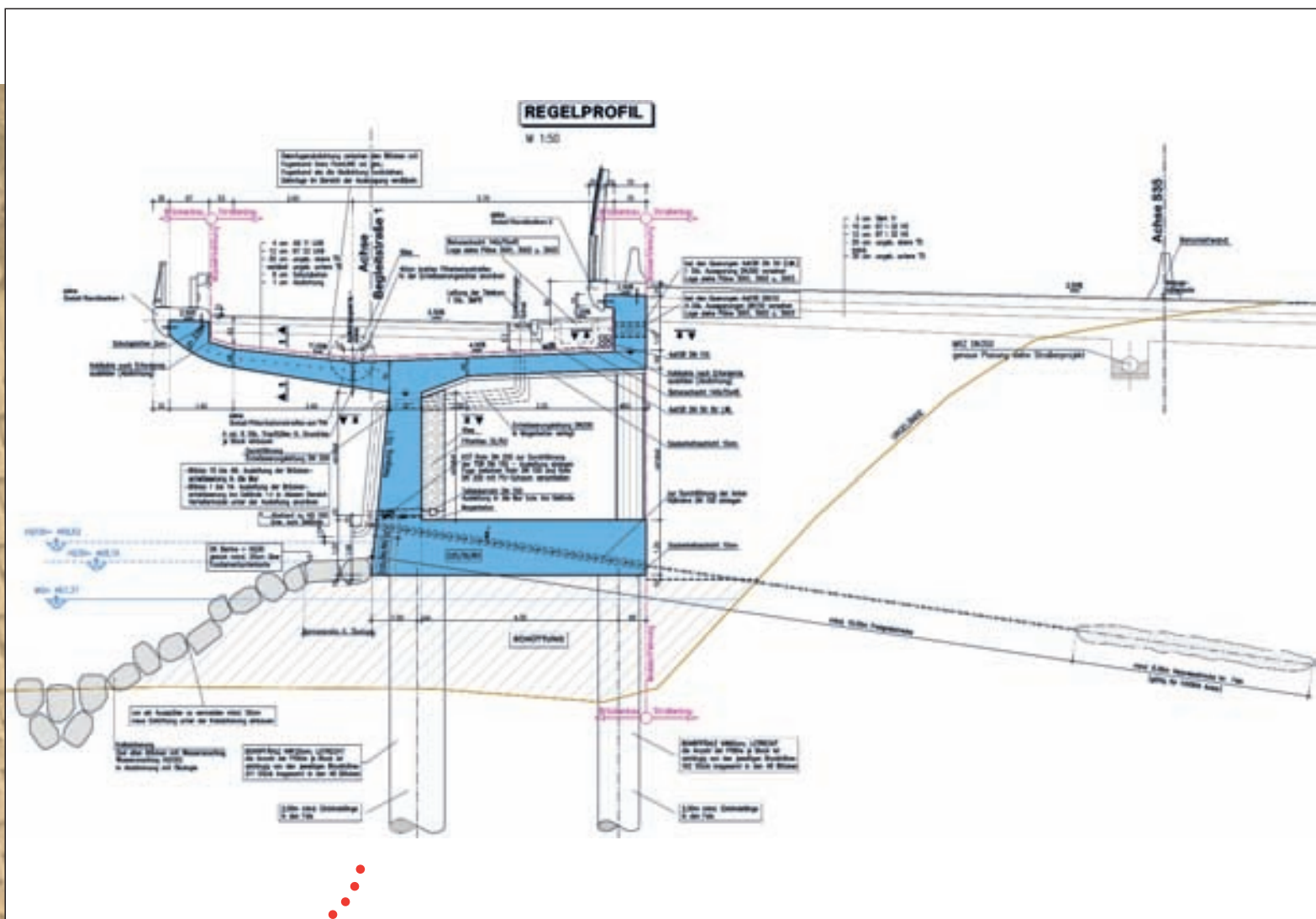


That is why the bridge was permanently anchored with 294 4x0.62", 5x0.62" and 6x0.62" DYWIDAG Multistrand Anchors. Anchor lengths vary between 25 and 40m.

The service loads are between 650 and 1,000kN. The anchor stressing operations were carried out in two steps: application of partial

post-tensioning before backfilling and complete post-tensioning to 100% of the service load after completion of the backfilling for the retaining wall.

DSI Austria supplied approximately 1,600 DYWIDAG Multistrand Tendons and 10,000m R32 L+N DYWI® Drill Hollow Bar Anchors, including accessories for lots 22 and 23. In addition, DSI carried out the acceptance inspections and suitability tests for the anchorage systems supplied. Furthermore, DSI rented the equipment necessary for stressing operations.



INFO

Owner ASFINAG Bau Management GmbH, Austria +++ **Engineer of tie back walls and shore bridge** Kirsch-Muchitsch & Partner ZT GmbH, Linz, Austria +++ **Subcontractor Anchors** Lot 22: PORR Technobau und Umwelt AG, Abt. Grundbau, Vienna, Austria; Lot 23: Baubeteiligungs-GmbH, Graz, Austria

DSI Unit DSI Austria, Elsbethen/Salzburg, Austria

DSI Scope For lot 22: supply of approximately 1,300 DYWIDAG Multistrand Anchors in lengths of 13-40m; approximately 10,000m DYWI® Drill Hollow Bar Anchors; for lot 23: supply of 294 DYWIDAG Multistrand Anchors in lengths of 25-40m; For both lots: technical assistance; acceptance and suitability tests; rental of stressing equipment



Stay Cable Bridge over the Ohre River in Karlovy Vary

■ Traffic has been growing continuously in the well-known spa city of Karlovy Vary (Carlsbad). In order to improve the infrastructure, an additional bridge over the Ohre River was built in 2007. This stay cable bridge has created a direct connection between the outskirts and the city center as well as the spa promenade. In the autumn of 2006, the company SMP-CZ in Prague was awarded a contract to build the new 128m long stay cable bridge.

As an additional partner for this project, SM7 A.S. in Prague, DSI's licensee for the Czech and Slovak Republics, supplied all of the required stay cable and post-tensioning systems. SM7 A.S. is the market leader for the production and supply of Post-Tensioning Systems and Geotechnical Products in the Czech Republic.

SM7 A.S. supplied and installed 16 DG-P12 DYNA Grip® Stay Cables as well as 16 DG-P19 DYNA Grip® Stay Cables with 12 and 19 strands respectively. All cables were supplied with triple corrosion protection. The 32 stay cables were anchored at the bridge deck and at each pylon.

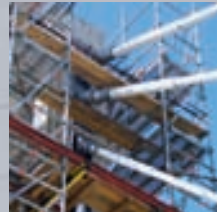
The DYNA Grip® System makes it possible to permanently and simply monitor the condition of the entire stay cable system. In addition, the DYNA Grip® Stay Cable System is characterized by the fact that individual strands can be replaced easily and quickly whenever necessary.

The Stay Cable Systems developed by DSI correspond to international requirements of the Post Tensioning Institute (PTI), the Fédération Internationale du Béton (fib) and of CIP/Setra.

The 15m wide bridge deck was built using a gantry/scaffold. SM7 A.S. supplied and installed all of the Post-Tensioning Tendons and carried out the tensioning works. 20 DYWIDAG MA 6809 post-tensioning tendons with 9x0.62" strands were used for the longitudinal prestressing of the bridge. Four DYWIDAG Post-Tensioning Tendons were pushed over the entire length of the bridge in one piece. In addition, 16 Post-Tensioning Tendons were coupled using a type R 6809 coupler in the bridge deck and post-tensioned.



Anchorage of DYNA Grip® Stay Cables at the Pier



Stay Cable Bridge over Ohre River in Karlovy Vary, Czech Republic



Bridge deck with anchorages



View onto the bridge deck

Transverse post-tensioning of the bridge was carried out using 223 DYWIDAG Post-Tensioning Tendons with 5x0.62" strands in each. All tendons incorporated a ZR 6805 anchorage on one side and an MA 6805 anchorage on the other side.

Furthermore, the two pylons of the stay cable bridge were also post-tensioned using DYWIDAG type MA Post-Tensioning Tendons with 9x0.62" strands. The total quantity of DYWIDAG Post-Tensioning Systems amounted to over 30t.

The important infrastructural project was completed on schedule to the full satisfaction of the owner, the Prague Highway Authority (RSD Praha). The bridge was opened to traffic in November 2007 in the presence of representatives of the Highway Authority, the municipality and the companies involved.



Guided tour of the site by Mirek Chvala and Jiri Srp



INFO

Owner Prague Highway Authority (RSD Praha), Czech Republic +++ **General Contractor** SSZ Praha (Stavby silnic a zeleznic), Prague, Czech Republic +++ **Subcontractor** SMP-CZ, Prague, Czech Republic +++ **Consultant** PONTIKA Karlovy Vary Ing. Prochazka, Czech Republic

DSI Units SM7 A.S., Prague, Czech Republic – Supplier of the Post-Tensioning System / DSI Austria, Elsbethen/Salzburg, Austria
DSI Scope Supply of 16t of DYNA Grip® Stay Cables, 30t of DYWIDAG-Post-Tensioning Tendons MA 6809, ZR 6805, MA 6805 and Couplers R 6809; technical assistance



Prestressed Concrete Railway Bridge Constructed Using DYWIDAG Strand Tendons

Railway Intersection Masaryk / Main Station, Prague, Czech Republic

■ **The Czech Republic is modernizing its railway system at full speed. As part of its overall improvement strategy, a central intersection in the capital of Prague is being enlarged. This cross-point is used both by trains running towards the main station (Hlavní nádraží, also called the Wilson Station) and towards Masaryk terminal (Praha Masarykovo nádraží).**

Both stations are important for national and international long-distance traffic. The main station was built between 1901 and 1909 in the art nouveau style, whereas the Masaryk station, which was built between 1844 and 1845, is the oldest station in Prague. The two stations are only about 500m apart, but since there was no satisfactory crossover, switching and changing trains was difficult. The “new connection” will provide a solution to this problem by establishing a new way in which trains coming from the North are regulated.

The construction of a new, 440m long bridge with four tracks was a major measure in the creation of the new connection. The construction of this 22-26m wide bridge was a challenge for everyone involved because the site is in the middle of the city and traffic flow had to continue both on the street and on the tracks. In addition, the bridge leads directly into a railway tunnel that crosses underneath Vitkov Mountain in Prague.

The complicated and technically demanding structure was planned by the engineering office SUDOP in Prague and built by the joint venture Skanska, SSZ, Subterra and Metrostav. The post-tensioning work was carried out by SM7 A.S., DSI's licensee for the Czech Republic and for Slovakia.

The bridge deck was constructed in lengths of 32 and 40m on gantry trusses. The collateral cantilevers were produced in a casting yard directly on site underneath the bridge and lifted and mounted onto the deck as precast concrete



elements. The cross-section has a height of 3.20m that increases to 3.70m at the pylon. The roadway slab has a thickness of 30cm, thickening to 80cm at the pylon.

For the transverse post-tensioning of the precast concrete elements, SM7 A.S. supplied type MA

6812 DYWIDAG Strand Tendons using 0.62" diameter strand. Longitudinal post-tensioning of the precast concrete elements was carried out using type MA 6819 and MA 6822 bonded DYWIDAG Strand Tendons using the same strand. All of the DYWIDAG tendons were inserted into HDPE ducts.

SM7 A.S. is proud to have been awarded the contract to post-tensioning this important railway bridge, which is one of the few to have been constructed using the prestressed concrete method.



INFO

Owner Department for Traffic, Prague, Czech Republic +++ **General Contractor** Joint venture Skanska, Metrostav, Subterra, SSZ, Prague, Czech Republic +++ **Contractor** SSZ, Prague, Czech Republic +++ **Consulting** SUDOP, Prague, Czech Republic

DSI Units SM7 A.S. Prague, Czech Republic / DSI Austria, Elsbethen/Salzburg, Austria

DSI Scope Supply of 382t of DYWIDAG Strand Tendons types MA 6812, MA 6819 and MA 6822, St 1570/1770 and couplers type R 6822; technical assistance



DYWIDAG Anchors Stabilize Construction Site in Marseille

Application of DYWIDAG Anchors during Construction of a Housing Estate, France

■ As in every French city, space to build new housing for the people of Marseille is at a premium. To provide some relief from this situation, the city of Marseille has provided an area of 6,000m² for the construction of new residential buildings.

In the area, which is located in the city center, 150 apartments and 1,000 new garages are being built that will be allocated to residents. Minimizing construction costs and optimizing space are important objectives of this project because as many parking spaces as possible are to be fit onto an area as small as possible. In addition, the project must blend in with the cityscape.

In order to create space for the new housing estate, a block of houses with old apartments was demolished. Subsequently, comprehensive excavation works with a volume of 100,000m³ were carried out. Afterwards, the participating companies stabilized the excavation with a 20m high retaining wall.

DSI-Artéon stabilized this retaining wall by installing temporary DYWIDAG Strand Anchors and DYWIDAG Bar Anchors with a total length of 7,000m. In accordance with geological pre-





requisites and differing heights of terrain, DSI planned the flexible utilization of different anchor systems for yield loads between 100 and 900kN.

In order to comply with the special demands of this project, DSI-Artéon used special anchor types for each calculated load. 20mm diameter *GEWI*® Bar Anchors were suitable for installation points with a load at yield of 100kN, whereas 26 and 32mm diameter DYWIDAG bar anchors were primarily used for loads of 350 and 550kN.

DYWIDAG Strand Anchors types 4 and 5 and type T15 were used for high service loads. These special DYWIDAG Strand Anchors were carried on site by gantry cranes and safely installed using an uncoiler.

The versatility and quality of DSI products and systems fully complied with the client's demands.

INFO

Owner SOGIMA, Marseille, France +++ **General Contractor** SECTP, Aix-en-Provence, France +++

Subcontractor SEFI INTRAFOR (13), France +++ **Architect** BECT, Marseille, France +++ **Engineers** BECT, Marseille, France

DSI Unit DSI-Artéon, Montluel, France

DSI Scope Supply and Installation of 7,000m of *GEWI*® Bar Anchors, types 20, 26 and 32mm, DYWIDAG Strand Anchors, types 4, 5 and T15







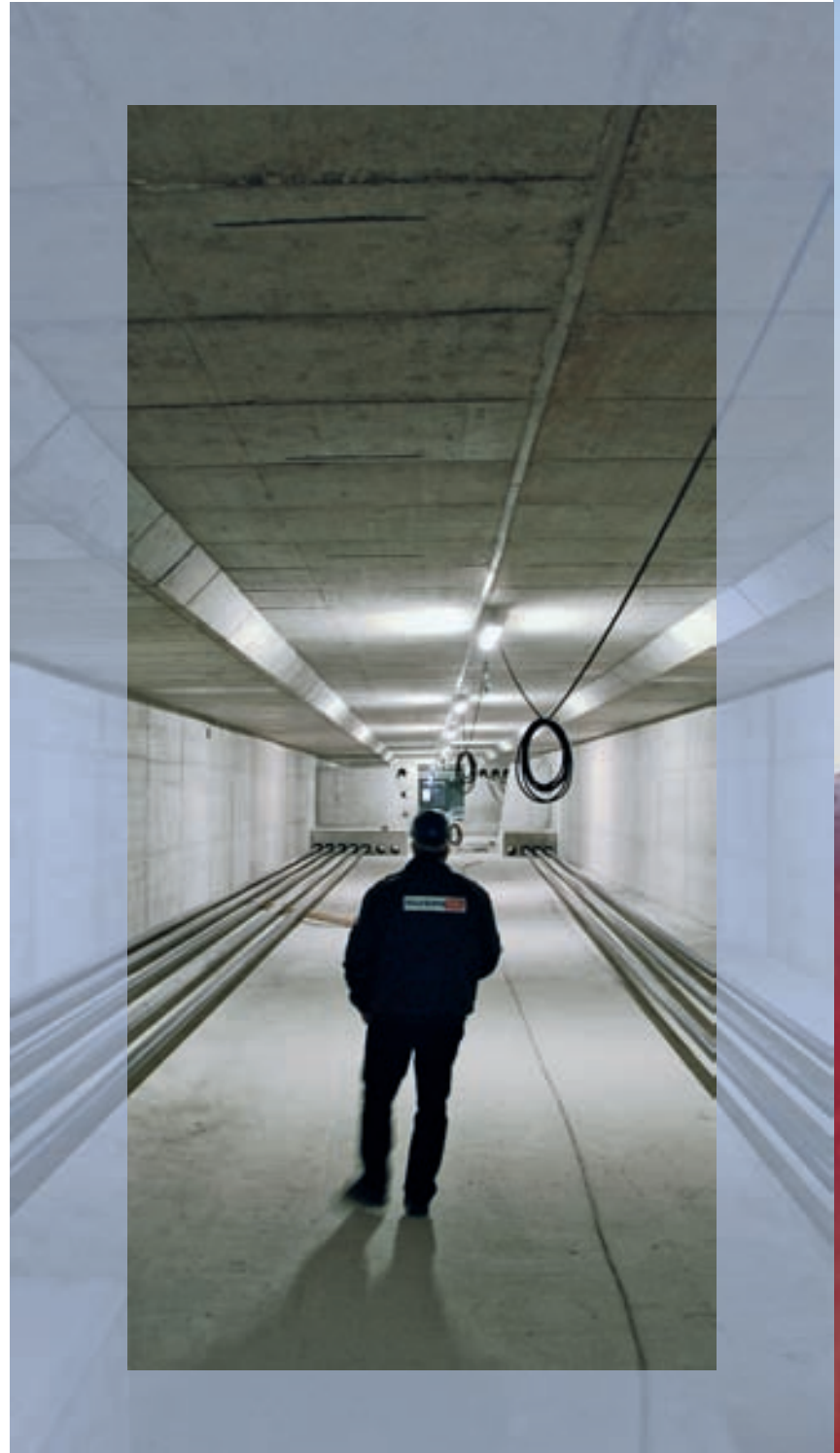
DYNA Grip® Stay Cable Systems Used for Stay Cable Bridge in Germany

Wesel Lower Rhine Bridge, Germany

■ The Rhine Bridge near Wesel, approximately 50km north-west of Essen, has always been an important part of the local traffic system. Consequently, the bridge, which was destroyed during the war, was reconstructed in 1953 on its old foundations in order to re-establish the Rhine crossing in this area. It was recognized at the time that the new bridge was only a temporary solution to allow Federal highway 58 to cross the river. With a volume of approximately 36,000 vehicles per day, the highway has turned into one of the main arterial roads on Lower Rhine. Recurring maintenance work on the narrow, 7.8m wide bridge often caused major traffic obstructions in surrounding towns and cities by creating traffic jams. In order to relieve those towns from a steadily increasing volume of traffic, federal highway 58 has now been relocated. When completed, the new bridge will also solve the problem of the bottleneck at the Rhine crossing.

The new stay cable bridge, with two lanes into each direction and bicycle lanes, is the core of the new Buederich-Wesel bypass. With its 130m high pylon, the architecturally pleasing bridge is clearly visible from the surrounding planes of the Lower Rhine region. Long before its inauguration in the summer of 2009, the bridge has already become a regional landmark.

The decision to construct a stay cable bridge as the new Rhine crossing was mainly influenced by inland navigation's demand for an obstruction-free, 300m wide waterway. Stay cable bridges are the most economic solution for large spans such as the ones required in this case. In addition, in the case of the Wesel Lower Rhine Bridge, the alignment of federal highway 58 allows for the construction of a bridge with a single pylon. Furthermore, the bridge deck can be erected using the free cantilever method, which constitutes an additional advantage in view of the importance of minimal disturbance of navigation.





The new Wesel Lower Rhine Bridge is the second stay cable bridge in Germany that is constructed using a stay cable system consisting of parallel strands. DSI developed the DYNA Grip® system at the end of the 1990s. In Germany, the system was first used on the second Strelasund Crossing between Stralsund and Ruegen. The Strelasund Crossing for which SUSPA-DSI had delivered 150t of DYNA Grip® stay cables with 64 DYNA Grip® anchorages was inaugurated on October 20th, 2007 by German chancellor Angela Merkel.

In autumn 2007, SUSPA-DSI started to install the stay cables in the new Wesel Lower Rhine Bridge. The bridge has a total length of approximately 773m and a main span of 335m over the Rhine river. After its completion, the bridge will be the third largest stay cable bridge in Germany.

The deck is divided into two segments. The 396m approach on the left of the Rhine comprising of six spans was constructed by incremental launching using a heavy two- to three cell reinforced concrete box girder. However, the river is spanned by a lightweight steel three cell box girder section that was constructed using the cantilever method.

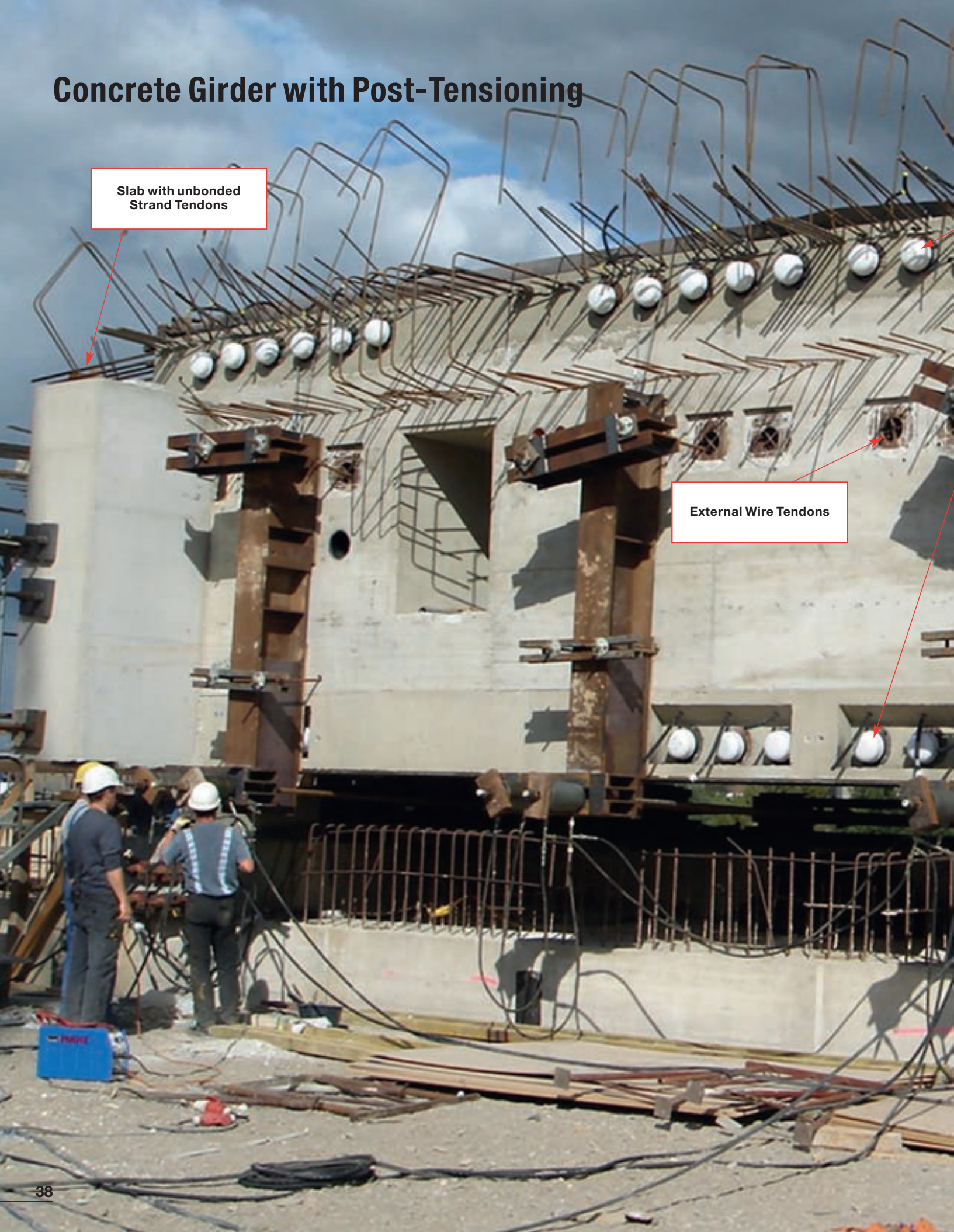
The concreting of the reinforced concrete deck was carried out in 13 sections. For incremental launching, the cross section was centrally post-tensioned in the floor slab and roadway slab. For this, SUSPA-DSI delivered factory-produced bonded SUSPA Strand Tendons that could be installed quickly. In addition, the 27.5m wide roadway slab was post-tensioned transversally using factory-produced unbonded SUSPA Monostrand Tendons. Inside the hollow box girder, external "Draht-EX 66" SUSPA Wire Tendons have been installed and aligned following the bending moment diagram. Additionally, DYWIDAG Bar Tendons were used in the final beam and for the incremental launching equipment.

The 130m high pylon is in the shape of an inverted Y, with the bridge deck running between the two branches. Both transverse branches consist of rectangular box girder sections made from high-strength concrete, with the vertical upper part realized as a steel bond cross-section where the cables are inserted. For future maintenance, an elevator is built into the pylon branch.

Concrete Girder with Post-Tensioning

Slab with unbonded Strand Tendons

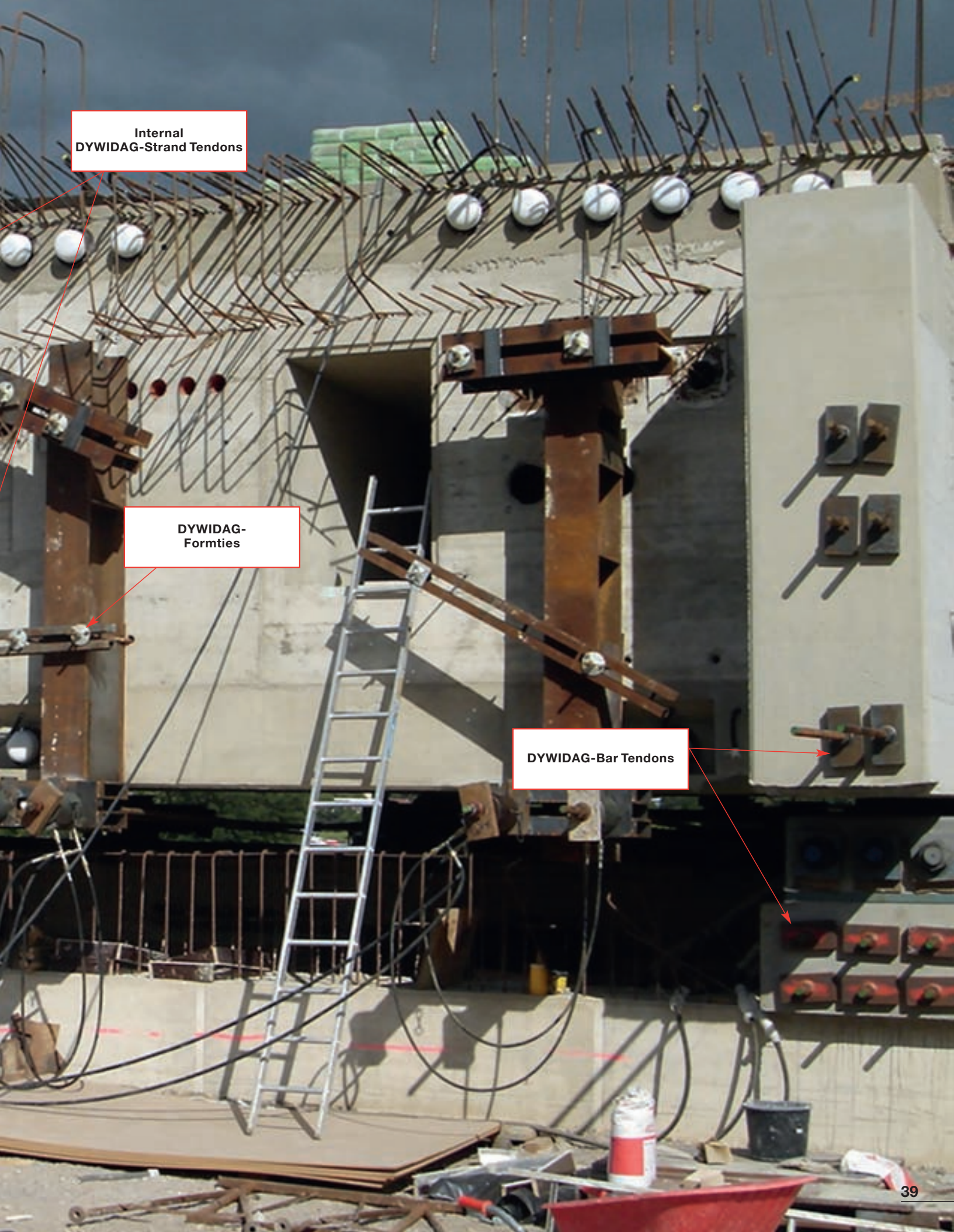
External Wire Tendons

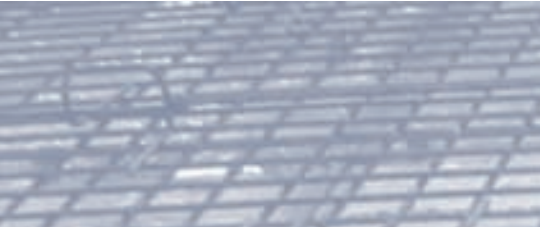


**Internal
DYWIDAG-Strand Tendons**

**DYWIDAG-
Formties**

DYWIDAG-Bar Tendons







The 72 type DG-P 37 and DG-P 55 DYNA Grip® stay cables are arranged into 12 groups of cables with 6 cables each and are located between the two roadways. Along the free cable length, the cables consist of single corrosion protected parallel stay cable strands that run through a duct. Waxed and PE coated strands consisting of seven galvanized cold-drawn smooth individual wires with circular cross sections are used for this project. Steel Grade ST 1570/17770 N/mm², a grade that is currently used in Germany, is used. The PE duct is ruby red, a color that has already been used on several Rhine bridges. A PE-helix applied on the duct eliminates vibrations of the cables induced by rain and wind. DYNA Grip® dead end anchors are used in the pylon, and DYNA Grip® stressing anchors with extra long threads are located in the middle cell of the three-cell deck. The use of DYNA Grip® Anchorages makes it possible to exchange or inspect individual strands in a cable wherever necessary.

While European Technical Approval (ETA) exists for internal and external post-tensioning tendons, there is still none for stay cables, which is why project specific approval had to be obtained for this structure. The main prerequisite for the approval were two fatigue tests in accordance with fib Bulletin 30 carried out on a strand bundle with 55 strands. The tests were conducted at the institute for material testing at Munich Technical University. 2 million cycles with a stress range of 200 N/mm² were carried out with an upper load of 45% GUTS (ultimate load capacity). In order to simulate tolerances in application and angle rotations of the cable in the structure, anchorages had to be installed with a planned vertical misalignment of 0.6°. After the fatigue tests were completed, ultimate capacity and elongation at maximum load were determined. The tests met all fib criteria.

The Lower Wesel Rhine Bridge once again shows DSI as a competent partner for construction companies - a partner who is able to cover the complete range of post-tensioning methods and stay cables necessary for bridge construction.

INFO

Owner Federal service for road construction North Rhine-Westphalia (NRW), Germany +++ **Main Contractor** Consortium Rheinbrücke Wesel, consisting of Hermann Kirchner Hoch- und Ingenieurbau GmbH, Bad Hersfeld, Germany and Donges Stahlbau GmbH, Darmstadt, Germany +++ **Design** Schüßler-Plan Ingenieurgesellschaft mbH, Berlin, Germany

DSI Units SUSPA-DSI GmbH, Langenfeld, Germany, and DSI GmbH, Technical Service, Unterschleissheim, Germany

DSI Scope Supply and installation of 330t of SUSPA Bonded Strand Tendons, 90t of SUSPA Unbonded Strand Tendons, 90t of "Draht Ex 66" SUSPA Wire Tendons for external post-tensioning, DYWIDAG Bar Tendons, 700t of DYNA Grip® Stay Cables with 60 anchorages DG-P 37 and 84 anchorages DG-P 55; technical processing of stay cables and realization of tests for individual approval



Comprehensive Strengthening of a 90 Year-old Quay Wall at a Kiel Canal Inland Port

Inland Port Quai Wall Kiel-Wik, Kiel Canal, Kiel, Germany

■ **Accommodating approximately 43,000 ships per year, the 99km long Kiel Canal is the world's busiest man-made waterway. It significantly accelerates shipping traffic and transportation of goods because ships do not have to take the longer route around the northern tip of Denmark. The canal is a mirror-inverted marine canal with a lock at each end. These locks protect the canal from fluctuating water levels caused by tides or wind surges. The western lock is located near Brunsbüttel on the Elbe River.**

The 797m long quay wall of Kiel-Wik inland port is located at the southern bank of the canal, directly in front of the eastern lock in Kiel-Holtenau which opens towards Kieler Förde bay.

The structure was built in 1911/1912 using timber piles. An increasing infestation of piddocks boring themselves deeper and deeper into the timber caused considerable damage in the timber structure. First repairs were carried out in 1957 by adding a driven steel sheet pile wall that stabilized the timber pile structure. After a service life of over 90 years, damage caused by age and use called for a comprehensive repair and strengthening of the quay wall.

19.60m long Z-sheet piles were installed in front of the existing sheet pile wall and anchored using 30m long, \varnothing 63.5mm double corrosion protected GEWI® piles. In addition, the GEWI® piles, which were divided into two parts, were furnished with a plastic tube encasing the upper 15m. Thus, transmission of forces from the injection piles onto the old timber pile foundation could be avoided and forces were directly

transferred to the boulder clay underneath. Drilling through the 50 year-old original rammed sheet pile wall at 17m below ground level was the biggest challenge during this project.

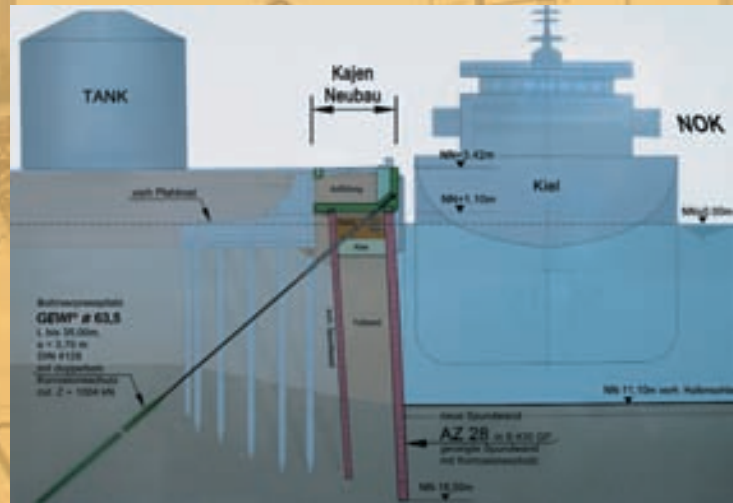


Photo reprinted courtesy of Ms. Vanessa Manthey

INFO

Owner Northern Authority of Water and Navigation (WSA Luebeck), Germany +++ **General Contractor** Consortium consisting of F + Z Baugesellschaft mbH, Hamburg, and Heinrich Hirdes GmbH, Kiel, Germany +++ **Subcontractor** Neidhardt Grundbau GmbH, Hamburg, Germany

DSI Unit SUSPA-DSI GmbH, LU West, Langenfeld, Germany

SUSPA-DSI Scope Supply of 190 pieces of 30m long, double corrosion protected \varnothing 63.5mm GEWI® Piles



Development of a New Guard Rail System Using *GEWI*® Bars

R&D Activities in Germany

■ **The current European standard, EN 1317, requires an upgrading of existing restraint systems for roads because “leaving the road” is still one of the most frequent causes of accidents. In Germany, the issue of developing reinforcement for restraint systems in accordance with EU regulations was addressed by Toge in Nuremberg. SUSPA-DSI made a significant contribution to what is now a successful method for upgrading restraint systems. The result was a system that can not only be used for the construction of new restraint systems, but can also be used as a cost-efficient and quick upgrade for existing guard rails.**

Guard rails usually consist of metal. During the last few years, hot-dip galvanized steel has increasingly established itself due to its high form stability. At the same time, steel's deformability is one of its major advantages in comparison to restraint systems consisting of rigid walls. This elasticity allows the safety system to absorb part of the vehicle's impact energy without breaking.

In the case of the German RAL system EDS 2.0 in its driven version, the containment level could

be brought up to H2 by the installation of reinforcement into the existing systems. This reinforcement is cost-effective and can be installed at a daily conversion rate of approximately 1,500m. EDS 2.0, which is patent pending, is especially suitable for use in areas that do not have to conform to efficiency level W4.

Another patent-pending system, ES 2.0, is used in areas where containment level N2 is sufficient, but where a smaller sphere of action is desirable. Since upgrading can also be carried out efficiently and quickly in this case, the system is an efficient alternative to higher strength systems.

The suitability of both systems was confirmed by comprehensive tests.

In co-operation with SUSPA-DSI GmbH, Toge developed the new *GEWI*® Guard Rail Reinforcement System consisting of high quality *GEWI*® Bars that exactly meet requirements with regards to elasticity and strength. Furthermore, *GEWI*® has an extremely low weight per meter, thus facilitating quick installation. Single *GEWI*® Bars are linked with high-strength couplers.

The newly developed restraint system EDS 2.0 was first used in Germany during the construction of the Strelasund Crossing to Ruegen. The photos show the *GEWI*® guard rail reinforcement system that was installed in the upper part of the restraint system. At the moment, SUSPA-DSI is working on several other projects where the new *GEWI*® Guard Rail Reinforcement System is to be used.



INFO

Owner Federal Republic of Germany/Federal State of Mecklenburg- Western Pomerania +++ **Main Contractor** DEGES GmbH (German Division of Highway Design and Construction), Germany +++ **Engineers** Schmitt Stumpf Fruehauf und Partner, Germany +++ **Consulting Engineers** Buechting + Streit, consulting engineers VBI, Germany

DSI Unit SUSPA-DSI GmbH, Koenigsbrunn, Germany

SUSPA-DSI Scope Development and supply of *GEWI*® mounting parts for *GEWI*® Guard Rail Reinforcement System



Olympic Ski Jump Garmisch-Partenkirchen

■ The Olympic Ski Jump in Garmisch-Partenkirchen, in the South of the German federal state of Bavaria, is one of the most famous jumps in the world and has been an integral part of the international Vierschanzentournee (4 jump tour) since 1952. The traditional New Year's ski jump that is organized here is broadcast worldwide. In 2007, the jump was completely re-built because the old ski jump's profile no longer complied with the regulations of the international skiing association.

The K-125 Olympic Ski Jump is going to set new standards as a distinctive structure. The jump's front end is positioned 12m above ground and features a 100m long run up tower. Together with the arch-shaped landing platform, the front end forms a dynamic sculpture symbolizing the act of conquering gravity during ski jumping. The structure is covered with translucent polycarbonate plates which transform themselves with daylight and illumination and turn into a glowing sculpture at night.

The new ski jump consists of approximately 1,000t of steel and fabricated metal. 18,000m³ of soil had to be moved and 1,200m³ of concrete poured into its foundation to make it stable. Stabilization was enhanced by 2,000m of piles



Tensioning equipment



Run up before completion



Installation



Installation



Installation of pivotal bearing



Tensioning equipment

and anchors. The maximum incline of the run up is 35°, with the jump's head being 144m above the stadium's floor.

Installation of the fabricated steel structure was carried out on the ground in a horizontal position. Once it had been coated and extended to a large extent, the 750t run up structure was pivoted around a bearing using SUSPA 15x0.6" (150mm²) Strand Tendons from its assembly position into its final position. The synchronized HOZ-3000 hydraulic jacks accommodated a total movement length of approximately 31.50m.

After erection, the run up was anchored into the jump-off-platform using 26mm Ø DYWIDAG Post-Tensioning Bars.

Construction work at this spectacular project began with the demolition of the old jump in April 2007, ending with the New Year's Jumps in 2008 only 8 ½ months later.

INFO

Owner Markt Garmisch-Partenkirchen, Germany +++ **Main Contractor** Bitschnau GmbH, Nenzing, Austria +++
Design of the supporting structure Mayr, Ludescher & Partner, Consulting Engineers, Munich, Germany
 +++ **Design and Conceptualization** loenhardt&mayr BDA Architects and landscape architects, Munich, Germany

DSI Unit SUSPA-DSI GmbH, LU South, Koenigsbrunn, Germany

SUSPA-DSI Scope Supply and installation of SUSPA Strand Tendons 15x0.6" type E-EP, supply, tensioning and grouting of 26 + 32mm Ø DYWIDAG Post-Tensioning Bars; execution of the pivoting procedure



Fabric Tubes by SUSPA-DSI Used for Bridge Foundation

Utilization of Fabric Tubes for Foundation of Friedetal Bridge / Sollstedt, Federal Highway A38

■ On Federal Highway A38 between Goettingen and Halle, a new bridge is to be built in the Friedetal valley, between Breitenworbis and Bleicherode. With a length of 485m, the new bridge is to span both the Friede River and an industrial park.

The foundation of the bridge proved to be a more than complex geotechnical challenge for designers and contractors.

Investigation of the foundation soil conditions revealed a layer of upper bunter “Roet” underneath the 5-8m thick quaternary consisting of run-of-hill scree and watered clay. The gypsum enclosed in the bunter is partly leached out and has left cavities that can fill with sludge or water. In addition, the fact that potash was exploited for 90 years in this area at 800m below ground level has led to subsidence at the surface. This causes depressions below ground, making a special foundation necessary.

In order to bridge the cavities in the “Roet” and to reduce negative skin friction caused by depressions, large bored piles in diameters of 1,800mm with lengths of up to 60m were planned that were to be equipped with an outer steel tube serving as a sleeve in the area of the cavities.

As a specialist solution, heavy-duty polyamide fabric tubes closed at the bottom were used instead of the steel tubes. These fabric tubes had to be drawn over the reinforcement cage like a sock before concreting works. In addition, a special connection had to be developed for linking the 2 to 3 individual sections of the hose without weakening the fabric.



The development of valves for the bottom piece was an additional challenge. Drilling water containing small particles needed to stream through the tube during the installation of the reinforcement cage, but concrete was not to leak from the tube during concreting.

Consequently, the metal sleeves could be eliminated entirely. In addition, post-grouting of

the annular space between borehole wall and steel sleeve, to avoid settlements at the surface, was no longer required.

With this innovative and economic procedure, transportation costs and construction time was significantly reduced. In addition, the installation of the reinforcement cages was considerably simplified.



INFO

Owner DEGES Deutsche Einheit Fernstrassenplanungs- und -bau GmbH, Berlin, Germany +++ **General Contractor** Gerdum u. Breuer Bauunternehmen GmbH, Kassel, Germany +++ **Subcontractor for bored pile works** Himmel u. Papesch Bauunternehmung GmbH & Co. KG, Bebra, Germany +++ **Geotechnical Consulting** Technical University of Cottbus, Faculty for Geotechnics, Cottbus, Germany
DSI Unit SUSPA-DSI GmbH, LU West, Langenfeld, Germany
SUSPA-DSI Scope Supply of 25 SUSPA-DSI Fabric Tubes XXL Ø 1,720mm in lengths of 30.5 – 46.6 m, in two and three pieces



DYWIDAG T76S Hollow Bars Stabilise Limerick Casting Basin, Ireland

Excavation for the Production of Precast Elements for Tunneling, River Shannon



■ **The City of Limerick, Ireland's third largest city, is currently Ireland's fastest growing city. Situated on the River Shannon, the city's picturesque waterfront has been a major attraction, but in recent times also a real hindrance, as the need for a South Ring Road and a new river crossing has led to virtual gridlock during rush hours.**

The solution chosen for the river crossing by the NRA (National Roads Authority of Ireland) is an immersed tube tunnel, consisting of five separate precast sections, placed in the Shannon at a point known as Bunlicky. The tunnel is part of the Limerick South Ring Road, a € 500m scheme linking the N7 Dublin Road with

the N18 Ennis Road. When operational, the tunnel will carry up to 40,000 vehicles per day, with a small toll collected from each vehicle.

Roadbridge engaged DYWIDAG-Systems International at an early stage in the design of the casting basin, where anchors were proposed as the main support to the sheet piled wall. The



New T76 ESS-D130 drill bit

ground conditions were known to be poor, consisting primarily of silty soils to a depth of 20m with very hard Limerick Limestone below. The challenge for the anchors was to install them at 45° through the silt and then achieve a rock socket in the hard Limerick Limestone.

Roadbridge were tasked with all of the excavations, earthworks and roads within the joint venture consortium known as Direct Route. Roadbridge's solution for the casting basin was to employ 330 No. T76S Dywidag hollow bar temporary anchors 30-35m long, installed over the full length of the 550m casting basin, on both sides.

The rigs used to install the T76S anchors were two Casagrande M6 hydraulic drilling rigs, equipped with Eurodrill top hammers (drifters). Both these rigs were operated by Ray Hilliard Piling and Foundations Ltd. In addition, two Putzmeister P13 grout pumps were used to pump in a 0.4 w/c ratio grout, as part of the simultaneous drill and grout technique used with self-drilling hollow bar anchors. Both drill rigs featured a special swing-away fly jib fitted to the top of the drill boom, to facilitate the lifting and placing of the 4m T76S hollow bars (weight = 79kg) at a 45° drill angle.

The Limerick Limestone is known to be particularly hard in this location, with Quartz bands permeating the local strata. A special drill bit with Tungsten Carbide buttons and a drop centre was developed during the execution of the works, to improve drilling performance. The drill bit has a cutting diameter of 130mm, with the leading face featuring 8 No. 13mm T/C hemispherical buttons. Further features of the drill bit include 3 No. deep side scallops for increased spoil removal and a retroflush side port with 2 No. forward flush ports. These special T76 ESS-D 130 drill bits are now thought to be the best rock bits ever made for large diameter

hollow bars. They offer superior cutting and spoil removal performance compared with any other hollow bar drill bit currently available on the market. It is now the most popular drill bit for forming rock sockets on temporary bar anchor projects.

In addition to the casting basin works, further T76S temporary anchors were required to stabilise the Combi-Wall at the North Side float out location, as part of the Lagan Group's works. This combi-wall consisted of Ø1400 x 20mm tubular piles, dowelled 10m into the rock and

interspersed with a pair of LX20 sheet piles. At the top of the combi-wall was a capping beam (2.2 x 1.5m) post-tensioned with DYWIDAG 47mm prestressing steel threadbars. Through this capping beam were placed 10 No. DYWIDAG T76S anchors at 45m long, socketed 6m into the rock. These anchors are designed to resist the thrust on the bulkhead, spanning between the combi-walls, when a high tide passes up the River Shannon.

Testing of the anchors required special measures, applicable only to self-drilled systems.

The installation technique, simultaneous drill and grout, results in a fully grouted column all the way up the anchor. This grouted column is essential for load transfer in the rock socket, but also has a distorting effect of picking up load in the overburden when the anchor is stressed. During the testing of the trial anchors, it was essential that the load picked up from the overburden during stressing was discounted from the overall test load. Load generated in the overburden (active wedge zone), does not contribute to the overall stability required in the design.

To overcome the influence of the overburden, the trial anchors were overstressed (up to 95% of yield) in order to break the grout bond in the active wedge zone. This enabled load to be transferred directly to the rock socket and accurate load readings to be taken at the jack. It is very important that true displacement is measured, not a factor of the apparent free length. Therefore, the Test Method 1 from EN1537 (displacement test) should be used for hollow bar temporary anchors, not BS8081 (where extension readings are set as the criteria, based on a factor of the apparent free length).

All of the anchors are now installed and stressed, with construction of the tunnel segments almost completed. Float out of the tunnel segments will follow shortly, where they will be placed in a dredged trench across the River Shannon and then covered with gravel. Completion of the South Ring Road is due in 2010, which is sure to bring relief to all the residents of the City of Limerick.



North Side float out structure



Limerick Limestone with Quartz Seams

INFO

Client National Roads Authority, Ireland +++ **General Contractor** Direct Route, comprising: Roadbridge, Lagan, Sisk, Strabag +++
Drilling Contractor Ray Hilliard Piling and Foundations Ltd., United Kingdom

DSI Unit DSI UK, Warwickshire, United Kingdom

DSI-Scope Supply of 350 No T76S DYWIDAG Hollow Bar Anchors between 30m and 45m long, 47mm Prestressing Steel for post-tensioning



DYWIDAG Bar Anchors used for Dam Project, Orgosolo, Sardinia

Cumbidanovu Dam, Sardinia

■ With over 2,500 hours of sun per year, Sardinia, the second largest island in the Mediterranean Sea, is a very popular holiday destination. However, its dry climate and extreme summer temperatures regularly result in water shortages.

To alleviate these shortages, a new dam is being built in the province of Nuoro, in Eastern Sardinia. The dam with a final height of 72.73m is located on the river Cedrino, near Orgosolo village.

The lake created by the dam stretches over an area of some 281km² and has a volume of approximately 13 million m³ of water. It will not only provide several parishes with drinking water, but will also serve as the source of water for the industrial estates of Pratosardo and Oliena.

Approximately 303,297m³ of concrete are needed for the dam itself. Due to the presence of predominantly granite rock with signs of weathering on its surface, the excavation pit needed to be especially deep.

Rock conditions are especially unstable at the left dam abutment, which is why the DSI company DYWIDAG S.P.A. was assigned to supply double corrosion protected (DCP) and prestressed DYWIDAG anchors for securing the dam.

DYWIDAG decided to use DCP (Double Corrosion Protection) bar anchors because of their reliable and long-term corrosion protection. The company delivered 25,000m of 26.5, 32 and 40mm diameter WR 950/1050 DCP bar anchors. The anchors were in lengths of 15 to 30m with bond lengths of 5m each. DYWIDAG DCP Bar Anchors are the ideal solution for the reliable and secure permanent stabilisation of the new dam.





INFO

Owner Bonifica della Sardegna Centrale consortium, Nuoro, Italy +++ **General Contractor** Diga Alto Cedrino Scarl, Tortona, Italy +++
Engineers Lombardi SA, Minusio, Switzerland +++ **Subcontractor** Opere Geotecniche SNC, Monastir, Italy
DSI Unit DYWID S.P.A., Milan, Italy
DYWID Scope Supply of 25,000m of DCP Bar Anchors; technical assistance



DYWIDAG Post-Tensioning Systems stabilize Vajont Bridge, Pordenone, Italy

Construction of a Cantilever Bridge over Vajont Torrent using DYWIDAG Post-Tensioning Systems

■ In 1961, Vajont Dam, located in the south-eastern part of the Dolomites, 100km north of Venice, with a height of 262m, was one of the highest dams on earth. Only two years after its completion, a massive landslide caused a giant flood wave in which 2,000 people lost their lives.

More than 40 years after this tragedy, the Municipality of the towns Erto and Casso decided to reconstruct the road on the left side of Vajont Torrent, which had been swept away during the catastrophe. Within this project, a new cantilever bridge is being built because the old bridge had also been destroyed by the flood wave.

The bridge, situated about 50m above the river bed, connects two steep mountainsides that are difficult to access. The cantilever construction method was preferred due to the difficult topography.

The new bridge is a classic cantilever prestressed structure, arising from the right side of the torrent. Vajont Bridge has a total length of 87.25m and is 7.50m wide.

The DSI company DYWIT in Italy was chosen to supply DYWIDAG Post-Tensioning systems for this project. All in all, 26t of 12-15x0.6" St 1670/1860 post-tensioning tendons were installed in the bridge. The DYWIDAG Post-Tensioning Systems were installed, stressed and grouted by DYWIT.

DYWIT is proud to have made a major contribution to the stability of the new bridge with high quality DYWIDAG Strand Post-Tensioning Systems.



INFO

Owner Municipality of Erto and Casso, Italy +++ **General Contractor** Monti SPA, Auronzo di Cadore (Belluno), Italy +++
Engineers Ing. Giovenale-Rossi, Rome, Italy +++ **Subcontractor** Ing. Sommovilla, Belluno, Italy

DSI Unit DYWIT S.P.A., Milan, Italy

DYWIT Scope Supply and Installation of 26t of DYWIDAG Post-Tensioning Systems, 12-15x0.6"



Seismic Retrofit of the S. Felice Bridge using the DYWIDAG THREADBAR® System

Repair and Strengthening of the S. Felice Bridge, Belluno, Italy

■ The San Boldo single-lane mountain pass, built in 1918, is located in the province of Belluno near the southern border of the Alps. The 17 km long pass, SP 635, leads over a peak of 706m, with a maximum inclination of 12%, linking the towns of Trichiana and Tóvena. The pipeline route of the southern ramp is well worth seeing because it leads traffic through five helical tunnels blasted into the rock and over six bridges as it winds its way up to the peak of the pass.

The S. Felice Bridge, which was built from 1928 to 1929, is an important structure on the San Baldo mountain pass. The bridge is divided into 8 spans, each consisting of two 35.70m long arches. As the S. Felice Bridge was no longer able to cope with the steadily increasing volume of traffic, extensive repair and strengthening works are underway.

During the construction works, the bridge deck is being widened from 6.20m to 8.20m. Furthermore, a cantilevered steel pedestrian crossing is being added to the bridge.

Seismic stability was another important issue during the strengthening works.

The DYWIDAG THREADBAR® system was chosen for the seismic retrofit of the bridge because of the many advantages it brings to a project due to its quick and easy installation and its superior performance when used as short and intermediate length tendons. For this purpose, the DSI company DYWIT in Italy delivered DYWIDAG Bar Post-Tensioning systems which sustainably strengthen the entire bridge.



DYWIDAG 36 and 47mm diameter St 950/1050WR THREADBAR®s were installed in the bridge piers and crossbeams and post-tensioned and grouted afterwards. Consequently, the arches themselves did not need further reinforcement.

For this project, DYWIT supplied over 40t of DYWIDAG THREADBAR®s and accessories as well as rented field technical equipment such as bar prestressing jacks.

INFO

Owner Veneto Strade S.P.A., Mestre Venezia, Italy +++ **General Contractor** Carron Cav. Angelo S.P.A., San Zenone Degli Ezzelini, Italy
+++ **Engineer** Ing Mario D'Agostini, Italy

DSI Unit DYWIT S.P.A., Milan, Italy

DSI Scope Supply of approximately 40t of DYWIDAG THREADBAR®s, Ø 36 and 47 mm, St 950/1050WR, including accessories; technical assistance



Longest Viaduct in Lithuania Post-Tensioned with DYWIDAG Strand Tendons

Estacade Viaduct, Vilnius, Lithuania

■ **Due to its geographical situation, Lithuania serves as an interface between East and West as well as North and South. This fact constantly increases Lithuania's attractiveness for logistics and transport. In addition, traffic also increases because of the country's rapid economic growth.**

This is clearly demonstrated in the radial highways and arterial roads in its capital Vilnius. During morning rush hour, approximately 8,000 vehicles crowd at the intersection of the two northern radial highways Ukmergės and Geležinio Vilko each day.

An additional narrowing exists at the roundabout approximately 300m south of the intersection, where incoming and outgoing traffic meets traffic crossing the city from East to West.

In order to allow traffic to flow more smoothly at this highly frequented hub, the city of Vilnius has constructed an elevated crossing over Geležinio Vilko Road that connects the Konstitucijos Main Road with Ukmergės Road.

The 14.25m wide deck, constructed with post-tensioned concrete box girders, accommodates three lanes in one direction. With its length of 247m, this viaduct is the longest so far in Lithuania. Construction was estimated to have cost nearly 10.5 million Euros.

Difficult geological conditions and heavy traffic posed special challenges during the construction of the viaduct. It was therefore very important to install and post-tension the tendons as quickly as possible at the three concreting sections. The DYWIDAG Strand Post-Tensioning

System perfectly fulfills these requirements and offers highest possible stability in challenging ground conditions.

Through their licensee in Lithuania, UAB Delta Nova, DSI Austria supplied a total of 140t of DYWIDAG 19x0.62" type MA Strand Tendons, and provided the necessary tensioning jacks.

Thanks to the excellent timing of everyone involved, the viaduct was opened to traffic in July 2007, four months ahead of schedule.



INFO

Owner City of Vilnius, Lithuania +++ **General Contractor** AB Panevezio Keliai, UAB Fegda and UAB Tilsta, Lithuania +++
Subcontractors Post-Tensioning UAB Tilsta and AB Ukmerges Keliai, Lithuania +++ **Engineers** UAB Kelprojektas, Lithuania
DSI Unit DSI Austria, Elsbethen/Salzburg, Austria
DSI Scope Supply of 140t of DYWIDAG Strand Tendons 19x0.62", type MA; rental of technical equipment



Efficient Residential Construction in Lithuania using DYWIDAG Monostrand Tendons

Residential Estate “Gudeliu silas”, Vilnius, Lithuania



■ **With an average growth rate of 7.5%, Lithuania has one of the fastest growing economies in Europe. The most densely populated of the Baltic countries has been a member of the European Union since May 2004. Ever since, Lithuania’s geographic position at an intersection between East and West and North and South as well as its ice-free harbor on the Baltic Sea have contributed even more to its attractiveness.**

With its approximately 550,000 inhabitants, the capital Vilnius is the largest city in Lithuania as well as its economic and cultural center. Like the Austrian city of Linz, Vilnius has already been awarded the title of “European Capital of Culture 2009”.

In recent years, the country’s growing wealth has also significantly impacted the real estate market. More and more Lithuanians strive for their own homes, which is why the demand for a quicker completion of upmarket housing space is continuously rising.

The residential estate “Gudeliu silas” on Gudeliu Road, on the north-western outskirts of Vilnius, is one of these projects. All in all, the seven new,

six-story houses offer 282 elegant and comfortable apartments. Furthermore, each unit features generous terraces or balconies as well as parking spaces in an 8,400m² underground garage. A beautiful park in the immediate vicinity additionally increases housing desirability and quality.

The investor’s main focus is on completing the residential area as quickly and economically as possible while simultaneously achieving good construction quality. The DYWIDAG Monostrand System is well suited for post-tensioning ceiling and floor slabs under these circumstances. DYWIDAG’s Monostrand System is easy and quick to install and allows efficient, stable ceilings and thin floor slabs. Another advantage post-tensioned slabs offer in comparison to conventional slabs without post-tensioning are the significant savings with construction costs because smaller quantities are needed for the excavation and for concrete.

For the “Gudeliu silas” project, DSI Austria delivered approximately 62t of high-quality Monostrand Tendons including accessories via their licensee in Lithuania, UAB Delta Nova. The apartments are scheduled to be ready for occupancy at the end of 2008.

INFO

Owner UAB Gudeliu Silas, Lithuania +++ **General Contractor** UAB Hanner Development, Lithuania +++ **Design** UAB Probat, Lithuania +++ **Engineers for Post-Tensioning** Dr. Wolfgang Lindlbauer, Austria +++ **Subcontractor for formwork, reinforcement** UAB Vilsta, Lithuania

DSI Unit DSI Austria, Elsbethen/Salzburg, Austria

DSI Scope Supply of approx. 62t of DYWIDAG Monostrand Tendons incl. accessories



MPU Heavy Lifter for Offshore Platforms Built Using DYWIDAG Post-Tensioning Systems

MPU-Heavy Lifter, MPU Enterprise AS

■ A large part of the world's crude oil deposits is not located on the mainland, but offshore, under the sea bed, primarily in the coastal and flat areas of the continental shelf. The extraction of the oil in these deposits is carried out using offshore platforms. Since this form of oil and gas extraction has been carried out for decades, a large number of these platforms have become outdated and have been decommissioned or sunk into the sea. These proceedings are now to be stopped by international agreements aiming to protect the sensitive ecosystem of the sea. In the future, decommissioned platforms are to be dismantled in an environmentally friendly process on shore instead of being sunk. Furthermore, platforms that have already been sunk are to be lifted and brought ashore.



One of the first major projects concerning the disposal of such decommissioned platforms is the dismantling of the satellite platforms around the Ekofisk oil and gas field in the North Sea, near the coast of Southern Norway. The dismantling of old platforms with conventional methods is more than complicated and is made even more difficult by the fact that the work often has to take place on stormy seas.

The Task

Is there a way of recovering offshore platforms with as little effort as possible without using expensive and elaborate special ships? The Norwegian engineering company Dr. techn. Olav Olsen a.s. developed a special lifting vessel made of post-tensioned lightweight concrete for this purpose. This special heavy lifter, known as "MPU-HL", is being constructed by order of the Norwegian company MPU Offshore Lift ASA in the Keppel-Verolme dry dock near Rotterdam.

For the first time, the MPU Heavy Lifter will allow the removal of the complete topside and jacket of the offshore platform, both in a single lift.

Thus, dismantling will be considerably quicker and dependability on long periods of calm weather will be significantly reduced.

The Concept

The MPU Heavy Lifter consists of a U-shaped hull structure with four 25m high towers – see Figure 1. The total length of the heavy lifter is 87m and its width is 110m. It is semi-submersible and can develop a lifting capacity of 15,000t for topsides or 28,000t for jackets. The towers of the "MPU-HL" have a diameter of approximately 20m. Special flushing tanks located in the towers can develop a lifting capacity of 8,000t within a very short time (within one wave length). This is achieved by the tanks' "dumping" water, which simultaneously allows operations even in difficult weather conditions. Aside from the single lifting capability, this feature is one of the major advantages in comparison to ordinary steel lifting vessels. Comparatively low construction and maintenance costs as well as the stability, robustness and durability of the structure are additional advantages of the proven concrete technology. Completely post-

tensioned lightweight concrete was chosen for the structure of the "MPU-HL" in order to keep its weight as light as possible and to allow fast semi-submersible ships to transport it from one region of the world to another.

The Tests

Due to the extremely large amount of reinforcement and little room in the concrete sections, the decision was made to use threaded couplers and "T-bars". In order to make sure that these methods of installation for complex reinforcement and casting methods (climbing formwork for walls of the hull and gliding formwork for the towers) corresponded to the special requirements of this structure, comprehensive full scale tests were carried out in advance. Figure 2 shows a full scale test in which horizontal post-tensioning tendons and vertical loops have been tensioned. Choosing the suitable anchor type for the particular lightweight concrete used in this case was an additional challenge. DSI was involved in these tests from their beginning. Static load transfer tests were carried out at the Delft University of Technology (see Figure 3).

Photos reprinted by courtesy of MPU and Aeroview B.V., Rotterdam, Netherlands

They proved that “oversized” plate anchors had to be used in order to achieve the required load without crushing the relatively “soft” Liapor aggregates in the concrete.

Post-Tensioning

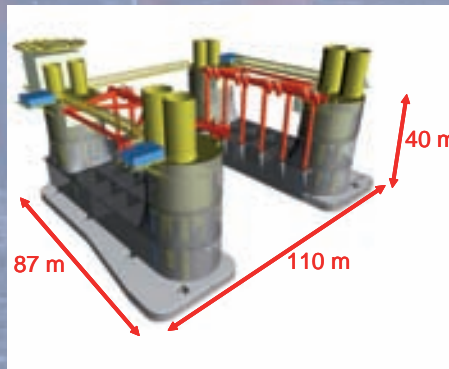
DSI received a contract for the delivery, installation, stressing and grouting of all post-tensioning tendons. Horizontal 19 strand DYWIDAG tendons are predominantly used in the bottom slab, the walls and the top slab. Additional vertical 19 strand tendons are used in the towers and some vertical 12 strand loops are used in walls.

In July 2007, the first part of the bottom slab was cast. Figure 4 shows the state of construction in March 2008. DSI installed the sheathing and plate anchorages prior to casting.

Approximately 1,000t of 15,7mm diameter grade 1860N/mm² must be installed, stressed and grouted in a very short construction time. The entire concrete hull structure is scheduled to be ready in August 2008. This is a real challenge for the Joint Venture “Kombinatie Heavy Lifter” and for DSI.

Summary

DSI is very proud of having received the post-tensioning contract for MPU's innovative heavy lifter. Due to the successful co-operation with Dutch companies during previous offshore-projects such as the Ekofisk Barrier and the construction of the NAM F3 Platform, DSI Netherlands was also chosen as a partner in this project. In the past, DSI has contributed to a large number of offshore projects as a reliable and competent partner. DSI is looking forward to contribute with its know-how to the success of similar projects in the future.



MPU Heavy Lifter



Full Scale Tests



Load transfer tests at the TU Delft



MPU Heavy Lifter in the Kepple-Verolme dock



Vertical Ducts for Post-Tensioning in Walls



Horizontal Ducts for DYWIDAG Post-Tensioning Tendons in the bottom slab

INFO

Owner MPU Offshore Lift ASA, Lysaker, Norway +++ **Main Contractor for Hull Structure** J.V. KHL (Van Hattum en Blankevoort & BAM Civiel), Netherlands +++ **Consulting** Dr.-techn. Olav Olsen a.s., Norway

DSI Unit DYWIDAG-Systems International B.V., Netherlands

DSI Scope Supply, installation, post-tensioning and injection of approx. 1,000t of Ø 15.7mm, 1860N/mm² DYWIDAG Multistrand Anchors



Swedish Wind Turbines Stabilized Using SUSPA Strand Anchors

Huds Moar Wind Park, Province of Västra Götalands, Sweden



■ Renewable energy has become increasingly important due to declining resources of fossil fuels and a globally augmenting awareness of CO₂ emissions. Wind energy is now one of the most important and efficient sources of renewable energy. In 2007, the capacity of wind parks was increased by over 30% globally, reaching a level of 94,112MW. For the first time, in 2007, wind energy replaced natural gas as the number one with regards to the increase in capacity for energy production in Europe. At the end of 2007, approximately 57,000MW of electricity were generated by wind energy in Europe. However, America, China and India are also investing considerable amounts in wind power.

Sweden's government made a special decision at the end of 2006: the country's power supply is to be generated entirely without fossil fuels by 2020. Ecologic sustainability is an important factor in the process of choosing suitable renewable resources. Due to its geographical situation, its long coastline, the predominant weather conditions and its many sparsely populated areas, wind is especially suitable as the predominant future source of energy in Sweden. Experts estimate the country's wind power potential to be up to 28 terawatt hours (TWh). Consequently, Sweden's aim is to increase wind energy tenfold during the next eight years in order to reach a level of 10TWh.

In this context, new wind turbines are being built across the entire country. This is also the case in Huds Moar, about 150km north of Gothenburg, where the construction of an onshore wind park was begun in November 2007. This wind park consists of six Nordex type N90/2500 wind

Photos reprinted by courtesy of: Nordex AG, Norderstedt, Germany; Engelhardt Spezialtiefbau GmbH, Uetze, Germany

INFO

Owner of the Wind Park Rabbalshede Kraft, Rabbalshede, Sweden +++ **General Contractor** Nordex AG, Norderstedt, Germany +++
Subcontractor Engelhardt Spezialtiefbau GmbH, Uetze, Germany

DSI Units Supply association of DYWIDAG-Systems International B.V., Zaltbommel, Netherlands and
 SUSPA-DSI GmbH, LU West, Langenfeld, Germany

SUSPA-DSI Scope Supply of 162 double corrosion protected, 11.5m long 17x0.62" SUSPA Strand Anchors; rental of equipment



Permanent SUSPA Strand Anchors before installation



Performance tests at permanent SUSPA Strand Anchors at 3.320kN



Boring of anchorage boreholes into the granite rock



Reinforcement of foundations with SUSPA Strand Anchors



Completed foundations containing installed SUSPA Strand Anchors

turbines with a hub height of 100m and 45m long rotor blades. The 100m high turbines are stabilized by massive foundations that were permanently anchored using 27 double corrosion protected SUSPA Strand Anchors. Very hard granite rock directly below the surface constituted a major challenge during the drilling of the holes for the 11.5m long SUSPA anchors in this area.

Performance tests of the SUSPA Strand Anchors were carried out in the first foundation. The tests were successfully realized at a test load of 3,320kN without any deformations. On the whole, SUSPA-DSI delivered 162 SUSPA 17 strand anchors each for anchoring the six pylon foundations. After their installation in the boreholes, these anchors were post-tensioned to a determined load of 1,700kN using a ZPE 460/31 tensioning jack.

Despite the icy temperatures in December 2007 / January 2008, the post-tensioned foundations could be turned over to the owner in accordance with the previously determined time frame. From May 2008 on, the new Huds Moar Wind Park will contribute up to 36GWh per year to Sweden's power supply.



Stabilisation of Approach Cuttings for Hindhead Tunnel with *GEWI*® Soil Nails

Tunnel near Hindhead, Motorway A3, Great Britain

■ **One of the main routes out of London is the A3, which connects London with Portsmouth. Over the years, this route has been upgraded to an efficient dual carriageway, except for one area known as the Devil's Punchbowl in the village of Hindhead, Surrey.**

The name Devil's Punchbowl is based on the legend that the devil spent his time tormenting the god Thor by pelting him with enormous handfuls of earth, and in the process created the huge bowl in the ground that can be seen today. In reality, the large bowl was created by erosion, caused by water percolating down through the sand and hitting an impervious clay layer, causing a number of springs to rise up, which over the course of time washed away a large chunk of the overlying sand.

Following the increase in traffic levels over the last 10 years, a solution was urgently needed to

ease the congestion at the section of the single carriageway through Hindhead. The solution chosen was a 6.5km dual carriageway with a 1.8km twin bore tunnel running under the Devil's Punchbowl.

The first phase of the project involved approach cuttings at both the North Portal and South Portal, involving large cut faces stabilised with soil nails. DYWIDAG-Systems worked closely with the designers and contractors to produce a soil nail solution consisting of *GEWI*®-Steel threadbars to stabilise the active wedge. *GEWI*®-Steel sizes varied from Ø16-28mm, depending on the nail loadings and their respective location on the slope face. Stability and erosion control of the facing utilised a reinforced geogrid overlaid with a multi-cellular facing to retain the top soil. DSI UK's unique angle compensation system for the bearing plates was employed to accommodate the natural undulations across the slope face.

Work on the stabilisation of the approach cuttings started in 2007 and are set to run for four years. Initially, two drill rigs were employed by Systems Geotechnique on the North Portal works, but as work increased, up to four drill rigs could be seen working. Ground conditions are predominantly cemented sands from the Upper Hythe Beds, enabling open-hole drilling with augers. Nail lengths vary from 3m to 10m.

Further soil nailing work will follow next year as there are a number of grade separated junctions, requiring stability of the cut faces, together with additional nails required in the approach cuttings of the South Portal.

The second phase of the work, the tunnelling, has just commenced with the installation of the tube canopy at the North Portal. ALWAG's AT Casing System is being used to stabilise the crown at both portals. The entrances are located in quite weak sands, where borehole stability





Geogrid



Drilling Operation



North Portal Tamrock Axera 8

was a concern. ALWAG's AT system was able to offer the high precision demanded by the contractor, where the tolerance between arrays and installation angle were quite critical. Following initial learning curves, production is now up to an array per two shifts, as required in the program.

In total 300,000m³ of soil will be excavated during the works. This excess spoil will be utilised at the South side, where there is a significant change in levels as the road exits the tunnel bores. Once the project has been completed, the old road will be returned to a natural landscape, with special measures adopted to ensure that wildlife and plants are not affected.



Grouting Operation

INFO

Client UK Highways Agency, United Kingdom +++ **Main Contractor** Balfour Beatty, United Kingdom +++

Drilling Contractor Systems Geotechnique Ltd., United Kingdom

DSI Units DSI UK, Warwickshire, United Kingdom / ALWAG Tunnelausbau Ges. m.b.H., Pasching/Linz, Austria

DSI Scope Supply of approximately 10,000No. 16-28mm dia GEWI®-Steel Soil Nails between 3m and 10m long; supply of AT Casing System



Construction of the Merowe Dam in Northern Sudan

Stabilization of Radial Gates at Merowe Dam

Using DYWIDAG Post-Tensioning Systems, Hamdab, Northern Sudan

■ **Construction of the Merowe Dam on the River Nile in Northern Sudan, 350km north of the capital of Khartoum, began in 2003. With its total length of approximately 9.2km and its hydropower capacity of 1,250MW, the Merowe Dam will be the second largest dam on the Nile after the Assuan Dam.**

The dam is to provide electricity, provide irrigation for the creation of new farmland, protect against flooding and reduce problematical sedimentation in the Assuan Dam located about 350km downstream.

The 154m long and 67m high spillway with its radial gates and the 370m long power station are at the core of the rockfill dams on each side. Construction cost is estimated to be around 555 Million Euros, with another 575 Million Euros to be added for the power station.

For anchoring the trunnion girders to the radial gates, DSI delivered a total of $4 \times 27 = 108$ pieces of 32mm St930/1080 DYWIDAG Post-Tensioning Bars in lengths between 6.0m and 11.20m with bilateral plate anchorages. All in all, the spillway dam contains 12 lower and 2 upper flood spillways where the water level can be regulated by means of the radial gates in times of critical flooding.

In addition to the supply of material, DSI assisted the client by supervising the installation, tensioning and grouting of the DYWIDAG bar tendons.





INFO

Owner Merowe Dam Project Implementation Unit, Khartoum Ministry of Irrigation and Water Resources, Sudan +++

General Contractor CCMD JV, Merowe Dam Project, Sudan (Joint Venture Partner: CWE und Sinohydro) +++

Engineers Lahmeyer International GmbH, Germany

DSI Units DSI Far East Ltd., Hongkong, China (supply of material); DSI Group Headquarter Operations, Munich, Germany

DSI Scope Supply of 2 x 108 pieces of 32mm DYWIDAG Post-Tensioning Bars and hydraulic jacks; supervision of the installation, injection and post-tensioning of DYWIDAG THREADBAR®



Making Traveling Safer: Upgrading of the spectacular Sea-to-Sky Highway

DCP Rock Bolts successfully tested and installed at Sea-to-Sky Highway in BC, Canada

■ **The Sea-to-Sky Highway is a scenic part of Highway 99 which offers spectacular views along its winding route from West Vancouver, BC, Canada to Whistler Mountain. It was first opened to traffic in 1962 as the major north-south connection through the Greater Vancouver Regional District.**

The original road was built on steep cliffs as a two-lane highway which neither featured an outside barrier nor a concrete divider between the lanes. Since the road also becomes dangerously slippery in bad weather, British Columbia's Ministry of Transportation has decided to take action.

The plans for redesigning and upgrading the highway were not only motivated by the wish to avoid accidents, they were vitally important in view of the many visitors expected to use this road during the Olympic Winter Games which will be held in British Columbia in 2010.

The new Sea-to-Sky highway will feature additional lanes, wider shoulders as well as new bridges.

Since the highway runs through areas which are highly prone to rock fall and exposed to inclement weather throughout most of the year, DSI, Surrey, BC, Canada developed a double corrosion protected (DCP) rock bolt designed especially to meet the difficult conditions of this project.

This high capacity DCP Rock Bolt is tensionable over its full length via an expansion shell. In fact, this aspect is the main feature which

distinguishes rock bolts from rock anchors. Rock anchors have to be longer since they have a distinct bond length, whereas another section of the anchor remains as "free length". Consequently, this type of DCP Rock Bolt has the advantage of being relatively short and light and is therefore easier to handle and to transport.

Another reason for the DCP Bolt's extremely light weight is the fact that the grout, which has to be placed between bar and corrugated sheathing and which is normally injected at the workshop, is now injected on site after the bolt has been installed and prestressed. This is a great advantage for handling rock bolts on steep slopes.

The special thixotropic grout, which does not flow out of the borehole by gravity even when bolts are facing upwards, but moves only under pumping pressure and which is used to establish bond between bolt and rock and for corrosion protection, is injected in a single step on site. This saves time and makes installation quick and easy.

The robust anchor head of the bolt, a hot dip galvanized cast hemisphere with hexagonal anchor nut sitting on an angled galvanized plate, allows for an angle compensation of up to 25° between rock face and anchor inclination and can thus be easily adapted to the steep slopes of the Coast Mountains.

Providing a most favorable seating for the nut and perfect support and centering for a stressing jack, this anchorage is very well adapted for the prestressing process of the bolt.

The anchor nut itself is protected by a corrosion protection compound and by a threadable, hot dip galvanized cast steel cap which offers complete long term corrosion protection, simultaneously shielding the anchorage against rock falls.

DSI is proud to have contributed to this important project with the new DCP Rock Bolt system, which was customized to meet the special demands for the improvement of the Sea-to-Sky Highway in B.C., Canada.



INFO

Owner Ministry of Transportation, S2S Transportation Group/ Government B.C., Canada +++ **Contractor** Kiewit and Sons, Richmond, B.C., Canada

DSI Unit DSI Canada Ltd., Western Division, Surrey, Canada

DSI Scope Supply of newly developed DCP Rock Bolts



DYWIDAG Tendons Support Precast Segments for Stress Ribbon Concrete Bridges

Construction of 4 new Bridges in Fish Creek Park, Calgary, Alberta, Canada

■ **Fish Creek Park is a provincial park located in the southern part of Calgary, in the Canadian Province of Alberta. With its total surface area of 13.5km², it is one of the largest urban parks in North America, stretching 19km from east to west.**

A variety of paved and unpaved pedestrian and bicycle trails with a total length of approximately 80km stretches through the park. This allows visitors easy access to on-site day-camping facilities, stables and a swimmable lake, simultaneously giving them the opportunity to observe a large variety of natural wildlife such as deer, coyotes, owls, and beavers.

In June 2005, heavy rains caused extensive flooding throughout Alberta, including severe damage to Fish Creek Park. During the floods, half of the park's trails were washed away, and the other half was severely damaged. In addition, many bridges were destroyed or rendered unsafe.

In October 2006, replacement works were begun on four of the destroyed bridges. The new bridges had to be designed in such a way as to cause minimal environmental disturbance. Furthermore, the bridges had to be aesthetically pleasing structures, allowing them to blend in well with the surroundings. A unique stress ribbon concrete bridge design was chosen because of its robustness and longevity. The design was also considered suitable because the new bridges needed high load-bearing capacities to allow their being used by park maintenance and emergency vehicles.

To fulfill these requirements, the bridge decks of the four new stress ribbon concrete bridges consist of narrow precast elements. Strong CIP concrete abutments anchored in the ground



guarantee tensile strength in the connection of the supporting stress ribbons. For anchoring the abutments, DSI Canada supplied a total of 128 pcs of the proven 36mm diameter Double Corrosion Protected (DCP) Rock Anchors. DYWIDAG Rock Anchors absorb horizontal forces from the stress ribbon superstructure, simultaneously countering the overturning moment.

For constructing the bridge deck, the precast panels were erected and assembled on temporary post-tensioning tendons. Afterwards, the permanent post-tensioning tendons were installed, stressed and grouted.

All of the stress ribbons for the four new bridges were installed and post-tensioned using 0.6" DYWIDAG Multistrand Post-Tensioning Systems with 9 strands each that were supplied and installed by DSI Canada. Much of the work was completed during the demanding winter season and much care was required to meet the stringent environmental parameters of this project. Fish Creek Park officially reopened in September 2007.

INFO

Owner City of Calgary, AB, Canada +++ **General Contractor** Trevcon Construction, Calgary, AB, Canada +++

Engineers Stantec Consulting Ltd., Calgary, AB, Canada

DSI Unit DSI Canada Ltd., Western Division, Surrey, Canada

DSI Scope Supply of 128 Double Corrosion Protected DYWIDAG Rock Anchors \varnothing 36mm, 16t of DYWIDAG Multistrand Tendons 9x0.60"; rental of equipment; installation and post-tensioning



Freedom Tower, USA: A Building as a Symbol for Freedom



■ **Right after 9/11, DSI USA was involved in stabilizing measures on Ground Zero. In 2001/2002, DSI supplied a great variety of high quality DYWIDAG Strand Anchors out of their factory in Toughkenamon, Pennsylvania, that were used to stabilize the excavation at Ground Zero.**

The new Freedom Tower is being built in the Northwestern area of Ground Zero. For the foundation work, DSI delivered high quality DYWIDAG bar anchors that were installed early in 2008.

On April 27th 2006, construction works began on Freedom Tower, which is being built on Ground Zero according to construction plans prepared by Daniel Libeskind and David Childs. Due to the traumatic experience of 9/11 that has impacted New York as no other experience, the tower has a symbolic significance reaching far beyond the city. That significance became apparent during the planning stages.

Even the planned height of 1,776feet (541,32m) has a historic significance: it is a reminder of the American Declaration of Independence signed in 1776. The building is to become an unmistakable sign of resistance against terrorism, with a

spire lit at night designed to match the Statue of Liberty's torch.

The fear of future attacks is also the reason for the comprehensive security measures that are of paramount importance during the construction of the building: the tower is erected on a nearly 60m deep foundation with a steel-titan compound designed to resist even severe explosions. The walls are going to consist of 90cm thick concrete with a steel armor.

Important building infrastructure, such as elevators, staircases and utility shafts are located in the interior in order to be protected from a



possible collapse. The tower is going to have a useable area of approximately 250,000m² and is going to be limited to only 69 floors for security reasons.

The outer structure of the Freedom Tower is erected using the steel frame method. Elevator shafts inside the Freedom Tower are erected using conventional reinforced concrete and employing the climbing formwork method.

Due to the design of the structure, the elevator shafts carry strong forces. Consequently, a horizontal massive 35.0 x 5.0 x 2.0m girder is being installed at a height of approximately 30m above ground. As a specialist for quality and security, DSI USA was charged with the supply of DYWIDAG Bar Tendons for the construction of this statically important girder.

The high quality 65mm DYWIDAG Bar Tendons are installed in 9 layers of two tendons each. In addition to the high strength 65mm Bar Tendons, 96 #20 DYWIDAG Bars for Horizontal Reinforcing as well as 168 #20 DYWIDAG Bars for Vertical Reinforcing in diameters of 63mm are installed inside the girder.

In addition, DSI is expecting to make future contributions to the successful construction of the Freedom Tower by supplying more products and systems as work on the building progresses.

INFO

Owner World Trade Center Properties, LLC/Port Authority of New York and New Jersey, USA +++ **General Contractor** Collavino Construction Company, Ontario, Canada +++ **Construction Manager** Tishman Construction Corp. of NY, USA +++ **Architect** Skidmore, Owings & Merrill LLP, USA +++ **Engineers** WSP Cantor Seinuk and Schlaich Bergemann and Partner LP, USA
DSI Unit DSI USA, BU Post-Tensioning, New Jersey, USA
DSI Scope Supply of 170t of #20, Ø 63mm DYWIDAG Bars, 16t Ø 65mm DYWIDAG Post-Tensioning Bars, Tensioning Jacks and design assistance







New York Step-Street Stabilized Using *GEWI*® Rock Bolts

Stabilization of Step Street at 183rd Street / Tiebout Ave., Bronx, NY, USA

■ In the hilly quarters of New York City, such as in Northern Manhattan and in the Bronx, there are streets consisting entirely of steps. Following an old maxim, these step-streets at one time were constructed on hills that were too steep for constructing normal roads.



INFO

Owner City of New York, Department of Design and Construction, NY, USA +++ **General Contractor** LAWS Construction, Pleasantville, NY, USA +++ **Contractor** JANOD Construction Inc., USA +++ **Engineers** Langan Engineering & Environmental Services, New York, NY, USA

DSI Unit DSI USA, BU Geotechnics, Long Valley, NJ, USA

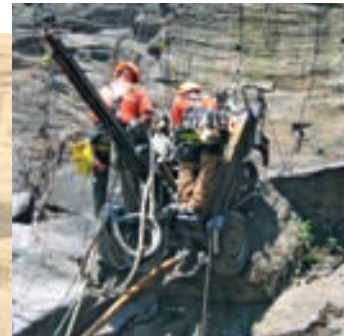
DSI Scope Supply of #8 grade 75: S 520/690 N/mm² epoxy-coated *GEWI*® Rock Bolts incl. accessories: hex nuts, eyebolts and anchor plates

One of these step-streets is located at 183rd Street / Tiebout Ave. in the Bronx. It is mainly used by commuters who walk to the train station on top of the hill, thus avoiding major detours.

Since the hill around these stairs was showing signs of instability, the city of New York carried out an extensive stabilization project in the summer of 2007.

DSI delivered #8 grade 75: S 520/690 N/mm² epoxy-coated GEWI® Bars from their local factory in Toughkenamon, PA. These bars were installed together with accessories such as hex nuts, eyebolts and anchor plates for use as rock anchors for stabilizing the steep slope wall above the step-street.

The installation and grouting of the 21 ft (6.5m) long double corrosion protected GEWI® Bars were special challenges during this project. The installation steps had to be carried out “from the top down” for every single rock anchor. Highly specialized technicians from JANOD Construction Inc., one of the few specialist firms in the USA for such work, roped down using mountaineering equipment to install the GEWI® Rock Bolts using innovative equipment.





Fast New York Pace Boosts Creative Construction Methods

Construction of a new Residential and Commercial Building on
23rd Street / 3rd Avenue, New York City, NY, USA

■ **Demand for luxury residential structures continues to be high in New York City. Extremely limited and expensive available building space has led to the purchase of air rights of neighboring properties. By doing so, investors have the possibility to maximize the useable floor space of their new buildings.**

Air rights of adjoining properties in the north and west were also bought for the new residential and commercial building on 23rd street / 3rd avenue. On a total area of 27,000m², the 21 storey building offers room for 304 residential units and a large number of retail shops as well as a private fitness center.

In order to fully profit from the air rights, this building was cantilevered over the neighboring buildings. The floor slab of the 6th storey cantilevers over the existing building to the North, while the floor slab of the 16th storey cantilevers over the building to the west.

The building's construction method allows 200mm thin, reinforced floor slabs to be used in the normal floor. However, an innovative system is required for stabilizing the cantilevered floor slabs. Since the motto "time is money" is alive and well in New York more than anywhere else, the construction plan had to be strictly followed by all means. As a rule, in New York, this means a floor has to be constructed within two days.

The chosen method of stabilization consists of a combination of sloping columns and a post-tensioning system. The concrete columns that are anchored in an acute angle of 48° transfer the vertical load of the cantilevered floor slab onto the perimeter walls of the building. The horizontal tensile force of these sloping columns is compensated by a post-tensioning system that is built into the cantilevered floor slabs.

To absorb axial loads in the supporting columns, up to seven 35mm diameter high strength DYWIDAG THREADBAR®s were installed in the center of the cantilevered floor slab. Subsequently, they were completely post-tensioned before the construction of new floors was





begun. The horizontal forces of the DYWIDAG THREADBAR®s are carried through the slab to the shearwalls in the second interior bay of the building, located about 22m away from the columns.

Both the owner and the general contractor were concerned about using the post-tensioning system because of the tight schedule. Their main concern was the additional time requirements for the instruction of the workers, the lead time and storage for the special materials and additional equipment, such as hydraulic jacks and grout pumps. However, DSI USA assured best possible support to everyone involved and supplied the DYWIDAG bars prefabricated with the required accessories and equipment delivered to the job site, exactly at the time of installation. Furthermore, employees of DSI USA were on site in order to support the workers during the installation, stressing and grouting of the THREADBAR®s.

Thanks to excellent coordination, the general contractor was able to reduce the construction time for the cantilevered floor slabs to a minimum. Consequently, the planned construction <schedule could be met without any problems to the complete satisfaction of the owner.



INFO

Owner J.D. Carlisle Development Corp., New York, NY, USA +++ **General Contractor** Century Maxim Construction, New York, USA +++ **Engineers** DeSimone Consulting Engineers, New York, NY, USA +++ **Architect** Perkins Eastman, New York, NY, USA

DSI Unit DSI USA, BU Post-Tensioning, Pompton Lakes, NJ, USA

DSI Scope Supply of 35t of DYWIDAG THREADBAR® \varnothing 36mm, grade 150: S 830/1035 N/mm² incl. equipment such as epoxy-coated anchor plates and couplers; rental of equipment; technical support



DYWIDAG Post-Tensioning System Stabilizes Important Highway Bridge

Reinforcement of Driscoll Bridge over Raritan River, Keasbey, NJ, USA

■ **Garden State Parkway Structure #127.2, better known as the “Driscoll Bridge”, spans the Raritan River, carrying the Garden State Parkway in New Jersey. It is one of the major structures on a highway that carries a large portion of the New York and New Jersey south-bound traffic.**

This bridge, built in 1952, consists of concrete and steel piers under deep steel beams carrying a concrete deck in two separate structures. Only two longitudinal girders carry the two nearly 70'-wide decks, which were widened several times to bring the width to its current size. Transverse floor beams, diaphragms and cross-bracing complete the steel superstructure.

In 2006, the bridge owner, the New Jersey Highway Authority, decided to completely overhaul the bridge in order to guarantee smooth traffic flows on the Garden State Parkway. Construction works included a complete redecking of both structures, the repair of the most critically deteriorated steel members and the replacement of its bearing pads as well as some of the stringers, diaphragms and bolsters.

In order to manage current speeds and traffic loads, an upgrade in floor beam capacity was necessary. DSI USA was entrusted with the planning, supply and installation of the new structural elements.

DYWIDAG Multistrand Tendons, which were newly installed, now ensure the necessary strengthening for absorbing additional moment loads. The design includes two custom DYWIDAG anchorages, bolted to the existing structure, and a center deviator, to give the

post-tensioning strand the eccentricity necessary to create the additional moment capacity.

The DYWIDAG Post-Tensioning System, which was used because of its high quality and reliability, was applied to each of the 201 floor beams comprising the 29 spans of the bridge. All in all, DSI installed 201 DYWIDAG Multistrand Tendons with nominal diameters of 0.6", 270ksi, with 3 to 5 strands each.

DSI also provided their expertise in mitigating the effects of lateral-torsional buckling of the floor beams under temporary loads by supplying and installing 2,700lf (810m) of #10 epoxy-coated THREADBAR®s, with associated hex nuts, along the centerline of the bridge, connecting and stabilizing the floor beams.

In addition, DSI USA installed 24 units of the newly developed electromagnetic DYNA Force sensors, which guarantee easy long-term

inspection on site and simultaneous monitoring of the force in the tendons. For monitoring, DYNA Force sensors are attached to individual strands during tensioning and linked to a central readout box.

Reduced working space above water and an exceptionally tight schedule for installation were especially challenging during this project. Being easy and quick to install, the DYWIDAG Post-Tensioning System was predestined for fulfilling the owner's guidelines regarding bridge stability and construction time of merely one year per bridge structure.

DSI project manager and superintendents worked in close collaboration with the local units, sometimes in two daily shifts, to stay on the aggressive schedule. DSI work was successfully completed at the end of 2007. The bridge is to be returned to full traffic by the end of 2009.



INFO

Owner New Jersey Highway Authority, NJ, USA +++ **General Contractor** Conti Enterprises, South Plainfield, NJ, USA

DSI Unit DSI USA, BU Post-Tensioning Systems, Pompton Lakes, NJ & Washington, DC, USA

DSI Scope Planning, supply and installation of DYWIDAG Multistrand Post-Tensioning Tendons and DYWIDAG THREADBAR®s; supply and installation of DYNA Force Sensors





DYWIDAG Tieback Anchors Stabilize Retaining Wall at I-295 Interchange

Woodrow Wilson Bridge, Washington D.C., USA



■ The new Woodrow Wilson Bridge over the Potomac River south of Washington D.C. is to be finished in 2008. It is part of the Washington beltway, where traffic has increased considerably during the past few years. A further increase of traffic is expected once the new Woodrow Wilson Bridge is completed since its primary purpose is to ease a current bottleneck in the South.



During this project, additional capacity to handle future traffic was also required for most access roads, for example at the Intersection of I-495 and I-295 in Oxon Hill, MD. A new 410m long (1,345 ft) by 12m high (40 ft) permanent soldier pile and lagging wall with a cast-in-place concrete face was built to stabilize the widening of the highway. Wall reinforcement was achieved using DYWIDAG Double Corrosion Protected (DCP) Tieback Anchors. The new soldier pile wall provides a dual purpose as it simultaneously serves as a tie back wall for the existing, mechanically stabilized MSE wall and for the roadway above.



The original plans and specifications called for drilled soldier piles using a caisson rig. However, due to the steep slope and limited room at the jobsite, it was determined that driven piles would actually result in the use of smaller



equipment and a more economical approach that ultimately resulted in considerable savings to the owner.

Construction of the retaining wall began with two soldier piles driven next to each other at a distance of 0.6m (2ft) on center. These served as the foundation for the construction of a special waler detail where both a trumpet pipe and anchor plate were welded at a previously determined angle. This waler detail helped ease the installation of over 450 permanent 32mm (1-1/4") grade 150: S 830/1035 N/mm² DYWIDAG DCP Tieback Anchors with an average length of 15m (49ft). Since the soil properties behind the retaining wall varied from one point to another, a special post grouting solution was required. In order to allow for additional grout reinforcement in suspect soil areas, all of the DCP anchors were installed with a DSI regrout tube.

After 15 months of construction and excellent teamwork, the retaining wall was completed on schedule in August 2007. DSI is proud to have contributed to the realization of this technically demanding project by supplying high quality products.



INFO

Owner Maryland Department of Transportation, State Highway Administration, USA +++ **General Contractor** G.A. & F.C. Wagman, Inc., USA +++ **Consulting Engineer** Potomac Crossing Consultants (Rummel, Klepper and Kahl LLP, URS, and Parsons Brinckerhoff), USA +++ **Architect** KCI Technologies, USA +++ **Contractor/Engineer** GeoStructures, Inc. (formerly Terratech, LLC)

DSI Unit DSI USA, BU Geotechnics, Toughkenamon PA, USA

DSI Scope Supply of 450 DYWIDAG DCP Tieback Anchors grade 150: S 830/1035 N/mm², accessories; technical assistance



Precision Measuring Instrument for Precise Repair of Stay Cable Bridges, USA

Tallmadge Bridge, Savannah, GA, USA

■ **The Eugene Tallmadge Memorial Bridge crosses the Savannah Harbor Navigation Channel approximately 15 miles (24km) from the mouth of the Savannah River.**

With a vertical clearance of 136 feet (182m) at high tide and a horizontal clearance of approximately 600 feet (40m), the original Tallmadge Bridge, built from 1953 to 1954, soon proved to be too restricting. In order for Savannah's container harbor to grow, the bridge had to be adapted to allow bigger ships to pass through. Consequently, in 1981, the decision was made to replace the bridge. The new Tallmadge Bridge, a cable-stayed structure, has a vertical clearance of 185 feet (311m) at high tide and a horizontal clearance of 1,023 feet (56m), with both main piers located on land outside of the Savannah River allowing more navigable space. The new bridge was opened to traffic in 1991.

After 15 years of service and regular site investigations, the Tallmadge Memorial Bridge has now had to undergo repair of its cables and, in particular, their damper system.

As is usually the case with cable-stayed bridges of similar design, urethane dampeners are at the base and top of each cable. They are located between the cable-stay duct and the exit pipe that is part of the deck or pylon, where the cable stay enters the exit pipe. With this system, dampeners suffer from the continuous vibration in the bridge cables over time and eventually come loose, thus failing to provide the necessary dampening.



INFO

Owner Georgia Department of Transportation, GA, USA +++ **General Contractor** Scott Bridge, Inc., Opelika, AL, USA +++

Engineer Lichtenstein Consulting Engineers, Natick, MA, USA

DSI Unit DSI USA, BU Post-Tensioning, Arlington, VA, USA

DSI Scope 288 Retrofit Cable Dampeners



This retrofit poses a technical challenge because it requires the exact placement of the new urethane dampeners in the existing exit pipe geometry. This geometry is influenced by several constantly changing factors. For instance, the cable stays and the deck show differing changes in volume when reacting to variations in temperature. Consequently, in order for the new dampeners to achieve ideal results, the time span between measurements and installation has to be as short as possible.

State-of-the-art technology is used for achieving this goal. Precision instruments, up to date reverse engineering software and innovative production processes quickly and reliably deliver the necessary precise measurement results and production parameters.

Stay cable specialist DSI USA makes use of these precision instruments and has developed the procedure to include this technology in a streamlined production and installation process. With the aid of a robotic arm, the DSI crew can take measurements down to one thousandth of an inch. Based on these measurements, a 3D model that serves as fabrication drawing is issued. Thus, innovative DSI technology contributed to the successful rehabilitation of Tallmadge Bridge. The new dampeners were ready for installation within the required aggressive time schedule of one week after measurements.



Active Dam Reinforcement with DYWIDAG Multistrand Anchors

Sturgeon Pool Dam, Rifton, NY, USA

■ **The Sturgeon Pool Dam was one of the largest hydroelectric power facilities in the middle Hudson River area, when it was completed in 1922. The name of the storage lake is derived from the large ocean dwelling sturgeon fish that, much like salmon, migrate to fresh water lakes to spawn. Sturgeon Pool was one of these spawning pools because migration further upstream was prevented by natural barriers such as waterfalls and cataracts.**

Sturgeon Pool Lake is fed by the Wallkill River, which has its source in Northern NJ and is one of the few north flowing rivers in North America. Historical records show that the Wallkill River has been harnessed for commercial power use since at least 1628, when it powered commercial flour milling. This was the first commercial use of water power in North America.

The area's topography, the natural basin area of Sturgeon Pool, and the nearby Dashville Waterfalls make the area an excellent location for hydroelectric power generation. Sturgeon Pool has a hydraulic gradient of 34m and a catchment area of 2,000km². Dashville has a 13m gradient

giving a total gradient across both facilities of 47m.

The hydroelectric facility at Sturgeon Pool consists of a concrete gravity dam 33m high and 150m long, and three water turbines producing 5MW of electricity. Water is channeled to the turbines through an intake structure at the southern end of the dam that is connected to 100m long penstocks. Ice and debris are kept from entering the penstocks by a trash rack and rake system.

Central Hudson Gas & Electric (CHG&E), the owner and operator of the facility, determined



Installation of DYWIDAG Multistrand Anchors in the crest

that it would be feasible to raise the power output of the dam from 5MW to 15MW by raising the water level behind the dam by 1.2m to 1.5m. This would be accomplished by renovations to the dam and the addition of an inflatable bladder system. The increased head required an extensive analysis of the structural capacity of the dam, as well as its ability to withstand 100 year flood events. The result of these analyses showed that the structure needed reinforcing in order to meet State of New York and Federal safety codes.

Structural reinforcing of the dam was accomplished by the installation of 47 epoxy-coated multi-strand anchors. The anchors ranged in size from 12 to 33 strands and lengths from 20m to 60m; anchors were installed along the crest and down stream face of the dam. The crest anchors were vertical while the down stream face anchors were either vertical or battered with batter angles between 10° and 40°.

Installation work was performed by Construction Drilling Inc. (CDI), a long time customer of DYWIDAG-Systems International; all work was performed from barges and temporary decking. The multi-strand anchors were shipped

pre-assembled with the anchor head and wedges attached to the epoxy coated strands. Multiple spacers for cable alignment were appropriately spaced along the length of the cable clusters, and grout tubes were also part of the pre-assembled product. The prefabricated epoxy strand anchors proved easy to install in the field with an appropriately sized crane working off of a barge.

Field verification of the anchor installation was performed by CDI with oversight by DTA, the project engineering firm. The unique creep characteristics of epoxy coated strand had to be taken into account for field testing of the anchors. DSI worked with the contractor CDI and engineering firm DTA to develop a unique PTI based testing procedure specifically for epoxy coated strands. The testing method verified the long term load holding capability of the anchors.



Penstocks with turbine house



Overview of the dam



View onto Sturgeon Pool Lake



Installation of DYWIDAG Multistrand Anchors below the crest into the dam



DYWIDAG Multistrand Anchors before Tensioning



INFO

Owner Central Hudson Gas & Electric, Poughkeepsie, NY, USA +++ **General Contractor** Construction Drilling Inc., North Adams, MA, USA +++ **Consulting** DTA Engineers of New York, Inc., USA

DSI Unit DSI USA, BU Geotechnics, Toughkenamon, PA, USA

DSI Services Supply of 47 extrusion and epoxy coated DYWIDAG Multistrand Anchors with accessories; rental of equipment



DYWIDAG Strand Systems Stabilize new Highway Bridge near Chicago

Bridge over Des Plaines River Valley, Veterans Memorial Tollway I-355, Bolingbrook, IL, USA

■ The extension of Interstate 355 is part of a comprehensive congestion relief program in greater Chicago. The new, approximately 20km long highway section is an additional connection from North to South between Interstates 55 and 80. The new connection allows residents in the rapidly growing southern portion of Will County much faster access to the North suburbs of Chicago and O'Hare airport.

The interstate highway crosses the wide and shallow valley of the Des Plaines River, which at one time was the only navigable connection between the Great Lakes and Mississippi River. Today, the river and its immediate surroundings are used as a local recreation area by Chicago residents, who come here for a variety of leisure activities and to visit towns nearby.

The 2,000m long bridge crossing the Des Plaines River consists of a dual carriageway with three lanes in each direction. The bridge crosses the river valley with a total of 35 spans having an average length of 67m each. The bridge superstructure consists of 3.0-3.6m deep post-tensioned spliced segmental bulb tee precast beams. Individual precast beam elements were transported to the jobsite by heavy duty vehicles and then lifted into position by cranes. The beam elements were then temporarily spliced together with 26 mm diameter DYWIDAG Bars in preparation for the permanent longitudinal post-tensioning. The beams were later post-tensioned with a total of 240 15 strand DYWIDAG tendons that were pre-assembled and pulled into the ducts of the beams. Some of these tendons were up to 410 meters long.





The bridge was erected on a total of 34 pier bents with heights up to 20m. The pier bents form a rigid frame under each carriageway, composed of four circular concrete columns supporting a post-tensioned cap beam that was stressed with 19x0.6" DYWIDAG Strand Tendons.

Due to the limited time frame for construction, it was especially important to supply the post-tensioning systems "just in time" for manufacturing the concrete beams at the casting yard. DSI USA was able to effortlessly comply with this condition from their local factory in Bolingbrook, in the immediate vicinity of the bridge. In addition, DSI USA preassembled all of the DYWIDAG Strand tendons for the piers from this location. In total, DSI USA used more than 900,000m of 0.6" diameter strand to post-tension the entire bridge.

The new bridge was opened to traffic in November 2007, at the same time as the complete new section of the highway. The bridge is currently one of the longest bridges in the state of Illinois, USA.



INFO

Owner Illinois State Toll Highway Authority, Chicago, IL, USA +++ **General Contractor** Walsh Construction Company, Chicago, IL, USA +++ **Engineers** Janssen & Spaans Engineering, Chicago, IL, USA
DSI Unit DSI USA, BU Post-Tensioning Systems, Bolingbrook, IL, USA
DSI Scope Supply of approximately 900,000m of DYWIDAG Strand Tendons 15x0.60" and 19x0.60", supply of DYWIDAG THREADBAR®s Ø 26 mm; rental of equipment



New Combination of Suspension and Cable-Stay Bridge with DSI Systems

Construction of North Avenue Bridge, Chicago, IL, USA

■ The existing North Avenue Bridge over the Chicago River was built in 1907 as one of the famed Chicago-style trunnion bascule bridges. In recent years, traffic jams were frequent on the bridge due to the narrowing of the street into one lane in each direction. To reduce this congestion, the city of Chicago decided to build a new bridge.

The new bridge uses the same alignment, with two lanes of traffic in each direction, and has a 77m long main span and two side spans of 26m each. The modern architectural design of the 129m long bridge includes both characteristics of a suspension and of a cable-stay bridge. Since the new bridge uses the same alignment, the project included erecting a temporary bridge on a different alignment before demolition of the old bridge could begin.

Several location factors required the construction of the 77m long main span as self anchored suspension bridge. In this design, the horizontal component of tensile force in the suspension cables is transferred as a compressive force into the concrete deck slab. The forces from the vertical hangers are transferred into separate anchor blocks. Since this method requires a strong bridge beam, the 77m long main deck was post-tensioned with high strength 19x0.6" DYWIDAG Strand Post-Tensioning Systems. DSI USA supplied these post-tensioning systems from its factory in Bolingbrook near Chicago.

Both of the 26m long side spans including the steel pylons were constructed as a cable-stayed bridge. The stay cables were also supplied by DSI USA. They are sheathed in polished stainless steel, which simultaneously offers efficient corrosion protection and fits in very well with the bridge's aesthetics. For the new North Avenue Bridge, DSI USA designed and supplied a total of 24 23x0.6" DYNA Grip® Stay Cables.





Photos reprinted by courtesy of James McHugh Construction Co., USA

The hybrid design permits elegant aesthetics through slender elliptical steel pylons and stiffens the superstructure while limiting its depth to less than 1.2m. This was key in providing the minimum clearance required by the US Coast Guard.

The new bridge was opened to traffic prior to Christmas 2007, adding extra Holiday Cheer in Chicago. Now, the light design of the new bridge opens up unrestricted views of Chicago's skyline which had been obstructed by the hefty beams of the old bridge.

The first-time combination of suspension and stay cable technique bestows a high degree of attention on the new North Avenue Bridge. The bridge offers the opportunity to inspect this innovative architectural design closely in order to gain valuable insights into future applications of its technique.

INFO

Owner Transport Authority Chicago City, Chicago, IL, USA +++ **General Contractor** James McHugh, Chicago, IL, USA +++ **Architects** Muller & Muller, Chicago, IL +++ **Technical Advice** URS, Chicago, IL, USA +++ **Engineers** HNTB, Chicago, IL, USA
DSI Unit DSI USA, BU Post-Tensioning, Bolingbrook, USA
DSI Scope Supply of DYWIDAG Post-Tensioning Systems types 5x0.6" and 19x0.6", design and supply of 24 DYNA Grip® Stay Cables 23x0.6"







Difficult Excavation Stabilized Using Flexible DYWIDAG Geotechnical Systems

Calumet Water Reclamation Plant, Chicago, IL, USA

■ **The water reclamation plant in Calumet, IL, at the southern tip of Lake Michigan, is the oldest wastewater treatment plant in the municipal area of Chicago. Its catchment area of approximately 800km² includes the southern suburbs as well as parts of the city of Chicago. The current plant's design provides a purification level of more than 90%, which is considered to be very high. To further optimize the process, the project "Hydraulic Optimization" – designed to begin working in 2010 – is currently underway. Among other things, it includes the construction of a new raw-wastewater pumping station, a new screen building, diversion chambers and additional buildings.**

Since foundations for the new buildings are to be located up to 20m below the current grade, extensive excavations and a deep building pit were necessary. More than 75,000m³ of soil had to be moved.

The excavation pit is located in an extensive network of existing underground structures, including several tunnels. During the stabilization of the excavation pit, the protection of existing structures was a major concern.

Consequently, an extensive system of tie back walls, soil nails and shotcrete walls was designed especially for this pit. In particular, engineers had to make sure that the tie backs did not accidentally damage tunnels or similar structures during installation. 3D computer modeling supported the engineers by calculating the exact points of installation for the 15 – 27m long anchors and soil nails.

Due to these constraints, more than 30 different

types of soldier beams and tie backs were needed for the extensive stabilization of the excavation walls with their total surface area of approximately 4,200m².

For the tie back walls, DSI USA supplied approximately 300 permanent DYWIDAG Strand Anchors as well as DYWIDAG Soil Nails and Tie

Rods including accessories from their plant in Bolingbrook near Chicago. The flexibility and easy handling of DYWIDAG Anchor Systems and the close proximity of the Bolingbrook plant to the job site made it possible for DSI to precisely meet the project's exacting requirements.



INFO

Owner Metropolitan Water Reclamation District of Greater Chicago, Chicago, IL, USA +++ **General Contractor** IHC/FHP Tectonics JV, Elgin, IL USA +++ **Subcontractor** Hayward Baker, Inc., Roselle, IL, USA +++ **Engineers** Metcalf & Eddy / AECOM, USA

DSI Unit DSI USA, BU Geotechnics, Bolingbrook, USA

DSI Scope Supply of permanent DYWIDAG Strand Anchors, DYWIDAG Soil Nails and Tie Rods including accessories; technical assistance



Utilization of Post-Tensioning Systems in Residential Construction in the USA

■ Especially in the USA, the utilization of post-tensioned slab-on-ground foundations is an approved method for stabilizing residential buildings on shrink-swell soils that can incur volumetric changes induced by moisture fluctuations. In order to resist those volumetric changes, the foundation slab needs to either be extremely massive or contain sufficient compressive stresses to resist the anticipated tension stresses induced by the soil movements. Post-Tensioning Systems are an economical and highly effective solution that is suitable for a variety of applications and has numerous advantages in comparison to non-prestressed construction methods.

The efficient utilization of Post-Tensioning Systems allows for the significant reduction of concrete and the simultaneous reduction of the percentage of cement needed for construction. As a consequence, CO₂ emissions occurring during the production of cement can also be reduced.

The utilization of Post-Tensioning systems makes sense from an economic point of view as well because it allows shorter construction cycles with a significant reduction of costs due to reductions in concrete, steel and excavations. The economy of time is mainly relevant for the construction company, while the economy of cost is important for the owner.

Even after installation, Post-Tensioning Systems have definite advantages in comparison to non-prestressed methods of construction. Post-Tensioning Systems are made for long-term utilization and offer little intensity of maintenance.

Post-Tensioned floor slabs help protect against the formation of cracks by the creation of compressive stress. Since they have higher stability of deformation than conventional floor slabs, they are also highly suitable for use in seismically active zones.

In view of these advantages, it is not surprising that the US-American market for floor slabs in private residential construction is the segment



with the highest growth rates in Post-Tensioning. In 2006 alone, 450,000 houses were constructed on post-tensioned foundation slabs.

Post-Tensioning Systems compress concrete, thus creating permanent compression. Post-Tensioning is achieved by the installation of 12.7mm (0.5 inch) unbonded Monostrand Tendons distributed in both directions and stressed to 14.9t (33,000 lbs.). Thus, a residual compressive force of approximately 345.5 – 689kPa (50-100 psi) is achieved. Consequently, floor slabs post-tensioned with unbonded Monostrand Tendon Systems have a much higher performance than non-prestressed floor slabs.

On highly expansive soils, post-tensioned foundations typically consist of a monolithic “ribbed” foundation with an approximately 10cm (4in.) thick slab, a perimeter beam and interior beams placed in both directions at approximately 3-4.5m (10-15ft.) maximum centers. Uniform thickness foundations, “California slabs”, are mainly used on less expansive soils. These floor slabs either have a minimum 12.7cm (5in.) thick floor slab with a perimeter beam and no interior beams or, in areas of stable soils, a minimum 19cm (7.5in.) thick solid slab with no perimeter or interior beams.

For many years, DSI has developed and produced high quality Post-Tensioning Systems that fully correspond with Post-Tensioning Institute (PTI) recommendations.

DYWIDAG Post-Tensioning Systems are not only used in private residential construction: they are an economical alternative for light commercial and heavy industrial construction as well as for sports courts and paving.



Floor Slabs for Executive Aircraft Hangars Post-Tensioned Using GSI/DSI Monostrand Tendons

Collin County Regional Airport, McKinney, Texas, USA

■ **Collin County Regional Airport in McKinney, Texas, 45km north-west of Dallas, has become increasingly popular in recent years. The airport is a favorite of pilots and owners using executive and personal aircraft for trips throughout the country. In order to accommodate growth potential and make the airport even more attractive, 24 private high quality aircraft hangars were built in 2007. These free-standing hangars offer ample space for a variety of planes. Furthermore, the hangars are equipped with offices, kitchenettes and bathrooms.**

The highly expansive soil in this area posed a special challenge during the construction of the hangars. Additionally, the use of white high gloss epoxy paint, to finish the floors, made concerns about cracks and the use of crack control joints a critical issue. In order to avoid potential damage and achieve long term durability, the floor slabs were post-tensioned using GSI/DSI Monostrand Tendons.

The first lot consisted of eight 20 x 23m hangars (the equivalent of a total area of 460m² each) and sixteen 19 x 20m hangars (the equivalent of a total area of 380m² each). In total, nearly 10.000m² of floor slabs were built for this project.

The individual slab-on-ground foundations are monolithic ribbed slabs with a 15.24cm thick slab and perimeter and interior beams spaced in both directions at 25.4cm x 76.2cm maximum centers. Post-tensioning is accomplished utilizing 12.7mm unbonded GSI/DSI Monostrand Tendons in the slab and beams. A final effective force of approximately 1.034kPa was achieved utilizing a two-stage stressing operation. Post-tensioned floor slabs are resistant to tensile stress that is caused by movements of the expansive soil. Consequently, the risk of shrinkage cracks was reduced and the use of crack control joints became unnecessary.

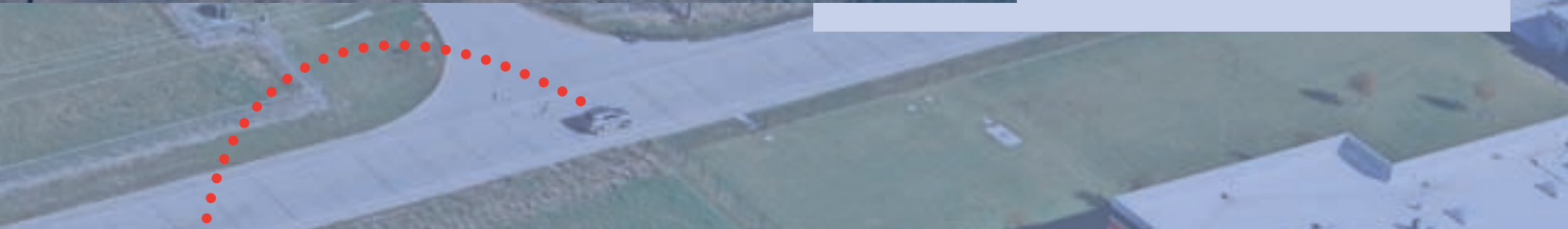




The use of these floor slabs resulted in considerable cost benefits for the owner in comparison to the original design without post-tensioning. These benefits are achieved by reductions in quantities of concrete, reinforcement, excavations and the elimination of the crack control joints. Long term cost benefits will also be realized by the elimination of maintenance to cracks and control joints.

The developer and owners are extremely happy with the results obtained and future projects utilizing GSI/DSI Monostrand Post-Tensioning Systems are on the drawing board.

DSI is proud to have contributed to the success of this exceptional project with their long standing expertise. The new hangars were handed over to the owner in autumn 2007. The project won the prestigious 2008 Award of Merit from the Post-Tensioning Institute.



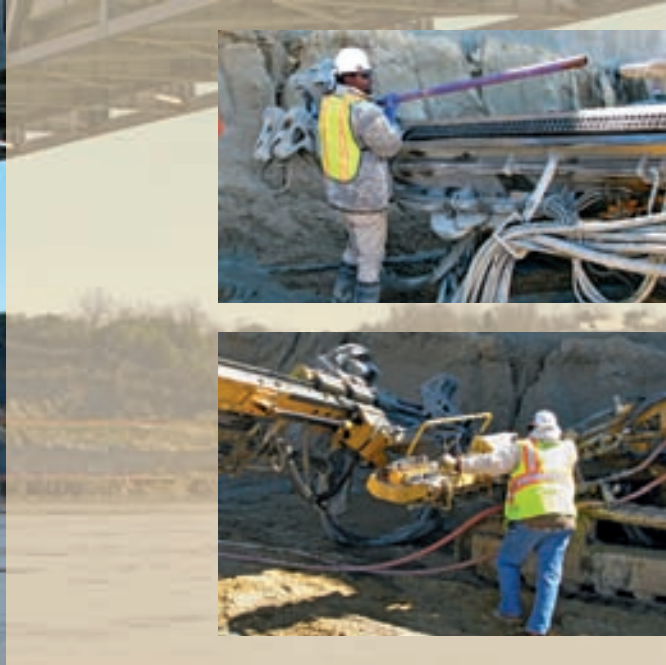
INFO

Owner Collin County Hangar Owners Association, McKinney, TX, USA
DSI Unit DSI USA, BU Slab on Ground, Ft. Worth, TX, USA
DSI Scope Production and Supply of Monostrand Tendons



Sandy Mississippi Bluffs Turned into Quai Wall Using DYWI® Drill Hollow Bar Anchors

Emerald Star Casino Project, Natchez, MS, USA



■ The new “Grand Soleil” Casino owned and managed by Emerald Star Group is located in a three deck ship on the Mississippi River. The casino is anchored near Natchez, approximately 200km north of New Orleans. From mid 2008 on, visitors will be able to play at numerous slot machines and gaming tables in an area of approximately 9,200m².

To accommodate this facility, the Mississippi bluffs along the ship’s berth had to be extensively stabilized. The new 400m long retaining wall is used as a quay, while simultaneously serving to stabilize parking spaces in the immediate vicinity of the river bank. At the same time, the wall secures a railroad nearby that had to be

burrowed under to accommodate the Casino’s access road.

Unstable soil conditions in the area have repeatedly caused landslides, making a stabilization of the river banks difficult in itself. Around the anchorage of the “Grand Soleil” casino, sand concentration in the soil is extremely high, thus creating an additional challenge during the construction of the retaining wall.

The sand considerably complicated normal retaining wall construction using soil nails installed from the top down. A construction technique consisting of shotcrete and reinforced steel was chosen that was tied back using 50mm DYWI® Drill Hollow Bar Anchors. In areas where the sand falls were strong, an additional layer of shotcrete was applied.

DYWI® Drill Hollow Bar Anchors are appropriate for use in soft, unstable soils. Since DYWI® Drill Hollow Bar Anchors are self-drilling, pilot holes are unnecessary. In addition, drilling and grouting is done in a single step since grout is injected during the drilling procedure through the anchor’s hollow core. This feature significantly increased productivity during anchor installation. In many cases, water was pumped through the hollow bars to liquefy the sand, making drilling far easier. The bars were grouted after this installation procedure.

From their factory in Arlington, Texas, and from DSI facilities across the USA, DSI USA supplied a total of 6,716 DYWI® Drill Hollow Bar Anchors for reinforcing the quay wall for the “Grand Soleil” casino ship.

INFO

Owner Emerald Star Group, Natchez, Mississippi, USA +++ **General Contractor** Yates Construction, Biloxi, Mississippi, USA +++

Subcontractor Hayward Baker, Alpharetta, Georgia, USA

DSI Unit DSI USA, BU Geotechnics, Arlington, Texas, USA

DSI Scope Supply of 6,716 DYWI® Drill Hollow Bar Anchors, Types R50 N and R50L



DYWIDAG Monostrand Repair Methods Save Parking Structure

Structural Repair of the Galleria Parking Structure in Bismarck, North Dakota, USA

■ **The Galleria Parking Structure is attached to the Radisson Hotel in downtown Bismarck, North Dakota. The structure was built in 1982 and is owned and operated by the Bismarck Parking Authority (BPA). The parking structure features a terrace level with an outdoor patio area that is not accessible to vehicles for parking.**

Concrete planters located on the roof terrace level had been leaking for years. Furthermore, plants had to be replaced on a regular basis because the high degree of lime in the concrete tended to damage the plants. The BPA employed a contractor to remove the planters and install a new watertight roofing system. Concrete topping below the planters was to be removed as part of the work and the contractor decided to saw cut this topping into several pieces to speed its removal. Because the topping varied in thickness to allow drainage and the contractor was not aware of the variation in thickness, several post-tensioned tendons were cut by mistake.

The structural integrity of the parking structure was severely compromised, and the structure had to be immediately stabilized with a shoring system in order to avoid possible collapse. Two of the parking levels were completely shut down, and parking at ground level was limited.

Bismarck Parking Authority commissioned the experts at DSI USA to perform comprehensive repairs of the damaged post-tensioned tendons. The severed sections of post-tensioned strands were removed and replaced with new strand. DSI USA used coupler splices and special center stressing anchorages to attach

the new strand to the existing strand. Subsequently, DSI USA carried out the necessary re-tensioning of the tendons and sealed the exposed strand at the splice locations.

One of the supporting columns required special attention during the repair. Most of the top reinforcing bars were cut at this column, causing an increased concern of puncture shear failure at this location. For this special problem,

the engineering company Walker Parking Consultants designed special negative moment straps that were installed by DSI USA. The straps were laid on a bed of epoxy and fastened by DSI USA using anchor bolts per Walker Parking Consultants instructions.

Thanks to the competent help of DSI USA, the repairs were successfully brought to a close in January 2008.



Installation of coupler splices



Monostrands with reinforcement before concreting



Recesses with repaired monostrands



Ends of tendons waiting to be linked with couplers

INFO

Owner Bismarck Parking Authority, Bismarck, USA +++ **General Contractor** Rocky Gordon & Co., Bismarck, USA +++
Subcontractor Capital City Const., Bismarck, USA +++ **Technical Consultant** CW Structural Engineers, Bismarck, USA +++
Engineer Walker Parking Consultants, Elgin, USA +++ **Consulting Engineers** Darg, Palanisami & Associates, Minneapolis, USA +++
Architect Trossen Wright & Associates, Saint Paul, USA

DSI Unit DSI USA, BU Monostrand, Bolingbrook, USA

DSI Scope Repair of damaged post-tensioned tendons and installation of column moment straps



DYWIDAG Soil Nails Allow Construction of Commercial Buildings in Difficult Soil

Canyon Crossing Center, Frederickson, WA, USA



■ The Canyon Crossing project is located in Frederickson, WA, a rapidly growing suburb of the town of Tacoma, south of Seattle. The project site of approximately 55,000m² will include the construction of a supermarket, six out-parcel buildings and a fueling center. The topography of the site prohibited a project of this size from

being constructed without a shoring system. Permanent shotcrete walls with an average height of 14m were constructed along the east and south sides of the area and were stabilized and tied back using DYWIDAG Soil Nails.



A gravel pit previously occupied the project site; consequently, extremely difficult drilling conditions were encountered. Soils generally consisted of 1-2m of fill containing a medium dense mixture of gravel, sand and silt. In addition, the mixture's compression ratio strongly varied in relation to different depths. An unexpected high water table with various impermeable clay lenses added to the special requirements for stabilizing the area.



For stabilizing the shotcrete walls, DSI USA supplied 709 epoxy-coated DYWIDAG Soil Nails for the eastern wall and 543 DYWIDAG Galvanized Soil Nails for the southern wall.

The two retaining walls have a surface area of approximately 2,400m². The construction procedure began with the installation of the DYWIDAG Soil Nails. After each row of soil nails were installed and grouted, a 10.2cm thick temporary shotcrete facing was placed at a height of 182cm. The final step of the construction sequence was to place a 20.3cm thick permanent shotcrete face over the entire wall surface. The permanent facing was architecturally carved and textured to resemble natural granite stone.

INFO

Owner WGW Development, Sumner, WA, USA +++ **General Contractor** SGA Corporation, Shoreline, WA, USA +++
Contractor Olson Bros. Excavating, Puyallup, WA, USA +++ **Subcontractor** Northwest Cascade, Inc., Puyallup, WA, USA +++
Engineers Theis Engineering, LLC., Helotes, TX, USA

DSI Unit DSI USA, BU Geotechnics, Kent, WA, USA

DSI Scope Delivery of 709 epoxy-coated DYWIDAG #9 Soil Nails and 543 galvanized DYWIDAG #9 Soil Nails



DYWI® Drill Hollow Bar Anchors Stabilize Railway Line in California

Line Section over Cajon Pass near Devore, CA, USA

■ The 1,277m high Cajon Pass in the San Bernardino Mountains east of Los Angeles is an important connection from the Los Angeles Basin to other regions in the USA. Since the beginning of the American railroad history, a highly frequented railway line has been located in this area. Some time ago, the line was expanded to two tracks. On the rails owned by BNSF (Burlington Northern and Santa Fe Railway), approximately 90-100 trains per day cross the Cajon Pass. The trains mainly transport freight that arrives in the ports of Los Angeles and Long Beach and is then distributed across the USA, especially to Chicago. In order to traverse the slopes and curves of the Cajon Pass, trains have to slow down considerably. The slowdown poses a problem that often leads to delays throughout the system.

In order to eliminate this bottleneck, BNSF is now adding a third track to this important railway line. The new 26km long third track runs near Interstate I15 from Summit, near the top of the pass, to Keenbrook, just west of Devore. As a result of the addition, the total capacity of Cajon Pass will be increased to 150 trains per day, allowing more efficiency in transport and track maintenance. This USD 80 million project is extremely important for keeping goods flowing through the region in the future because freight traffic has doubled since 1990 and is expected to continue growing in the coming years.

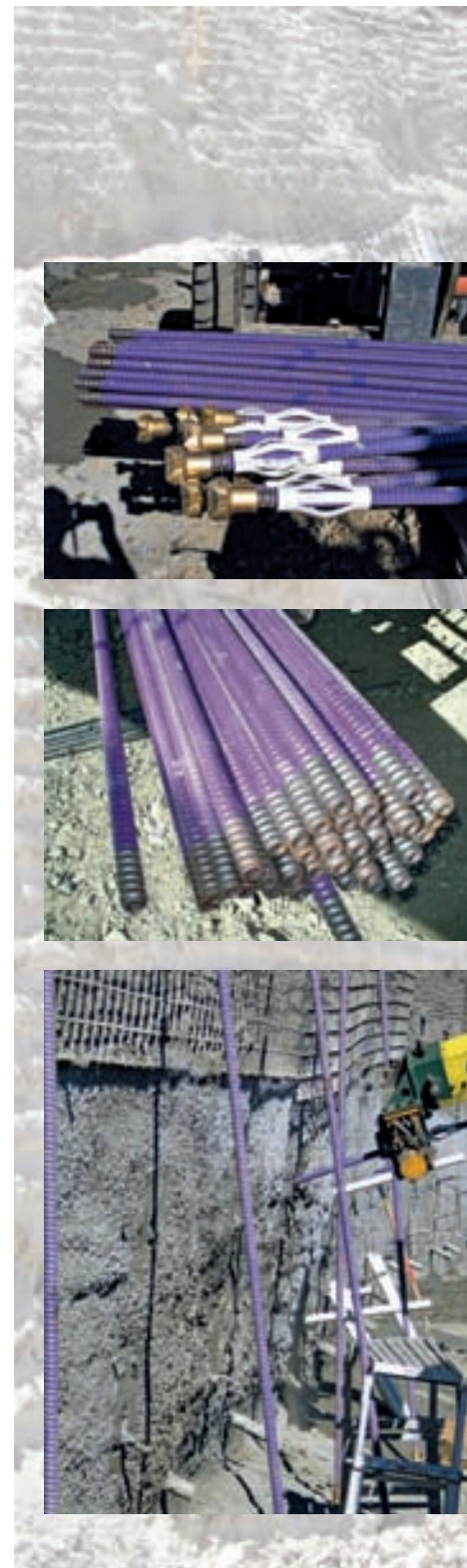
To make room for the third track, hillsides had to be carved out, two small tunnels had to be demolished and some winding roads had to be realigned. Approximately 765,000m³ of dirt had to be removed.

The project constituted a great challenge for everyone involved, especially with regards to difficult geological conditions, environmental protection and the fact that interruptions to ongoing train traffic were to be minimized.

The excavated hillsides along the widened tracks were stabilized by concrete walls. Eleven of these walls are additionally reinforced with DYWI® Drill Soil Nails. The DYWI® Drill Hollow Bar System is especially suitable for use in limited space and soft grounds. Self-drilling DYWI® Drill Hollow Bar Anchors can be installed using small drill rigs without pre-drilling. In addition, self-drilling with simultaneous drilling and injection is a great advantage in soils where uncased boreholes would not be stable.

From their local distribution facility in Long Beach, DSI delivered over 12,000m of epoxy-coated type R32N and R32S DYWI® Drill Hollow Bar Anchors including drill bits, couplers and additional accessories.

The installation of the DYWI® Drill Soil Nails will be completed in April 2008 and the third track is scheduled to be completed by the end of 2008.



INFO

Owner BNSF Railway, USA +++ **Subcontractor** Drill Tech Drilling & Shoring Inc., CA, USA

DSI Unit DSI USA, BU Geotechnics, Long Beach, CA, USA

DSI Scope Supply of approximately 12,000m of epoxy-coated type R32N & R32S DYWI® Drill-Hollow Bar Anchors including drill bits, couplers and additional accessories



Excavation Support and Post-Tensioning for a Parking Structure Using DYWIDAG Systems

San Manuel Indian Casino, Highland, CA, USA

■ **The San Manuel Reservation inhabited by the San Manuel Band of Serrano Mission Indians was founded in 1891 and simultaneously recognized as a sovereign territory with the right to self-governance. The reservation is named after the great chief Santos Manuel. It is located at the foot of the Californian San Bernardino Mountains, slightly north of the town of Highland and about 100 km (60 miles) east of Los Angeles. With its approximately 320 hectares (791 acres), the reservation is located in a mountainous area that is not suitable for farming.**

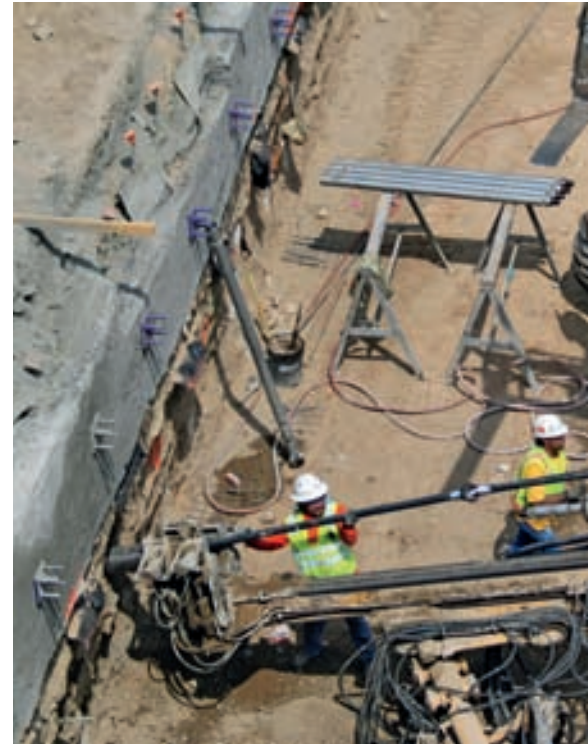
In the mid 1980s, the tribe had constructed the San Manuel Indian Bingo Center inside the reservation in order to promote its economic development. This bingo center quickly became popular. Consequently, in the mid 1990s, a 10,000m² (approx. 107600 sq ft) casino with card game rooms and gambling machines was added. Since then, the center has been called "San Manuel Indian Bingo and Casino".

In order to maintain its position as one of the leading points of amusement in Southern California, "San Manuel Indian Bingo and Casino" was renovated and its offer of games extended in the new millennium. Since January 2005, these measures have brought additional revenues of over 200 Mio. USD to the surrounding communities, simultaneously creating hundreds of new jobs.

Due to the increased popularity of this gambling hall, parking capacities had to be increased as well. From their local factory in Long Beach, DSI USA delivered various DYWIDAG products and systems for the construction of the new 7 story 2,400 space parking structure.

Permanent stabilization of the excavation was achieved using 674 double corrosion protected (DCP) DYWIDAG soil nails. The double corrosion protection insures longevity. In order to improve wall stability during excavation, vertical soil nails (V-Nails), also produced by DSI USA, were installed behind the future shotcrete wall prior to excavation.

DSI USA delivered the approved DYWIDAG Monostrand System for post-tensioning the floor slabs and the beams of the seven story building. With their small diameters of 0.5" and 0.6" respectively, DYWIDAG Monostrand Tendons are well suited for post-tensioning extremely thin reinforced concrete slabs. The new 80,000m² parking structure is to be opened at the end of 2008.





INFO

Owner San Manuel Band of Mission Indians, Highland, CA, USA +++ **General Contractor** Bomel Construction Anaheim, CA, USA +++ **Constructor** Pennhall Company, Las Vegas, NV, USA +++ **Subcontractor** Condon-Johnson & Assoc., San Diego, CA, USA +++ **Engineers** PB&A (Pirooz Barar & Assoc.), San Anselmo, CA, USA

DSI Unit DSI USA, BU Geotechnics, Long Beach, CA, USA

DSI Scope Supply of 481 double corrosion protected DYWIDAG soil nails #8 grade 75: S 520/690 N/mm², 193 double corrosion protected DYWIDAG V-Nails #8 grade 75: S 520/690 N/mm² and #8 grade 75: S 520/690 N/mm² test nails



DYWIDAG Systems for US-American Base in Micronesia

Tie Rods installed at American Military Wharf on Guam



Tie Rod installation



Tie Rods with Anchor Plate in Reinforcement

■ Guam Island, in the western Pacific Ocean, is the largest island in the Marianas Archipelago and a territory of the USA. The island is located approximately 5,300km west of Hawaii and 2,500km south of Japan. Due to Guam's strategic location, USA's Andersen Air Force Base and Naval Base Guam are situated on the island. On-going and future upgrades of both bases are planned over the next several years to enhance the USA's military capabilities in the region.

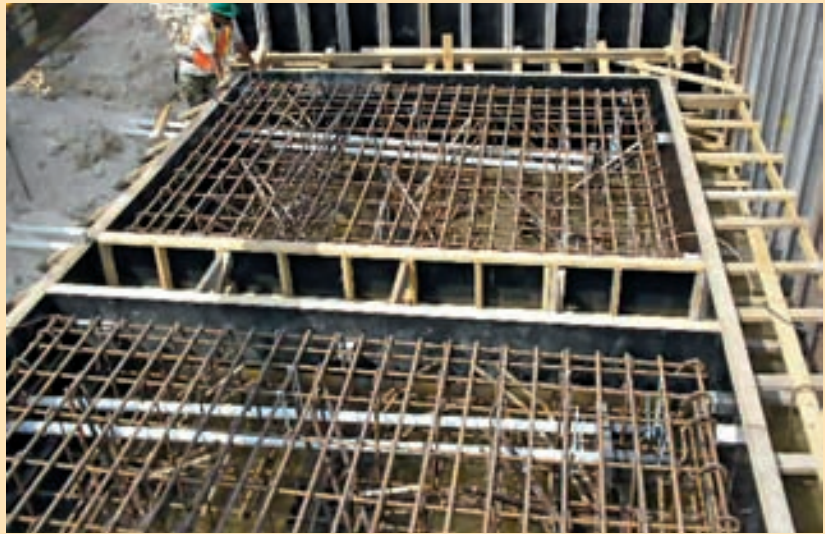
One such military improvement project is the lengthening and upgrade of Guam's Alpha and Bravo naval wharves to service submarines which occasionally call at the base. For this project, both wharves had to be extended, deepened and reinforced with new steel sheet piles. DSI USA was awarded a contract to supply special bar tie rods for stabilizing the wharves.

In order to extend the wharves, DSI USA delivered approximately 8,000m (26,000ft.) of #18 grade 75: S 520/690 N/mm² Tie Rods. The anchors have excellent and long-lasting corrosion protection due to their Polyken tape wrap corrosion system, which is why they are ideal for use in salt water.

The owner chose the DYWIDAG Tie Rod System because of its ease of installation and its economic advantages: it offers up to 50% reduction in weight compared to conventional bars grade S355. In addition, it allows the accommodation of minor misalignments with sheet piles without the need to cut and re-weld upset rods.



Levying of Tie Rods



Tie Rod Anchorage Blocks



Installation of Tie Rods at sheet piles



Coupler Area of Tie Rods

INFO

Owner US Navy, Naval Base Guam, USA +++ **General Contractor** Black Construction Corporation, Guam, USA +++
Architect-Engineer Wilson Okamoto Corporation, Honolulu, Hawaii, USA
DSI Unit DSI USA, BU Geotechnics, Long Beach, CA, USA
DSI Scope Supply of approx. 8,000m (26,000ft.) of Tie Rods with Polyken tape wrap



DYWIDAG Rock Anchors Protect Panama Canal against Landslides

Stabilization of a Slope at “Gaillard Cut”, Panama Canal, Panama

■ “Gaillard Cut” is the name of the part of the Panama Canal leading through the Continental Divide of the American continent. This cut through 64m high hills started in 1882 and was one of the biggest technical challenges during the construction of the Canal. The 12.6km long cut used to be called Culebra Cut (Culebra = snake in Spanish) because of its many bends. However, it was later renamed after the American engineer Col. David DuBose Gaillard, who was the main person responsible for the construction of the cut. Due to the continuous increase in transit traffic, there had already been two enlarging projects from the original width of 91.5m to 222m today. As a result, the capacity of this bottleneck was increased to two Panamax ships into each direction and the safety of the passage could be ameliorated.

Ever since its construction, there have been massive landslides in this area because the substance of the soil is extremely unstable. The floor mainly consists of tertiary volcanic tuff, schistous clay and mudstone. At the time, the first massive landslide in 1907 led to fears that the construction of the channel would not be possible. However, the slopes were stabilized in such a way as to allow the opening of the Canal in 1914. Despite this, up to today, there continue to be mudslides into the canal, making continuous dredging necessary.

These geological surroundings are extremely sensitive to vibrations caused by construction works. Both of the widenings of “Gaillard Cut” caused further landslides that continued even after the completion of the construction work.





A comprehensive landslide control program was undertaken to minimize these risks. Extensive stabilization was carried out at a slope that was especially critical in mid 2007. For the additional stabilization and support, DSI USA supplied a total of 368 double corrosion protected DCP Rock Anchors consisting of 1" (26mm) and 1 3/8" (36mm) grade 150: S 830/1035 N/mm² post-tensioning bars from their factory in Bolingbrook, IL USA. The 7.5-15m long DCP Rock Anchors were installed and grouted by Rodio Swissboring Panama and the stabilization of the anchors was complemented by massive concrete blocks.

Consequently, the last of the extension works at „Gaillard Cut“ were brought to an end and the minimum requirements for the visibility range were fulfilled. This project was the last one before the start of the widening of the complete Panama Canal in 2007.

INFO

Owner Panama Canal Authority (ACP - Autoridad Canal de Panama), Panama +++ **General Contractor** Constructora Urbana S.A. (CUSA), Panama City, Panama +++ **Contractor** Atlantic Tractor S.A. +++ **Subcontractor** Rodio Swissboring Panama, Panama City, Panama +++ **Engineers** Panama Canal Authority, Panama

DSI Unit DSI USA, BU Geotechnics, New Jersey, USA

DSI Scope Supply of 368 double corrosion protected DCP Rock Anchors, Ø 26 and 36 mm, grade 150: S 830/1035 N/mm²



PROTENDIDOS DYWIDAG: Specialist Supplier in Brazil

■ **PROTENDIDOS DYWIDAG**, the Brazilian company, was founded in July 1979 and has been operating out of its new headquarters in Sao Paulo since May 2005. From their office in the city's southern services area, 7 highly qualified employees attend to their clients' daily needs, while 18 more employees are involved in the production process in Guarulhos, in the northern area of Sao Paulo.

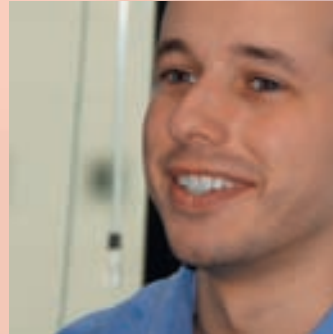
PROTENDIDOS DYWIDAG is characterized by a young and motivated team with an average age of 42. The company is highly profitable, doubling its turnover between 2005 and 2007. High growth rates are also expected in the future because PROTENDIDOS DYWIDAG will undoubtedly continue its contribution to important and responsible projects in Brazil.

PROTENDIDOS DYWIDAG is a company functioning within DSI's Construction division. In fact, 90% of their most important clients are active in the field of Construction, and all of them are located in Sao Paulo, where they can be supported and advised effectively on site.

PROTENDIDOS DYWIDAG is a specialist supplier for Geotechnical and Post-Tensioning applications as well as for Repair and Strengthening. The company mainly supplies grade 85/105, 32mm diameter hot-rolled DYWIDAG bars as well as *GEWI*® bars in identical diameters. In addition, the company offers 15mm DYWIDAG bars used as form ties as well as all of the accessories needed in this field of application.

The company's products are specifically characterized by their special anchor lengths. With their average length of 12m, the anchors are considerably more flexible to use and more economic in terms of application and transport than comparable products on the Brazilian market.

As a DSI subsidiary, PROTENDIDOS DYWIDAG attaches great importance to safety and quality. That is why all products fully comply with the Brazilian norm NBR 5629 for Geotechnical applications.



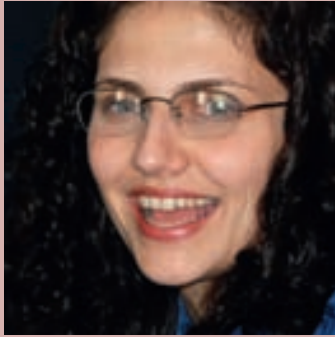
Otavio Pepe



José Luiz Castro



From left to right: Fabio Casaca, Mr. Toninho (Truck Company's owner), Carmine Esposito



Vania Dias



Haroldo Nogueira

Product quality is assured through factors such as ongoing R&D activities and the exchange of know-how with accredited organizations. The company is a member of ABMS, the Brazilian society for Geotechnics. ABMS is the official Brazilian representative of ISSMGE (International Society for Soil Mechanics and Geotechnical Engineering), ISRM (International Society for Rock Mechanics) and ITA (International Tunneling Association). Through its membership with ABMS, PROTENDIDOS DYWIDAG profits from important professional conventions and contacts to Geotechnical specialists.

In the future, PROTENDIDOS DYWIDAG will further expand its presence in niche markets. A stronger involvement of the company during the planning stage of engineering clients plays an important part in this development. The company will continue to attach great importance to close cooperation with their clients on site – always in accordance with the slogan

»Local Presence – Global Competence«



Galdino Mendes



Alessandro Morata



Marcelo Salustiano



Efficiency with Technique Béton: Customized Products for Modern Condominium

Special Concrete Admixtures for New Housing Estate in Rueil Malmaison, France



Plastic spacers

■ **Parisian suburbs are still very attractive to commuters. A great number of companies offer turnkey housing estates in these areas in order to keep up with the growing demand. This is why Bateg is constructing a new condominium in Rueil Malmaison near Paris for Kaufman & Broad.**

As a well-known supplier of new high quality real estate in the French market, Kaufman & Broad attaches great importance to first class quality. Therefore, Bateg asked Technique Béton to supply the special concrete additive superplasticizer Addifor 2001. This additive is characterized by its flexible adaptability: for achieving the required concrete compositions, it can either be added to the mixing water or afterwards. The high performance concrete superplasticizer ameliorates the concrete consistency, thus facilitating on site construction works. Simultaneously, the additive increases the mechanical stability of the concrete employed.

Another important product used in Rueil Malmaison is the setting accelerator Techniprise 25. This product is added at the beginning of the mixing procedure and is environmentally friendly because it is chlorine-free. Thanks to its special composition, Techniprise 25 is suitable for use in cold weather.

As a specialized supplier for Concrete Accessories, Technique Béton also delivered Laroche® magnet profiles. They allow a perfect positioning of spacings because of their magnetical characteristics and are therefore used in a wide range of construction projects. Magnet profiles by Technique Béton can be delivered in different shapes and sizes and are therefore very flexible in their use.



View of new residential condominium in Rueil Malmaison, France



Concrete mixing facility with superplasticizer Addifor 2001

INFO

Owner Kaufman & Broad, Neuilly sur Seine, France +++ **General Contractor** Bateg, Velizy Villacoublay, France +++
Architects Architectes J & E Haour, Paris, France, and SFICA, Paris, France

DSI Unit Technique Béton, Moissy Cramayel, France

Technique Béton Scope Supply of superplasticizer Addifor 2001, setting accelerator Techniprise 25 and Laroche® magnet profiles



Technique Béton Accompanies French Institute for Sports into the Future

Supply of Customized Products for Modernisation of INSEP in Paris, France

■ **The national institute for sports and high performance physical education in France (INSEP) has been educating the French sports elite since 1945. The institute is supervised by the ministry of education, cultural affairs and sports and combines high performance physical education with college education or vocational training for the 850 athletes currently residing at the institute.**

The INSEP is located in the Vincennes forest, in Paris, on an area that totals 78,000m². Since the complex of buildings was built between 1945 and 1958, it is now unable to comply with current standards. That is why sports facilities, school buildings and residential buildings are being modernized and restructured on an area of 30,000m². In addition, a new 13,000m² sports center is under construction.

The public sector contributed to the construction project with 55 million Euros, while 60 million Euros were provided by a Public-Private-Partnership (PPP). Technique Béton also participated by supplying its high quality customized products to this important project.

Technique Béton supplied the high performance repair mortar Fibraltchoc for window frames and door cases. This special one component mortar offers strong adhesion and high mechanical strength. The thixotropic material also offers excellent impact and abrasion resistance.

Biodem S was used as mould release agent. It is a non-polluting agent due to its biodegradability of over 60%.

Technique Béton is proud to have supported the expansion of the INSEP and the repair works with specialist know-how.



Repair mortar



Utilization of repair mortar Fibraltchoc



Storage of mould release agent Biodem S

INFO

Owner French Ministry of education, cultural affairs and sports, Paris, France +++ **General Contractor** GTM/Petit, Courbevoie, France +++ **Engineer** Barthelemy-Grino Architectes, Paris, France

DSI Unit Technique Béton, Moissy Cramayel, France

Technique Béton Scope Supply of repair mortar Fibraltchoc and mould release agent Biodem S



Customized Products by Technique Béton for Modern Housing Estate in Paris

Use of Concrete Admixtures and Mortars in Le Blanc Mesnil, Paris, France

■ **The city Le Blanc Mesnil with its high density of population is part of the Département Seine-Saint-Denis in the metropolitan area of Paris. The city is located on one of the major axes of economical development in the region of Ile-de-France. At the moment, a large number of housing estates is being built in this area within the scope of an urban modernization program. One of these compounds is constructed by SABP from Le Raincy. This housing estate is to contain 82 state of the art apartments.**

Among other products, Technique Béton supplied the two component self-levelling mortar Ravalchoc AL for this project. This mortar is used as levelling product. It has an exceptionally good adherence to concrete and high mechanical strength. In addition, Ravalchoc AL is not only waterproof, but also resistant to frost and de-icing salts.

The one component levelling product Finimur is used for smoothing uneven surfaces. It renders even surfaces and is characterized by its easy and quick application as well as its good adhesion to other surfaces.

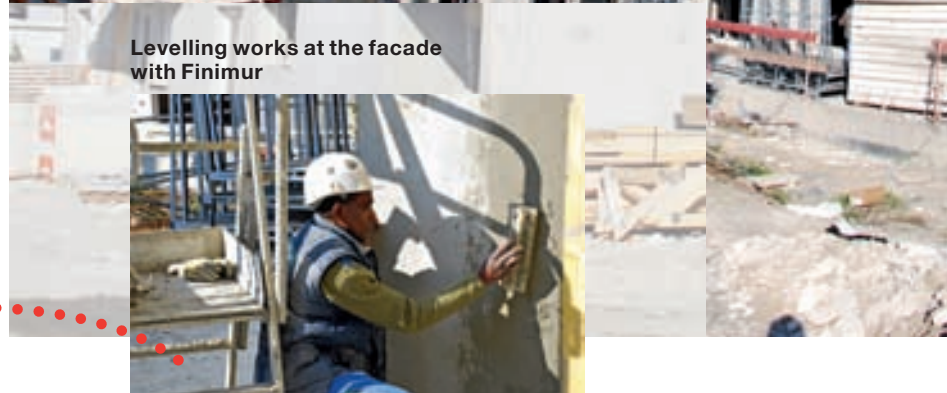
In addition, Technique Béton supplies Addifor 2001 as superplasticizer, while Biodem SI2 is used for the cladding. It does not stain and is therefore especially suitable for high grade facades. Biodem's biodegradability is above 60%, which is why it is especially environmentally friendly.

Once again, Technique Béton has made an important contribution to the construction of this modern housing estate with its high quality products.

Overview of new housing estate



Levelling works at the facade with Finimur



INFO

Owner Kaufman & Broad, Neuilly sur Seine, France +++ **General Contractor** SABP, Le Raincy, France +++
Engineer Remi Viard, Ile St Denis, France

DSI Unit Technique Béton, Moissy Cramayel, France

Technique Béton Scope Supply of: levelling products Ravalchoc AL and Finimur, concrete admixtures Addifor 2001 and Techniprise 25, and mould release agent Biodem SI2



Utilization of Ravalchoc AL (powder with resin) for floor levelling



Smoothing after application of levelling paste



Self-levelling mortar Ravalchoc AL





“Concrete Accessories” for Overhead Noise Barrier on A 86 near Paris

Customized Products by Technique Béton for New Motorway A86, Jouy en Josas, France

■ **As one of the busiest streets in Europe, the Boulevard périphérique, a multi-lane highway that leads around Paris, is notorious for its regular traffic jams.**

A new beltway, A 86, is now being built in order to relieve traffic congestion in Paris and to facilitate quick and easy connections between the different Parisian suburbs. The beltway leads around the Boulevard Périphérique at a distance between 5 and 7 km, replacing federal road RN 186, which will no longer be adequate for the high traffic volume.

Since reducing street noise is an important element in this construction plan, an overhead noise barrier is being built on the modern multi-

lane highway between Jouy-en-Josas and Vélizy-Villacoublay. This gallery-like barrier is going to reduce traffic noise to a maximum of 65 Decibels for the adjacent residential areas. The overhead noise barrier’s architecture is appealing and aerial. Furthermore, the barrier will blend in due to its being covered with resilient climbing plants.

Since the construction plan also included finding a solution for an easy and safe crossing of the motorway, a new pedestrian underpass was built.

Technique Béton delivered mould release agents Biodem SI 1 and Cirtec L to the job site. Both allow the easy removal of concrete from the mould while creating a homogenous high-

quality surface. In addition, Biodem SI 1 is especially environmentally friendly due to its biodegradability of over 60%.

Once again, Technique Béton’s products were chosen by the owner because of their excellent quality and reliability.



Overview of overhead noise barrier on motorway A86 near Paris



Detailed view of bearing profile with beams



Construction of the high quality smooth bearing profiles

INFO

Owner Direction Départementale de l'Équipement des Yvelines, Paris, France +++ **General Contractor** TPI/Dodin Sud, Toulouse, France +++ **Engineer** Marc Mimram ingénierie, Paris, France

DSI Unit Technique Béton, Moissy Cramayel, France

Technique Béton Scope Supply of mould release agents Biodem SI 1 and Cirtec L



Customized Products by Technique Béton for the New Lidl Logistics Center in France

Admixtures for Lidl Warehouse in Cregy lès Meaux, France

■ The rapidly growing discounter Lidl continues to strengthen its market position throughout Europe. In France, for example, Lidl is maintaining its position as the market leading discounter with approximately 1,000 retail outlets.

In order to further strengthen its position and to shorten supply routes within the country, Lidl is building a new central warehouse with a total area of 31,932 m² in Cregy lès Meaux, Seine et Marne. In this logistics center, non-food and dry products are to be centrally stored. In another part of the building complex, a cold storage unit is being constructed for accommodating perishable goods.

In logistics centers, high-quality floor slabs are especially important because of the steady flow of goods and material handling equipment. The industrial floor has to be extremely resilient in order to absorb any kind of dynamical load.

“Protecdal”, a product developed by Technique Béton, is applied during the extensive concreting works. Protecdal is a curing compound that



Utilization of Protecdal during concreting

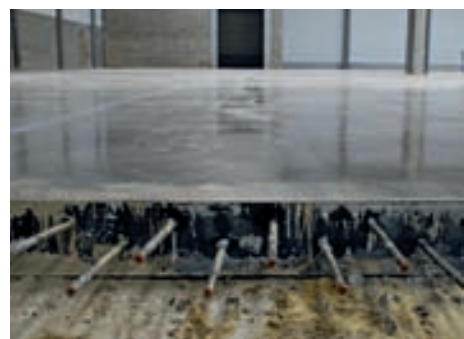
protects against the rapid evaporation of water from concrete. The product prevents dusting and shrinkage cracks.

Additionally, the superplasticizer Addifor 2001 is used on site. It is a powerful water reducing agent and significantly increases plasticity and workability. At the same time, this admixture improves the mechanical strength of concrete.



Franck Misandeau, Pierre Durand (right)

Technique Béton’s products once again were chosen by the client because of their quality and reliability.



Construction of the floor slab

INFO

Owner Lidl, Strasbourg, France +++ **General Contractor** Mendes, Neuilly sur Marne, France +++
Engineers Ageca, Boissy St. Léger, France
DSI Unit Technique Béton, Moissy Cramayel, France
Technique Béton Scope Supply of curing compound Protecdal and superplasticizer Addifor 2001



High Quality Products by Technique Béton for New Wastewater Treatment Plant

Mould Release Agent Decosyntec 2003 for Sewage Plant Marne Aval, Noisy Le Grand, France



Formwork elements,
height: 10.4 m

■ Every day, more than 3 million m³ of sewage water are processed in four major wastewater treatment plants in the conurbation of Paris, in the region of Ile-de-France. In order to cope with these huge amounts of water, the Marne Aval sewage plant in Noisy Le Grand, built in 1976, is now being modernized.

At present, the wastewater treatment plant treats sewage water for the 125,000 inhabitants living in Seine-Saint-Denis and Seine-et-Marne. By 2009, the plant is to have increased its daily capacity from 30,000m³ to 75,000m³ of sewage water. Three new buildings have been planned for this purpose – two facilities for treating water and sludge as well as a new office building. Since the area the future wastewater treatment plant will cover only takes up 3 instead of today's 8 hectares, new green spaces will be created.

During the construction works, individual tanks are being built using large surface formwork. Formwork is concreted to a height of up to 10.40m in a single step wherever possible. In order to guarantee the quick and reliable setting and stripping of the wall surfaces from the moulds, the owner decided to use mould release agent Decosyntec 2003.

Decosyntec 2003 is a high quality mould release agent. It offers corrosion protection and, in contrast to many similar products, does not stain surfaces.

Furthermore, Technique Béton developed special plastic cones for this construction project that were used for steels in special sizes during forming. Technique Béton also supplied the original Laroche[®] concrete spacers which are assembled into the formwork's reinforcement in order to guarantee proper spaces between the interior wall of formwork and the reinforcement. Laroche[®] concrete cones were used for sealing concreted walls. Technique Béton is proud to have contributed with high-quality products to this important infrastructural project.



Formworking at new plant building



Laroche[®] spacers



Especially developed plastic cones



Biodem SI 1 and Decosyntec 2003



INFO

Owner SIAAP (Paris metropolitan consortium for sewage treatment), Paris, France +++ **General Contractor** Urbaine de Travaux Parence, Eiffage TP, Spie Batignolle, Paris, France

DSI Unit Technique Béton, Moissy Cramayel, France

Technique Béton Scope Supply of mould release agent Decosyntec 2003, Laroche[®] spacers and concrete cones



Precast Factory Chazey-Bons: Successful with Customized Products from Technique Béton

Technique Béton supplies Quality Products to Precast Factory Chazey-Bons, Lyon,



View of production facility

■ **The Precast Factory Chazey-Bons in Lyon was founded in 2000 and produces precast elements such as stairs, bridge elements, retaining walls, piers and beams for commercial buildings. The company has established itself successfully in the French market.**

In order to guarantee the quality of their high grade precast elements, Chazey-Bons have been collaborating with specialized suppliers for years. Because of its long-standing know-how in the field of concrete technology and chemistry, Technique Béton is the ideal partner for Chazey-Bons Préfa.

Technique Béton supplies the following customized products to Chazey-Bons Préfa:

Mould Release Agent Décosyntec 2001: Moulds are treated with this high-quality mould release agent before casting the concrete so that precast elements can be easily removed after setting.

Admixture CRD 19: This chemical product is designed for the construction industry; it accelerates the setting of concrete. It was specifically developed for use in cold weather and to increase the use of moulds. Furthermore, it is successfully used with projects such as the construction of avalanche protection walls and -tunnels in alpine regions.

Mortar Finimur fin: this special one component mortar seals pores in concrete, thus creating smooth surfaces. Finimur Fin is easy to apply and shows excellent adhesion to different substrates.

Lifting and Fixing Tools: Eye anchors and lifting loops are especially important because of their fundamental lifting and fixing function.

Magnets: When producing stairs, Chazey-Bons also uses special Laroche® Magnets. These high performance magnets are used for stabilizing and fixating formwork during concreting.



Concreting and formworking



Storage yard for precast elements



Levelling of pores with Finimur Fin

INFO

Owner Chazey-Bons Préfa, Lyon, France

DSI Unit Technique Béton, Moissy Cramayel, France

Technique Béton Scope Supply of Special Mortar Finimur Fin, Mould Release Agent Décosyntec 2001, Setting Accelerator CRD 19, Lifting and Fixing Tools and Laroche® Magnets



White Concrete Cladding for Hotel in Marseille

Technique Béton successfully contributes to Hotel Compound in Europe's Third Largest Seaport, Marseille, France



Overview of the construction site

Detailed view of the facade

■ **The third largest European seaport, Marseille, is not only an attractive destination for tourists, but also an important location for the French industry. In order to meet the great demand for hotel rooms created by tourists and business people each year, a new building compound is being constructed in Marseille. This new compound will not only include parking spaces and shops, but is also going to contain a Suitehôtel as well as a new IBIS-hotel.**

For this project, Technique Béton supplied high quality concrete admixtures, special mortars and magnet stripes for recesses.

The use of „white concrete“ is one specific feature within this project. This fair faced concrete forms the finished surface, thus making further wall cladding redundant.

Special two component mortars Ravalchoc NF and Ravalchoc blanc are used for smoothing concrete. The high performance mortar Ravalchoc NF achieves a compressive strength of 58MPa after 28 days.

Technique Béton also supplied the mould release agents Décosyntec 2001 and 2003 for stripping precast elements from formwork. Both products are water resistant and offer corrosion protection.

In addition, very thin magnetic stripes with strong magnet forces are used for recesses. Thanks to the mould release agents Décosyntec, these magnets can be easily removed from the mould after finishing the concreting works.

Technique Béton is looking forward to contributing to new important infrastructural projects in France in the future.

INFO

Owner SCI-Coeur Méditerranée, Ilot D3, Marseille, France +++ **General Contractor** Eiffage construction, Marseille, France +++
Subcontractor SOCOTEC SETOR, Marseille, France

DSI Unit Technique Béton, Moissy Cramayel, France

Technique Béton Scope Supply of mould release agents Décosyntec 2001 and 2003 and of special mortars Ravalchoc NF and Ravalchoc blanc



Customized Products for Wastewater Treatment Plant

Technique Béton Contributes to the Modernization of one of the Largest Sewage Plants in France

■ The municipality Marseille Provence Métropole (MPM) treats sewage water for 18 parishes with more than 980,000 inhabitants in Greater Marseille. The wastewater treatment plant has been operating since 1987 and is located directly below the center of Marseille. On average, the plant treats 360,000 m³ of water per day, which is why it is one of the largest subterranean wastewater treatment plants on earth.

Because the plant no longer complied with European norms, it was fundamentally repaired and enlarged. A subterranean biological treatment with a total surface area of 20,000m² was added to the plant in order to minimize the water's organic content as well as its contamination from detergents. Since the sewage plant discharges its treated water directly into the Mediterranean Sea, the water quality around Marseille was also significantly improved by this measure.

Technique Béton supplied the following products for this major project:

Repair Mortars Ravalchoc 0/5, Ravalchoc NF and Ravalchoc blanc

These two component mortar mixtures are used for levelling concrete and attain excellent compressive strength in a short amount of time.

Finimur Fin Clair

This one component levelling mortar closes pores in concrete, thus creating a smooth surface. It demonstrates excellent adhesion to different substrates.

Mould Release Agent Décosyntec 2001

This product allows easy removal of precast elements from the mould and offers reliable protection against corrosion. This product is a synthetic base.



Sealed surfaces in subterranean sewage plant

Concrete Bonding Agent Copox colle reprise

Smoothly bonds fluid with solid concrete and is suitable for use on damp grounds. Copox colle reprise can be used for repairing cracks in concrete or, as in this case, for creating waterproof surfaces.

With their customized products, Technique Béton successfully contributed to the modernization of Marseille's wastewater treatment plant.





Technique Béton staff talking to job site personnel



Utilization of Ravalchoc (powder with resin) for floor levelling



View into pump room

INFO

Owner Municipality Marseille Provence Métropole (MPM), Marseille, France +++ **General Contractor** Dumez Méditerranée, Aix-en-Provence, France; Eiffage TP, Marseille, France; GTM, Marseille, France +++ **Engineers** OTV, Marseille, France; OTH, Marseille, France +++ **Subcontractor** Socotec, Marseille, France; Veritas, Marseille, France

DSI Unit Technique Béton, Moissy Cramayel, France

Technique Béton Scope Supply of repair mortars Ravalchoc 0/5, Ravalchoc NF, Ravalchoc blanc and Finimur Fin Clair, mould release agent Décosyntec 2001 and concrete bonding agent Copox colle reprise



Tauern Tunnel's Second Tube Completely Driven and Secured using ALWAG Tunnel Solution Systems

Second Tube of the Tauern Tunnel, Flachauwinkel, Salzburg, Austria



■ The Tauern Highway ranks among the most important north-south transportation links in Austria. For transalpine on-road passenger and goods traffic, it is one of the essential routes crossing the Alps. Of the 12 tunnels on this highway with a total length of approx. 24km, the 6.5km long Tauerntunnel is by far the longest and best known. It is one of the last two remaining single-tube tunnels and the major bottleneck of the Tauern

Highway. To provide a continuous two-lane highway connection, excavation works for the second tube started in September 2006.

According to the working schedule, the primary excavation is to be completed by the end of 2008. The opening for traffic is planned for midyear 2012.

The construction of the first tube of the Tauern-tunnel in the beginning of the 1970s marked a milestone not only in the Austrian Tunneling History. For the first time after World War II, a traffic tunnel was excavated in squeezing rock mass. Far beyond the borders of Austria, experiences gained during the construction of this project contributed to the worldwide development of modern tunneling techniques. The difficult ground conditions at the Tauern-tunnel resulted from the need to excavate through a thrust plane as well as from the superimposition height of over 1,000m.

Another technical challenge in the course of the construction works worth mentioning was the heading through a debris slope with an approximate length of 330m. The material in this area primarily consists of cohesionless fine to middle grained gravel that is partially interspersed with larger boulders. All rock reinforcement and support systems such as PANTEX® Lattice Girders, Rebar Rock Bolts with special rib geometry for squeezing rock mass conditions, Forepoling Boards, and Injection Spiles- just to mention a few- were exclusively distributed by ALWAG. Especially during excavation through the debris slope zone, 2.5-3.0m long forepoling boards which were rammed into the ground above the lattice girders proved their capability as

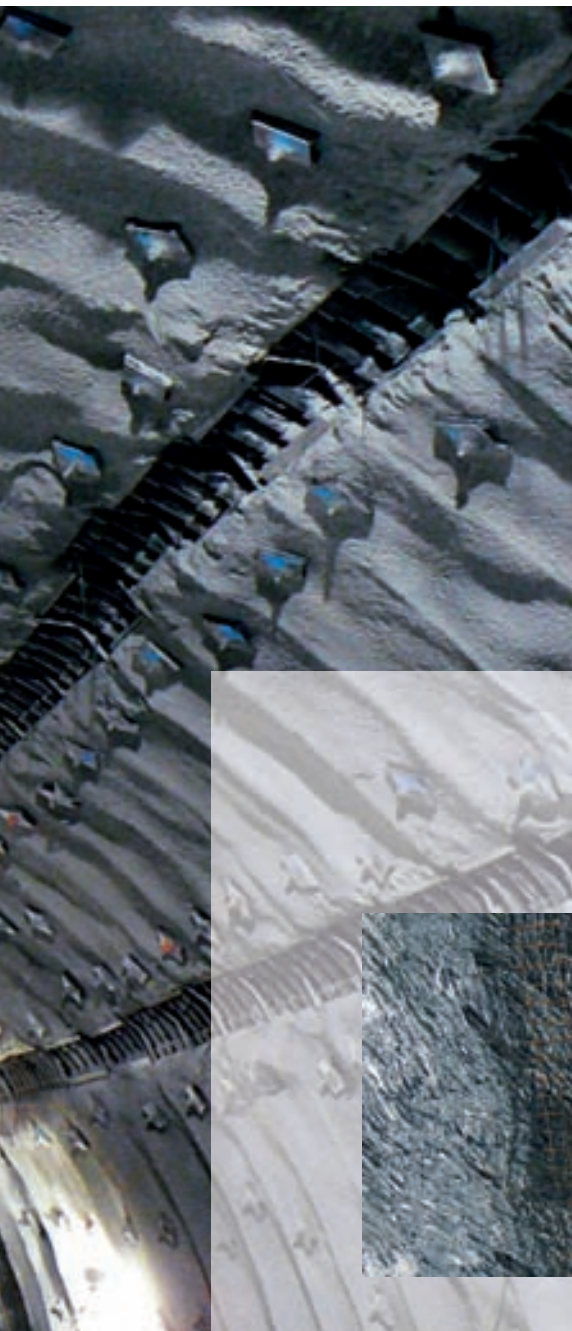
pre-support system for the extremely difficult ground conditions in this area.

Due to squeezing rock mass conditions, long-term deformations of up to 1.2m were measured during construction of the first tunnel tube. These large deformations lead to overstressing and a complete rupture of the shotcrete lining. As a consequence, longitudinal deformation gaps were introduced to divide the tunnel lining into sections to protect the shotcrete against overstressing. By doing so, the shotcrete lining could accommodate larger displacements without damage up to the point when the deformation gaps were closed because of radial displacements.

However, a disadvantage of this method was that the required load-bearing capacity of the shotcrete lining could not be provided due to the division into segments. As a consequence, additional and uncontrolled displacements did take place that had a negative effect on the excavation. To eliminate this disadvantage, today, deformable ductile elements are placed into deformation gaps when they are employed under these conditions. These so-called AT – LSC-Elements (Lining Stress Controllers) were developed at Graz University of Technology in cooperation with ALWAG, which is responsible for the exclusive worldwide distribution of this patented support system for squeezing rock mass conditions.

By using AT – LSC-Elements, large deformations that occur during excavation of the second tube of the Tauerntunnel can be controlled and the load bearing capacity of the support and ductility of the tunnel lining is ensured. In combination with AT – LSC-Elements, rebar rock bolts with an ultimate load of 350kN and special rib geometry for squeezing rock masses (related rib area between 0,02 and 0,04) ensured the excavation through difficult ground at the Tauerntunnel project.

ALWAG is proud to contribute to this prestigious traffic infrastructure project with its comprehensive assortment of tunneling solutions. After finalization of the second tube, traveling along the Tauern Highway will become safer and delays will be eliminated.



INFO

Owner ASFINAG Bau Management GmbH, Vienna, Austria +++ **General Contractor** PORR Tunnelbau GmbH, Vienna, Austria +++ **Planning Agency** IGT – Geotechnik und Tunnelbau, Salzburg, Austria +++ **Supervision** ARGE Spirk & Partner Ziviltechnikergesellschaft m.b.H., Salzburg, Austria, and Müller + Hereth GmbH, Freilassing, Germany
DSI Unit ALWAG Tunnelausbau Gesellschaft m.b.H., Pasching/Linz, Austria
ALWAG Scope Supply of PANTEX® Lattice Girders, IBO-Self-drilling Anchors and Spiles plus Accessories, Rebar Rock Bolts with standard and special ALWAG rib geometry for increased bond capacity, Expandable Friction Bolts, Rebar Spiles, Tube Spiles, Forepoling Boards, AT – LSC-Elements (Lining Stress Controllers), Pull Testing Equipment for Anchors and Rock Bolts; technical assistance



Innovative Rock Support System for Squeezing Rock Mass Conditions

■ The Metsovo Tunnel is located in the Pindus mountain range between the Epirus and West Macedonia administrative districts south of the village Metsovo. This tunnel is part of the A2 Egnatia Motorway (E90 according to the international E-road network), which is the east-west highway connection in Greece and one of the largest ongoing road construction projects in Europe.

As a priority project of the European Union, the 670km long Egnatia Motorway will enhance the transportation network between east (Greek-Turkish border) and west (Adriatic and Ionian Sea) as a modern complement to the ancient Roman Via Egnatia which linked Italy and Byzantium. Experts indicated that traveling times, compared to traffic on existing transportation links, should be cut in half. In addition, the economic development of Northern Greece should be significantly accelerated and the Epirus, Macedonia, and Thrace districts should be brought out of their infrastructural isolation. The total costs for the Egnatia Motorway are estimated to be in the range of 5 billion Euros.

In the course of building the 74 twin-tunnels of the Egnatia Motorway with a total length of 50km, accounting for approximately 7% of the overall highway length and 30% of the construction costs, difficult ground conditions had to be overcome for some of some tunnels. One of these tunnels is the second tube of the Metsovo Tunnel. The construction of the 3.5km long tunnel which started in 2006 were undertaken by Aktor S.A. using the principles of the New Austrian Tunneling Method (NATM). In this method, excavation is divided into different faces (top heading, bench, and if necessary invert) and is conducted by drilling and blasting or tunnel excavators.



Metsovo Tunnel / Tunnel portal

The geological conditions at Metsovo can briefly be described as follows: in the western tunnel area, the ground consists of a wide thrust fault zone characterized by a heterogeneous composition of weak fault rocks; the eastern part mainly consists of magmatic rocks. As part of the primary lining, which stabilizes the rock mass temporarily after excavation, the following rock support is installed: shotcrete with steel reinforcement, lattice girders and steel arches, rock bolts, and in some critical sections AT-LSC-

Elements (Lining Stress Controllers) as support for squeezing rock mass conditions. This unique and patent-registered support system was developed at the Institute for Rock Mechanics and Tunnelling, Graz University of Technology, Austria, and is distributed worldwide exclusively by ALWAG.

AT-LSC-Elements, which are installed in circumferential deformation gaps, divide the tunnel lining into longitudinal segments. Due to the

INFO

Owner Egnatia Odos A.E. (EOAE), Greece +++ **Contractor** Aktor S.A., Athens, Greece +++ **Consulting Engineers** 3G Gruppe Geotechnik Graz ZT GmbH, Graz, Austria

DSI Unit ALWAG Tunnelausbau Gesellschaft m.b.H., Pasching/Linz, Austria

ALWAG Scope Supply of AT-LSC-Elements; technical assistance



Excavation works at the Metsovo Tunnel

elements' well-defined load-deformation characteristics, large deformations which occur during excavation in unfavourable (e.g. squeezing) rock can be controlled. By doing so, overstressing of the lining is prevented and the load-bearing capacity of the support and ductility of the tunnel lining is ensured. Another unique feature of AT-LSC-Elements is worth mentioning as well: the load-displacement behaviour (load line) is adjusted to project-specific demands, providing for a smooth initial load development and a constant final design load.



When construction is attempted under similar unfavourable ground conditions without using AT-LSC-Elements, severe overstraining of the tunnel lining can occur resulting in significantly higher construction costs. Today, planners and contractors make use of this optimized and reliable support system that has been successfully proven during construction of several tunnels in difficult ground conditions.



AT-LSC-Elements / Division of the tunnel lining into longitudinal segments



Excavation of Large-Scale Caverns in Difficult Ground Conditions

Sentvid Tunnel, Sentvid Caverns, Ljubljana, Slovenia

■ **The flow of traffic in the course of the transalpine cross-border trade from Austria to Slovenia starts in the south of Austria near the city of Villach. From there, traffic continues through the Karawanken Mountain Range that is part of the Southern Limestone Alps to the foothills to Ljubljana, the capital city of Slovenia.**

The last bottleneck in this supra-regional traffic connection has now been eliminated by the construction of the Sentvid Tunnel. This tunnel

links the Karawanken Highway from the north and the Ljubljana city bypass. As a result, the connection from Ljubljana's highway ring road to traffic destinations in the southeast such as Trieste, Rijeka, and Zagreb, has now been completed.

To enhance the transport connections in the city area, the Sentvid Tunnel is also linked to the highly frequented access road "Celovska Cesta". This link road to the underground highway is accomplished by means of two one-way ramp tunnels that are constructed in two

caverns with a maximum cross-section of 360m². Due to difficult ground conditions and the proximity of the existing tunnel sections, large deformations were expected in the cavern areas.

Based on lessons learned during the construction of the Sentvid Tunnel, the support design of the caverns was modified. The original radial bolting concept using IBO-Self-drilling Anchors (ultimate load: 320kN) was replaced by a more efficient rock reinforcement system. Using this system in combination with AT – LSC Elements





(Lining Stress Controllers), the expected large rock deformations were controlled to ensure the integrity of the shotcrete lining.

The designer considered the following requirements for the alternative rock reinforcement system: rock bolting works should be easily accommodated by the personnel on-site; a proper bond between rock bolt and rock mass had to be guaranteed, and the minimum breaking load of each rock bolt should be 400kN. When looking for the proper rock reinforcement system able to comply with the design requirements, ALWAG's IBI-Self-drilling Anchor system was the logical choice.

This system has the advantage that its installation principle is similar to IBO-Self-Drilling Anchors; in addition, the use of post-grouting couplings allows the complete injection of the annulus between the anchor and the rock mass. The criterion of a minimum breaking load of 400kN was fulfilled using the IBI R 38/51 system with a yield load of 420kN.

To verify the performance characteristics of this system, which was new on the Slovenian market, the project owner required that a series of tests be conducted. In the course of these tests, IBI – Self-drilling Anchors were installed into the tunnel face. It turned out that the development of an optimum grout body was warranted by

multiple re-injections at high pressure (approx. 40 bar). Subsequently, the IBI-anchor system was approved by the owner for on-site usage.

The outer lining of the caverns was completed in the fall of 2007 without any problems. By installing AT – LSC-Elements into deformation gaps of the shotcrete lining, damage to the lining due to large rock mass deformations was prevented and an optimum utilization of the load-bearing capacity was ensured. The application of IBI-Self-drilling Anchors for systematic tunnel reinforcement significantly contributed to the successful construction of the large-scale Sentvid Caverns.

INFO

Owner DARS d.d., Ljubljana, Slovenia +++ **General Contractor** SCT d.d., Ljubljana, Slovenia +++ **Planning Agency** Elea iC d.o.o., Ljubljana, Slovenia +++ **Supervision** DDC d.o.o., Ljubljana, Slovenia

DSI Unit ALWAG Tunnelausbau Gesellschaft m.b.H., Pasching/Linz, Austria

ALWAG Scope Supply of IBI Self-drilling Anchors with Post-grouting Couplings plus

Accessories, AT – Flow-Pressure Meters, AT – LSC-Elements (Lining Stress Controllers); technical assistance on site







DSI's Mining and Tunneling Seminar in Central America

February 17-24, 2008



■ In keeping with DSI's mission statement "*Local Presence – Global Competence*", DSI-Soprofint organized a Mining and Tunneling Seminar for clients and interested parties which was hosted in Central America in February 2008.

In recent years, DSI has successfully expanded its Mining and Tunneling activities in North and South America. In addition to these major business areas, Central America is another ascending market in need of ground control systems for its rapidly developing and spreading Mining and Civil Engineering projects. Participation in this development is both a major opportunity and a challenge.

From February 17th to 24th, four seminar events, each with four presentations, took place in the following countries: Panama, Costa Rica, and Guatemala. The authors making contributions to these seminars were all from DSI:

Mining Division:

Luis Talamilla (DSI-Soprofint, Chile) and Roland Walker (DSI Mining America, USA)

Tunneling Division:

Larry DeGraff (American Commercial Inc., USA) and Wolfgang Dolsak (ALWAG, Austria)

The seminars successfully presented the wide product range of DSI's "one-stop-shop" to customers of the Mining, Tunneling, and Civil Engineering business. In addition, they offered an excellent opportunity for the members of the Mining and Tunneling Divisions to experience face-to-face contact with planners, contractors, and technical engineers concerning state-of-the-art ground support systems. Various contacts that have been established during these seminars are expected to be the kick-off for effective cooperation and business growth in Central America.



ITA-AITES World Tunnel Congress, Prague, Czech Republic

May 5-10, 2007

■ **The ITA-AITES World Tunnel Congress (WTC), held in Prague in 2007, was a big success for everyone involved. More than 1,380 participants from approximately 50 countries actively participated in the congress and 80 exhibitors presented their products at this important international platform.**

For DSI, WTC was an excellent occasion to present its high quality Underground products to professionals and to simultaneously cultivate contacts to clients from all over the world. For the first time, all of the DSI companies that specialize in tunneling were actively represented at DSI's stand. The companies included were ALWAG Tunnelausbau Ges.m.b.H., Austria; Commercial Structures and Systems LTD., Great Britain; American Commercial Inc., USA; DSI-SOPROFINT, Chile and DSI Tunneling, Australia.

The congress motto "Underground Space – the 4th dimension of Metropolises" provided DSI with the opportunity to present innovative systems for Tunneling and recent developments in Geotechnics.

As before, DSI was very satisfied with the outcome of its WTC attendance and has decided to actively participate in the next international World Tunnel Congress in India from September 19th to 25th.





DSI Develops Geo Grid for Safe Longwall Relocation

R&D Activities in Australia

■ Longwall mining is a very efficient method for exploiting underground coal seams, with large blocks of coal being mined in a short time. However, the longwall mining equipment has to be relocated to a new location after mining of a block has been completed.

A new polyester geo grid developed by DSI Australia now makes this relocation quicker and easier. The geo grid is placed over the longwall shields to facilitate their removal.

DSI Australia assembled this geo grid for the Springvale Colliery managed by Centennial Coal Company Limited, one of the largest coal producing organizations in the Australian federal state of New South Wales. Springvale Colliery is located in central New South Wales, about 15 minutes' drive from the mining town of Lithgow. The mine uses a 305 meter long wall to mine 3.5km blocks of coal in the Lithgow seam.

The length of the Springvale long wall is another challenge during the relocation of the longwall equipment. The new geo grid is an integral part of the dangerous relocating process, providing a barrier between the loose material in the goaf and the drive in which the miners remove the equipment.

The development of this special geo grid for Springvale Colliery is another good example for DSI's client orientation. The process requires the constant close communication between DSI and representatives of their clients. In particular, tests are carried out in collaboration on site and concepts for solutions are closely coordinated.

This was also the case at the Springvale Mine, where DSI went underground for an inspection of local conditions and worked through and approved a pre-check list together with mine personnel.

The conclusions drawn from this procedure formed the base for DSI's design of the geo grid.





Subsequently, manufacturing and test plans were also presented to the mine owner for approval. Furthermore, mine representatives visited the DSI factory to inspect the assembly and the loading of the geo grid for transportation.

The critical point in the application of every geo grid is the process of pulling the assembly across the longwall face. DSI Australia provided supervision during this phase, with a full report being supplied after relocation.

DSI Australia has participated at the last four relocations at Springvale Colliery. Excellent teamwork between DSI and the colliery allows the quick installation of the geo grid, thus speeding up the relocation process and making it considerably safer.



INFO

Owner Centennial Coal Company Limited, Sydney, NSW, Australia

DSI Unit DSI Pty. Ltd., Bennetts Green, NSW, Australia

DSI Scope Development, production and supply of special geo grid for the stabilization of longwall relocations



Fast Heading Development Through Innovative DSI Strand Anchors

Construction of the Decline to Cadia East Orebody, New South Wales, Australia



■ For many years, raw materials have been extracted from the Cadia Valley, approximately 250km west of the Australian Metropolis of Sydney. Lately, comprehensive soil analyses revealed the presence of additional major gold and copper deposits in the eastern edge of the Cadia Hill open pit orebody. The orebody in this area is mined by Newcrest Mining Limited, a leading developer and owner of gold and copper mines. In 2005, Newcrest began to open up the raw material resources in Cadia East.

Geologically speaking, Cadia East is located in a porphyry zone with gold-copper mineralization. The system has a length of approximately 2.5km and is up to 600m wide. Test drilling indicated that the orebody extended to 1.9km below the surface. The mineralised resource estimate for Cadia East is 18 million ounces of gold and 2.9 million tonnes of copper.

Part of this general development project is a decline to access the Cadia East orebody. At the beginning, cross cuts were stabilized using common grouted cable bolts. However, for security reasons, during the grout curing time, heading development could not continue until the cable bolts had reached their defined load-bearing capacity.

DSI Australia was contacted by Newcrest Mining Limited to investigate possible alternatives to the traditional cable bolting methods. DSI proposed to adapt their Hi-Ten Strand Bolt to Newcrest's requirements. DSI recently developed this high capacity bolt especially for requirements in underground coal mines.

The Hi-Ten Strand Bolt is anchored "from the bottom up". At first, anchorage is achieved in a length of 2m by using resin. The Hi-Ten Strand Bolt is then tensioned to 250kN, thus providing immediate stabilization of the development area. Grout injection can be carried out immediately or at a later stage. Consequently, decline development can proceed at once, independent of the grouting process and curing time.

Post-groutable Hi-Ten Strand Bolts are especially suited for areas in which full resin encapsulation is impossible due to technical limitations or unstable rock layers.

Thanks to the use of Hi-Ten Strand Bolts, the Cadia East project was able to achieve record-breaking development rates. Utilizing Hi-Ten Strand Bolts considerably accelerates the installation cycle because grouting of the Hi-Ten Strand Bolts is carried out independent of heading development.

Cadia East is an excellent example of DSI's innovative strength and commitment to fulfilling their customers' needs. The satisfied client Newcrest Mining Limited now uses Hi-Ten Strand Bolts at each of the declines for the new Cadia East Mine.

INFO

Owner Newcrest Mining Limited, NSW, Australia

DSI Unit DSI Pty. Ltd., Bennetts Green, Australia

DSI Scope Modification and supply of Hi-Ten Strand Bolts



DSI Australia receives Award for Successful Export Activities

HunterNet Chairman's Awards 2007

■ **DYWIDAG-Systems International Pty. Ltd. (DSI Australia)** is a patron member of the HunterNet group that encourages measures for enhancing manufacturing excellence in the Hunter Valley Region.

To recognise the efforts and contribution of its members through 2007 to the Hunter Valley manufacturing network, HunterNet held its Chairman's Awards Dinner in November 2007 in the Newcastle town hall.

At this event, DSI Australia was awarded the prestigious HunterNet Export Award. The Export award category recognises a HunterNet member business that has developed and implemented a successful export strategy. Andrew Boychuk, Research and Development Engineer at DSI Australia, was on hand to accept the award on behalf of DSI.

This award is an important recognition of the export strategy which has been successfully developed and implemented by DSI Australia. The fact that the expanding export business of high quality mining products and systems represents an increasing portion of DSI Australia's annual turnover is ample proof of the success of DSI's marketing and sales strategy.



Andrew Boychuk accepting the Export Award from Chris Jones

INFO

HunterNet is a co-operative which was founded in 1992 in the Australian Hunter Region. It has more than 80 member companies which represent the major manufacturing and engineering industries in the state of New South Wales. HunterNet's board of directors promotes the interests of its members by providing networking connections and important opportunities for strategic growth.

HunterNet's aim is to further enlarge its position as one of the most important manufacturing networks in the Hunter Region. Its members can actively exchange know-how with other member companies and, when purchasing, profit through combined vendor contracts, which are more efficient than individual contracts. In addition, HunterNet also offers help with projects through collaboration agreements or cross-industry teams to face challenges which are common to a large number of businesses.

By offering several awards for different key activities in business, Hunter Net enhances growth in New South Wales by providing new incentives for performance to local companies.





DSI Stabilizes Australia's Mine of the Year

DSI Supplies Quality Products for Awaba Mine, New South Wales, Australia

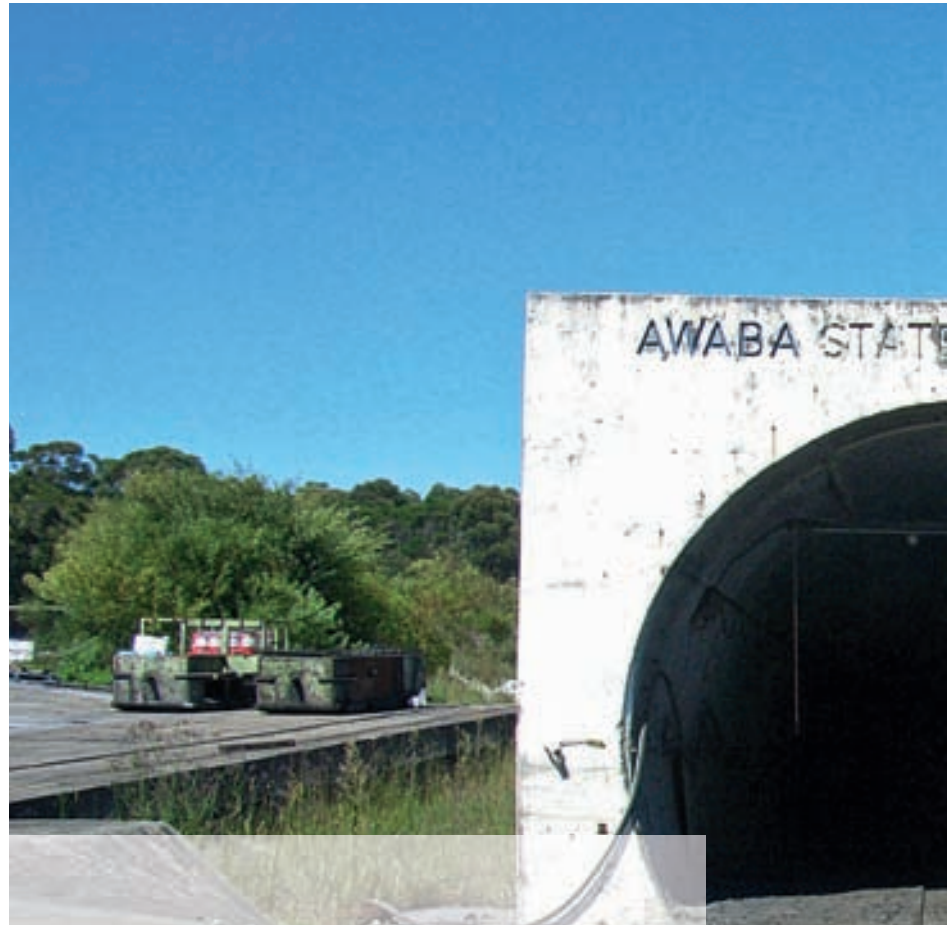
■ **At the 2007 Annual Australian Mining Prospect Awards gala ceremony, the title "Australian Mine of the Year 2007" was awarded to Awaba Mine.**

Located south of Newcastle in New South Wales, Australia, Awaba Mine is an underground operation run by Centennial Coal. Each year, 73 employees produce around 740,000t of coal that is sold both to a local power station and on the export market.

The Mine was awarded the title because its life had been successfully extended by more than two years, allowing the recovery of an additional two million tonnes of salable coal.

The extension of coal exploitation in the Awaba Mine was made possible by innovations and an extension of the mine to which DSI contributed.

DSI Australia supplied high-quality and innovative Mining Products to the mine. The delivery



included products such as rock bolts, anchor plates and resin cartridges with a maximum degree of security as well as quick and easy installation procedures.

In accordance with its slogan **“Local Presence – Global Competence”**, DSI delivered the necessary products and systems just in time from its production facility in Bennetts Green, in

close vicinity of the coal mine. DSI Australia is looking forward to continuing its support for Centennial Coal by supplying important mining products in the future.



INFO

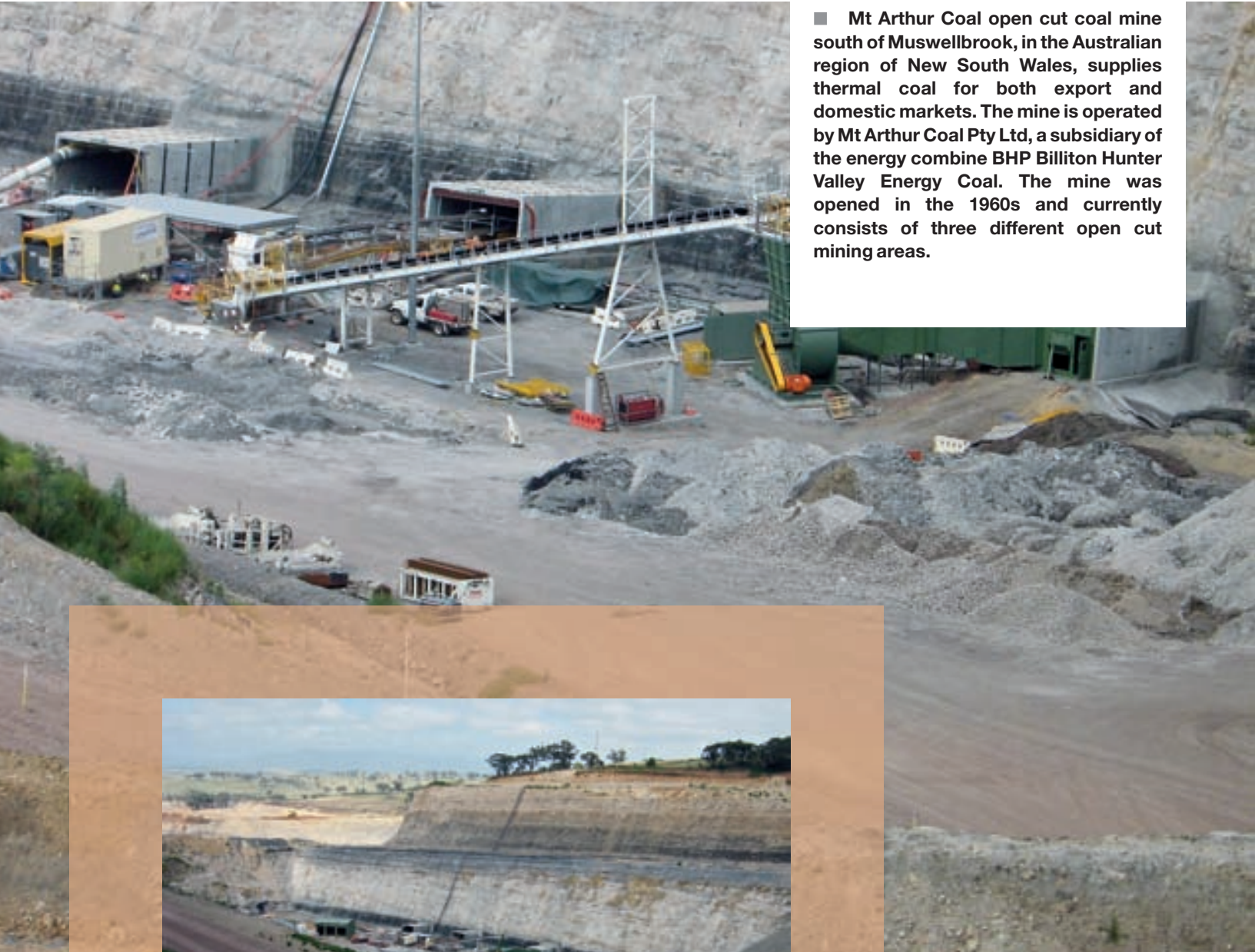
Owner Centennial Coal, NSW, Australia
DSI Unit DSI Pty. Ltd., Bennetts Green, Australia
DSI Scope Delivery of rock bolts, anchor plates and resin cartridges



DSI Provides High Quality Mining Products for Australian Exploration Adit

BHP Billiton Adit, New South Wales, Australia

■ Mt Arthur Coal open cut coal mine south of Muswellbrook, in the Australian region of New South Wales, supplies thermal coal for both export and domestic markets. The mine is operated by Mt Arthur Coal Pty Ltd, a subsidiary of the energy combine BHP Billiton Hunter Valley Energy Coal. The mine was opened in the 1960s and currently consists of three different open cut mining areas.



To meet increased export demand for coal, Mt Arthur Coal is currently investigating the potential for underground mining in some areas of the mine. The Mt Arthur Coal Underground Project will access the coal reserve through existing open cut pits. This allows the use of existing infrastructure, including the coal handling and preparation plant (CHPP) and rail loading facility.

The concept mine plan involves longwall mining in five seams. The relevant underground seams are estimated to have a total reserve of over 160 Million tons. In addition, further, lower coal seams are estimated to assure underground mining for approximately 50 years. The owner is expecting a production rate of up to 8 million tons of coal per annum, with a total production of 23 million tons of coal per annum for Mt Arthur Coal Mine as a whole, i.e. including resources that are already being mined.

As part of the feasibility study, an exploration adit was constructed in the Woodlands Hill coal seam. DSI also participated in the construction of this new adit. The exploration adit borders existing pits and will have a length of approximately 3,600m once completed. In addition, the adit is to be used for mining coal and is expected to produce 200,000 t of run of mine coal within 2 years' time.

In addition to producing coal, the exploration adit will provide valuable information for detailed mine and infrastructure planning. One important aspect is to gather more detailed information about the underground coal mining resource that cannot be gathered by surface exploration techniques. In addition, further information regarding the geological setting, data on coal quality and conditions for exploitation are to be gathered. Collecting geotechnical

information for safe underground mining operation is another key aspect of the project.

Due to DSI's high quality products, technical support and excellent logistics network, BHP Billiton selected DSI from all potential ground support suppliers. DSI supplies rock bolts, resins, anchor plates and special "mambo bolts" for this project.



INFO

Mine Mt Arthur Underground Project, NSW, Australia +++ **Owner** BHP Billiton, Australia
DSI Unit DSI Pty. Ltd., Bennetts Green, Australia
DSI Scope Supply of rock bolts, resin, anchor plates and special "mambo bolts"



DSI Preserves History: Stabilization of Historic State Coal Mine in Australia

Rock Anchor Installation at Wonthaggi State Coal Mine

■ At the start of the 20th century, the Australian region of Victoria was completely dependent on coal supplies from other regions. Since the colony had no coal production of its own, high prices and disruptions to supply were a recurring problem. When Victoria was cut off completely from its coal supply as a result of a strike in New South Wales in 1909, the decision was made to open Wonthaggi State Coal Mine, at approximately 150km from Melbourne.

During its 59 years of existence, the colliery delivered more than 17 million tons of coal that were used for the railway, several power plants and for industrial and domestic purposes. Since the demand for coal strongly decreased once diesel locomotives were introduced, the mine was closed in 1968. Another reason for closing the colliery was the fact that it no longer complied with safety regulations. In fact, during its operational life, the mine was considered to be one of the biggest and most dangerous mines in Australia.

Recently, the government of Victoria decided to reopen the mine as a museum. In order to guarantee the safety of the visitors, the old mine had to be extensively stabilized. As an expert for mining products, DSI Australia was awarded a contract to supply the complete range of strata control products such as cable bolts, plates, grout, drill rods and accessories. Two experienced DSI employees were on site to guide and supervise the installation process.

Volunteers, including former miners, were expertly trained by DSI's employees. Thus, the



roof bolts necessary for stabilization could be installed quickly and easily using a hand held roof bolter and a drill rig that had also been supplied by DSI Australia.

The comprehensive stabilization works at Wonthaggi State Mine are to be finished in time for its 100th opening anniversary.

INFO

Owner federal government of Victoria, Australia

DSI Unit DSI Pty. Ltd., Bennetts Green, Australia

DSI Scope Supply of roof bolts and anchors; training of workers and supervision of installation works



AIMEX (Asia-Pacific's International Mining Exhibition), Sydney, Australia

September 4-7, 2007



■ AIMEX, which has been in existence since 1970, takes place every four years. It is the leading and largest trade fair for mining in Asia/Pacific. In 2007, more than 500 exhibitors and 12,000 interested visitors from 38 countries participated in the exhibition. In comparison to 2003, visitor numbers increased by 6.2%. Participants' numbers from outside of Australia increased by 40%.

As a global company, DSI took an active part in AIMEX, presenting its innovative range of underground products that are tailored to suit individual customers' needs.

DSI's exhibit booth was once again a very popular gathering point for many international experts in attendance. For DSI Australia, AIMEX is the ideal platform for strengthening existing international customer relationships and for establishing a variety of new and interesting business contacts.





DSI – Leading Manufacturer of Underground Mining Products for Gold Mines in South Africa

Deepening of Gold Fields Ltd.’s Driefontein Mine



Driefontein’s shaft No 5

■ **DSI is South Africa’s leading manufacturer and supplier of underground mining products. Its clients are South Africa’s largest mine operators, including the Driefontein Mine owned by Gold Fields Ltd. The Driefontein mine alone consumes 50,000 grouting rods per month.**

Gold Fields Ltd., one of the world’s largest precious-metals producers, has an output of approximately 4.1 million ounces gold (about 116t) per year from its mines in South Africa, Ghana, Australia, Venezuela and Peru. Gold Fields Ltd. has ore reserves of 65 million ounces and mineral resources of 179 million ounces. Its investments have played a leading role in the development of the South African gold-mining industry.

South Africa’s 35% share of the world’s known global gold reserves is by far the world’s largest, followed by Australia with 8.6% and the US with 7.3%. Gold mining officially contributes about 4% to GDP. However, taking into consideration the indirect contribution to the economy and the multiplier effects, gold mining’s total contribution to South Africa’s GDP is closer to 10%.

One of the world’s most important gold mines is the Driefontein Mine located about 60 km south-west of Johannesburg. In September 2006, Gold Fields Ltd. announced that it will deepen the Driefontein gold mine from its current depth of 1,988 m below sea level to a final depth of 4,121 m below sea level, making it the deepest



Driefontein's shaft No 8

mine in the world. This will enable Driefontein to mine deeper gold reserves, so that an additional 8.8 million ounces can be produced. At the same time, the life of the mine will be extended by at least 13 years to about 2035.

Gold Fields Ltd. is also investing in a shaft system at its Kloof gold mine to increase production.

The fact that South Africa has become the cheapest major producer of gold on a total cost per ounce basis will be an important factor contributing to the future prospects for the industry despite declining gold prices.

DSI South Africa manufactures a full range of high-quality support products for the underground mining industry, including friction anchors, resin roof bolts as well as deformed and flat anchor plates at its 5000m² factory in Elandsfontein near Johannesburg. Thus, DSI is well equipped to secure further expansion of South Africa's vital gold production with top-quality and efficient mining products. All products and systems manufactured by DSI South Africa are delivered to mines just in time.



Vishnu Pillay, Vice President and head of operations at Driefontein

INFO

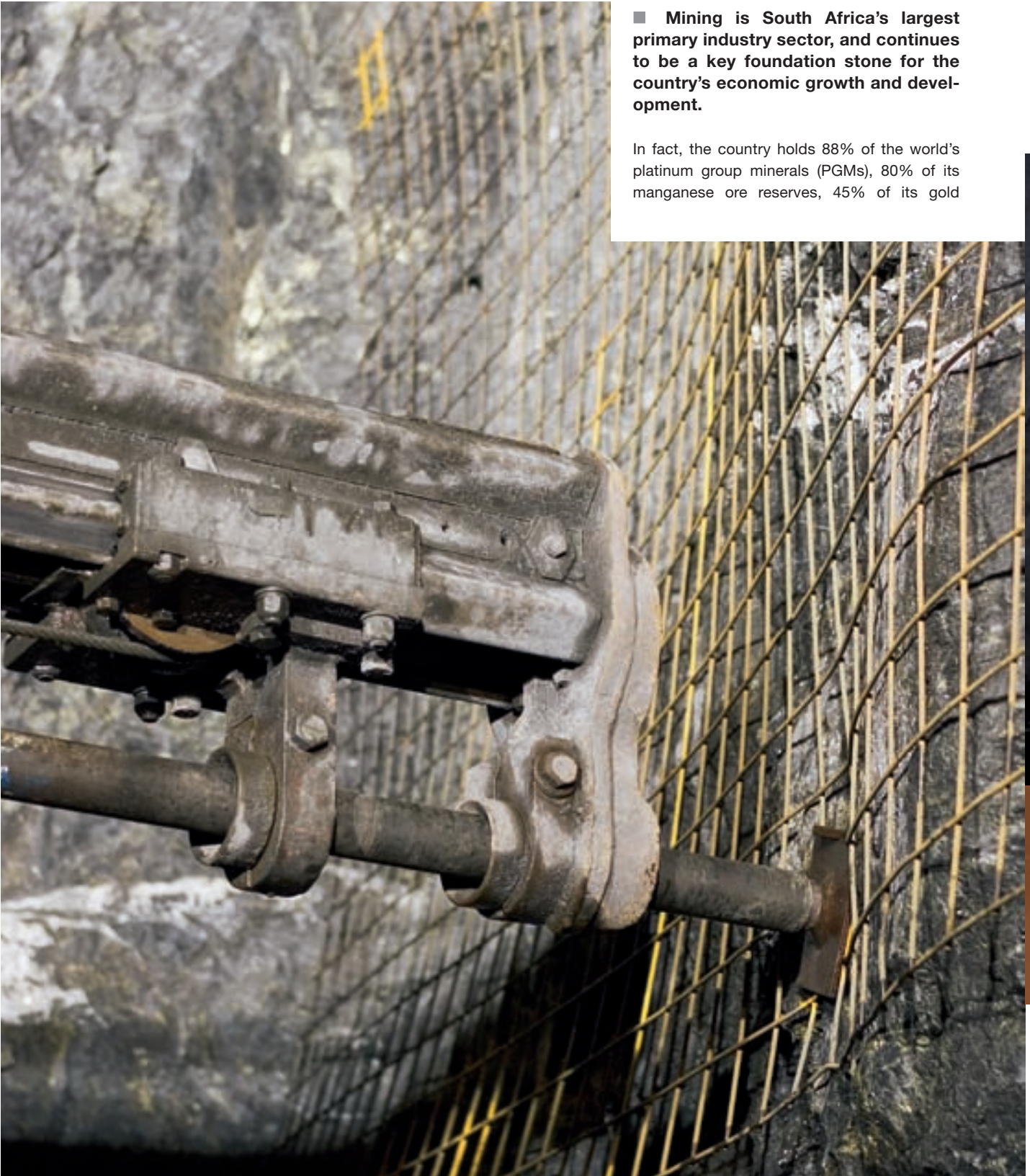
Mine operator Gold Fields Ltd., Johannesburg, South Africa

DSI Unit DSI South Africa, Johannesburg, South Africa

DSI Scope Contract to supply 600,000 pieces of grouting rods per year



DSI Leading Provider for Platinum Mines in South Africa



■ Mining is South Africa's largest primary industry sector, and continues to be a key foundation stone for the country's economic growth and development.

In fact, the country holds 88% of the world's platinum group minerals (PGMs), 80% of its manganese ore reserves, 45% of its gold

reserves and 73% of the globe's chromium resources.

DSI South Africa is a supplier of a full range of high-quality support products for the underground mining sector and has become an important partner for South African mine operators over the last five years. The company manufactures a wide range of products from its 5,000m² factory in the mining area Johannesburg.

Among other products for underground support, DSI South Africa produces friction anchors, deformed and flat anchor plates, resin bolts, oslo straps and pigtails, and supplies a number of these products to players in the South African platinum industry along with more than 80,000 roof bolts each month.

Platinum, palladium and rhodium are important components of catalytic converters used for

pollution control and are also widely applied in high technology, in the electrical, chemical and petrochemical industries as well as in the jewelry industry. Their excellent corrosion and oxidation resistance, biocompatibility, high melting points and high electric conductivity are merely some of the reasons why the demand for these metals continues to be high.

South Africa's Bushveld Igneous Complex (BIC), which stretches over 400km in the Northern Province, holds the world's largest known deposits of PGMs which include platinum, palladium, rhodium, ruthenium, iridium and osmium.

This unique area contains estimated PGM reserves of roundabout 62,000 tons, amounting to about 55.7% of the world's total. Apart from the Bushveld Complex and Zimbabwe's Great Dyke, the rest of the globe holds only very few of the known platinum resources. South Africa and Zimbabwe are the only producers of platinum group elements in Africa.

South Africa's platinum mines produced roughly 16,000 kg of rhodium and 71,000 kg of palladium in 2003, and provided jobs for approximately 90,000 people.

Rustenburg Platinum Mines (RPM), which belong to the Anglo American Platinum Corporation Limited (Anglo Platinum), is the largest single producer in the world and operates three geographically separate sections: Rustenburg, Union and Amandelbult, all on the western limb. DSI supplies Anglo Platinum with roof bolts for underground support.



INFO

Owner Platinum Mines in South Africa

DSI Unit DSI South Africa, Johannesburg, South Africa

DSI Scope Supply of 80.000 Roof Bolts per month



Development of Corrosion Protection for Omega Bolt®

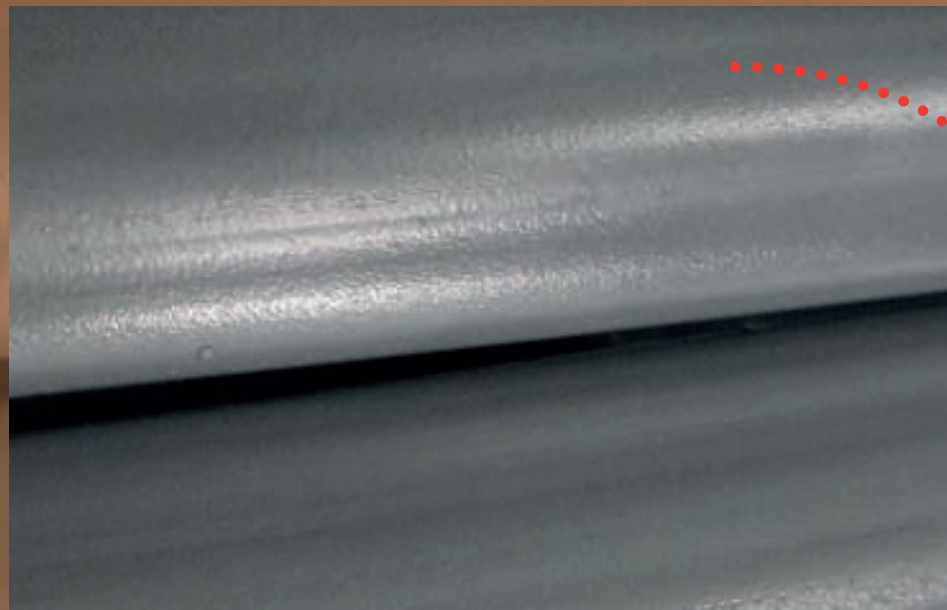
R&D Activities in Northern America

■ The Omega Bolt® is a relatively new product for mining and tunneling. The tubular anchor is named after the Greek letter “Omega”, which it closely resembles in shape. A longitudinally welded steel tube is “roll-formed” into the shape of an Omega during production and then sealed at both ends with welded-on ferrules.



During installation, the Omega Bolt® is inserted into the pre-drilled and cleaned borehole. Afterwards, water is pumped at high pressure into the interior cavity through the inflation ferrule. The hydrodynamic pressure of the water causes an expansion of the anchor. The Omega Bolt® deforms to match the irregular shape of the borehole. After installation is complete, the deformed bolt maintains its installation pressure on the rock surface providing rock mass compression or ground support.

The Omega Bolt® System combines rapid bolt installation with high strength capacity. Due to their flexibility of deformation, Omega Bolt®s are especially suited for use in seismically active mining regions or in highly fragmented ground because of their ability to link multiple weak strata layers together and to continually conform to the existing conditions of the installation ground.



The advantages of Omega Bolt®s quickly convinced customers of their viability. However, customers had high requirements with regards to efficient corrosion protection in mines with difficult rock conditions. Following their customers' requirements, DSI Ground Support Inc. developed a special coating that serves as corrosion protection for the Omega Bolt®.

The necessary deformation flexibility was a special challenge during the development of this coating. The coating had to be developed in such a way as not to form cracks during the expansion of the anchor during water injection. At the same time, the coating had to be thin enough to avoid an "over coating", e.g. to avoid the coating delaminating along the length during the expansion process.

In addition, the newly developed coating had to function in a variety of environments. DSI selected an epoxy based powder for acidic environments and a high zinc content for basic environments. The coating was baked on after being applied to the anchor. The result was a thin, strong and simultaneously elastic coating that insures adhesion during expansion due to installation pressure.

DSI Ground Support tested the performance of the new coating in several mines near Elko in the state of Nevada, USA. Mine owners in the test mines were excited by the new, efficient multi-purpose corrosion protection. The thin coating does not interfere with installation and proved to be durable even when installed by industrial mining equipment. In addition, tests proved resistance to highly corrosive environments. Consequently, the high strength coating offers multi-purpose protection for the Omega Bolt®.

All of the tests of the new coating for the Omega Bolt® were carried out to the utmost satisfaction of the clients. As of today, the new Omega Bolt® System with multi-purpose corrosion protection is available in all standard sizes.



INFO

Owner various mining companies in the USA and Canada

DSI Unit DSI Ground Support Inc., Salt Lake City, UT, USA

DSI Scope Development of a highly corrosion resistant coating for the Omega Bolt®



DSI acquires US-based MET-TECH Industries

■ In January 2008, DSI acquired MET-TECH Industries. MET-TECH, which was founded in 1981, has become one of the leading US-American producers of mining products in recent years. Important factors in this success story are the company's comprehensive R&D activities as well as its tailor-made products that are adapted to clients' needs and produced quickly and effectively.

Situated in Cambridge, Ohio, MET-TECH is strategically well located to serve the coal mines in the northern region of the Appalachian Mountains. The new facility perfectly complements DSI's three existing North-Eastern USA

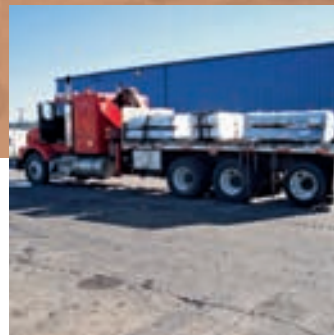
locations. DSI produces roof bolts in Blairsville, Pennsylvania and resin cartridges for mining in Martinsburg, West Virginia. In addition, a DSI factory for tunneling products is located in Bristol, Virginia.

MET-TECH specializes in the development, production and supply of high quality ground support products and individual systems for the coal mining industry. MET-TECH's product range includes a wide variety of top-quality safety-engineered roof bolts and roof support plates. The company also offers advanced testing capabilities. Thanks to state-of-the-art testing facilities and techniques, MET-TECH is able to contribute to higher security standards in mines.



The integration of MET TECH is a further move in strengthening the DSI Group's global market leadership in the supply of mining products and systems and allows an extension of the existing comprehensive product range for mine owners. The commitment of MET-TECH employees, especially to a high level of service, product quality and technological innovation characterizes the complete DSI Group. These values, which have made MET TECH a reliable and well respected supplier in the Mining Industry, are also the integral values of the whole DSI Group.

From now on, the company will operate as **DSI MET-TECH**.





DSI's Technical Expertise Needed for Re-Opening of Mexican Mine

Phosphate Rock Mine Rofomex, La Paz, Mexico

■ Phosphate rock is the basic material for producing phosphate and thus the crucial component in the production of fertilizers. On the Pacific Rim, the only exploitable phosphate rock deposit is near La Paz, south of the Mexican peninsula, Baja California. Until 2001, phosphate rock had been exploited for the production of fertilizers in the Rofomex Mine. These fertilizers were then sold both on the Mexican and on international markets.

The mine was closed in 2001 in the aftermath of a hurricane that severely damaged the port facilities and caused heavy rains that flooded the mine. In 2007, the owner decided to resume





phosphate rock exploitation in this mine. The exploitation is carried out underground in a mine with room and pillar design, at an average seam height of 1.70m.

From the start, DSI-Anclas Mineras has been working closely with the owner to define all products and systems needed for mining. This project is yet another good example of using synergy effects inside the DSI Group. Technical experts from DSI-Anclas Mineras turned to their colleagues from DSI Ground Support Inc. in Salt Lake City for additional expertise. They were also actively supported by employees of the DSI company Fasloc Inc. in Martinsburg with regards to questions about the safe utilization of resin cartridges. Fasloc Inc. is the market leader in the development and production of high quality gluing systems based on synthetic resin in the USA.

For re-opening the Rofomex Mine, DSI-Anclas Mineras supplied nearly the whole range of mining products, ranging from threadbars, rock bolts, anchors, anchor plates, loop anchors, resin cartridges and drilling bits to auger drilling bars for exploratory drilling.

The Rofomex Mine was successful in resuming phosphate rock exploitation in 2007. An expansion of the exploitation is planned for 2008. For this, the mine owner and DSI-Anclas Mineras agreed on another delivery of high quality mining products.

INFO

Owner Minera Rofomex, La Paz, Mexico

DSI Unit DSI-Anclas Mineras S.A. de C.V., Jalisco, Mexico

DSI-Anclas Mineras Scope Supply of the complete range of mining products to Rofomex Mine



DSI-SOPROFINT – the Specialist for Mining Products in Latin America



■ **SOPROFINT was founded in 1997 as a supplier of products for rock and soil stabilization. In 2007, the company became part of the DSI Group's Mining division and has since been doing business as DSI- SOPROFINT.**

There are currently 150 employees at the company's headquarters, which is centrally located in Santiago de Chile. Both production and administration personnel are employed at the headquarters in one of the most important industrial areas of the city in order to guarantee efficient workflow and product distribution.

During the last few years, DSI-SOPROFINT has successfully expanded its business activities. In fact, the company increased its turnover by 20% per year between 2005 and 2007. One of the contributing factors to this dynamic growth is the fact that the company is supported by a motivated young team with an average age of approximately 40 years.

DSI-SOPROFINT is one of the most important specialist suppliers of mining products in South America. The company has a market share of approximately 80% in Chile and has strong export activities into other Latin American

markets. As a company which is active on an international scale, DSI-SOPROFINT exports its products to Latin America, as well as to the United States and Canada.

On a regional scale, DSI-SOPROFINT supplies major customers such as the public copper organization CODELCO in Chile. CODELCO is the world's largest copper producer and is planning to further expand its market position in the future. DSI-SOPROFINT supplies high quality mining products to the world's biggest copper mine in Northern Chile. Chuquicamata Copper Mine's open pit exploitation is going to



be expanded by the addition of an underground operation, which is why a 400 km long tunnel is now under construction.

DSI-SOPROFINT produces specialized products customized to the requirements of the mining industry. The product range includes products such as the friction bolt “Split Bolt” or the rock bolt “Safe Rock” with hot rolled threads. In addition, the company supplies products such as longwall recovery mats for roof stabilization in coal mines or the “Cable Bolt” anchorage, which is ideal for use in mining due to its strength and flexibility.

DSI-SOPROFINT puts quality first. The complete product range complies not only with specific Chilean regulations, but also with accredited international norms. In the future, DSI-SOPROFINT will keep making work in mines faster, easier and safer. That is why the company continuously develops its products and systems in cooperation with Chilean universities in order to achieve a maximum of efficiency in installation on site. The company will open a second subsidiary in Peru shortly in order to further expand its local presence in the Latin American market and to support its local clients even more efficiently.





36 Years of Service to DSI: Mr. Heiler Retires

■ **Mr. Heiler, who began his career an intern for Dyckerhoff & Widmann AG in 1970, took leave of his colleagues in December 2006 during his retirement ceremony.**

Mr. Heiler first worked as an engineer in Dyckerhoff & Widmann AG's design office and rose to the position of team leader of the engineering office for Allspann GmbH in 1972. In 1989, Mr. Heiler was promoted to the position of manager of Allspann and then became manager for DSI GmbH's European division following the merger of DSI GmbH and Allspann GmbH.

From January 2003 on, Mr. Heiler worked successfully for the DSI Group as Chief Technical Officer until his well-deserved retirement in December 2006. We wish him all the best and good health for the years to follow.

After Mr. Heiler's retirement, DSI's technical divisions were restructured. Today, those divisions are positioned within DYWIDAG-Systems International GmbH in Unterschleißheim. They belong to the DSI Group's Construction division and are managed through RHQ Europe.



DSI bids Farewell to Mr. Otmar Langwadt after a Long and Successful Career in the Company



From left to right: Christian Schroeder, Frank Schmidt, Otmar Langwadt, Florian Stuetzel

■ **On May 31st, 2006, Otmar Langwadt, technical director for DSI Geotechnics, celebrated his retirement after spending almost 40 years of his professional life with DYWIDAG and DSI. Otmar Langwadt began his career in July 1968 in DYWIDAG's engineering office.**

Later on, he spent a large amount of time abroad working on international job sites, with a main focus on important construction projects in Canada. For example, Mr. Langwadt made a significant contribution to the construction of the Olympic Sports Facilities in Montreal.

Mr. Langwadt's international orientation and extensive experience made it possible for him to provide invaluable support to DSI subsidiaries in many countries such as the USA, Thailand, the Netherlands, Austria, Switzerland, Italy, the Dominican Republic, Greece or Gabon.

Another important time abroad was the period between 1989 and 1993 when he worked in South Africa with the DYWIDAG subsidiary Steeledag. Mr. Langwadt returned to DSI's Geotechnical department in Munich in 1993, which he successfully led for the last four years of his professional life.

During Mr. Langwadt's retirement party, the internationality of his career was once again emphasized as greetings and presents from former colleagues from all over the world found their way to Munich. We wish Mr. Langwadt all the best and excellent health for his new phase of life.

On June 1st, 2006, Mr. Frank Schmidt succeeded Mr. Langwadt as the team leader of the Geotechnics department. Mr. Schmidt has been working for DSI since August 2000 and started working as engineer in the Technical Service. We congratulate Mr. Schmidt on his promotion and wish him all the best for his future with DSI.



Festive Ceremony: Dr. Andor Windisch Takes his Leave into Well-Earned Retirement

■ In 2007, another important DSI employee retired: Dr. Andor Windisch celebrated his retirement together with employees of DSI Holding and DSI GmbH in Unterschleißheim in September.

Dr. Windisch began his carrier as a construction engineer for Dyckerhoff & Widmann AG in 1987. Later, he worked as a product manager in Construction and then as a leading engineer for DSI GmbH.

In addition to his work for DSI, Dr. Windisch was also actively engaged in research and teaching as well as in the development of solid building. Among other awards, he received the László-Palotás Medallion from the Hungarian national group of fib (fédération internationale du béton) in 2005.

Since April 1st 2006, Dr. Windisch worked as a Technical Director for DSI GmbH. His excellent technical knowledge as well as his extraordinary skills in dealing with people were valuable assets for the company. We wish Dr. Windisch good health and a recreative new period of life.

On October 1st 2007, Mr. Markus Traute was appointed his successor and has since been managing the technical division – DYWIDAG Post-Tensioning Systems. Mr. Traute first took up his work for DSI as an engineer in the Technical Service department in March 2000. DSI congratulates Mr. Traute on his promotion and is looking forward to a long-term successful co-operation.

DSI USA: Ron Bonomo Retires from DSI America

■ After 28 years of successful work for DSI USA, Ron Bonomo retired on the 31st of December 2007. Mr. Bonomo served the company in the USA, and in several other key management positions around the world.

Ron Bonomo last worked as Regional COO for the division Construction Americas. This position incorporates responsibility for DSI's complete production, acquisition and distribution process on the American continent. Prior to assuming this position, Ron served as RCEO for the Asia Pacific and Managing Director of DSI Australia.

Mr. Mark Milici has been appointed as the successor of Mr. Bonomo. Mr. Milici has been working for DSI since 1982 and has had several team leader and management positions. Before his promotion to COO, Mr. Milici managed the division DYWIDAG Post-Tensioning and Reinforcement in the USA.

We wish Mr. Bonomo all the best as he enters this new phase of life and we are pleased to know that a worthy successor for this responsible position has been found with Mr. Milici.





PTI Technical Conference & Exhibition, St. Louis, USA

May 4 -7, 2008

■ **The PTI (Post Tensioning Institute) has promoted Post-Tensioning since 1976. The PTI supports its members through research, technical developments and marketing activities. Annual conferences and training sessions during which members have the possibility to exchange know-how about the latest technical developments in Post-Tensioning represent one important part of the institute's activities.**

In 2008, the technical conference was held in St. Louis, Missouri. Each year, the best Post-Tensioning projects are given awards during the conference banquet dinner. This year, DSI received three important awards.

The first Award of Merit was granted to the Otay River Bridge, a recently completed bridge in San Diego. The bridge is an important part of a new highway that will connect the Otay Mesa region to the southern Californian highway infrastructure. The precast segmental bridge was built using the cantilever method and is featured in DSI Info 15, pp.62-63.

The second Award of Merit was given to DSI for stabilizing Gilboa Dam. The dam was completed in 1926 and is situated approximately 180km north-west of New York. During an examination, the dam's stability was found to be compromised by erosion. Consequently, the structure was stabilized by 80 post-tensioned rock anchors between December 2005 and December 2006 in order to guarantee the security of neighboring residential areas. This project is also featured in DSI info 15, p. 74.

DSI/GSI received the third Award of Merit for the Collin County Hangars project in Texas. You will find a detailed article on this interesting project in the first part of DSI Info 16.

As one of the suppliers, DSI also contributed to the repair of the State Capitol in Utah, USA. The historic building was given seismic stability with the help of post-tensioning systems and was given an Award of Excellence.

DSI also supplied Post-Tensioning for the seismic rehabilitation of a six-story office building in Berkeley, California. PTI granted an Award of Merit for the repair and strengthening of this building.

Once again, DSI has been able to prove its competence in Post-Tensioning. We are looking forward to participating in PTI's next Technical Conference in Portland, Oregon on May 3-5, 2009.



From left to right: Mike o'Brien, Don Singer, Jack W. Graves, Roger Frenn, Gerhard Kahr, Doug Schlegel, Ken Purinton, Billy Dickinson, Robb Dietrich, Erich Aigner, Dave Martin



**Erich Aigner (DSI),
Scott Greenhaus (PTI President)
Award of Merit, Project:
Otay River Bridge**



**Jack W. Graves (DSI),
Scott Greenhaus (PTI President)
Award of Merit, Project:
Collin County Hangars**

**Ken Purinton (DSI),
Scott Greenhaus (PTI President)
Award of Merit, Project:
Gilboa Dam**



pti POST-TENSIONING
INSTITUTE

Jefferson National Expansion Memorial (Gateway Arch),
St. Louis, USA





From left to right:

Rob Mezick (DSI Sales Engineer, Toughkenamon, Pennsylvania), Bernhard Froemel (DSI Project Manager, Long Beach, California), Lucian Bogdan (Chief Engineer GT USA, Long Beach, California), Kris Kriofske (DSI Sales Engineer, Arlington, Texas)

Deep Foundations Institute (DFI) – 32nd Annual Conference

October 11 – 13, 2007, Colorado Springs, CO, USA

■ Members of the Deep Foundations Institute (DFI) traditionally meet once a year during a three-day event in order to exchange experiences and discuss developments in the field of Geotechnics. In different events, participants discuss technical challenges in relation to design and construction as well as to reinforcement and stabilization of heavy foundations. The annual conference maintains high technical standards because representatives of a great variety of disciplines such as engineering companies, universities, construction companies, suppliers and manufacturers from all over the world participate in the event.

During the conference, members also have the possibility to present new products and techniques to professional visitors. At the 32nd Annual Conference, which took place in Colorado Springs in the US state of Colorado from 11th to 13th of October 2007, DSI USA's Geotechnical Business Unit once again participated by exhibiting at the conference.

DSI USA's booth was visited by many participants. A large number of existing contacts could be renewed and many new business contacts were made.

Geotechnical Sales Meeting, Marseille, France

September 20 – 21, 2007



■ In 2007, DSI's European Geotechnical specialists once more gathered in order to exchange experiences and to discuss recent developments in the field of Geotechnics.

Meetings such as this serve as a forum for international DSI companies, who use them to make

strategic decisions about newly developing and ameliorating products and systems. This event was intensively used for exchanging internal DSI geotechnical know-how.

Apart from presentations and meetings on planned innovations, several excursions to job sites in Marseille were on the agenda.



The BIG5 Show, Dubai, United Arab Emirates

November 25 - 29, 2007

■ **With more than 2,000 exhibitors at the fully booked fair grounds near the World Trade Center in Dubai, the BIG5 Show once more proved itself to be the largest and the most important construction trade fair in the Middle East and the Gulf Region.**

Once again, the German Pavilion was the biggest International Pavilion. More than 350 German businesses presented themselves on 6,000m² of fair grounds. This fact in itself is proof of the high appreciation of the quality feature “Made in Germany”.

DSI successfully participated at the BIG5 for the third time. Increasing demand for high quality products and systems lead to DSI's repeatedly widening the range of products it offers at the BIG5 Show.

In addition to DYWIDAG Form Tie Systems and products from its division “Concrete Accessories“, DSI also presented DYWIDAG Post-Tensioning Systems and Geotechnical Systems to the show's attendees for the first time.

High quality cross-section models of DYWIDAG Post-Tensioning anchorages underlined the high quality standards and technical know-how within the DSI Group.

The expert public expressed great interest in DSI's comprehensive product range. Many personal relationships were renewed, and DSI's booth was an excellent platform for many new business contacts.

The next BIG5 Show is to take place from the 23rd to 27th of November 2008. Once again, DSI will make an impressive trade show appearance.





ExpoMin, Santiago, Chile

April 15-18, 2008



■ **ExpoMin in Santiago de Chile is one of the most important mining exhibitions in the world. The biannual trade fair is the largest event of its kind in Latin America. DYWIDAG-Systems International (DSI) first participated at ExpoMin in 2006. This first participation as an exhibitor, a joint effort of DSI's American and Australian mining units, proved to be an excellent opportunity for sounding the Chilean market.**

Following ExpoMin in April 2006, DSI found the right local partner in the Chilean company SOPROFINT SA. In accordance with DSI's growth strategy, SOPROFINT was successfully acquired at the beginning of 2007. Since then, the company operates as DSI-SOPROFINT.

At its tenth anniversary, ExpoMin 2008 broke all records. The efforts of the mining industry to satisfy the ongoing high demand for mineable resources by increasing capacities were evident during this exhibition. Overall, around 85,000 professional visitors and decision makers from science, politics, economy and mining were present and used this platform for an intensive exchange of ideas. They were impressed by the state of the art technical products and services on display as well as by more than 3,000 innovations presented by the 1,042 exhibitors. In comparison to ExpoMin 2006, the exhibition

space increased by 13%, while the number of exhibitors rose by 22.5%.

DSI-SOPROFINT was present at ExpoMin 2008 with its own booth. The extensive product range that is produced in the company's Santiago factory was viewed with great interest by visitors to the display. In addition, products and systems by other DSI companies in America were presented at the booth.

The participation at this trade fair was a great success. DSI-SOPROFINT is therefore planning to participate at the next ExpoMin in 2010.



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