Dear Readers,

A warm welcome to the 17th edition of our DSI Info. I hope you will agree this document presents an interesting range and scale of projects in many locations around the world.

It once again demonstrates the ingenuity of our customers and the professional way they carry out and complete increasingly complex tasks. We at DSI are very proud to be associated with these projects and once again thank our customers for the invitation to participate.

In 2008, we have been very pleased to welcome Fosminas Ancoragens Ltda Brazil and AGRHIMERC S.A.C. Peru to our Underground group. Both have a high reputation for delighting customers. We will do everything we can to preserve and enhance that service and reputation as well as bring new products and solutions to our new Latin American customers.

You, like me, must look back over the last 9 months with total disbelief at the change of dynamics and the speed of change in the fortunes of our construction, tunnelling and mining environment. The associations who report on trends could not keep up. The contrast between the forward projections of a year ago and what we saw from December onwards brings that disbelief into full reality.

Most of you, like DSI, are adjusting and planning for the difficult period ahead. Serving customers is what we do. Our aim, as always, is to secure our position as your supplier of choice by delivering customer satisfaction and value for money. In that regard, DSI will continue to challenge itself to be more innovative, efficient and smarter in delivering what we promise.

Despite the challenges we all face, there are some wonderful projects underway. We look forward to participating in and illustrating them in the next edition of DSI Info.

Thank you.

Kind regards

Alan Bate
Chairman and Group CEO
<table>
<thead>
<tr>
<th>Region</th>
<th>Business Segment</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ASIA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8  Japan</td>
<td>Bridges</td>
<td>Technology meets Tradition: Extradosed Bridge in Japan</td>
</tr>
<tr>
<td>10 Japan</td>
<td>Bridges</td>
<td>Extradosed Bridge establishes new Landmark of South Osaka</td>
</tr>
<tr>
<td>12 Korea</td>
<td>Bridges</td>
<td>Busan, Korea: DYWIDAG Systems Stabilize one of the World’s Longest Immersed Tunnels</td>
</tr>
<tr>
<td>16 Korea</td>
<td>Slope Stabilization</td>
<td>Stable Infrastructures with DSI: Slope Stabilization in South Korea</td>
</tr>
<tr>
<td>18 Nepal</td>
<td>Hydro- &amp; Marine Structures</td>
<td>Large-scale Project finished in Nepal after 6 Years: Middle Marsyangdi Dam</td>
</tr>
<tr>
<td>20 Singapore</td>
<td>Tanks</td>
<td>DYWIDAG Post-Tensioning Systems used for Modern Ethylene Tank in Singapore</td>
</tr>
<tr>
<td>21 Sri Lanka</td>
<td>Bridges</td>
<td>DYWIDAG Post-Tensioning Systems Secure Sri Lanka’s Economic Development</td>
</tr>
<tr>
<td><strong>EUROPE, MIDDLE EAST, AFRICA (EMEA)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 Austria</td>
<td>Slope Stabilization</td>
<td>Special Foundations for the new Hungerburg Funicular Railway, Innsbruck, Austria</td>
</tr>
<tr>
<td>24 Czech Republic</td>
<td>Bridges</td>
<td>DYWIDAG Post-Tensioning Systems help connect Czech Republic and Germany</td>
</tr>
<tr>
<td>25 Czech Republic</td>
<td>Bridges</td>
<td>DSI Supplies Comprehensive Scope of Products for Oparno Bridge</td>
</tr>
<tr>
<td>26 France</td>
<td>Slope Stabilization</td>
<td>Rock Face in Marseille Stabilized using GEWI® Rock Bolts</td>
</tr>
<tr>
<td>28 Germany</td>
<td>Special</td>
<td>DYNA Protect® - Novel Protection System for Stay Cables and Bracings</td>
</tr>
<tr>
<td>30 Italy</td>
<td>Bridges</td>
<td>Cantilever Construction facilitates Easy Travelling: the Tanaro Bridge in Italy</td>
</tr>
<tr>
<td>32 Italy</td>
<td>Hydro- &amp; Marine Structures</td>
<td>Smooth Flow of Trade between Europe and the Far East with DYWIT</td>
</tr>
<tr>
<td>33 Norway</td>
<td>Hydro- &amp; Marine Structures</td>
<td>Repair by Helicopter: the Dalvatnet Dam in Norway</td>
</tr>
<tr>
<td>36 Spain</td>
<td>Bridges</td>
<td>DSC Supplies Stay Cable Systems for Spain’s First Environmentally Friendly Bridge</td>
</tr>
<tr>
<td>37 Spain</td>
<td>Excavation</td>
<td>Special Anchorages used for New High-Speed-Line between Spain and France</td>
</tr>
<tr>
<td>38 Spain</td>
<td>Commercial Buildings</td>
<td>DYWIDAG Ductile Iron Piles used for the First Time in Spain</td>
</tr>
<tr>
<td>39 Spain</td>
<td>Commercial Buildings</td>
<td>More Living Space with DSI: Modern Housing Development in Madrid</td>
</tr>
<tr>
<td>40 Turkey</td>
<td>Bridges</td>
<td>Record Spans with Prestressed Concrete in Turkey: DSI Group at Work</td>
</tr>
<tr>
<td>42 United Kingdom</td>
<td>Bridges</td>
<td>Demolition of Mossband Viaduct, Carlisle</td>
</tr>
<tr>
<td>44 Bahrain</td>
<td>Bridges</td>
<td>DSI connects: Bridge Construction in Bahrain Financial Harbour</td>
</tr>
<tr>
<td>45 Nigeria</td>
<td>Structural Repair Solutions</td>
<td>Longest Bridge in Africa Strengthened using GEWI® Bars</td>
</tr>
<tr>
<td>46 Benin</td>
<td>Bridges</td>
<td>Bridges in Africa constructed using DYWIDAG Strand Tendons</td>
</tr>
<tr>
<td><strong>AMERICA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48 Brazil</td>
<td>Bridges</td>
<td>Stay Cable Footbridge Stabilized using DYWIDAG Bars</td>
</tr>
<tr>
<td>50 Brazil</td>
<td>Commercial Buildings</td>
<td>Protendidos DYWIDAG: Extension of São Paulo Subway System</td>
</tr>
<tr>
<td>51 Brazil</td>
<td>Bridges</td>
<td>New Stay Cable Bridge in the Metropolitan Area of São Paulo Improves Local Infrastructure</td>
</tr>
<tr>
<td>52 Brazil</td>
<td>Bridges</td>
<td>DYWIDAG Bar Tendons stabilize Paraná Bridge</td>
</tr>
<tr>
<td>54 Canada</td>
<td>Commercial Buildings</td>
<td>Rapid Construction Progress in Vancouver with DYWIDAG Post-Tensioning Systems</td>
</tr>
<tr>
<td>55 Canada</td>
<td>Commercial Buildings</td>
<td>Lightweight structures with DSI: Premiere for Post-Tensioning Systems in Calgary</td>
</tr>
<tr>
<td>56 Canada</td>
<td>Commercial Buildings</td>
<td>Oil Extraction using DSI Technology: Oilsands Project in Alberta, Canada</td>
</tr>
<tr>
<td>58 Canada</td>
<td>Commercial Buildings</td>
<td>DYWIDAG Post-Tensioning Systems stabilize Bankers Court Project, Calgary</td>
</tr>
<tr>
<td>59 Canada</td>
<td>Bridges</td>
<td>Efficient Transit Link in Vancouver: Construction of the Canada Line with DSI</td>
</tr>
<tr>
<td>60 Canada</td>
<td>Commercial Buildings</td>
<td>DSI Monostrand System Prevents Loss of Material</td>
</tr>
<tr>
<td>61 Canada</td>
<td>Hydro- &amp; Marine Structures</td>
<td>DYNA® Force Project: Retrofitting of Boundary Dam in Canada</td>
</tr>
<tr>
<td>62 Canada</td>
<td>Commercial Buildings</td>
<td>Innovative Roof Design for Modern Skating Oval in Canada with DYWIDAG Systems</td>
</tr>
</tbody>
</table>
66 USA Excavation Large-scale Project in Baltimore’s Inner Harbor: DSI stabilizes Excavation at Inland Port
67 USA Slope Stabilization DYNA® Force Load Monitoring Sensor for Strand Tieback Retaining Wall
68 USA Special DYNA® Force - a Reliable Elasto-Magnetic Sensor for Force Measuring
69 USA Slope Stabilization Soldier Pile Retaining Wall and Slope Slide Stabilization on Hwy 49, Near Auburn, California
70 USA Commercial Buildings Unconventional Construction with DSI: Parking Structure as the Civic Center’s new Portal
72 USA Slope Stabilization Slope Stabilization at Devil’s Slide: DSI protects Highway from Landslides
74 USA Bridges Redevelopment of Downtown Phoenix, Arizona with DSI USA
76 USA Commercial Buildings DYNA® Force Load Monitoring Sensor for Strand Tieback Retaining Wall
77 USA Slope Stabilization DSI Supports WDOT during the Construction of its Tallest Soil Nail Wall
78 USA Structural Repair Solutions DSI USA Strengthens I-39/Kishwaukee River Bridge in Illinois
80 USA Structural Repair Solutions Soldier Pile Retaining Wall and Slope Slide Stabilization on Hwy 49, Near Auburn, California
82 USA Foundations DYWIDAG Driven Ductile Cast Iron Pile in St. Lucia, West Indies
84 USA Special Tallmadge Bridge, Savannah, GA, USA

Concrete Accessories
86 France Special Technique Béton Breaks new Ground: Innovative Fire Protection Mortar for Tunneling
87 France Special Technique Béton offers New Product Range for Passive Fire Protection

Underground – Tunneling
88 Australia Tunneling Faster Public Transport in Brisbane: DSI Supplies Systems for Bus Tunnel
92 Australia Tunneling Supply of Special Products for Australia’s Longest Road Tunnel in Brisbane
94 Canada Tunneling New Tunnel beneath Niagara Falls Built with DSI and ACI
96 Chile Tunneling Short Cut with DSI: Construction of the San Cristóbal Tunnel in Santiago de Chile
98 South Africa Tunneling Travelling Faster with DSI: Gautrain High Speed Train
102 USA Tunneling Tunnel avoids Landslide: ACI and DSI supply Quality Systems for By-Pass
103 USA Special American Commercial Shaft Equipment

Underground – Mining
106 Australia Mining DSI Australia Develops new Dynamic Bolt for Seismic Stability in Deep Mines
107 Australia Mining Encapsulation Trial of Resin Cartridges in Mines
108 Australia Mining DSI Australia sponsors Gujarat NRE Minerals Ltd. during Mines Region Competition
Australia Mining More Coal with DSI: Extension of Cook Colliery in Australia
109 Australia Mining Modern Gold Rush: DSI Australia supports Gold Producers with new Warehouse
Australia Special Underground Expansion of an Open Pit Mine using DSI Mining Products
112 USA Special DSI Solves Water Inflow Problem at Campo Morado Mine
113 Mexico Mining Mexico: Omega-Bolt® Technology for Precious Metal Mine of International Standing

Special
114 Special Special Clevis Anchorage for DSI Stay Cables
115 Exhibitions Special IUT 2008, Hagerbach Test Gallery, Switzerland
Special Conference at DMT in Essen
116 Special Special 57th Geomechanics Colloquy and 6th Austrian Tunnel Day in Salzburg
117 Special Special A Strong Partnership: 50th Anniversary of License Agreement between Sumitomo and DSI
118 Exhibitions Special ITA-AITES World Tunnel Congress, Agra, India
Exhibitions GEOFLUID, Piacenza, Italy
119 Special Special 3rd DSI Asia Meeting in Seoul
Dsi bids Farewell to Mr. Oswald Nuetzel after more than 40 successful years
120 Special Special 40 years of Service with DSI: Gary Kast takes Well-Earned Retirement
121 Exhibitions Special International fib Symposium, Amsterdam, Netherlands
Exhibitions The Big 5 Show, Dubai, United Arab Emirates
122 Exhibitions Special IV, ACHE Congress, Valencia
Special MINExpo INTERNATIONAL 2008, Las Vegas
123 Special Special DSI USA: Kris Kriofske Retires

Addresses
124 Addresses
128 Imprint
Technology meets Tradition: Extradosed Bridge in Japan

The Sannai-Maruyama Overpass is a bridge for the Shinkansen Japanese bullet train that crosses the National Beltway No.7 through Aomori City at the northern tip of Honshu, Japan’s main island. The bridge is part of the longest bullet train line in Japan, the Tohoku-Shinkansen Line. This line connects Tokyo to the northern city of Hachinoe and is currently being extended.

The bridge is located next to the Sannai-Maruyama Site, a 4,000 to 5,500 year-old ancient settlement dating back to the Jomon Period. Sannai-Maruyama is one of the largest National Historical Sites in Japan. Given the need to harmonize with these surroundings, the design selected was a four-span continuous extradosed bridge. With an overall bridge length of 450m and a main span of 150m, this will be the bridge with the longest span on any of the Shinkansen lines.

The bridge features saddles in the pylon in which the strands run through a curved steel pipe. The reliability of the structure was carefully verified before the start of construction through loading tests using a full-scale mockup.

Sumitomo, DSI’s licensee in Japan, supplied 66 Type XD-E27 Extradosed Tendons consisting of 27 epoxy-coated prestressing strands in a HDPE pipe that was subsequently grouted.

Construction was completed in December 2008. The new section of the Tohoku-Shinkansen Line between Hachinohe and Shin-Aomori will become operational in December 2010. Thanks to the extension of this bullet train line, Tokyo will be linked to the six prefectural capitals of Tohoku, a region in north-eastern Japan.
Owner: Japan Railway Construction Transport Technology Agency, Japan

General Contractor: Joint venture consisting of Zenitaka Corporation, Tokyo, Japan and partner companies

DSI Unit: Sumitomo Electric Industries Ltd., Tokyo, Japan

Sumitomo Scope: Supply and installation of 66 Extradosed Tendons Type XD-E 27 and Saddles
Extradosed Bridge establishes new Landmark of South Osaka

Installation of extradosed tendons

Saddles

Full view of Hirano Bridge after completion
The city of Osaka is an important location for business in Japan. In order to extend the city's transportation system, a new railway line between Shin-Osaka and Kyuhoji has been constructed. The Osaka Higashi Line was created by converting an existing freight line into a double-track passenger railway line.

At the same time, a viaduct was built in the Hirano district, south-east of the city of Osaka. This viaduct will facilitate future maintenance services on the Osaka Higashi Line and will be used to carry vehicular traffic across the railway. The new viaduct will replace two existing grade crossings that used to cause traffic obstructions in the district of Hirano on a regular basis. The new structure will also improve the infrastructure in all of Osaka's eastern districts.

The Hirano Bridge has a main span length of 63m and was built as part of the viaduct in the Hirano district. Due to an intersection of two public roads in the immediate vicinity of the bridge, space for the construction site was limited. Taking into consideration various site constraints, the owner opted for an extradosed concrete bridge, the aesthetic design of which turns it into a regional landmark.

The pylon, in which extradosed tendons are deviated by means of a saddle system, deserves special attention. A system consisting of two tubes, one inside the other, and a shear nose ensures that differing forces in the extradosed tendons are transferred safely into the pylon so that the replaceable extradosed tendons cannot slide over the saddle, as in the case of ordinary external tendons.

For the design of the saddle system, detailed calculations were done, taking into account a tolerance of +/-1° for deformations of the structure and a sagging of stay cables in the vertical position. Thus, bending stress in the parallel strand bundles at the transition of the saddles can be minimized and wear due to friction can be prevented.

The extradosed tendons consist of double corrosion protected epoxy coated strands and polyethylene (PE) sheathing inside an HDPE duct. The stay cables were prefabricated in a factory and installed at the site using a crane.

In the anchorage and saddle region, the PE sheathing on the strands was removed. These tendons were grouted after tensioning to establish triple corrosion protection and provide sufficient bond in the saddle. In addition, all wedges of the individual strands were post-blocked using a hydraulic jack to ensure that the wedges grip each strand firmly, particularly in the case of strands with low initial tension.

For the anchorages at the main girder, the DYWIDAG Post-Tensioning System for external tendons was used. Since the orientation of each anchor pipe was different owing to the curved profile of the bridge, the exact orientations of the anchorages was established by using laser technology.
The city of Busan on the south-eastern coast of South Korea is the location of one of the world’s largest container ports. Another important industrial city of the country is located in the vicinity of Busan: Geoje city, which is scattered on approximately 60 small islands. Geoje is especially important for the shipbuilding industry. Up to now, there has been no direct road connection between Busan and Geoje. Commuters between Busan and Geoje had to either use a ferry or put up with a 140km long detour.

Consequently, the construction of an approximately 8.2km long highway from Busan to Geoje began in 2004. The Busan-Geoje Fixed Link will shorten the route to 60km and thus cut average travelling times by about two and a half hours. The new highway will not only relieve the surrounding roads and save logistics costs, but it will also strengthen the region’s economy.

The Busan-Geoje Fixed Link includes two stay cable bridges approximately 3.5km long as well as a 3.7km long immersed tunnel. Once completed, the tunnel will be one of the longest immersed tunnels in the world. With a depth of up to 50m, the tunnel is also the world’s deepest road tunnel. It is composed of 18 precast concrete tunnel elements that will be floated into position.

The first of the two stay cable bridges has two pylons, a main span of 475m and two side spans of 220m each. The second stay cable bridge leads over 3 pylons, with two main spans of 202m each and a total length of 672m.

Due to the region’s high seismicity, the companies involved had to face special project requirements. Construction was also made difficult by weather conditions at sea: each section had to be stabilized to withstand possible storms.
DSI Korea was involved in several sections of the infrastructure project. The company supplied type 32 WR, St 950/1050 DYWIDAG THREADBAR® in lengths of 1.2m each for steel structure segment lifting. In addition, 4,640 anchor nuts and 160 anchor plates were delivered to the site.

DSI Korea also supplied 312 type 36 WR, St 950/1050 DYWIDAG THREADBAR® in lengths of 2.96m each for stabilization. In addition, DSI Korea supplied a total of 312 hex nuts, 312 couplers and 624 lock nuts.

Type 40 WR, St 950/1050 DYWIDAG THREADBAR® were used for the construction of the immersed tunnel. In addition, a total of 272 nuts and 544 couplers were supplied.

DSI Korea is pleased that DYWIDAG Systems were used for this special infrastructure project.
Due to its geographic position, South Korea is an excellent location for worldwide maritime trade. In order to further increase the country’s economic attractiveness for international trade, a new highway is being built in the south.

Among other cities, the route will link the strategically important seaports of Mokpo and Gwangyang, thus considerably improving the area’s infrastructure. Simultaneously, the new highway will enhance tourism along Korea’s south coast.

The 106.8km long highway is being constructed in 12 sections and connects Mokpo on the west coast with the city of Gwangyang on the south coast. The four lane highway will have a width of 23.4m and will include approximately 26km of tunnels and 17km of bridges.

The route partly runs through hilly and mountainous regions. In order to impact the environment as little as possible and to protect the route from landslides, the contractor awarded DSI Korea the job of supplying the anchorage systems necessary for slope stabilization.
For section 2-1, DSI Korea supplied a total of 1,135 Type 5x0.6" DYWIDAG Strand Anchors in lengths of 16-29m. 1,121 Type 4x0.6" DYWIDAG Strand Anchors in lengths of 8.5 to 22m were installed in lot 3.

In order to insure the long-term stabilization of the slopes in question, re-stressable anchors with long-term corrosion protection were used to allow for a flexible adaptation to future geological changes.

Construction began in May 2007 and is due to finish in March 2009.
Large-scale Project finished in Nepal after 6 Years: Middle Marsyangdi Dam

Because the country of Nepal is not blessed with abundant natural resources such as oil or coal, their main source of energy is water power. Due to the exportation of electricity to India, water power also represents a long-term source of income. Year after year, demand for electricity and peak loads of Nepalese hydroelectric power plants rise by 8-9%.

As a result, construction began 20 years ago on three dams on the Marsyangdi River. The middle dam, Middle Marsyangdi, is located approximately 170km west of Kathmandu.

Construction started as early as 2001, but was delayed by political conditions and only resumed recently. The new power plant generates 72 MW or 400 GWh per year. Even during the dry season, the plant has a peak load capacity of 5 hours. The dam did not need to be very large because the power plant takes advantage of the 108m of the Marsyangdi River’s natural change of elevation over a 5.5km long section.

The dam features an intake weir and a spillway and mainly serves as an equalizing reservoir on a daily basis. With its length of 85m, width of 36m and height of 36m, the spillway has a capacity of approximately 4,270m³/s.

In 2007, DSI supplied DYWIDAG Post-Tensioning Systems for tensioning the trunnion girders of the radial gates. A total of 62t of 0.6”2 strand, 120 type 6812 MA Anchorages and 60 type 6812 HV Loop Anchorages were installed at the job site. In addition, DSI supplied 4,000m of 90mm ∅ x 0.5mm metallic sheathing.

DSI also provided the required strand installation equipment. An experienced DSI employee supervised the tensioning and grouting work, which was also carried out using DSI equipment.

Middle Marsyangdi Dam began to fill in November 2008 and inaugurated in December 2008. DSI is proud to have been part of a tough and dynamical building team that contributed to the economic development of the country of Nepal.
Owner Nepal Electricity Authority, Kathmandu, Nepal +++ General Contractor Joint Venture consisting of DYWIDAG International GmbH, Munich, Germany, Dragados Industrial, S.A., Madrid, Spain and China International Water & Electric Corporation (CWE), Beijing, China +++ Consulting/Engineering Fichtner Joint Venture (Fichtner GmbH & Co., Stuttgart, Germany, Statkraft Groner, Oslo, Norway, CES-Consulting Engineers Salzgitter GmbH, Braunschweig, Germany)

DSI Unit DSI Group Headquarter Operations, Munich, Germany

DSI Scope Supply of 62t of type 0.6” strand, 120 MA Anchorages type 6812, 60 HV Loop anchorages type 6812, 4,000m of metallic sheathing; rental of equipment; technical assistance on site
In the fourth quarter of 2006, Shell Eastern Petroleum Ltd (SEPL) broke ground for the construction of a petrochemical complex on the island of Pulau Bukom in Singapore. The Shell Eastern Petrochemical Complex includes an ethylene cracker in Pulau Ular (extension of Pulau Bukom) which will produce 800,000t of ethylene per year after its completion.

Ethylene is one of the most important basic chemicals in petrochemistry and is mainly used to produce plastics. Ethylene also serves as a fuel gas and can be used to ripen fruit.

Ultracon Structural Systems Pte Ltd (USS), DSI’s licensee in Singapore, was awarded the subcontract to construct an 18,000m³ capacity post-tensioned concrete tank for the ethylene cracker complex. The tank measures 33.8m at its outer diameter. Its wall is 28.6m tall and has a varying thickness of 550mm to 650mm. There are a total of 3 prestressing buttresses in which type MA 6819 Tendons are anchored for stressing purposes.

The tank’s dome roof is cast on a shell steel roof which was constructed at ground level. Once completed, this steel roof was air lifted and floated to its final position using two specially designed air compressors.

Well-known throughout the world for its cryogenic post-tensioning systems, DSI was able to provide invaluable advice to USS on the post-tensioning system that was used for the tank. The system had to fulfill special cryogenic requirements due to the tank’s very low operating temperature.

Apart from providing specialist advice on post-tensioning matters, USS was also responsible for the construction of the tank superstructure. Wall construction was carried out using the special USS jump form system and was cast in 11 lifts of 2.75m height each.

Thanks to the experienced specialists on site, the post-tensioning systems were installed quickly and efficiently.
DYWIDAG Post-Tensioning Systems Secure Sri Lanka’s Economic Development

The island state of Sri Lanka on the southern tip of India is not only a popular tourist destination, but also exports agricultural products such as coffee, tea or natural rubber. As the country’s road network was built 50 years ago, it is no longer able to cope with increasing traffic volumes.

In order to assure the future development of both the economy and tourism, a new expressway is being built in the south of Sri Lanka. The approximately 130km long route between the cities of Colombo and Matara on the south-west coast of the island is being constructed as a two-lane road. However, it can be expanded to four lanes if necessary.

The new expressway meets current standards of traffic security and will considerably shorten driving times between southern cities in Sri Lanka. Agriculture will also profit from this infrastructure development: currently, due to bad road conditions and time lags during transportation, up to 40% of crops spoil before reaching the market. Furthermore, the overall economic situation of the population in the south of the island is expected to improve.

The project is divided into two sections that are funded by the Japanese Bank for International Cooperation (JBIC) and the Asian Development Bank (ADB). The expressway includes several bridge structures. The bridge superstructures consist of post-tensioned T-girders in lengths of up to 40m that were transported to the jobsite by heavy duty vehicles and then lifted into position by cranes.

World renowned for reliability and performance, DYWIDAG Post-Tensioning Systems were chosen for the construction of the post-tensioned girders. The systems used were DYWIDAG FA Flat Anchorages and MA Anchorages, ranging from types FA 6804 to MA 6819. UTRACON Overseas Pte Ltd, a subsidiary of DSI licensee UTRACON Structural Systems Pte Ltd in Singapore, supplied and installed the Strand Tendons and supplied the necessary equipment.

DSI and UTRACON are pleased that high quality DYWIDAG Systems were used for the construction of the new expressway.
Special Foundations for the new Hungerburg Funicular Railway, Innsbruck, Austria

Stabilization and Foundation using GEWI® Piles and DYWI® Drill Hollow Bar Anchors

Project
In 2005, after a detailed assessment of various project solutions, the Innsbruck city council decided to build a new funicular railway from the congress center near the city center to the district of Hungerburg. The existing “Nordkettenbahn” railway, which leads from Hungerburg to Hafelekarspitze, the highest mountain in the Karwendel mountain range, was also fully reconstructed including all of its stations. The realization of this solution required a public-private partnership model (PPP) because the city was unable to raise the total project cost of approximately 50 million Euros.

The architectural challenge was to maintain the historical buildings to a large extent and to create a modern design for the stations that was in accordance with nature and the landscape.

Special Foundations using Micropiles
Due to the difficult ground and water conditions as well as the steepness of the terrain, special construction methods and micropile systems were needed for the foundation of some buildings and bridges.

Congress Station
The foundation is positioned at a depth of 5 to 7m, with the calculated ground water table located 1m below the top ground surface. Consequently, the foundation had to be stabilized to resist uplift forces. Due to limited space, a micropile solution for small drill rigs was chosen in order to achieve an adequate distribution of the uplift piles. The ground consisted of sediments of the river Inn: slightly silty to medium silty, sandy gravel consisting of stones in diameters of 300 to 400mm. Double corrosion protected GEWI® Piles with steel diameters of 40 and 50mm were installed at the site. The service load of the piles was between 345 and 540kN, with pile lengths ranging from 6 to 9m.
Alpenzoo Station
Due to the steepness of the ground, the basements of this station could not be excavated conventionally. To reach basement level, very large soil nail walls had to be constructed. Earth pressure acting on the retaining structure was not taken into consideration; therefore, both the soil nail walls as well as the micropiles were designed for permanent use. Due to the installation method of the DYWI® Drill Pile (uncased, only cement grout for corrosion protection, applied during drilling), a reduction of load using sacrificial corrosion was taken into consideration in the design calculation. This means that the ultimate load of a standard type R 51N DYWI® Drill Pile is 800kN, the reduced ultimate load is 721kN, allowing for a corrosion rate of 1.0 mm at the bar surface over a period of 50 years. At this location, the soil consisted of dense silty sand down to a great depth. The pile working loads were approximately 480kN with pile lengths of 6 to 12m. The piles were subjected to alternating loads and had to be drilled at various angles of up to 45°.

Track between Alpenzoo and Hungerburg Station
In this section, the track runs mainly on a steel bridge construction up to the Hungerburg Station. The soil conditions were as described in the previous paragraph: dense silty sands, partly with gravel. Therefore, the bridge columns are also founded on DYWI® Drill type R 51N micropiles with lengths between 5 and 8m.

Conclusion
This highly demanding project of constructing the new funicular in Innsbruck, Austria, exemplifies the multiple applications of micropiles using either GEWI® Piles or DYWI® Drill Hollow Bars.

These micropiles have proved to be very versatile in foundation, stabilization and anchoring projects in both urban and alpine areas. The foundations can be constructed in nearly all kinds of soils, including rock conditions and in difficult terrain, using lightweight drilling equipment. Technical advantages and commercial competitiveness are further benefits of this system.
DYWIDAG Post-Tensioning Systems help connect Czech Republic and Germany

In order to improve infrastructure and to make the region more attractive for new industries, a new highway was built to serve as a direct connection between Prague and Chemnitz. Construction of this project included a by-pass around the city of Chomutov. In this section, the Hačka Bridge was built using the classical free cantilever construction method. The viaduct is located on a curve with a radius of 500m and a 6% incline.

The Hačka Bridge is 332m long and has spans of 60m + 106m + 106m + 60m. The three delicately designed main pylons consist of two parallel concrete slabs that are linked to each other at the pier head. The roadway is 23m wide and leads over the valley at up to 60m height.

The DSI licensee for the Czech Republic, SM7, Prague, was awarded the contract for supplying and installing all of the longitudinal and transversal post-tensioning tendons in this structure. The approved DYWIDAG 19x0,62” Bonded Strand Post-Tensioning System and type MA 6819 Anchorages were successfully used for longitudinal post-tensioning. Transversal post-tensioning was carried out using DYWIDAG 4x0,62” Strand Tendons with SD 6804 and ED 6804 Plate Anchorages.

In addition, the piers were post-tensioned using a total of 300m of 36mm Ø DYWIDAG Bars. All in all, SM7 supplied 255t of DYWIDAG Strand Tendons, 29,000m of ducts and approximately 300m of DYWIDAG Bar Tendons for this project.

The bridge was opened to traffic in October 2006. It is now part of one of the most important bypass roads in western Bohemia with a direct connection to Germany.
DSI Supplies Comprehensive Scope of Products for Oparno Bridge

In November 2007, construction work began on the last section of the highway that will link Prague and Dresden. The highway is another outstanding example of how countries in Europe are drawing together. It is also important for promoting and improving tourism in the region.

The last Czech section runs through the Oparno Valley in the Bohemian low mountain range and includes an arch bridge, for which two DSI partners made significant contributions. DSI’s licensee for the Czech Republic, SM7 Prague, and Doprastav, Slovakia, are the two companies that co-operated for this project. SM 7 carried out the geotechnical work for the bridge piers, and Doprastav supplied post-tensioning systems, carried out post-tensioning work for the bridge superstructure and installed temporary stay cables for the bridge’s arch.

The bridge consists of two parallel structures. The main deck is 273 m long, with 13 spans in lengths varying from 17.5 m to 24 m. Each superstructure has a 1.2 m x 14.25 m double T-beam cross section that will accommodate two lanes and a pedestrian walkway. The bridge deck is supported by 12 columns, eight of which are connected to an arch with a span of 135 m.

A total of 116 DYWIDAG Strand Anchors with 7x15.7mm Ø, St 1570/1770 strands were installed for the foundation of the pillars. 48 DYWIDAG Strand Anchors were fabricated as temporary anchors in lengths of 19 m in SM7’s factory in Brandýs nad Labem. 68 DYWIDAG Strand Anchors were produced as permanent double corrosion protected DYWIDAG Strand Anchors in lengths of 19-25 m by DSI Austria.

Post-tensioning of the bridge deck required 160 t of 18x15.7mm Ø DYWIDAG Strand Tendons as well as type MA6819 anchorages and type R6819 couplers. The bridge’s arch is divided into two cantilevers with 14 segments that were built using a form traveller. From segments 2 to 14, two temporary stay cables were stressed for each segment. 12-strand and 18-strand stay cables were installed in the pier using temporary type MA6812/19 anchorages. Type ZF6812/19 anchorages were used as passive anchorage in the arch.

The dorsal stay cables were anchored in the pier as well as in the foundation of the adjacent pier. The stay cables were individually inserted into PE ducts and coupled using type D6801 couplers. In addition to supplying the post-tensioning systems, Doprastav also provided the necessary installation and stressing equipment.
The Notre Dame de la Garde Basilica is located high above Marseille, on the southern side of the old port. With its height of approximately 160m, the hill on which the basilica was built is the highest natural point in Marseille. Its strategically advantageous position is the reason why the hill was used as an observation post as far back as the Middle Ages.

To one side of the hill, there is a very steep slope. Due to atmospheric exposure and subsequent weathering, this steep rock face had become unstable and had to be extensively reinforced. Consequently, the general contractor SIMECO awarded specialist supplier DSI-Artéon a contract to supply all of the anchors necessary for stabilizing the rock face.

Since the customer attached great importance to receiving a package solution, SAGGAM, the local representative of DSI-Artéon, supplied not only the anchors, but also the mesh with its total surface area of 1,600m² that was used for stabilizing the rock as well as 1,000m of strand.

For stabilizing the rock face, SAGGAM supplied a total of 455 GEWI® Rock Bolts directly onto the job site.
The GEWI® Rock Bolts with their total length of 1,300m were used for securing the protective mesh, which was attached to the rock face. The GEWI® Rock Bolts were bored into the rock in individual lengths of approximately 3m, post-tensioned and subsequently injected with grout.

The fact that the work had to be executed directly at the rock face constituted a major challenge during this project. The anchors were installed using climbing ropes from which the technicians rappelled down the rock face.

Due to DSI’s package solution and to the excellent co-operation of all parties involved, the job was completed quickly. DSI is pleased to have contributed to preserving one of Marseille’s major landmarks.
Perfect corrosion protection is an essential precondition for the durability of stay cables and bracing systems. Today, the construction industry uses coatings based on epoxy resin and polyurethane or similar products for full locked cables. These are usually applied on site before or after the installation of stay cables. This method is time-consuming and requires clearly defined climatic conditions. Once stay cables have been installed, scaffolding or lifting equipment is necessary to apply the coatings.

DYNA Protect® is a novel method in terms of both material and technology that avoids all of these disadvantages. It can both be used with new stay cables and stay cables and bracing systems that are already in use.

Corrosion protection tapes DYNA Protect® B and C are at the core of the corrosion protection system DYNA Protect®. These are wrapped around the stay cable or bracing to form an impervious surface. The exterior layer is laminated by means of a polyethylene carrier film that is available in several colors.

On the market for over 40 years and tested and proven, multi-ply tapes by DENSO GmbH, Leverkusen, formed the basis of and were optimized for this special application, resulting in the development of corrosion protection tapes DYNA Protect® B and C.

DYNA Protect® B consists of 3 plies: 2 duroplastic layers that are based on butyl rubber and an interjacent stabilized polyethylene carrier film. DYNA Protect® C consists of 2 layers: an external polyethylene carrier film and an internal butyl rubber coating. The manufacturing process ensures that no boundary or intermediate layers form between the different materials.

If the butyl rubber tapes overlap, there is cold vulcanization of the tapes beyond the layer edges. Thus, a closed, tubular, mechanically highly resistant and stable coating is formed that is practically impermeable to water vapor and oxygen.

The standard color of the outer polyethylene carrier film is white, which positively affects temperature behavior of stay cables and bracing systems. Other colors are available on request.

The corrosion protection tapes are wrapped at a defined tensile stress and an overlap of approximately 50%. DYNA Protect® B is in immediate contact to the cable surface and shows good adhesive strength. DYNA Protect® C is used for exterior corrosion protection. The complete coating is approximately 2.6mm strong.

DYNA Protect® tapes can be applied immediately onto the metallic surface of the stay cable or onto existing coatings as long as the surface is dry and free of stains or loose particles.
The DYNA Protect® corrosion protection system was tested for corrosion protection properties and long-term durability during extensive tests at the material testing institute of the University of Stuttgart. The system complied with or exceeded values requested by TL/TP-KOR cables/ RKS bulletin in all relevant sectors. Excellent results were achieved in terms of condensation resistance or permeability to water vapor. Even at the impact of salt fog, no corrosion was detected beneath the wrapped tapes. In order to prove durability of material and color, the corrosion protection system was exposed to artificial weathering using xenon lamps and ultraviolet rays. No change whatsoever could be detected at the polyethylene surface.

In order to ensure constant good quality of the corrosion protection tapes, the certification authority DVGW carries out external inspection and testing.

The DYNA Protect® corrosion protection system was first used at Passerelle des deux Rives Rhine Bridge, a footbridge between Kehl and Strasbourg that was designed by the Paris architect Marc Mimram for the national garden show in 2004. The bridge incorporates 76 60mm Ø to 139mm Ø full locked stay cables that are hot-dip galvanized for corrosion protection.

Some 3 years later, the contractor decided to apply additional corrosion protection. These measures proved to be necessary in retrospect because visual stay cable inspection showed slight corrosion on individual wires that had probably been caused by damage during stay cable installation.

Due to the architecturally challenging bridge design, the use of scaffolding or lifting equipment that would have been necessary for conventional wrapping methods was problematical. The same was true for sand blasting of the stay cable surfaces. Due to the fact that DYNA Protect® did not require any of these techniques and due to the positive test results at the Technical University of Stuttgart as well as a positive assessment by LAP Stuttgart consulting engineers, DSI GmbH were awarded the contract for the corrosion protection work. Work began in the summer of 2008 in cooperation with Alpin Technik and Ingenieurservice GmbH and has been carried out to the complete satisfaction of all parties involved.
Cantilever Construction facilitates Easy Travelling: the Tanaro Bridge in Italy

The city of Alessandria in northern Italy is located between two rivers, the Bormida and Tanaro, and as a result has been frequently flooded.
That is why construction work started on the “Variante” a short while ago. This 93km long special bypass will not only serve to relieve the traffic situation in the city center. In fact, the road is also designed as a dam structure that will protect the town from future floods.

DYWIT has been contributing to one of the bypass sections: the construction of the Tanaro Bridge. This bridge has a total length of 400m and is being built using the cantilever method.

The Tanaro Bridge consists of two parallel superstructures with 3 spans each. The bridge’s main span is 100m, and the side spans have lengths of 50m each.

DYWIT used Low Relaxation Strands Type 1670/1860 in sizes of 9,12 and 15x0.6” for longitudinally prestressing the bridge deck. In total, DYWIT supplied approximately 218t of strands including anchorages and sheathing. In addition, DYWIT also rented the equipment necessary for installation and provided technical assistance on site.

The Post-Tensioning Systems used facilitated the rapid completion of this innovative infrastructure project.
Smooth Flow of Trade between Europe and the Far East with DYWIT

Gioia Tauro is an important seaport in southern Italy. The city is located directly on the route that connects Suez to Gibraltar – on one of the world’s most frequented marine corridors. Gioia Tauro Harbor’s Medcenter Container Terminal (MCT) is the seventh largest container port in Europe.

Since shipping traffic and container handling have dramatically increased over the last few years, Gioia Tauro’s harbor is currently being expanded. In order to permit a simultaneous entering and exiting of ships, the harbor basin is being enlarged. This also includes construction work at the southern harbor entrance and an 18m deep excavation. The plans also specify a wharf extension from 4 to 5km and an enlargement of the shipping channel. Construction work on one of six lots began in December 2007 and will be finished by August 2010.

In order to be able to receive the new, bigger generation of ships used for container traffic, the Port Authority decided to increase the depth of the port channel and docks to -16.00m and to enlarge the eastern quays.

DYWIT supplied 165t of 63.5mm GEWI® Bars and accessories for the extension of the harbor. The 13.4m long GEWI® Bars were used as shear connection between the new quay slabs and the old crane-rail beams. In addition, DYWIT’s experienced personnel provided technical assistance on site.
Repair by Helicopter: the Dalvatnet Dam in Norway

Norway’s west coast is characterized by a multitude of bays and fjords. In many places, steep rock faces that leave no room for roads surround the water landscapes in this region. The Dalvatnet Dam is also surrounded by steep mountains and does not have direct vehicle access.

The dam had to be repaired because it no longer complied with modern requirements. The contractor came up with an unusual solution in order to reach the dam without any available road access. All of the materials needed were transported to the dam by a float.

DSI also contributed to this exceptional construction project. The 21 DYWIDAG 19 Strand Anchors that were necessary for the repair work were transported to the end of the road by truck and preassembled at that location. However, the anchors could not simply be transported to the dam by float, because strand anchors need to be installed vertically in dams and there was no crane available on the dam itself.

The solution to the problem was as innovative as it was simple: the DYWIDAG Strand Anchors were flown to the dam one by one by helicopter. Each of the anchors were hung vertically below the helicopter and then individually secured and brought into position by the construction workers on the dam.

As soon as the anchors reached their respective end positions, they were released from the helicopter’s hooks and the helicopter returned to transport the next anchor from the shore to the construction site. Once the flight maneuver was finished, the grout pump and cement needed to inject the DYWIDAG Strand Anchors was transported to the construction site by float.

Thanks to the innovative special solution proposed by the contractor and DSI, the repair work was carried out quickly and efficiently.
DSC Supplies Stay Cable Systems for Spain’s First Environmentally Friendly Bridge

The cities of Manises and Paterna near Valencia, Spain, are linked by an unusual new bridge: a stay cable bridge that uses the materials of its predecessor.

According to experts, up to 1,250 m³ of concrete were taken from the beams of the old bridge structure, reprocessed and used for the new bridge. The recycled materials were used for the construction of the new bridge deck and for the driving surface of the 1km long new communication road.

The new bridge has a total length of 145m, a main span of 92m and a width of 22.4m. It is thus considerably wider than its 9m wide predecessor and offers room for one lane per driving direction as well as a pedestrian crossing and a new bicycle lane.

In addition, the connection between the cities of Manises and Paterna has been improved by the addition of a new bus line across the bridge. The stay cable bridge leads to a newly constructed roundabout and can now be used by approximately 14,000 vehicles per day instead of the previous 11,500. With its height of 35m, the new bridge is 4m higher than the old connection between Manises and Paterna.

DYWIDAG Sistemas Constructivos S.A. supplied and installed the 34 stay cables on the bridge. In total, 16 type DG-55, 6 type DG-37 and 12 type DG-31 DYNAGrip® Stay Cables with a total strand weight of 115t were used for the bridge.

The stay cables are arranged in two planes with the longest cables being 80m in length. The strand used is galvanized, waxed and PE coated. The strands run inside a white duct that is fitted with an external PE helix.

The installation of the stay cables started on November 13th, 2008 and was successfully completed on December 27th, 2008, after an installation period of only 6 weeks. A second stressing operation was carried out at the end of January 2009, and work was completed in March 2009 to the satisfaction of all parties involved.
Special Anchorages used for New High-Speed-Line between Spain and France

Rail trips between Spain and France will be considerably more pleasant and faster in the future: a new high-speed-line is being built between Madrid, Barcelona and the French border. The project is being supported by the European Cohesion Fund, which encourages the consolidation of Europe by means of trans-European road-rail networks.

The 4.75km long Nudo de la Trinidad-Montcada between Barcelona and the city of Montcada, north of Barcelona, is one of the sections of this new route. The section includes a 3.7km long tunnel, a 2.9km long section of which is being excavated using a special Tunnel Boring Machine (TBM) with an exterior diameter of 11.3m.

Before tunnel advancement, a starter shaft had to be excavated for the modern TBM. The starter shaft consists of an excavation pit with two lateral retaining walls that have to be stabilized by temporary strand anchors or struts. Since struts would have obstructed the advancement of the TBM, the engineers decided to use strand anchors for stabilizing the walls.

Keller Terra, a member of the Terratest group, the market leader for drilling technology in Spain, offered special SBMA (Single Bore Multiple Anchors) Anchorages as the solution to the problem. The system, which was developed and patented by Tony Barley, consists of anchorages in varying lengths that are combined to form a single anchor in one borehole. Each of the anchorages has a short bond length, in contrast to traditional anchorages with long bond lengths.

Because the anchors are staggered, load transfer can be optimized along the entire grout body length.

DYWIDAG Sistemas Constructivos S.A. (DSC) is the only producer of this anchor type in Spain. DSC supplied a total of 65 SBMA Strand Anchorages types 15 and 18x0,6" that were produced in a technically meticulous production process. In addition to the special anchorages, DSC also provided the anchor heads and necessary tensioning equipment for this project.
DYWIDAG Ductile Iron Piles used for the First Time in Spain

For the first time in Spain, the ductile iron pile system was used for the foundation of a commercial building in the Catalan town of Abrera in northeastern Spain, replacing drilled piles in the original design. The contractor, Cimar S.L., decided to use ductile iron piles because they were less expensive and faster to install.

The DYWIDAG Ductile Iron Pile System uses special joints to link individual high strength ductile cast iron piles. These joints permit both a quick connection and a high degree of stiffness. The piles are installed in quick succession using a hydraulic hammer. Because the piles are manufactured from spheroidal graphite cast iron, the system is exceptionally strong and offers superior durability over conventional steel piles.

Additional compressive strength is provided by concreting or grouting the borehole, to create a friction bond with the pile.

Ductile iron piles can either be installed as end-bearing piles, which means that they are dry driven and concreted afterwards, or as skin friction piles, with driving and grouting being executed simultaneously. Thus, Ductile Iron Piles can be adjusted to a wide range of different ground conditions.

The piles were driven in two different ways for the new building in Abrera. In the first case, the excavations for the piles already existed and the piles were driven into the boreholes. Subsequently, over lengths were cut and anchor plates were assembled. In the second case, the piles were driven into the ground and excavation around the piles was carried out afterwards.

In total, approximately 3,300m of type 118/7.5 and 118/9.0 DYWIDAG Ductile Iron Piles were installed and grouted to accommodate additional loads. After driving all of the piles, DSC carried out load tests to determine the skin friction load of the piles. The results were very satisfactory: the friction force alone was enough to support the required load. In addition, some of the piles were excavated to test the results of the grouting operation. These tests were also very successful.

The general contractor was very satisfied because construction work was carried out quickly and efficiently.
A few years ago, construction started on a modern residential estate in the south-east of Madrid’s urban area: the Ensanche de Vallecas (literally: enlargement of Vallecas). On an area of approximately 7 million m², the new residential area will provide space for 25,000 apartments as well as for sports and shopping centers.

Some of the new apartments are targeted for residents aged 35 or younger. Since living space in Madrid’s center is often too expensive for these citizens, they frequently depend on their parents’ apartments.

DYWIDAG Sistemas Constructivos S.A. (DSC) participated in the construction of one of these new apartment buildings. The seven storey building is one of the signature projects of the architects Francisco Ortiz and Lucia Esteban.

The building required the use of post-tensioned flat slabs. DSC designed the slabs for the building floors with a minimum average thickness of 20cm and a total surface of 6,000m² and also supplied the necessary DYWIDAG Monostrand Tendons. A total of 28t of monostrand and 3,000 anchorages were installed in an area of 1,400m². Experienced DSC employees supervised the installation and post-tensioning of the tendons.

Construction began in December 2007 and was finished in March 2008. As all of the tendons were supplied directly on site preassembled from DSC’s warehouse in Madrid, post-tensioning could be carried out successfully within the time frame that had been agreed upon.
Record Spans with Prestressed Concrete in Turkey: DSI Group at Work on a Bridge Construction Project

The 715km long Black Sea Coast Road is part of the 2nd important connection between Asia and Europe. It leads along the coast of the Black Sea through Turkey and will be one of the relevant parts of the road network connecting Bulgaria, Turkey and the Caucasian countries.

Recently, traffic volumes have increased steadily on this important transit route. Consequently, the Black Sea Coastal Road is now being upgraded to a dual 4 lane carriageway. Highway construction is particularly difficult along the middle and eastern Turkish Black Sea coast because the Black Sea Mountains extend directly to the coast and the whole area is characterized by a steep topographical structure.

A section of the Black Sea Dual Carriageway is being designed as a viaduct in order to avoid the problem of the mountainous topography in this region. DSI Group Headquarter Operations and two DSI licensees, the Turkish company DIVIGER Yapi Teknoloji A.S. and DYWITECH Co. Ltd, are involved in the realization of this project.

The bridge is being built between the city of Giresun and the town of Espiye by the Contractor GÜRIS-METIS JV. When completed, the viaduct with its main span of 165m will be the longest box-section bridge in Turkey. The Viaduct is 330m long and consists of two individual bridges with spans in lengths of 82.5 + 165 + 82.5m each.

The superstructure of each bridge, constructed using the free cantilever method, consists of two 330m long hollow box girders each supported by two piers. Both bridge decks are approximately 14.5m wide, and the superstructure of each bridge weighs 12,000t.
The maximum section depth of the single-cell box girder superstructures is 8.25m at the pier table and decreases to 3.5m at mid-span.

Two pairs of newly developed form travelers are used to construct both parallel box girders simultaneously. The form travelers were produced by DYWITECH and installed and operated by DIVIGER. The form travelers are designed for a maximum concreting length of 5m per segment.

DSI Group Headquarter Operations supplied a total of 744 ETA conform DYWIDAG Post-Tensioning Tendons type MA 6819 as well as DYWIDAG Post-Tensioning equipment. The Post-Tensioning system is installed, stressed and grouted by DIVIGER.
Since the mid 1990’s, the main trunk road on the west coast of England for drivers heading to Scotland has been the M6 motorway. However, the motorway ends at Junction 44 near Carlisle, and a 9km stretch of the A74 dual highway continues before reaching the A74(M) just inside the border at Guards Mill near Gretna Green. In 2005, work started on a contract known as the M6 Extension to uprate the old A74 and provide drivers with a continuous 640km of motorway stretching from Dover to Scotland.

The old A74 was built in the 1970’s and while the roadways could be widened and realigned, the old concrete viaduct that carried the road over the West Coast Main Line railway had a history of corrosion in its post-tensioned tendons and could not be incorporated into the new scheme. It was redundant and demolition was the only answer.

The design of the old viaduct consisted of a number of 45.00m long x 10.30m wide deck sections, each weighing approximately 1000t. With an actual span of only 33.52m and constructed with suspended span bearings, clearly a novel approach was needed to demolish this aging structure, particularly because it was located both adjacent to and crossing over a live railway line. The main contractor, Carillion, decided to use a pair of Self Propelled Modular Transporters (SPMT’s), to lift the deck sections and transport them approximately 20m sideways where they would be positioned onto temporary supports. From here, the SPMT’s would be removed and the sections would subsequently be lowered to the ground hydraulically before demolition.

However, from a temporary construction point of view, the bridge decks were not designed to be supported on the 19.0m span effectively dictated by the SPMT’s and an additional and substantial amount of external
post-tensioning was required on the top deck to keep the structure stable during handling. To meet this requirement, the main contractor designed and specified 84 type 12 x 47mm St 950/1050 tendons, each 36.0m long, installed on six of the bridge decks. New concrete restraint blocks 0.6m deep x 1.5m wide x 5.5m long were cast on top of the existing deck and the tendons passed through ducts at 300mm centres and 300mm above the existing deck.

Tendon Installation
Special timbers cut to the right depth were laid across the deck to both support the bars and aid their assembly prior to stressing. Despite their 170kg weight, the 12.0m long bars were easily slid into position and fed through the ducts. However, to avoid rotating the heavy bars during coupling, the technique adopted was to fully thread a coupler onto one bar, align the other bar using a simple guide to maintain the correct pitch and then screw the coupler back over the two bars. Set screws in the coupler were used to ensure it was retained in its correct position and additionally the bars were pre-marked to show the correct coupler engagement and give DSI’s technicians an accurate and permanent visual reminder that the joint had been assembled correctly.

Tendon Stressing
Stressing was carried out in a specified sequence of 50%, 75% and 100% of working load before all the bars were locked-off typically between 570kN - 713kN, depending on the span. In order to keep the load in the deck balanced at all times, 4 x 1100kN stressing jacks were utilized in conjunction with a 4 way hydraulic manifold and a petrol powered hydraulic pump unit. The deck was surveyed continuously at the restraint blocks during the stressing operation and an increase in height of 2mm was recorded – exactly as predicted.

Tendon Destressing
The individual bridge decks were subsequently lifted by the SMPT’s and transported and stored on a specially constructed concrete apron adjacent to the railway line. Following lowering of the decks to ground level, DSI’s technicians were recalled to site to destress the DYWIDAG Bars in reverse order using the same equipment and technique as was used during the stressing operations. From here, the redundant bridge decks were demolished using a variety of techniques and removed from site.

DSI UK Technical Department had a long involvement with Carillion from the on-set and because of the specialist nature of the work, they were invited to install, stress and subsequently destress these tendons, all meeting the very tight and demanding programme.
The Kingdom of Bahrain is an archipelago consisting of 33 islands in the Arabian Gulf. Due to its location along major Arabian and international trade routes, the country has been and continues to be an important economic and financial location.

A major project is now being realized in the capital of Manama that will greatly enhance the country’s economic attractiveness: Bahrain Financial Harbour (BFH). A new district with a total size of 380,000 m² will be built on the northern coast of the main island of Bahrain. This project will concentrate the financial sector, currently spread all over the city, within a single district.

BFH is relatively close to both the city center and the Bahrain International Airport. Bahrain’s tallest towers, the 53-storied Harbour Towers, will be built at this location. Harbour Mall, a shopping mall and service center with a total surface area of 74,000m², will also be constructed as an integral part of the new district.

Within the new financial center, a modern street and bridge network will allow a quick and easy connection between the district itself and the main island. DSI supplied DYWIDAG Post-Tensioning Systems for four of these bridges.

Three of the bridges are designed as single span girders with spans of 35 and 37m. The fourth bridge has three spans with span lengths of 39, 65 and 39m. All of the bridges were built on false work.

On the whole, DSI supplied 336t of type 15.7mm Ø St 1670/1860 Strand. Bridge construction also required a total of 200 Type 6837 MA Anchorages as well as 8,400m of HDPE Sheathing and various accessories. Furthermore, DSI provided the shop drawings and stressing records. The contractor installed the post-tensioning system, and DSI sent an experienced supervisor who carried out the stressing and grouting of the tendons.
According to historical sources, settlement on Lagos Island started as early as the 14th century. In modern times, the natural port basin continues to be an excellent starting point for trade and traffic. Situated at the gulf of Guinea, Lagos has become Nigeria’s largest city. During the 20th century, the metropolitan area extended from the island onto the mainland and onto other islands.

Today, approximately 11.6 million inhabitants live in and around Lagos, and many of them drive into the city center each day to go to work. Lagos Island is connected to the mainland and the international airport by three bridges. The longest of these bridges is the Third Mainland Bridge, which was built in two phases: the 1st phase was opened to traffic in 1980, and the 2nd phase was opened to traffic in 1991. The 11.8km long bridge is not only the longest bridge in Nigeria, but also the longest bridge in Africa. DYWIDAG Post-Tensioning Systems were used at the time the 1st phase of the bridge was constructed.

The greatly increased traffic on the bridge has lead to the deterioration of the steel parts of the sliding hinges at the cantilever ends and to vibrations in the bridge deck ends that were clearly detectable during the last few years. The condition of four expansion joints proved to be especially critical. For the repair work, the tarmac and concrete of the facing cantilever ends were removed by hydro demolition using high-pressure water, thus avoiding additional damaging vibrations to the bridge.

To repair the four expansion joints of the Third Mainland Bridge, DYWIT supplied approximately 1t of type 36 WR DYWIDAG Post-Tensioning Tendons including accessories as well as approximately 1.5t of 28mm diameter GEWI® Bars and accessories. The latter were partly used as a replacement for similar GEWI® Bars that had been removed during the demolition of the cantilever ends.

New DYWIDAG Post-Tensioning Tendons were installed for transverse reinforcement of the cantilever ends where the original tendons were removed. These tendons, as originally designed, serve to stabilize the bridge to accommodate the increasing traffic load that has become much higher than was planned when the bridge was built.

DYWIT also supplied a 110 Mp tensioning jack as well as a type 77-159 hydraulic pump.

The simple handling of the easy to install, high-quality DYWIDAG Post-Tensioning Systems also helped to limit traffic obstructions caused by the unilateral blocking of the bridge during repair works to merely two months.
Bridges in Africa constructed using DYWIDAG Strand Tendons

Steinmetz Flyover, Cotonou, Benin

Several rivers along the tropical coast of the western African state of Benin exit to the sea by forming lagoons. Cotonou, a city that has grown to become the largest in Benin, is also divided by a lagoon. Cotonou features the country’s largest harbour and is the economic center of Benin as well as the country’s seat of government. The city’s strong growth has resulted in a considerable increase in traffic volume on each side of the lagoon. Additionally, the main route along the western African coast also leads through Cotonou. In order to cope with the increase in traffic volume, three new bridges were built over the lagoon’s outflow channel into the sea.

All of the traffic that crossed the lagoon via the Konrad Adenauer Bridge, a four lane bridge structure completed in 2004, in the past was directed to the Steinmetz roundabout at the western end of the bridge. Because one of Cotonou’s main roads also connects to this roundabout, lengthy traffic obstructions occurred on a daily basis. These traffic jams have now been eliminated by the construction of an overpass over the Steinmetz roundabout. Now, traffic flows...
across town much more fluently. In addition, this important traffic junction has now become considerably safer for all road users.

The inner-city bridge designed to alleviate the Steinmetz roundabout congestion is 180m long. The access ramps to both sides of the bridge measure 50 and 120m in length and are 15m wide. The bridge accommodates one lane for vehicles as well as a special lane for two-wheelers and a narrow sidewalk into each direction. In order to eliminate the traffic obstruction as quickly as possible, a short construction time was paramount. That is why the bridge was constructed using the prestressed concrete method.

First of all, the contractor, DYWIDAG International GmbH, concreted the piers together with the crossbeams. After the completion of all of the piers, concreting began for the 9 bridge spans in lengths of 20m each using false work. In order to achieve the required structural capacity of the bridge, 18 DYWIDAG strand tendons with one type MA-A 6815 stressing anchor and one type MA-B 6815 fixed anchor each were installed per superstructure segment. The strands were inserted into the ducts before concreting. Afterwards, the concrete for the superstructure segment was cast, and once the required concrete strength was achieved, the tendons were stressed using a HOZ 5,400 bundle jack. Finally, the ducts were injected with cement grout to achieve bonding between the strands and the superstructure and to protect the tendons against corrosion.

DSI delivered DYWIDAG Post-Tensioning Systems for this important inner-city bridge. The new Steinmetz traffic hub was opened to traffic at the end of 2008 following a festive ceremony at which both Benin’s president and the German ambassador were present.
Stay Cable Footbridge Stabilized using DYWIDAG Bars
New Connection between Railway Station and City: the Miguel Reale-Bridge in São Paulo

With its more than 19 million inhabitants, São Paulo is the largest industrial metropolis in Latin America and the most populous city in the southern hemisphere. This explains its enormous traffic volume: on average, three million cars use the city’s main roads every day.

Since the heavily travelled multi-lane roads also constitute a problem for pedestrians, the Companhia Paulista de Trens Metropolitanos (CPTM) decided to build a new footbridge to improve public safety. The new bridge was designed as a single pylon stay cable bridge leading over the multi-lane road Cidade Jardim, one of São Paulo’s main arteries.

The bridge considerably facilitates the passage for the five thousand people who have to get from Cidade Jardim Station to the offices, restaurants or commercial facilities on the other side of the street each day. The bridge’s aesthetically pleasing design as well as the redesign of green space near the structure has considerably improved the cityscape around Cidade Jardim Station.

The superstructure crosses Cidade Jardim Road at a height of 6.00m so that the street below can be used without any restrictions by heavy duty vehicles. In addition, the bridge has handrails in two different heights and a wheelchair-friendly elevator to meet the needs of the disabled.

Protendidos DYWIDAG supplied more than 800m of St 85/105 DYWIDAG bars for the
construction of the Miguel Reale Bridge. The 32mm bars were used as stay cables during bridge construction and were anchored individually at the pylon as well as centrally on the driving surface. The lengths of the individual stay cables vary between 23.20m and 53.50m.

The Miguel Reale Bridge was inaugurated in São Paulo on July 26th, 2007 in the presence of the São Paulo State Minister of Transportation, Jose Luiz Portella, the Governor Jose Serra and the chairman of the owner CPTM.
Transportation Efficiency Improvements with Protendidos DYWIDAG: Extension of São Paulo Subway System

Traffic congestion and air pollution are a daily occurrence in São Paulo, a city where the vehicle population has more than tripled since 1975. Today, there are approximately five million cars and trucks traveling the city roads each day. In addition, approximately 15,000 buses with high levels of emission worsen the city’s traffic burden.

The city’s subway system, Metrô, which was opened in 1974, has a total length of 61.3 kilometers and consists of 4 lines. As it is today, the subway system can only transport a relatively limited number of passengers and as a result, many people have to rely on the city’s bus system and are therefore also dependent on the congested streets in the metropolitan area.

That is why the owner of Metrô, Companhia do Metropolitano de São Paulo, has decided to considerably expand the subway route network. Line 5 is to be extended and a new airport express line is to be built. In addition, the route network is to be extended as a whole and completed by adding a new line. This new line, Line 4, is the first infrastructure project in Brazil to be carried out by Public-Private-Partnership.

As a specialist supplier of Post-Tensioning Systems, Protendidos DYWIDAG is supplying DYWIDAG Post-Tensioning Systems in several Subway stations on Line 4. At Higienópolis-Mackenzie Station, the Consolata Building must be repaired and strengthened in order not to endanger the subway tunnel below. For this purpose, Protendidos DYWIDAG is supplying approximately 220m of 32mm St 85/105 DYWIDAG THREADBAR®. In addition, the company rents tensioning jacks and offers training in which the responsible workers learn how to install DYWIDAG THREADBAR® correctly.

Approximately 3,000m of 32 mm St 85/105 DYWIDAG THREADBAR® will be supplied for República Station. The Post-Tensioning Systems are used for stabilizing the load bearing pillars and beams for the subway path. 600m of 32mm St 50/55 GEWI® Bars will be supplied for Morumbi Station. These will be used to anchor a retaining wall. For the extension of Line 2, Protendidos DYWIDAG also supplies DYWIDAG THREADBAR® that will be used to stabilize a concrete slab in the middle of Ipiranga Station.

Protendidos DYWIDAG is proud to be contributing to this major project in São Paulo.
New Stay Cable Bridge in the Metropolitan Area of São Paulo Improves Local Infrastructure

The city of Guarulhos borders São Paulo to the northeast. With approximately 1.3 Million inhabitants, it is part of the metropolitan area of São Paulo. It is also the location of São Paulo International Airport, the largest airport in Latin America.

Many of the country’s main highways run through Guarulhos. The Dutra Interstate, one of Brazil’s main highways, linking São Paulo and Rio de Janeiro, is a principal component of the highway network passing through Guarulhos. Since the existing feeder roads for Dutra Interstate were no longer able to cope with the high traffic load in Guarulhos, the city decided to improve the traffic flow by building a new feeder road.

The new highway exit will connect Paulo Faccini Road with Presidente Dutra Highway via a bridge, thus providing relief for city traffic. The new bridge is 170m long, with a main span of 96m. The bridge is designed as a stay cable bridge and is erected using the free cantilever method. The structure’s only pylon has a height of 61m. The road surface is 24m wide and will accommodate two traffic lanes into each direction as well as two footpaths and bike lanes.

The General Contractor Construções e Comércio Camargo Corrêa S.A. awarded Protendidos DYWIDAG a contract to supply all of the DYWIDAG THREADBAR® Systems necessary for the stabilization of the bridge. Part of the Post-Tensioning Systems is used for stabilizing the foundation of a tower crane that is used during pylon construction. Additional DYWIDAG bar tendons are needed for temporarily post-tensioning the moveable cantilever formwork.

A total of 400m of 32mm diameter DYWIDAG THREADBAR® will be supplied by Protendidos DYWIDAG from their local factory in Guarulhos.

Protendidos DYWIDAG is proud to have been chosen as a specialist supplier of Post-Tensioning Systems for this project.
DYWIDAG Bar Tendons stabilize Paraná Bridge

BR-158 Federal Highway runs through Brazil from North to South, linking several federal highways to the federal state of São Paulo. With approximately 19 million inhabitants, the metropolitan area of São Paulo is the most important economic and financial center of the country as well as Latin America's largest industrial agglomeration.

Until recently, people had to cross the Paraná River, the second longest river in South America, by ferry to get from one part of the federal highway to another and to reach the
province of São Paulo. As this ferry trip is very time-consuming, a new bridge is now being built. The Paraná River Bridge will allow a quicker passage into the province of São Paulo, significantly improving the country’s infrastructure.

The bridge structure, which has an overall length of 1,700m, consists of a 200m long and 18m wide main span with two side spans of 100m each as well as 1,300m of approach structures. The main bridge spans the Paraná River by virtue of a 400m long, two pylon stay cable structure.

While the access bridges were built using precast segmental construction, the free cantilever method was chosen for constructing the 400m long superstructure segments on each side of the pylons. In the latter case, reinforced concrete elements are used that are post-tensioned longitudinally with double corrosion protected DYWIDAG St 85/105, ø 32mm THREADBAR®. The epoxy coated bar tendons were installed in corrugated sheathing and permanently grouted after tensioning.

DYWIDAG Bar Tendons were also used as reinforcement in both pylons and especially in the upper part of the pylons for the installation of the stay cable anchorages. DYWIDAG Bars were also used to temporarily support the form travelers.

On the whole, Protendidos DYWIDAG supplied approximately 13,000m of DYWIDAG Bars, 1,672 anchorages as well as the technical equipment for installation and post-tensioning.

Protendidos DYWIDAG is pleased to have contributed to the successful completion of this important infrastructure project.
Rapid Construction Progress in Vancouver with DYWIDAG Post-Tensioning Systems

The Canadian coastal city of Vancouver, BC is not only an important sea port in the western Canada, but is also known for its high quality of life. Especially in downtown Vancouver, continuing construction activities prove the city’s popularity as a place to live and work.

The Fairmont Pacific Rim project is centrally located on the waterfront in Coal Harbour. After its completion, this 48-story building will be one of the most expensive residential addresses in Canada. Fairmont Pacific Rim has a total area of approximately 93,000 m² and includes a hotel as well as parking, retail and residential space. The project features a five-star 22-floor hotel with 415 rooms and amenities, and 173 luxurious residential condos on the upper 26 floors.

For aesthetic reasons, the building has relatively few interior columns. Fairmont Pacific Rim is scheduled to be completed in 2009 after 40 months of construction, just in time for the 2010 Winter Olympics.

In order to have the structure completed in time, the majority of the post-tensioned slabs had to be constructed on a one week cycle. This was difficult because an average of 300 DYWIDAG Monostrand Tendons and 7,600 m of type 0.6" unbonded strand had to be installed in each slab. The contractors all worked closely together, even using CAD files to prevent delays.

Construction was also made difficult by the project’s being located in the busy downtown core next to the cruise ship terminal. During peak periods, shipments could not be delivered: the large transport trucks needed special traffic control to access the site and would have caused considerable traffic congestion.

INFO

Owner Fairmont Developments, Toronto, Canada +++ General Contractor Fairmont Developments, Toronto, Canada +++
Contractor Lower Mainland Steel, Vancouver, Canada +++ Architects James KM Cheng Architects Inc., Vancouver, Canada +++
Consulting Engineers Jones Kwong Kishi, Vancouver, Canada

DSI Unit DSI Canada Ltd., Western Division, Surrey, Canada
DSI Scope Supply of unbonded DYWIDAG Monostrand Tendons; technical equipment
Genco Place is a 14 storey building located in the south of Calgary. This structure originally began construction during the boom of the early 1980’s. Construction was halted due to financial reasons after only completing the parking garage and a ground level structure. However, the current building owners recently decided to complete the building because office vacancies were getting increasingly scarce in Calgary.

An extensive design analysis of the existing structure and existing design drawings was undertaken and it was concluded that the existing foundations could support the new building. However, post-tensioning would be essential in order to minimize the overall building weight.

The consulting engineers selected a reinforcing system with post-tensioned beams and slabs. The beams use size 6x0.6” and 7x0.6” DYWIDAG Multistrand Bonded Tendons. It was critical to post-tension the slabs in addition to the beams to keep the structure weight within the limits the design engineer set. The slabs were reinforced using Bonded Monostrand Tendons. This system is new to the Calgary area and as a result received much attention.

All of the strands were protected with oil so grouting could be delayed until the warmer summer months. As a precaution, some of the strands in the first slab were investigated to confirm corrosion was not taking place within the length of the tendon. Thanks to the high quality materials used, there was no trace of rust or corrosion whatsoever.

DSI provided a full time supervisor during the installation of all post-tensioning systems. Qualified DSI employees ensured the quality of materials used, schedule timely deliveries and proper procedures and trained the contractor’s personnel in post-tensioning. The contractor was pleased with all aspects of the post-tensioning operations and has since awarded DSI several additional projects.

Owner C&T Reinforcing, Calgary, Canada +++ General Contractor Clark Builders, Calgary, Canada +++ Architects HCI Architecture, Calgary, Canada +++ Consulting Engineers RJC Calgary, Calgary, Canada

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

DSI Scope Supply of size 6x0.6” and 7x0.6” DYWIDAG Multistrand Post-Tensioning Systems and Monostrand Post-Tensioning Systems; rental of equipment; installation supervision
Oil Extraction using DSI Technology: Oilsands Project in Alberta, Canada

The city of Fort McMurray, in the Canadian province of Alberta, is located in the Athabasca Oilsands area, at the center of the country’s oil producing region. According to expert estimates, the province’s oilsands deposits cover approximately one fourth of Canada’s oil consumption. Oilsands are a mixture of bitumen, sand and water and for the most part are mined using the open pit mining method.

The oil producer Suncor, one of the largest Canadian companies in this market, is currently building a new upgrading facility. The Voyageur project will increase crude oil production by 200,000 barrels per day to 550,000 barrels per day.

The facility consists of three coke drum pairs, the framework of which is supported on cast-in-place concrete foundations. Due to their large cross sections, the coker columns are heavily reinforced because they have to resist large forces during operation. Inside the coker facility, bitumen is split into its chemical components.

Because they are easy to splice during installation, the engineer decided to use DYWIDAG bars as reinforcement for the concrete structure and the foundations. Approximately 390t of 63mm Ø DYWIDAG bars with a yield strength of 552 MPa/80 ksi were used for this project.

Due to the large diameter of the bars and their high load bearing capacity, the total quantity of vertical reinforcement bars were reduced and the clear space between individual reinforcement bars was increased. Consequently, a congestion of reinforcement elements at the intersections was avoided. Thanks to the couplers, the DYWIDAG Bars were installed easily and quickly at their respective locations, and a complicated threading of the bars through the vertical reinforcement structure could be avoided.

What made the project challenging was the fact that the DYWIDAG Bars had to be precisely positioned because the reinforcing steel cages did not have any allowance for adjustment once completed. The exact positioning of the DYWIDAG Bars was necessary so that the bars could be connected to each other through couplers to link the completed cages.

The DYWIDAG Bars were anchored in the pile cap with plate end anchorages. All anchor plates were combined into one anchor frame in order to facilitate placement and stabilization of the bars during the construction of the pile cap.

At the upper end of the columns, forces had to be transferred from the vertical column reinforcement to the horizontal reinforcement of the slab.
This is usually achieved by bending the reinforcement. However, the large diameter of the bars made bending them impractical. Consequently, a transfer frame was installed at the bottom of the top slab into which the large DYWIDAG bars were anchored with plate anchorages. In addition, four #8, 25mm Ø DYWIDAG Bars with a yield strength of 517 MPa / 75 ksi were integrated into the frame construction for each 63mm bar. A total of approximately 40t of #8, 25mm Ø DYWIDAG Bars were supplied. These bars were extended up through the slab and bent to overlap with the horizontal top slab reinforcement.

DSI Canada is pleased that DYWIDAG Reinforcement Systems were used for this unconventional project.
DYWIDAG Post-Tensioning Systems stabilize Bankers Court Project, Calgary

Since post-tensioned slabs are considerably thinner than conventional slabs, Bankers Court features especially large open spaces with high ceilings. In addition, the selected bonded system has excellent long-term corrosion protection.

All in all, DSI supplied approximately 64,000m of strand as well as 658 type 9x0.6", 15x0.6" and 19x0.6" anchorages for Bankers Court Project. The slabs were built using a bonded post-tensioning system consisting of flat slabs with an integrated beam system underneath. Each beam includes a single 9x0.6" multistrand Post-Tensioning Tendon that is fully encased and grouted after stressing. At each end of the building, there are two perpendicular beams that are post-tensioned with type 15x0.6" bonded DYWIDAG Multistrand Tendons. Type 19x0.6" DYWIDAG Tendons were installed into the roof slab due to increased loads and the architectural shape of the upper floors.

Since the building was constructed during the cold winter months, the strands were supplied with corrosion protection oil that allowed grouting of the tendons many weeks after the stressing operation. This option permitted grouting when the weather warmed up in the spring and saved having to heat the slab. In addition, the grouting could be done independently of the construction progress. Grouting of all of the DYWIDAG Tendons that were installed at Bankers Court was completed in only three separate operations using a special cement grout with thixotropic properties and grouting multiple floors in a single operation.

One of the challenges for this site was the lack of experienced crews for the tensioning work. For this reason, DSI provided an onsite supervisor to oversee every aspect of the post-tensioning operation and coordinate deliveries and schedules.

Work was also made difficult by the fact that the access road leading to the site had to be closed completely for each delivery. The resulting limited street usability in Calgary’s downtown core and the lack of onsite storage meant deliveries had to be coordinated with the manufacturing plant just-in-time.

As a result of the excellent co-operation of everyone involved in this demanding project and of the chosen materials and methods, construction was successfully completed according to the initial construction schedule.

Downtown Calgary, Canada, features two impressive skyscrapers rising in its very center: the Bankers Hall towers. A third building is currently being built as an addition to the two high rise buildings, which were completed in 1989 and 2000 respectively and are considered to be one of the city’s landmarks. The Bankers Court building will make the shopping center even more attractive by diversifying the existing leisure facilities. Bankers Court, with its modern design, will be directly connected to the towers’ shopping floors via an enclosed pedestrian bridge.
Efficient Transit Link in Vancouver: Construction of the Canada Line with DSI

The transportation corridor between the cities of Vancouver and Richmond is one of the four main corridors of the region. Approximately 20% of the population and a third of the jobs in Greater Vancouver are located in this area. In order to significantly improve traffic flow, a new rapid transit link is being built in Vancouver: the Canada Line.

The Canada Line is a new Automated Light Metro System joining the Vancouver International Airport (YVR), the suburb of Richmond, and the Vancouver downtown core and providing a fast link to the cruise ship terminals and the Convention Centre.

This large-scale project is approximately 19km long and consists of an elevated guideway, two bridges and an at-grade section at the airport. Furthermore, the project includes a cut and cover tunnel and a bored tunnel section under False Creek Harbor in downtown Vancouver. The Canada Line will initially have 16 stations and is estimated to carry 100,000 passengers per day. Public operation of the new transit link is scheduled to start in November 2009, just prior to the Winter Olympics.

DSI Canada West was awarded a contract to supply the Multistrand Post-Tensioning Anchorages and stressing equipment for the elevated guideway. The project called for 374 type 27x0.6", 2,294 type 19x0.6" and 421 type 12x0.6" complete anchor assemblies and associated stressing equipment. DSI also supplied the corrugated galvanized steel PT duct for the tendons.

The anchors and ducts were cast into 3m long precast concrete segments. Due to the fast-track nature of the project, supply of the initial anchors had to be carried out at a very fast pace. The precast segments allowed for the necessary flexibility in the span between the columns. The precast segments were trucked to site and installed using a moveable launching truss.

The tendons were installed on-site and stressed by the contractor, who employed two trusses at separate locations to meet the construction schedule. Once a guideway section was completed and stressed, the launching truss was moved to the next column, allowing for less interruption to traffic.

Thanks to the excellent co-operation of all parties involved, and thanks to the high-quality systems used, all requirements were met to the complete satisfaction of the owner.
DSI Monostrand System Prevents Loss of Material

The Canadian city of Red Deer, an important industrial location of the Province of Alberta, is located between the cities of Calgary and Edmonton. As is common for the region, the winters in Red Deer are very cold, which especially affects the city’s road network. Each year, large quantities of sand and de-icing salts are used to free the city streets from ice and packed snow. Up to now, these materials were stored unprotected from the elements. This resulted in loss of material due to atmospheric exposure and in environmental problems caused by de-icing salts that contaminated surrounding soil.

Within the scope of a relocation program of several civic service buildings, the City of Red Deer decided to build a covered storage facility for sand and de-icing salts in April 2007. By appropriately storing these materials, the city will save considerable cost and protect the environment.

In order to achieve the main goal of preventing material loss, the consulting engineers chose a post-tensioned slab-on-grade structure that would result in a monolithic slab with no cracks. With a length of about 78m, a width of 38m and a thickness of 0.355m, the slab is very large.

Since the slab needs to hold a lot of weight and support loading and moving equipment, a tremendous amount of post-tensioning is required. All in all, DSI supplied 58,000m (64t) of 0.6" Extruded Monostrand and 2,160 special Monostrand Anchorages. Other than slab edge reinforcing, there is no rebar installed in the slab. To compensate for temperature shrinkage, the strands, which were installed both transversely and longitudinally, were stressed in a staged pattern.

DSI supplied, installed and stressed all of the post-tensioning materials. With winter quickly approaching, time was especially scarce. Consequently, materials had to be delivered to the site quickly and the layout had to be completed as soon as possible so concrete could be poured. Post-tensioning was successfully completed within a mere 5 ½ weeks from the date of receiving the order to proceed. Due to the tight schedule, all of the strands were fabricated on site by pulling the strand directly from the bulk packs.

Everything proceeded seamlessly, and the contractor was able to pour the concrete one week earlier than originally scheduled. The structure was completed according to schedule to allow use during the coming winter months.
DYNA® Force Project: Retrofitting of Boundary Dam in Canada

The Boundary Dam near Estevan in the Canadian province of Saskatchewan was built in 1957. The dam has a spillway that protects it from flooding. The spillway ensures that floodwater cannot run over the top of the dam and damage the structure.

The dam owner, SaskPower, has just started retrofitting the spillway because the 50 year-old structure showed signs of frost heaving. In addition, it does not meet today’s probable maximum flood requirements established by the Canadian Dam Association. Furthermore, an investigation in 2006 found that inadequate joint design and a drainage malfunction had lead to undermining and to slab movements in the spillway.

Work is made particularly difficult because construction may neither compromise the functioning of the spillway during high-water periods nor interrupt the cooling water supply to a nearby power station.

The retrofitting of the dam will be carried out in phases and involves installing Post-Tensioned Strand Anchors in the spillway chute and the stilling basin to enhance slope stability and resist uplift forces during eventual high water flow. The new spillway also needs to resist a potential swelling of the rock strata underneath both the chute and the stilling basin.

DSI executed a test program during the first phase of the retrofit program in order to determine the length and capacity of the resulting anchors. The test anchors were installed in the western side of the spillway. Ten DYWIDAG Strand Anchors with 9 strands (ASTM A416) and single corrosion protection were used as test anchors. The design load per anchor was 910kN and the ultimate load was 2400kN. The anchor bond lengths were post-grouted because the soil consists of mudstone and siltstone.

Two of the test anchors with intentionally long bond lengths of 18m and unbonded lengths of 20m and 24m were equipped with three DYNA® Force Sensors placed on the bonded length of the anchors. The sensors were attached to the anchors at various depths measured from the top of the bonded length at 0.2m, 6.2m and 12.2m.

The main purpose of the DYNA® Force Sensors was to determine how stress is distributed throughout the anchor bond zone in these specific soil conditions. The tests also needed to determine whether there was any potential benefit to shortening the bonded length below the limits recommended in the specifications.

Readings during testing to 80% of the ultimate load showed that the sensor at the top of the bond zone matched the tensioning force, the middle sensor indicated significant load reduction and the bottom sensor indicated zero loads.

Consequently, the results of the sensor measurements confirmed that the entire 1900kN load was transferred to the soil in less than the first half of the bonded length, resulting in anchor lengths designed with a shorter bond length. This is due to the fact that the shear strength of rock strata can be mobilized to sustain the entire test load, provided that the post grouting method is carried out and that the hole size and drilling methods are consistent with those employed during the testing program.

Because of this test program, the owner is saving material, drilling and labor costs and will be able to carry out construction work much faster as a result of the shorter bond lengths.
Innovative Roof Design for Modern Skating Oval in Canada with DYWIDAG Systems

The western Canadian city of Richmond in the south of Vancouver is looking forward to the 2010 Olympic Winter Games: the modern ice skating rink, Richmond Oval, was opened to the public in December 2008. The 2010 Olympic Winter Games’ long track speed skating will take place on the Oval’s 400m long skating track.

The 32,000m² Richmond Oval will accommodate 8,000 visitors during the 2010 games. After the Olympics, the Richmond Oval will be converted to house multi-purpose areas for other forms of sport. The Oval will be used as a sports and wellness center both before and after the Winter Games.

What is especially interesting about the Richmond Oval is its roof structure. The uniquely designed wooden roof is wave-shaped and features one of the longest spans in North America with an approximate surface area of 26,300m². The blue tinged “beetle wood” of British Columbia’s mountain pine beetle ravaged forests was deliberately chosen for the Richmond Oval’s roof to showcase this unique British Columbian product to the world.

Working with wood on such a large scale introduces special problems not encountered in smaller wood structures. The designers solved these problems by including steel elements along with the wood. The problem of maintaining the curve in each of the roof’s unique wave-shaped panels was solved by using DYWIDAG THREADBAR®.
Each panel of the roof is made of many small pieces of wood assembled in a V-shaped length which is curved along its bottom edge. To maintain that curve, a galvanized bolt runs directly below the curve, tying the ends of the panel together and maintaining the tension in the segments. As a result, the DYWIDAG THREADBAR® used for the roof are clearly on display as an integral part of the roof structure.

For the roof of the new skating oval, DSI supplied over 1,300 galvanized 19mm 517/690 MPA, GR 75 (BST 500/550) DYWIDAG THREADBAR®s with associated hardware. In addition, 54 galvanized 28mm 517/690 MPA, GR 75 (BST 500/550) DYWIDAG THREADBAR® were used for the lobby roof.

Because of the visual prominence of the bolts in the roof design, couplers were not acceptable to the designer. This meant that the DYWIDAG THREADBAR® (average length = 13.1m) had to be supplied full length: a challenge not only for shipping, but also for galvanizing.

Because the longest locally available galvanizing kettle could only accommodate lengths of up to 9.2m, all the bars had to be double dipped rather than just single dipped. Fortunately, full length threadability was not required for this project, and the galvanizer was skilled enough to double dip the 19mm DYWIDAG THREADBAR® without bending them in the process.

All bars had to be individually tested for threadability at both ends. In addition, there were over 204 uniquely identified bar lengths, each of which had to be individually tagged in order to facilitate assembly at the contractor’s shop.

The contractor, StructureCraft, who had chosen DSI because of its specialized systems, was very satisfied with the DYWIDAG Post-Tensioning Systems supplied.
Large-scale Project in Baltimore’s Inner Harbor: DSI stabilizes Excavation at Inland Port

The city of Baltimore, with a population of approximately 641,000, is the largest city in the state of Maryland and one of the most important seaports in the US. The city is an important industrial and commercial center as well as a significant location for research and development in pharmaceutics and medicine.

Due to its many historic buildings, Baltimore also attracts numerous tourists. The Inner Harbor, the city’s inland port, is especially popular with visitors. The historic inner harbor was a working port from the 17th century up to the mid 20th century. In the 1970’s, the harbor area was rediscovered as an economic and cultural center of the city, and new buildings were constructed in the area.

Since then, an increasing number of museums, shops, residential buildings, restaurants and hotels have emerged in Baltimore’s Inner Harbor. Construction activities continue to be strong – especially so in Harbor East.

DSI is making a significant contribution to one of these projects: the construction of the high rise Four Seasons Hotel. Since the new building is a mere 6m away from the port basin, the bathtub-like excavation for the four-story parking garage, which is up to 18m deep in places, had to be stabilized by an 8,800m² tieback diaphragm wall. The excavation’s bathtub structure is supported laterally by the concrete slabs that form the parking garage floor.

DSI USA supplied a total of 537 temporary DYWIDAG Strand Anchors with 9-26 strands each in lengths of approximately 27 to 30m.

In addition, DSI USA also supplied 65mm Gr 150 DYWIDAG bars and couplers for 36 temporary micropiles in lengths of 20.5m. These micropiles were later removed between the floors.

The work was made difficult by extremely differing soil conditions and high hydrostatic pressures. Due to the varying pressures, four different levels of tiebacks were used. In addition, DYWIDAG Strand Anchors were adapted individually to meet expected levels of pressure. In the lowest anchor row, strand anchors with up to 26 strands were successfully installed and post-tensioned.

The completion of the new Four Seasons Hotel is planned for summer 2010.

INFO

Owner: Harbor East Parcel D, LLC, Baltimore, MD, USA
General Contractor: Armada Hoffler Construction Company, Baltimore, MD, USA
Tieback Subcontractor: Nicholson Construction Company, Bridgeville, PA, USA, a Solentanche-Bachy company
Consulting Engineers: Mueser Rutledge Consulting Engineers, New York, USA
DSI Unit: DSI USA, BU Geotechnics, USA
DSI Scope: Supply of 537 temporary DYWIDAG Strand Anchors with 9-26 strands in lengths of approximately 27 to 30m; supply of 65mm Gr 150 DYWIDAG bars and couplers; supply of approximately 272,800m of strands; rental of equipment
DYNA® Force Load Monitoring Sensor for Strand Tieback Retaining Wall

The experienced contractor Hayward Baker was hired to do engineering, general construction, and subcontract work for a design-build wall retrofit. The theoretical failure plane of the slope was far behind the wall face. The contractor decided that the best method was to use very long (27m to 65m) tiebacks, anchored 13m behind the theoretical plane. 345 type 9x15.2mm strand anchors with double corrosion protection were installed at different wall heights. They were stressed to 80% of strand ultimate strength or 2,342kN and the anchor load was transferred through a bearing plate placed against very large precast concrete pads. This method allowed the load to be spread over a large area of the wall, preventing punching shear of the crib units. The anchorage was encapsulated with a galvanized cover cap and fully cement grouted after installation.

Eight DYNA® Force elasto magnetic sensors were installed at different wall locations on the stressing length of the eight anchors. The sensor is placed and taped over one strand and the leading wire protruding from it is left long enough to be easily accessible for future readings. The sensors were used as an additional load control during proof test and lock-off load transfer and will serve as the future anchor load monitoring system.

Measurements taken during the test matched the equipment pressure gauge and, 4 hours and 28 days later, showed that the anchors and the wall behaved as expected.

The robust DYNA® Force Sensor can be easily installed and also provides a reliable anchor load monitoring system.

The Patton Creek mall, with approximately 55,750m² of commercial space, has several buildings located near a very tall, steep slope that ends at the Patton Creek shoreline. The original development stabilized the slope with a 500m long crib wall that is up to 15m tall. During recent years, field inspections and consequent studies discovered that the wall was showing signs of slow movement.

Patton Creek shopping center was opened in 2004 in Hoover, Alabama. The center was built to satisfy the increasing demand for shopping facilities in one of the fastest growing cities in Alabama.
DYNA® Force - a Reliable Elasto-Magnetic Sensor for Force Measuring for Post-Tensioning Tendons and Anchors

On many occasions during construction and the service life of structures, it is crucial to know the exact loads and forces in post-tensioning tendons and anchors. Although there are many methods to measure the tendon force, most of them are cumbersome, expensive and unreliable.

The DYNA® Force Sensor System is a new development that allows the quick and easy monitoring of load changes both during performance tests and during the entire service life of tendons in any kind of structure. The DYNA® Force System can determine the load along the bonded length of anchors at any time so that anchorage lengths can be flexibly adapted to clients’ needs.

The DYNA® Force System uses a combination of elasto magnetic technology (EM) and non-destructive testing (NDT) to directly measure the interior stress level in prestressed strands, bars, post-tensioning tendons and anchors. The system is based on the principle that the permeability of steel to a magnetic field changes with the stress level in the steel. This means that, by measuring the change in a magnetic field, the magnitude of the stress in the steel element can be determined. With a monitoring accuracy of +/-1%, the DYNA® Force Sensor permits a measurement of actual forces which is very reliable.

The sensor system consists of a solenoid composed of a primary coil and a secondary coil that are insulated from each other by plastic or other polymers and which work together to formalize the elastic, magnetic characterization of the material. Pulsed current passes through the primary coil, and the secondary coil picks up the induced electromotive force that is directly proportional to the change rate of the applied magnetic flux and the relative permeability of the prestressed steel. The secondary coil is linked to a power stress reading device. The DYNA® Force Sensor is designed as a self-contained unit which can be directly applied to the strand or bar anchor whose properties are to be measured. The system can be applied over uncoated, epoxy coated, greased, extruded or HDPE sheathed tendons.

The materials used for the DYNA® Force System are flexible in order to allow an adaptation of the sensor to the service life of individual structures. Durable materials such as copper wire or special steel alloys for the sensor’s shell steel cover can be used as required.

Furthermore, the system has a temperature compensating function in order to avoid perturbations due to variations in ambient temperature. The calibration process also takes into account the altered characteristics of the tendon which are caused by magnetization. In order to ensure an exact accuracy of measurement at all times, every single sensor is calibrated in the laboratory prior to use.

DYNA® Force is an exceptionally robust and maintenance free system that permits installation and reading of results by a single person.
Soldier Pile Retaining Wall and Slope Slide Stabilization on Hwy 49, Near Auburn, California

California Highway 49 used to be the main route for gold diggers of the 1850’s. The picturesque region around the historic route continues to be a touristic attraction, especially around the American River.

The California Department of Transportation (CALTRANS), the owner of State Route 49, detected and recorded landslide movements over the years at mile post (MP) 37.82, near the city of Auburn, El Dorado County, 0.4 mile south of the North Fork American River Bridge. CALTRANS’ original slope stabilization design specified slope stabilization consolidated with micropiles.

The project was awarded to the experienced contractor Condon-Johnson & Associates, Inc. (CJA), Oakland, CA. CJA realized that challenging conditions would be encountered with the original design, so they developed a Cost Reduction Incentive Proposal (CRIP) design. They hired specialized structural engineer P B & A Inc. of San Anselmo, CA to finalize the design of the retaining wall.

The final project specified passive permanent, 46mm (#14) grade 517 MPa (75 ksi) DYWIDAG THREADBAR® tieback anchors with a 35-ft unbonded zone, working in conjunction with structural steel soldier piles and a cast in place concrete grade beam. The tieback anchors were produced using the DYWIDAG double corrosion protection system.

In order to monitor future slope movements, twelve DYNA® Force Sensors were installed on the bars, close to the anchorage at alternate locations. Up to 30m long lead wires were conducted to a waterproof box where the CALTRANS instrumentation team will have access for future load monitoring. Proof and performance load (666 kN) and lock-off load (0 kN) produced by the stressing equipment were verified by the reading unit.

The soldier piles and anchorages were embedded inside the concrete grade beam and the entire area was covered with original soil which was brought to the initial slope.
Unconventional Construction with DSI: Parking Structure serves as the Civic Center’s new Portal

The city of Santa Monica located west of downtown Los Angeles is one of the most popular residential areas in the greater Los Angeles area. The city has approximately 94,000 inhabitants and is known for its shortage of parking. Parking spaces were especially scarce for visitors to the Santa Monica Civic Center.

Consequently, a new 900 car parking structure facility was built in 2006 to serve the parking needs of the Santa Monica Court House, Police Station, City Hall and Civic Auditorium. The plans envisioned an exceptional design: instead of an ordinary functional parking structure, a lively building was to serve as the Civic Center’s portal.

Colorful shades at the facade of the parking structure protect the interior from direct sunlight, yet still allow the wind to pass through the structure to keep the temperature down. Solar panels were also located at the top of the structure to power the lighting in the garage and the 14 electric charging stations for zero emission electric vehicles.

The building’s design, the materials that were used and the construction practices preserved natural resources and reduced waste. That is why the US Green Building Council (USGBC) recognized the structure as a “Green Building”.

The exceptionally light structure of the building was made possible by incorporating the DYWIDAG Monostrand Tendon Post-Tensioning System. The six level parking structure was built using a combination of post-tensioned beams and slabs. The beams were poured monolithically with the columns that support the structure. DYWIDAG Monostrand Tendons were used in the beams and slabs for building the 25,270m² beam and slab system.
In addition, DSI USA supplied and installed runs of 11 strand galvanized barrier cable for the 6 levels of ramps from their local production facility in Long Beach. The barrier cables were attached to the exterior of the columns with galvanized structural steel angles with cap angles at the ends of each run. The galvanized cables were also attached at each intermediate column with structural steel channels. Galvanized spacer bars were placed between each column in order to maintain the proper clearance between cables.

DSI is pleased to have contributed to this special project for the city of Santa Monica.
Slope Stabilization at Devil’s Slide: DSI protects Highway from Landslides

Ever since its inauguration in the 1930s, California highway 1 has been damaged on a regular basis by landslides and rock slides at Devil’s Slide near San Francisco. Nevertheless, the road is very popular due to its location directly along the pacific cliff line and is universally considered as one of the most scenic roads in the world.

Consequently, slope stabilization measures were begun on Highway 1 in order to maintain the future stability of this route even though a tunnel is being constructed that will redirect the major part of traffic around Devil’s Slide region.

The fact that Highway 1 is very popular with cyclists was one of the crucial factors in the decision to maintain the road serviceable in the future. Cyclists will continue to use the old highway along the cliff line once the bypass tunnel is completed. By separating motor vehicles from bicycles, a higher degree of safety is ensured for all road users.

Additional reasons for maintaining the old route after the completion of the bypass tunnel were its attractiveness for tourism as well as the availability of an alternative route in case of high traffic volumes.
Due to the fact that Devil’s Slide is situated in a highly corrosive environment because of its proximity to the ocean, DSI USA used Double Corrosion Protected (DCP) Multistrand Tieback Anchors for stabilizing and repairing the slope after the latest landslide. A total of 184 type 9x0,6” Multistrand Anchors in average lengths of 42.7m were used for emergency repair.

Thanks to the excellent co-operation between all parties involved, repair work on Highway 1 could be completed quickly and safely.
Minneapolis’ I-35W Bridge over the Mississippi River Reconstruction within Record Time

St. Anthony Falls Bridge, Minneapolis, MN, USA

On August 1st, 2007, a steel truss arch bridge built in 1967 across the Mississippi River in Minneapolis, Minnesota collapsed during the afternoon rush hour. 13 people lost their lives and over 100 others were injured in this tragic bridge failure.

Carrying 140,000 vehicles per day, the I-35W Bridge was one of the busiest bridges leading over the Mississippi River. This bridge was an extremely important connection for the citizens of Minneapolis and St. Paul, particularly for the business people in the center of the metropolitan area. The economic loss caused by this accident has been estimated to be in the range of 400,000 USD per day.

The bridge had to be replaced as soon as possible for everyone’s benefit. A structure of this type would take at least three years to construct under normal circumstances, not including at least one additional year for design. However, due to the paramount importance of this connection across the Mississippi and the daily negative financial impact to the community, all imaginable measures were taken to cut down construction time as much as possible.

The owner decided to employ the design-build method of project delivery. A short-list of four qualified bidders was established consisting of contractors and design-engineers together forming each team. Three of the four teams proposed steel, plate girder type bridges, with the fourth proposing a post-tensioned concrete box girder bridge. Ultimately, the concrete design won over the judges even with the higher cost and more days to complete.
The new, approximately 371m long bridge consists of four separate parallel box girder structures resting on eight elegant piers. With its modern design, the double bridge pays tribute to the versatility and durability of the construction material concrete. The safety of the bridge was of utmost importance at all times. High performance post-tensioned concrete ensures high quality and lasting durability, while at the same time providing an aesthetically pleasing design. In addition to state of the art construction methods and top grade materials, sensors integrated into the structure will allow for substantial and continuous monitoring of the bridge in the future.

Each bridge has a main span of 154m that consists of precast concrete box girder segments supported by eight 21m high piers. The end spans are 108m long each cast-in-place, post-tensioned concrete box girders built on false work which seamlessly blends into the precast main span sections. Each of the Northbound and Southbound, 28m wide bridges can accommodate 5 lanes of traffic. Additionally, both the foundation and superstructure can accommodate future light rail expansion as well as a bus lane. The parabolic shape of the double bridge is created by the specially formed piers as well as the box girder with its variable depth ranging from 7.6m at the pier to 3.4m at main span.

Production of the 120 precast box girder segments took place in a nearby casting yard set up on the closed section of the I-35W roadway. The segments were cast using the long-line casting method in one of the coldest winters Minnesota has experienced. DYWIDAG 4x0.6” FMA Multistrand Tendons were installed transversely in the segment top slab and prestressed and grouted in the casting yard. Afterwards, each precast segment was moved to a staging area on the riverbank where they were then barged under the bridge. A barge mounted crane lifted each segment into position where 36mm diameter DYWIDAG THREADBAR®s were used to temporarily hold the segment. DYWIDAG 19x0.6” Multistrand Tendons were used to permanently post-tension the segments longitudinally. DYWIDAG 19x0.6” and 27x0.6” Multistrand Tendons were threaded throughout the entire box girders in both top and bottom slabs. Finally, these tendons were all stressed and then pressure grouted.

All in all, DSI was a key supplier for this monumental project. 1,300km of prestressing strand was supplied as well as 4,100 Anchorages for the Post-Tensioning. DSI USA also supplied over 9,000m of GEWI® Bars and hardware for the Form Ties and false work bracing. A total of over 57,000m 63mm GEWI® Bars, as well as over 2,000 63mm Couplers were used for vertical reinforcement of the drilled shaft foundation elements. DSI USA also supplied all post-tensioning installation, stressing, and grouting equipment required to complete this project.

DSI USA supplied all Multistrand Tendons for the new Mississippi River Bridge just-in-time from their nearby Suburban Chicago, Illinois plant. The high quality and simple handling of the DYWIDAG Multistrand Tendons perfectly matched everybody’s vision for highest possible performance within an extremely short time period. In fact, the last of the 120 precast segments was installed only 46 days after the first unit. This equals an average of nearly three segments erected per day.

DSI is proud to have contributed to the extremely rapid replacement of this important bridge.
Redevelopment of Downtown Phoenix, Arizona with DSI USA

For more than ten years, there was a nearly empty area the size of three blocks in the downtown area of Phoenix in Arizona. This space included two parking lots as well as the city’s only central park, Patriots Square Park. In order to revive Phoenix’s city center and make better use of this important location, a decision was made to build the Phoenix CityScape Project.

The project includes an area of more than 232,000m² with several new buildings that will accommodate shops, restaurants, apartments, offices and parking spaces. In addition, the city will redesign Patriots Square Park to make it more appealing for all citizens.

The project is the largest private investment project to have ever been carried out in downtown Phoenix. The new complex of buildings will function as a service center and be open to residents, tourists and visitors to the Phoenix Congress Center. It will be directly linked to the city’s new light railway network.

The plans currently include four forty-story, 120m tall high-rise buildings in which a surface of more than 232,000m² will be available for shops and restaurants. Approximately 55,700m² are planned for offices, and there will be 400 new hotel rooms in two different hotels. In addition to approximately 1,200 condominiums and 65 apartments, the project will include approximately 3,900 parking spaces.

For excavation support, DSI USA was awarded a contract to supply the DYWI® Drill Hollow Bar Soil Nail System. All in all, DSI supplied 18,480m type R38N DYWI® Drill Hollow Bars as well as 13,200m type R51N DYWI® Drill Hollow Bars. The hollow core of these special rods allows for simultaneous drilling and grouting of the nail.

DSI USA also supplied the necessary system accessories such as nuts, washers, plates, drill bits and grout swivels. In addition, DSI USA rented the stressing jack needed for testing the soil nails.

DSI USA was awarded a contract to supply the DYWI® Drill Hollow Bar Soil Nail System. All in all, DSI supplied 18,480m type R38N DYWI® Drill Hollow Bars as well as 13,200m type R51N DYWI® Drill Hollow Bars. The hollow core of these special rods allows for simultaneous drilling and grouting of the nail.

DSI USA also supplied the necessary system accessories such as nuts, washers, plates, drill bits and grout swivels. In addition, DSI USA rented the stressing jack needed for testing the soil nails.

Construction for this major project began in October 2007 and the first part of the project is scheduled for completion by the end of 2009. The new complex of buildings in the city center of Phoenix is scheduled for completion in 2011.
DSI Supports Washington State Department of Transportation during the Construction of its Tallest Soil Nail Wall

The University of Washington in Bothell, approximately 20km north of Seattle, is one of the newest universities in Washington State. Due to its popularity with students, the university plans to increase its enrollment from 3,000 to 10,000 full time students. According to an ordinance by the city of Bothell, an expansion of the university is only possible if a new access to the campus is constructed.

The new exit is being constructed on highway SR 522 and offers a direct connection to the south entrance of the campus. In addition to considerably relieving traffic at the university’s north entrance, this project will also permit traffic towards Bothell to flow more smoothly.

One of the signature portions of the project was the construction of an approximately 4,180m² retaining wall selected to stabilize the hillside adjacent to the new south entrance. The owner, the Washington State Department of Transportation (WSDOT), designed an approximately 29m tall soil nail / shotcrete wall shoring system. It is the tallest soil nail wall ever constructed by WSDOT.

DSI USA supplied approximately 387 #8, Gr 75 Epoxy Coated DYWIDAG Soil Nails in lengths of 4.9m and approximately 1,470 type 1-3/8” Gr 150 Ksi Double Corrosion Protected DYWIDAG Soil Nails in lengths of 26m, which were installed by the contractor, Northwest Cascade, Inc.. Afterwards, an approximately 13cm thick temporary shotcrete facing was applied on the soil nail wall.

DSI is pleased to have contributed to an improvement of traffic flow around the University of Washington.

---

**INFO**

Owner Washington State Department of Transportation (WDOT), Olympia, USA
General Contractor Mowat Construction Company, Woodinville, WA, USA
Contractor Drilling Work Northwest Cascade, Inc., Puyallup, WA, USA

DSI Unit DSI USA, BU Geotechnics, USA
DSI Scope Supply of 387 Epoxy Coated DYWIDAG Soil Nails and of approximately 1,470 Double Corrosion Protected DYWIDAG Soil Nails in lengths of 26m
DSI USA Strengthens I-39/Kishwaukee River Bridge in Illinois

The Kishwaukee River Bridge is part of Interstate I-39, which crosses the US-American state of Illinois from North to South. I-39 is especially frequented on weekends by Chicago residents who spend their weekends in Wisconsin.

The Kishwaukee River Bridge consists of two separate bridge structures, one for each direction of travel, over the Kishwaukee River near Rockford.

The double bridge consists of two precast segmental concrete bridges opened to traffic in 1980. Each bridge has five spans with lengths of 170ft + 3 x 250ft + 170ft (51.8m + 3 x 76.2m + 51.8m). Since the double bridge belongs to the first generation of segmental structures, the responsible engineers chose the design of a single shear-key joint usually located close to the centroid of the cross-section.

Both bridge decks have an overall length of approximately 332m (1096ft) and were built using the balanced cantilever method. Each cantilever consists of 17 segments approximately 2.2m (7'-3/5") long and one pier segment approximately 1m (3'-6") long. Cast-in-place closures have a length just short of 1m (3'-2 3/4''). During the construction of the bridge at the end of the 70s, DSI USA used the special DYWIDAG THREADBAR® system instead of the post-tensioning system that had been part of the original plans.

At the beginning of the new century, the owner of the bridge, the Illinois Department of Transportation (IDOT), decided on a strengthening program to extend the design life of both bridge structures. The strengthening design developed by Parsons Transportation Group required an addition of a total of 24 12x0.6" external Post-Tensioning Tendons of various lengths in each bridge.

The contract for the strengthening of the bridges was awarded to the same team as 28 years previously: Edward Kramer & Sons again subcontracted with DSI to supply and install the post-tensioning. The special challenge during this project was the fact that all work needed to be completed within a very short time schedule in order to obstruct the traffic flow as little as possible.
In the 1970’s, design practice did not require the inclusion of provisions for future additional post-tensioning tendons. Therefore, new tendon deviators had to be constructed throughout both bridges as well as new post-tensioning anchorage zones at the diaphragms and abutments. The new anchor zones and deviators were cast in place within the segmental box and then post-tensioned.

Instead of using traditional steel pipes in the deviators, continuously curved voids (diablos) were cast in the deviation diaphragm to allow large deviations from the theoretical tendon profile. According to recent technical standards, the post-tensioning was designed with a continuous air tight HDPE pipe from anchor to anchor grouted with high performance grout and equipment. Due to the diablos and continuous HDPE pipe requirements, specially designed post-tensioning anchors were installed at the faces of the existing diaphragms. The location of the new anchors was made difficult by the tight constraints of the existing reinforcement and post-tensioning.

All parties worked very closely together throughout the project due to the complex 3D geometry and challenges of accommodating the tendon paths throughout the existing bridges. In order to locate existing post-tensioning and reinforcing in the diaphragms and abutments, ground penetrating radar (GPR) was used. Thus, crews could follow closely behind with coring of the holes for the tendon paths. After casting, the new anchors and the HDPE pipes were successfully installed.

The work was made difficult by the largely deviated tendon paths and tendons lengths of over 770ft (235m). In addition, the tendon stressing was difficult due to the location of the tendons in the upper corners of the box, along with the congestion of the new tendons and new anchors.

The southbound bridge was completed in May 2008 and the northbound portion of the project was successfully completed in early August 2008, with final project completion coming within the owner’s short-term schedule.
32% of the surface area of Rhode Island, the smallest US state, consists of water. In the past, travelers either had to put up with a long ferry trip or take a long detour along Narragansett Bay in order to get from one part of the state to another. That is why the first bridge to allow a direct crossing from Jamestown to Newport was opened as early as 1940.

Because the old bridge was in a state of disrepair and no longer able to cope with increasing traffic volumes, it was replaced by the Jamestown Verrazano Bridge in 1992. This new bridge is part of a route network that leads over Narragansett Bay, providing a faster connection between the states of Rhode Island and Massachusetts.

The Jamestown Verrazano Bridge is a 2-cell box girder bridge of variable cross section that is post-tensioned with tendons and bars.

During inspections in 2002 and 2005, some post-tensioning ducts in the bridge structure were found to be empty of grout, while others were found to contain voids. Voids often occur where conventional or outdated grouting methods are used and are undesirable because they can result in corrosion of the tendons, when water infiltrates and collects in those voids.

The detection of these deficits prompted a more extensive inspection and repair program in 2007. Within the scope of the repair work that was carried out on the bridge, DSI was awarded a contract to fill all known voids and to repair the post-tensioning tendons.

During this project, DSI employed a special non-destructive testing method (NDT). This special method uses ground penetrating radar (GPR), Impact Echo Scanners and videoscopes to detect voids in the ducts from the outside.

As a result, faulty ducts can be identified with absolute certainty.

Since NDT technology is fairly new to the Rhode Island Department of Transportation, and since most of the work is being done “below the visible surface”, the responsible project managers have to receive extensive training from experienced DSI staff personnel.
This project is one of many vacuum grouting projects undertaken by DSI in the USA. In fact, many Departments of Transportation in the USA have realized that voids in grouted PT tendons can severely compromise the load bearing capacity of bridges.

In particular, DSI is conducting a similar operation on two bridges on the Sawgrass Parkway near DSI’s Miami, Florida office.

**Owner** Rhode Island Department of Transportation, Providence, USA  
**General Contractor** Aetna Bridge Company Inc., Pawtucket, USA  
**Engineers** Parsons Brinckerhoff, New York, USA

**DSI Unit** DSI USA, BU Post-Tensioning, USA  
**DSI Scope** Location of voids in ducts with ground penetrating radar (GPR); inspection of existing post-tensioning tendons with videoscope; volumeter measurement; vacuum grouting of tendon voids
The Caribbean island of St. Lucia is an island paradise with a tropical climate, densely wooded mountains, beautiful beaches and bays. The island has developed a reputation as a premier honeymoon and family vacation spot, and continues to attract tourists from all over the world. As a result, commercial and residential real estate development on the island is also booming. Many people are now choosing St. Lucia as an ideal location for their second or retirement home.

NH International (Caribbean) Ltd., is a leading construction company with a highly regarded reputation in the Caribbean, and has been involved in major building projects on the island of St. Lucia. These projects include the Almond Morgan Bay Hotel for which it received the prestigious Contractor of the Year Award by the Trinidad and Tobago Contractors Association; Le Sport Hotel; Sandals Halcyon Resort and Spa; St. Lucia Financial Centre; Hewanorra International Airport; Bordelais Correctional Facility; and the Castries Market Development.

More recently, NHIC was contracted to build the L’Avant Mer Resort project on Rodney Bay. Construction of the Foundations began on June 9th, 2008 and the entire project is scheduled for completion by September 2009.

This resort is situated adjacent to the marina and involves the construction of 73 luxury apartments comprising of Garden and Waterfront Suites including Penthouse Units. The reinforced concrete four-storey buildings, using the FORSA System introduced by NHIC, have been founded on driven pile foundations.
The project specifications required DYWIDAG 170/10.6mm ductile cast iron pipe end bearing pile with 400kN design load, driven at least 3m into weathered rock to a refusal of 30mm per minute. The end of the pile is extended and embedded into the concrete foundation with a hooked rebar dowel and a bearing plate. The geotechnical soil report provided alluvium fills, and weathered rock on top of solid rock.

DYWIDAG ductile iron pipe pile supplied in 5m segments can be easily connected through spigot and socket joint with double wall thickness to resist driven impact. The simplicity of the pile system provides high production rate and vibration free installation, allowing driven close to adjacent existing buildings.

The contractor built a new rapid-stroke hydraulic hammer and shank and installed the piles with the help of an excavator and a skilled crew. The pipe segments with rock point end were quickly driven into the weathered rock up to an average depth of 11m. Pipe excess was cut-off and reused for the next pile. The bore pile was filled with concrete and the rebar dowel and steel bearing plate placed on top of the pile.

DSI America supplied the piles and provided the initial stage of installation and technical assistance. DSI looks forward to its continued successful relationship with NH International (Caribbean) Ltd.
Tallmadge Bridge, Savannah, GA, USA

In our last edition, we published an article on the Eugene Tallmadge Memorial Bridge (cf. Info 16, p. 78/79). This bridge crosses the Savannah Harbor Navigation Channel approximately 24 km from the mouth of the Savannah River and is considered to be the region's landmark. DSI employees recently installed a new individually designed urethane damper system in the anchorages of the stay cables. The detail pictures provide an insight into the construction work.
Technique Béton Breaks new Ground: Innovative Fire Protection Mortar for Tunneling

Fire Protection has been a central topic in tunneling for decades. Traditional methods for fire protection in tunneling include the use of fiber concrete or prefabricated panels. However, both systems have significant disadvantages. Fiber concrete cannot be repaired after fire damage, and if prefabricated panels are used, the resulting voids between the panels are problematical.

Following years of intensive research, Technique Béton has now launched a special mortar as a new solution to the problem. The mineral mortars IR 4020-TUN and IR 4010-TUN can be applied directly onto the interior tunnel lining, thus forming an efficient shield. Both products are part of the new product range IR Technologie PTI that has been developed specifically for fire protection in the concrete sector.

The special mortars can resist up to 30 fires and do not generate smoke. In contrast to ordinary concrete, IR 4020-TUN and IR 4010-TUN are porous. In the event of a fire, the developing water vapor can escape into the mortar voids. Thus, a flaking of the tunnel lining, which can obstruct rescue work in an emergency and endanger lives, is prevented.

IR 4020-TUN and IR 4010-TUN provide safe fire protection of up to 6 hours at up to 1,200°C. Thanks to the efficient protection of the tunnel reinforcement, it does not have to be replaced even after a fire has taken place. This saves both expensive renovation and long downtimes of the affected tunnel.

The fact that repair work at the tunnel lining can be carried out easily at all times is another important advantage: the products are merely applied as a protective film onto the tunnel lining. In comparison to conventional fire protection methods, Technique Béton’s new product range is also especially economic and can be easily sprayed or rolled on.
Technique Béton offers New Product Range for Passive Fire Protection

Technique Béton now disposes of a comprehensive product range for passive fire protection in the industry sector. Among many applications, products belonging to the new fire protection range IR Technologie PTI are also used in the oil producing and chemical industries.

The utilization of special mortars for fire protection has considerable advantages: the products already protect when applied in thin coatings so that the statics of buildings are not affected. Quick and easy passive fire protection is both possible in the case of new and existing buildings.

Technique Béton’s newly developed materials do not drip when exposed to fire and stop the spreading of the fire itself. The products provide heat insulation, thus preventing the loss of static stability in the reinforcement of building structures.

Special mortar IR 4010 is used for sealing tanks and for preventing carbonatation. The product can even be applied directly onto reinforcement in concrete that has already carbonated, thus preventing the replacement of the damaged reinforcement. Consequently, IR 4010 offers the opportunity of repairing older structures efficiently and quickly.

This property is a decisive criterion, especially in areas where production needs to continue due to high resulting costs. Thanks to its fast curing time, when using IR 4010, operating procedures are only marginally disrupted.

Special mortar IR 4020 protects concrete tanks from damage and is also used as passive fire protection. Both products are especially suitable for storing easily flammable chemical products or mineral oil products.

The new product range perfectly completes Technique Béton’s offer and will shortly be CE certified.
Faster Public Transport in Brisbane: DSI Supplies Systems for Bus Tunnel

In May 2006, work started on the Boggo Road Busway in Brisbane, Australia. Boggo Road is a special busway that will create a much needed connection between the southern and eastern districts of Queensland University without going through the city centre. The Boggo Road Busway is part of a plan issued by the state government of Queensland that is aimed at improving public transport.

Because use of the 1.5km long lane is limited to buses only, city buses will not depend on the traffic situation, and traveling times will be shortened. The new bus route will also ensure easy access to the Park Road Train Station and to other bus lines. The busway will be used by approximately 600 buses per day, which will considerably improve traffic for all in the city of Brisbane.

In order to minimize the impact on residential areas near the busway, part of the Boggo Road Busway runs underground in a 430m long tunnel that will run below the Cleveland railway line and the Pacific Highway. The tunnel will be 14m wide and will accommodate two bus lanes.

Construction work must be carried out with special care for two reasons. First of all, the geological conditions near the tunnel are exceptionally diverse, which also makes them harder to evaluate than usual. Secondly, the tunnel runs below the historical Boggo Road Gaol, a listed building. This means that work had to be carried out with minimal soil movements. The tunnel walls are stabilized by lattice girders and a thick layer of sprayed concrete.
For achieving an even better degree of stabilization, DSI Austria and DSI Australia were contracted to supply special products. Approximately 7,000m of the AT-139 Pipe Umbrella Support System were used for stabilizing the tunnel.

This special self-drilling pipe umbrella system reduces displacements of the surrounding rock mass by immediately supporting the drill hole. Due to the easy extension of the casing tubes, the system is especially flexible and is used for drill holes in lengths of 9-18m.

Once again, DSI’s systems proved their efficiency and easy application to the client. Due to its high degree of safety, the general contractors plan to use the AT-Pipe Umbrella Support System in future projects as well.

In addition, DSI Australia supplied a wide range of other ground support products such as permanent and temporary DCP bolts. Among other products, DSI Australia supplied 735 resin anchored AX Rock Bolts, 350 Fiberglass Face Bolts, 450 Friction Bolts and 12 DCP 40mm GEWI® Anchors.
Supply of Special Products for Australia’s Longest Road Tunnel in Brisbane

The city of Brisbane on the East Coast of Australia is Queensland’s industrial, economic and financial center. Many service companies are located in the city center. Brisbane Central Business District is bordered by the Brisbane River to the east, south and west and is currently linked with the southern riverside by three bridges.

Since these three river crossings are often overcrowded with traffic, a decision was made to build a tunnel that will create an additional connection between the Central Business District and the main roads and motorways of the surrounding districts.

In construction, the project is known as the North-South Bypass Tunnel (NSBT). However, the tunnel has now been officially named after Clem Jones, one of Brisbane’s former Lord Mayors. The tunnel is the first section of the new M7 Motorway, which will improve the city’s road network as a whole. Once completed, the motorway will carry more than 100,000 vehicles per day.

The double tunnel with two lanes in each direction will have a length of approximately 5km and will thus be the longest road tunnel in Australia after its completion.

The toll tunnel is planned as an alternative route to a street with 18 sets of traffic lights and will save tunnel users approximately 15 minutes’ time. Tunnel advancement is carried out by special TBM s with a daily performance of approximately 15 to 20m. The TBM s stabilize the tunnel with precast segments during tunnel advancement.

Since the tunneling work is carried out in difficult geological conditions, DSI Austria and DSI Australia, the specialist suppliers for tunnel stabilization systems, are also involved in the project.
DSI Austria supplied more than 6,000m of the AT-114 Pipe Umbrella System. This system allows an accurate alignment of casing tubes +/- 1% in lengths between 21-24m. Due to extendable casing tubes, the self-drilling system is also flexible with regards to drill hole lengths. It can be easily adapted to the differing geological conditions of the project.

For the first time, DSI Austria’s AT-76 injection system was also used in advance for the TBM to protect it from water damage and ensuing failure. DSI also supplied IBO R51 Self-Drilling Anchors. Fast anchor installation is ensured by the fact that drilling and injection are carried out in a single operational step.

DSI Australia was selected by the contractor as the main supplier of rock bolt type ground support. DSI Australia supplied 14,500 temporary Double Corrosion Protected (DCP) Bolts as well as 4,750 permanent DCP Bolts. Both versions of the DCP Bolt (permanent and temporary) were used in the road header tunnel section. DSI’s product was chosen by the consulting engineers because of its high durability.

DSI’s 30t Fiberglass Bolts were installed at several tunnel faces since they can be excavated without damaging the equipment. Self-drilling 51mm hollow bolts were used for spiling in an area of poor quality ground, hence improving the tunnel advance rate, as the hollow bolt allows for drilling and grouting in a single operational step.

A total of 13,450 chemically anchored 20mm GEWI® Rock Bolts were used extensively as rock bolts as well as pins to retain lattice girders. The continuous coarse thread allowed for highly flexible anchor lengths in varying ground conditions. High strength, 26.5mm THREADBAR® anchored down the tunnel formwork. Large diameter 40, 50 and 63.5mm GEWI® provided stiff anchoring systems for the TBM launching cradles. In addition, DSI Australia supplied 2,000 26.5mm WR tie-down anchors as well as 1,090 resin anchored AX rock bolts.

Clearly, this project illustrates the wide product range offered by DSI Australia and DSI Austria.
New Tunnel underneath Niagara Falls Built with DSI and ACI: Natural Wonder and Energy Source

The impressive Niagara Falls on the border between the State of New York and the Canadian province of Ontario have always been one of the most popular destinations for tourists on the American continent.

What many people do not know is that a large part of the Falls’ original water volume is diverted to a weir and used for power generation at night and during off-peak hours. The exact quantity of water that can be diverted and used for power generation is explicitly regulated in terms of seasonality and times of day by a treaty dating from 1950.

Electrical energy has been generated by the Falls since 1922. In 1954, two 9km long tunnels that feed water to a local power plant were built underneath the city of Niagara Falls. Only a fraction of Niagara River’s energy, approximately 1,800m³ per second, is currently used for generating power.

As a result of Ontario’s ever increasing demand for electricity, Ontario Power Generation Inc. decided to build a third tunnel underneath the city. The new tunnel has a planned service life of 90 years and will supply 160,000 additional households with energy.

The new tunnel will be 10.4km long and will run at a depth of up to 140m underneath the existing tunnels. With its diameter of 14.4m, the pressure gallery will be 1½ times as wide as the Channel Tunnels. The tunnel will divert 500m³ of water per second from the headwaters of Niagara River to the power plant underneath Niagara Falls.

Tunnel driving is carried out using the world’s largest diameter hard rock Tunnel Boring Machine (TBM). The machine has a diameter of 14.4m and weighs 2,000t. The TBM’s starting shaft had a length of 400m. For this project, a TBM for the first time was not assembled in a factory, but on-site in 11 months.

The tunnel will have a lining consisting of non-reinforced concrete that will be up to 70cm thick. In addition, the lining will have to be tensioned by injection in order to resist operating water pressures of up to 15bar.
Tunnel construction is made difficult by the fact that the prevailing mudstone is fractured to a great extent and that the work has to be carried out in difficult ground water conditions. Consequently, DSI and ACI as the specialists for tunneling in geologically unstable environments are also involved in the project.

Up to now, DSI has supplied more than 40,800 friction bolts in lengths between 2.4 and 6.0m as well as more than 1,000 AT-Power Set Self-drilling Friction Bolts in lengths of 4m. AT-Power Set is a specialist product that is used for instant protection in cases of rock fall hazard. The anchor has immediate load-bearing capacity after installation, which is why it is especially suitable for the geologically unstable zones prevailing in this project. No special equipment is necessary for anchor installation. Another advantage is that neither injection nor grouting is necessary. AT-Power Set is non-sensitive to vibrations and blasting operations and features high shear resistance.

As of this writing, DSI has also supplied more than 1,200 type R32 and R38 IBO-Self-Drilling Anchors. These special anchors can be flexibly adjusted to different rock mass conditions by using different types of drill bits. By using couplers, IBO-Self-Drilling Anchors are flexible in terms of anchor length and can thus be adjusted to a variety of application requirements. The anchor rod's special profile ensures optimum bonding with grout.

ACI supplied steel beams for the stabilization of the new tunnel. In order to adapt to specific requirements on site, three types of steel ring beams were installed. The profiles used were steel beams type C150x16, W150x37 and W200x59.

DSI and ACI are proud to have been chosen as specialist supplier of Tunneling Systems for this major project.
Short Cut with DSI: Construction of the San Cristóbal Tunnel in Santiago de Chile

The 880m high Cerro San Cristóbal hill dominates Santiago’s cityscape. Although the hill is a popular lookout, it also represents a natural barrier that made a direct connection between the northern districts of Huechuraba and Recoleta and the southern district of Providencia difficult.

To alleviate this problem, construction work has begun on two parallel tunnels leading through Cerro San Cristóbal. The tunnels will create a more efficient connection between the northern districts and the southern business center of the city and considerably shorten the travel time between the individual districts.

The El Salto Tunnel is part of Santiago de Chile’s City Highway. This motorway was widened from two to three lanes in each direction in order to alleviate traffic congestion on Santiago de Chile’s road network. At the same time, it is part of the world famous PAN AMERICANA Highway that runs from Tierra de Fuego to Alaska.

The approximately 4km long toll road through Cerro San Cristóbal serves as an important feeder road to the toll road. Each of the tunnels is 2km long and is 9m in diameter.
DSI was involved in the construction of this new tunnel. The company supplied more than 20,000m of its AT-114 Pipe Umbrella Support System for tunnel advancement. The AT Pipe Umbrella Support System is used to stabilize the tunnel front and the geologically difficult zones in the tunnel’s interior. It reduces settlements and minimizes deformation of the rock mass during the excavation of the tunnel.

In addition, DSI supplied more than 10,000m of R32/ R38/ R51 Self-Drilling Anchors. This system consists of special hollow bar anchors with a continuous cold rolled thread on the outside that are especially suitable for use in geologically unstable rock mass. The hollow bar anchor also serves as a drill rod, thus facilitating shorter installation times as well as optimizing machinery requirements and operating times. DSI also supplied injection pumps for both products and supervised on-site installation.

Due to the efficient and competent co-operation of everyone involved, the project advanced quickly. In the summer of 2008, part of the new tunnel route was inaugurated and successfully tested.
With approximately 1.4% of the surface area of South Africa, Gauteng is the country's smallest province in terms of area. However, the province contains nearly 20% of the country's population. Because the capital of Johannesburg is located in Gauteng, the region is also the financial and economical center of South Africa.

The province's high population density is especially evident on the streets between Tshwane and Johannesburg. Today's public transport systems are mainly dependent on the road network and contribute to high traffic density. In addition, approximately 30,000 cars use the traffic corridor between Tshwane and Johannesburg each week day.

The high traffic density was one of the main reasons for the decision to build a new high speed train network, Gautrain, in the province of Gauteng. The new transportation system will also provide economic advantages by improving infrastructure and by transporting the many tourists expected for the Soccer World Cup in 2010.

The 80km long route network consists of two lines, the first of which will create a better connection between the cities of Johannesburg and Tshwane (Pretoria). The second line will connect OR Tambo International Airport with Sandton, a northern district of Johannesburg.

A total of 13km of the train route runs underground. The contractor was familiar with DSI's specialist products from several past projects, which is why DSI was awarded a contract to supply tunneling products for this project as well. DSI South Africa and DSI Austria contribute to three of a total of ten planned train stations: Rosebank, Sandton and Marlboro Stations.
It is in these stations and the tunnel network that DSI Austria’s new AT-114 Pipe Umbrella Support System was used for the first time in South Africa. DSI supplied more than 5,000m of the AT-114 Pipe Umbrella Support System for tunnel advancement and also supervised on-site installation. The AT-114 Pipe Umbrella Support System is one of the most modern systems currently on the market. The self-drilling system facilitates quick installation especially in difficult ground conditions and can be installed using conventional drilling machines.

DSI South Africa secured a 21 million Rand (approximately 1.8 million Euro) supply contract with the Bombela Consortium for the supply of 70,000 double corrosion protection (DCP) rock bolts for the Gautrain project over a period of 30 months. To date, 18,000 DCP rock bolts have been supplied.

The rock bolt technology is used for the very first time in South Africa. This particular anchor type is ideal for complex engineering structures and aggressive environments where groundwater within the rock predominates.

Geological conditions are especially diverse on the 13km long segment that is to run underground. In many places, sandstone deposits cause unstable ground conditions. In addition, ground conditions at the Rosebank site are very sandy, and the water table is high.

The double corrosion protection rock bolts are well suited for use in varying geological conditions. Due to differing geological conditions, anchor lengths varied between 2 and 10m.

Having adapted the lengths of the anchorages to specific requirements, DSI South Africa produced and supplied the rock bolts to the job site just in time.
South of San Francisco, California’s Highway 1 takes its course directly along the impressive steep cliffs of the coastline. Between the towns of Pacifica and Montara, the highway passes a region that is aptly named “Devil’s Slide”. This region is geologically extremely unstable and characterized by erosion, with landslides occurring on a regular basis.

Time and again, traffic on Highway 1 has been affected by these landslides. The last time it had to be closed was between April and August 2006 because the road had slipped towards the ocean and was severely damaged. In order to avoid similar incidents in the future, in May 2005, construction began on a double tunnel that is to lead traffic slightly further inland away from this dangerous rock formation. The two parallel tunnel structures run underneath San Pedro Mountain, each of them being 9m wide and nearly 1.3km long.

ACI (American Commercial Incorporated) and DSI are actively involved with specialist products for tunneling in this project. The primary method of supporting the tunnel excavation is with lattice girders, rock bolts and shotcrete, commonly known as NATM or Sequential Excavation Method. The contractor elected to work with ACI and DSI due to the complexity of supplying 18 different profiles of lattice girders which will be used to support the twin main tunnels, the equipment chambers, various cross passages and access areas. In total, 1,531 courses of lattice girders will be used, along with DYWIDAG THREADBAR®s used as rock bolts, also supplied by ACI and DSI.

The design required the use of approximately 20,000m of IBO Self-Drilling Anchors in diameters of 32mm and 38mm which can be easily adapted to different rock mass and soil conditions. The IBO Self-Drilling Anchor allows simultaneous drilling, installation and injection, which is why it is especially efficient in comparison to conventional anchoring methods.

ACI and DSI have also supplied approximately 3,000 4m long self-drilling Tube Spiles so far. The anchor bar is simultaneously used as a drill rod, thus optimizing machinery requirements.

For the construction of the two tunnel sections, ACI and DSI also supplied AT-Casing Systems AT-114 and AT-76/DR. The AT-Pipe Umbrella Support System is used for ground improvement during mechanical excavation, distributing loads longitudinally. The AT-Drainage System allows an efficient drainage of slopes during tunneling. Both of these specialist products are particularly efficient and time-saving thanks to simultaneous drilling and tubing.

Once again, high quality tunneling products by ACI and DSI made an important contribution to the quick and safe realization of the construction work for this project.
American Commercial Inc. (ACI), part of the DSI group since October 2006, has supplied ground control products for mining and tunneling around the world for almost 90 years. Steel Ribs, Liner Plates and Lattice Girders for tunnel lining are at the core of ACI’s business. In addition, ACI also supplies DSI Group products such as DYWIDAG Bolts, DSI’s AT-Systems and innovative rock bolt systems such as the CT-Bolt™.

In order to compliment its product range, ACI started supplying equipment and machinery for tunnel and shaft excavation in 1998. Today, in its role as a distributor, ACI offers a range of products by well-known international producers such as Wirth TBM’s, Condat Ground Conditioners for tunnel advancement, injection equipment by Aliva, Hany, Mai and Sika, Muehlhaeuser Rolling Stock, Interoc Tie Back Rigs, and Promat Fire Protection systems.

ACI has been particularly successful in supplying shaft boring equipment manufactured by the German long-term specialist Wirth. Besides classical tunnel boring machines, exploration- and shaft boring machines, Pile Top Drilling Rigs for use on-shore and off-shore are especially sought after. The latter have been used successfully in more than 25 projects in North America.

In the summer of 2007, Wirth, ACI and Frontier-Kemper Constructors, Inc. formed a joint venture to build a Blind Shaft Boring machine. This boring machine is used underground and is particularly suitable for use in mining areas. In such applications, sinking separate blind shafts down to deeper levels which have no access roads had previously been impossible. Rock cuttings inside the drill rods are brought up to the surface using the pneumatically based RCD method (Reverse Circulation Drilling). Compressed air is lead to the bottom of the borehole via a separate pressure line, and the flushing liquid (water) descends between the drill rod and the borehole wall. The discharge of the compressed air near the drill bit causes a drop in density of the water column inside the drilling rods – the flushing medium and the rock cuttings are brought to the surface by this differential pressure.

Wirth and ACI provided assistance and equipment to update and modify existing Frontier-Kemper machinery in order to allow drilling diameters of 2.5m to depths of roughly 300m. They were also involved in assisting with the design and the fabrication of a new rig for Frontier Kemper (drilling diameters up to 5m to depths of roughly 400m in hard rock). Late in the first quarter of 2008, the first shaft was successfully drilled using this new rig.

More new rigs capable of drilling diameters of 6.5 or 8m to depths of 450 or 300m respectively are already in the planning stages. Wirth and ACI are proud to be part of this successful joint venture and are looking forward to continuing long-term activities and developments in this innovative business area.

Wirth L 35 Series Rig, similar to the Equipment built by the Joint Venture
DSI Australia Develops new Dynamic Bolt for Seismic Stability in Deep Mines

R&D Activities in Australia

Among other mines, Barrick Gold also runs Kanowa Belle Metaliferous Gold Mine near Kalgoorlie, about 570km east of Perth in Western Australia. Barrick Gold had already experienced the versatility and reliability of DSI's mining products in several other mines. Consequently, when presented with a seismic activity problem on site, Barrick Gold asked DSI Australia to find a solution for stabilizing the working areas.

In accordance with the client’s specifications, DSI developed a new dynamic bolt that could be installed efficiently and safely and anchored with a standard resin capsule. The specific challenge in this case was the small borehole with a diameter of merely 43 - 44.5mm. An even greater obstacle was the fact that the dynamic support needed to be appropriate for installation using a face jumbo installation method, bolting in cycle in a crowded space.

During the development of the prototype bolt, DSI Australia’s specialists worked in close collaboration with Garford Pty Ltd’s mining engineers.

Extensive static and dynamic load testing was then carried out in WASM, a world renowned Geo-Mechanics testing facility located in Kalgoorlie. Excellent teamwork between DSI and Garford lead to successful testing results at first go for the new bolt prototype.

The initial site installation of the Dynamic Bolt also proved to be a success. The mine operator was impressed with the easy handling of the new dynamic bolt, which allowed fast installation without the need for extensive training.

DSI Australia has now supplied in excess of 3,000 Dynamic Bolts to Kanowna Belle for the substantial stabilization of the mine.

The development of this new dynamic bolt is yet another example of DSI’s innovative spirit and close connection to markets. As there is a tendency for today’s mines to become deeper and higher in ground stress, demands on mining products are increasingly severe. With its properties and performance characteristics, today’s new dynamic bolt now complies with the market’s future demands.
Encapsulation Trial of Resin Cartridges in Mines
George Fisher Zinc Mine, Australia

A strongly corrosive environment caused by geological influences characterizes the George Fisher Zinc Mine in the Mount Isa mining region in North Australia. Consequently, the owner, Xstrata Zinc, a subsidiary of the globally operating mining group Xstrata Plc., wanted to ensure good corrosion protection through full encapsulation of the anchors in the drill hole during driving works.

DSI Australia supplied chemical TB2220T1P10R Posimix Bolts for the anchorage. The bolts are 2,200mm long and have a diameter of 20mm.

During the fourth quarter of 2007, DSI Australia carried out a comprehensive range of tests in cooperation with Xstrata Zinc on site. The testing was conducted in order to find the best possible amount of encapsulation for the anchors by varying the sizes of boreholes and resin cartridges.

A choice could be made from 1,050mm long resin cartridges with both medium and slow components in 26mm and 30mm diameters.

When using the 26mm cartridge in the 35mm diameter boreholes typical for this anchor type, a degree of encapsulation of 55% was achieved. Consequently, two alternative trials were carried out.

Using the same resin cartridge and reduction of the borehole diameter to the minimum diameter of 33mm achieved an encapsulation of 80%.

Keeping the borehole diameter of 35mm and using a larger resin cartridge with a diameter of 30mm resulted in an encapsulation of 87%.

Both alternative tests achieved the degree of encapsulation required by the customer. Xstrata Zinc opted for alternative 2 because the 33mm drill bits could not have been re-used due to local rock characteristics.

In addition, the marginally higher costs for the larger resin cartridges are more than fully compensated by the multiple use of the 35mm drill bit.

Due to the successful test range, DSI Australia was given a contract for the supply of Posimix anchors and 30mm resin cartridges by the owner of the mine, Xstrata Zinc.
A Strong Partner for Security: DSI Australia sponsors Gujarat NRE Minerals Ltd. during Mines Region Competition

In August 2008, 10 teams with 6 members each participated in the Southern Mines Region Competition. This competition takes place at regular intervals in order to raise awareness of safety issues with mining companies.

The competition includes several exercises that are carried out above and below ground. On the 28th of August, the teams had to pass several tests in underground galleries. Besides theoretical and virtual reality exercises, the groups also participated in exercises in fire fighting, extricating injured persons and CABA (compressed air breathing apparatus) exercises.

As a supplier of secure mining solutions, DSI Australia sponsored the Gujarat NRE Minerals Ltd. team. Gujarat NRE Minerals Ltd. is a subsidiary of the largest producer of high quality low ash metallurgical coke in India. Gujarat NRE Minerals Ltd. is located in New South Wales, Australia and operates the NRE No. 1 Colliery with reserves of more than 300 million tons of coking coal.

DSI Australia is pleased with this further step on the way to increased safety in mines.

More Coal with DSI: Extension of Cook Colliery in Australia

High-Quality Mining Products by DSI secure Coal Mine in Queensland, Australia

Rising petrol prices govern our time. This is one of the main reasons why coal production is still an important alternative to other raw materials in Australia. The Cook Mine, situated 30km south of Blackwater in Queensland, Australia, hosts a robust resource base estimated to be 126 million tones of coking coal. The Cook Mine produces a low ash coking coal that is a recognized brand in the coking coal market. The Cook Mine’s resource base is currently being mined from two underground coal seams.

After its extraction, the coal is delivered to the Cook wash plant, which is located 14km north of the mine. Subsequently, the coal is transported by rail to the port of Gladstone, 315km away.

In order to satisfy the high demand for coal in the future, the owner, Caledon Resources, decided to gradually increase production to a level of 100,000t per month.

To achieve this goal, the traditional shuttle car conveyors were replaced by a continuous haulage system. In addition, the mine invested in a new continuous bolter/miner that allows simultaneous roadway development and stabilization.

As a specialist in mine stabilization, DSI Australia provided numerous innovative products for the extension and modernization of the coal mine. For stabilizing the new roadways, DSI supplied products such as rock bolts, anchor plates and resin cartridges.

DSI Australia is pleased to have assisted Caledon Resources with increasing its production at Cook Colliery by providing high-quality products.
Modern Gold Rush: DSI Australia supports
Gold Producers with new Warehouse

The city of Bendigo, in southern Australia, is the fourth largest city in the state of Victoria. During the gold rush from 1850 to 1900, more gold was found here than in any other gold region in the world. Even today, Bendigo continues to be the largest gold field in eastern Australia. Thanks to modern ventilating and drainage technology, gold reserves in deep layers that were not accessible previously can now be extracted.

The Australian company Bendigo Mining Limited is currently exploring the region’s deeper gold deposits. Test borings are being carried out in a 6.5km long exploratory shaft that runs at a depth of up to 850m underneath the city of Bendigo in order to determine the exact positioning and size of the gold deposits. Once the mine becomes fully operative in 2011, the chief executive of Bendigo Mining, Doug Buerger, is expecting a production of 1.6 million ounces of gold per year.

The company contracted with DSI Australia to supply a complete range of specialized products for mining and ground support. In accordance with the slogan “Local Presence – Global Competence”, DSI Australia opened a new central warehouse in Bendigo in 2008 to assure the prompt and flexible supply of the products needed. Thanks to the new warehouse, DSI Australia will be able to service the complete mining industry in Victoria by offering a comprehensive range of mining products from its new local warehouse.

Underground Expansion of an Open Pit Mine
using DSI Mining Products

Ernest Henry Mine, Cloncurry, QL, Australia

Ernest Henry Mine, a copper-gold-mine, is located approximately 115km east of Mount Isa and 40km north of Cloncurry. It started production in 1997 and has been owned by the Xstrata Group, a globally operating metal and mining group, for several years. Each year, approximately 100,000t of copper and 125,000 ounces of gold are extracted from the ore that is produced in the Ernest Henry Open Pit Mine. Open pit ore is predicted to be exhausted by 2010. However, research showed that a notable amount of ore layers still exists in deeper grounds.

Following plans to continue the exploitation at Ernest Henry Mine, Xstrata announced its plans for continuing the production underground in November 2007.

Pre-research concerning security and profitability for underground production showed positive results. Furthermore, several possibilities resulted from the pre-research that are going to be investigated further during the construction of the first tunnel.

At the end of 2007, the company Barminco secured a contract to drive the first 3.2km long underground decline. From early 2009 on, approximately 75,000t of copper concentrate are expected to be produced in a time span of approximately 3 to 4 years.

As agreed in the supply contract with Xstrata Copper, DSI Australia will supply its high quality and reliable DSI Mining Products for the underground expansion of Ernest Henry Mine.

INFO

Owner Xstrata Plc., Australia
DSI Unit DSI Pty. Ltd., Bennetts Green, NSW, Australia
DSI Scope Contract for supplying the complete range of Mining Products for accessing the new mine
DSI Solves Water Inflow Problem at Campo Morado Mine

The Canadian mining company Farallon Resources Ltd. runs a large polymetallic mine with zinc, gold, silver, copper and lead deposits in Guerrero State, in southern Mexico. The Campo Morado Mine is located approximately 160km southwest of Mexico City and has one of the largest metal deposits in Mexico. Farallon Resources Ltd. opened the mine in 1995 and has since discovered six new deposits.

In July 2008, the mine owner was facing a problem: parts of the mine were flooded by ground water and were no longer accessible for extracting ore. The contractor working on site knew the experienced DSI employee Gaetan Rivard from DSI Sudbury personally and knew that he had the experience and knowledge to solve the problem. Gaetan Rivard accepted the challenge and travelled to Mexico with DSI Mexico’s Sales Manager Jorge Gonzalez and Carlos Roacho, DSI Mexico Technical Sales.

The experienced DSI employees soon found a solution to the problem: DSI supplied a grout pump, grout plugs and the grout necessary for cutting off the water. The crew in charge had to pump grout continuously for two shifts on two holes before the water was successfully contained.

The DSI employees did not only instruct the crews during injection, but also trained personnel to install cable bolts and performed pull tests to ensure the stability of the mining products used.

INFO

Owner Farallón Minera Mexicana S.A. de C.V., Mexico City, Mexico +++ Contractor Farallón Minera Mexicana S.A. de C.V., Mexico City, Mexico +++ Subcontractor Wabi Development, Ontario, Canada +++ Engineering Ing. Jesús Rivera

DSI Units DSI Canada Ltd., Sudbury, Canada; DSI Anclas Mineras S.A. de C.V., Jalisco, Mexico

DSI Scope Supply of a grout pump, grout plugs and grout; technical assistance, training and pull tests on site
Mexico: Omega-Bolt® Technology for Precious Metal Mine of International Standing

The foothills of Sierra Madre, in Mexico’s northern state of Chihuahua, are known for their precious metal deposits. One of the mines in this region, the Palmarejo mine, has been part of the world’s leading silver and gold producing company since its opening in March 2009.

The mine is operated by Coeur d’Alene Mines Corporation, one of the world’s leading silver producers. According to the current 11 year plan for the operation of the new mine, approximately 120,000 ounces of Gold and 9 million ounces of silver will be mined per year at Palmarejo.

Because the strata near the main portal is predominantly unstable, a rock bolt was needed that could be installed quickly and reliably in order to provide the necessary stabilization for gallery advancement. The contractor chose DSI’s Omega-Bolt®s, which were used for the first time ever in Mexico.

The Omega-Bolt® is a special anchorage system used for temporary rock reinforcement in mining and tunneling. The anchor offers immediate full load bearing capacity along the entire bolt length and can be flexibly adapted to varying borehole diameters. The Omega-Bolt® is shaped into a Greek Omega and is expanded by high pressure water after insertion into the borehole. The result is immediate form closure and friction transfer with the surrounding rock mass. Another important advantage is the Omega-Bolt®'s deformation flexibility. This feature makes the anchor suitable for use in unstable rock mass as well as in seismically active mining regions.

For the construction of the main ramp, DSI Anclas Mineras supplied a total of 12t of Omega-Bolt®s in lengths of approximately 2.4m as well as the hydraulic pump necessary for the expansion of the anchorages. In Palmarejo Mine, Omega-Bolt®s are also used at the intersections, where longer bolts are needed. Thanks to the usage of the specialized Omega-Bolt® system, work at the main portal could be carried out quickly and safely.
Architectural requirements for the design of stay cable bridges are steadily increasing. This is especially true for the pylon, which needs to be as thin and elegant as possible because it can be seen from a great distance. As a consequence, the space inside the pylon is often insufficient to accommodate common stay cable anchorages that are supported by bearing plates. Frequently, solutions are needed in which the stay cables are connected to the structure by a clevis anchorage with a large pin. In the past, similar details have primarily been used in the case of full locked cables. From now on, a newly developed clevis anchorage by DYWIDAG-Systems International GmbH will also be available for strand cables, offering an economic alternative to conventional systems.

In 2004, 12 and 14 strand clevis anchorages were used for the first time on the Riel Esplanade in Canada (cf. DSI Info 14). At the time, the anchorage consisted of a thick-walled steel tube with welded steel plates. Further development resulted in more efficient clevis anchorages made of cast steel for 12, 37 and 61 strands.

The diagram shows a longitudinal section of the anchorage. The clevis is fastened to the structure via a pin and gusset plate. On the other side, a DYNA Grip® anchor block is threaded into an inside thread. The anchorage is connected to the stay cable sheathing by a flange tube that also contains the anchorage’s sealing unit.

The anchorages were subjected to fatigue tests and subsequent tensile tests in accordance with fib Bulletin 30 at the Technical University of Munich. Initially, a strand bundle containing 12 strands with a strength of 1860 N/mm² and a cross section of 150 mm² was installed in an vertical testing machine that was adapted to include an inclination of 0.6° as required by fib regulations. The assembled cable was then tensioned to an upper load that corresponded to 45% of the cable’s nominal breaking load. During the fatigue test, 2 million load cycles with a stress range of 200 N/mm² were applied. The test was successfully completed without a single wire fracture. During the subsequent tensile test, 95% of the nominal breaking load, or 92% of the actual breaking load in relation to the values of individual strands, and a minimum elongation of 1.5% at maximum load had to be achieved. These requirements were also successfully met without any wire fractures. An additional test with 61 strands was carried out successfully between March and April 2009.

The newly developed clevis anchorages are being used for the first time on the Sae Poong Stay Cable Bridge in Korea. A detailed article on this bridge will be included in the next edition of DSI Info.

The clevis anchorage is not only suitable for stay cable bridges, but can also be used for arch bridge hangers, where available space in the arch is too small for aligning ordinary fixed anchors.
During the International Underground Construction and Tunneling Fair (IUT), visitors are able to gain a special kind of insight into the world of mining and tunneling. From September 17th to 18th 2008, this trade fair took place for the 5th time inside the Hagerbach Test Gallery. This 5km long gallery has been used for research and development since the 1970s. Its unique setting offers visitors the opportunity to experience the equipment and products on display in a truly realistic environment.

In addition to the trade fair, the interested expert public can also participate in special tunneling seminars and technical excursions to current job sites. This year’s tunneling seminars were focused on the motto “Modern Tunnel Equipment for Road and Rail”.

This year, the DSI company SpannStahl AG, Switzerland, and DSI, Austria were present at the exhibition. The joint appearance of both companies enabled visitors to gain interesting insights into the newest developments of DSI’s business segments Construction and Underground. Both companies were satisfied with their visitors’ positive feedback.

The engineering and consulting company DMT GmbH & Co. KG is active in areas such as product testing, infrastructure, mining, industrial testing and measuring technology.

On November 6th, 2008, the company organized a conference titled “Parallel Strand Stay Cables in Bridge Construction” that was held in Essen, Germany. This event was of special interest for the expert public because parallel strand stay cables are increasingly used as high-strength tension members in German bridge construction. The conference was a welcome opportunity for participants to exchange experiences and knowledge.

DSI was represented by Mr. Oswald Nuetzel, who gave two technical lectures. The first lecture outlined the use of DYNA Grip® Stay Cables for the Wesel Lower Rhine Bridge, Germany. The second lecture introduced the DYNA Protect® System, a novel corrosion protection system for stay cables. You will find a technical article on this topic in the “Special” area of this DSI-Info edition. The 120 participants were especially interested in the new DYNA Protect® corrosion protection system and engaged in a lively discussion at the end of the lecture.
The latest annual Geomechanics Colloquy was held in Salzburg on October 9th and 10th, 2008. This conference is a forum for planners, engineers and construction companies in tunneling.

Due to the fact that, among other things, the event also offers a discussion forum with site managers, the Geomechanics Colloquy is the most important professional event for DSI Austria Ges.m.b.H. in the German-speaking area of Europe.

This year's half day topics addressed issues such as the latest developments in geomechanics, penstock and cavern construction and prediction models.

A day before the Geomechanics Colloquy, the 6th Austrian Tunnel Day was held in Salzburg’s convention center. This professional congress is organized by the International Tunneling Association’s (ITA) Austrian National Committee.

Topics such as changes in tunneling technology and current large-scale projects were at the center of the one-day event. The symposium was accompanied by a panel discussion titled “Fair construction execution - economic construction”.

Within the scope of the Geomechanics Colloquy, DSI Austria and Atlas Copco invited attendees to a traditional dinner in Salzburg’s Sternbraeu restaurant.

The pleasant atmosphere contributed to an intensification of existing contacts as well as to the creation of new contacts.

Once again, this year’s dinner was the festive highlight of the colloquy for more than 600 guests and a complete success for DSI Austria.
A Strong Partnership: 50th Anniversary of License Agreement between Sumitomo and DSI

Relations between Japan and Germany have always been close. In fact, the roots of this intercultural relationship reach back to the 17th century. Today, both countries cooperate closely in politics, as well as in science, social life and in issues relating to the economy.

The friendship between the two countries has also allowed many companies from both countries to establish business relations abroad. 50 years ago, the former DYWIDAG established a license agreement with Sumitomo that, for the first time ever, made DYWIDAG technology available in Japan.

The Sumitomo Group emerged out of the construction company Osaka Hokko Kaisha Ltd., which was founded in 1919. Today, Sumitomo is a global organization with more than 68,000 employees and approximately 150 agencies in 65 countries. The Group is active in the metalliferous and raw materials industries as well as in logistics, infrastructure and telecommunications.

The license agreement between Sumitomo and DSI makes it possible for Sumitomo employees to obtain detailed information concerning the characteristics of DYWIDAG Systems during visits in Munich. Since the beginning of the license agreement, more than 2,000 bridges have been built in Japan using the DYWIDAG Post-Tensioning System.

The cooperation between Sumitomo and DSI continues to be profitable for both partners. Sumitomo representatives regularly attend DSI’s Asia Meetings and use this occasion to exchange information about the latest developments and new markets with DSI.

On the 29th of May, Sumitomo employees and DSI representatives celebrated the 50th anniversary of the license agreement in Tokyo. The delegation from Munich consisted of Mr. Mossmann, the RCEO for Construction Europe, Mr. Reif-Lemke, the RCFO for Construction Europe, Mr. Nuetzel as the representative of the technical office and Mr. Weber, the contact person for Asia.

Today, we would like to thank Sumitomo for our partnership and we are looking forward to many more years of cooperation between our two organizations.
GEOFLUID, Piacenza, Italy

October 1 - 4, 2008

GEOFLUID is a highly specialized exhibition on geotechnics and tunneling. In 2008, the 17th annual trade fair was held in Piacenza, Italy, from October 1 – 4, 2008.

The exhibition is divided into four subject areas concerning drilling technology, tunneling and geotechnics and is focused on special market segments. The 2008 fair was attended by approximately 10,000 visitors and nearly 400 exhibitors.

Due to its special focus, the exhibition is a welcome opportunity for DSI to cultivate professional relationships and create new relationships with the expert public.

This time, the specialist for geotechnics, DYWIT S.p.a. from Milan, Italy and the Tunneling Headquarters, DSI Austria Ges.m.b.H., located in Pasching/Linz, Austria, presented their newest products and systems at a joint booth at GEOFLUID.

The participation at this trade fair was successful for both DSI companies.

Once again, the ITA-AITES World Tunnel Congress in India in 2008 provided participants with the opportunity to learn about the latest developments in the tunneling industry within the framework of presentations and a trade exhibition. The presentations and poster exhibitions dealt with topics such as the interpretation of geological data, rock mass analysis, and different methods of tunnel construction.

As a member of the DSI Group, DSI Austria actively participated with technical contributions. Mr. Volkmann gave a presentation on “Tender Document Specifications for Pipe Umbrella Installation Methods”. Additionally, DSI Austria contributed a poster titled “Technical Advances of Self-Drilling Rock Reinforcement and Ground Control Systems” to the poster session.

As every year, DSI Austria used this opportunity to present the DSI Group’s newest product developments in tunneling to the expert public during the accompanying exhibition.
3rd DSI Asia Meeting in Seoul
May 26 - 27, 2008

For the third time, DSI representatives from Europe have had the opportunity to meet their colleagues and licensees from eight important Asian countries.

DSI's Asia Meetings allow participants from both Europe and Asia to gain a better insight into Asian markets and working methods. For this purpose, each of the participating Asian countries presented the latest developments in their respective regional markets.

In addition, participants could get an idea of their Korean colleagues' work on a jobsite while visiting Incheon Bridge. DSI Korea supplied DYWIDAG THREADBAR®s, anchor systems and associated accessories for this impressive bridge structure which has a main span of 800m.

Once again, the large number of participants proved how important it is for all DSI Group members to work hand in hand with their international colleagues. In fact, it is our global internal communication that allows us to truly live up to our motto „Local Presence – Global Competence“.

DSI bids Farewell to Mr. Oswald Nuetzel after more than 40 successful years in the Company

On November 30th 2008, Oswald Nuetzel, chief engineer for DSI Stay Cable Systems, retired after spending over 40 years of his professional life with DYWIDAG and DSI. Oswald Nuetzel began his career in July 1968 in DYWIDAG's engineering office.

Soon, his innovation potential was realized and in April 1969, he became a member of the research and development department. During the early days of this department, he contributed to many of the developments of bar post-tensioning systems. Even the first stay cable bridge that was equipped with a DSI system in 1972, the Hoechst bridge over the Main River, took advantage of these developments and was supported by bar cables.

During the 1980’s, he conducted basic developments for external post tensioning systems and once more prepared the ground for a major step in the development of DSI stay cable systems. His persistence and enthusiasm were not limited to the development of such systems, but were much required when he was responsible for the installation of the stay cables at the Alamillo Bridge in Spain in 1990 and 1991. Besides this intensive experience abroad, his expertise was requested during the construction of many well known bridges all around the world. Several national and international committees benefited from his competence.

Many of Mr. Nuetzel’s companions joined his retirement party in Munich. We wish Mr. Nuetzel all the best and excellent health for this new phase of his life.

On December 1st, 2008, Werner Brand succeeded Mr. Nuetzel as the team leader of the stay cable department within Technical Services. Mr. Brand has been working for DSI since September 1999 and started working as an engineer in the Technical Service Department.

We congratulate Mr. Brand on his promotion and wish him all the best for his future with DSI.
On April 30, 2009, after 40 years of service with DSI, Gary Kast, the General Manager of Canada West, retired. Gary was well known and respected within DSI and throughout North America for his strong technical skills, leadership and dedication.

Gary graduated from the University of Civil Engineering in Konstanz, Germany in 1962 with a diploma in Civil Engineering. He spent several years working in the Swiss Alps with Conrad Zshokke AG as a site engineer / estimator on hydro-electric power projects before immigrating to Canada.

In April 1969, Gary started working with DYWIDAG Canada in Calgary, Alberta as a Field Engineer, Estimator and Project Manager before becoming Manager of the Prairie Region in 1973. In 1981, Gary’s territory expanded to include all of Western Canada, and in 1985, he moved to British Columbia.

During his tenure, Gary was heavily involved in product and system development and enjoyed the challenges of large projects, particularly in difficult conditions with technical challenges. Along the way, Gary built a strong and loyal team which helped Canada West become a strong influence in its small but geographically diverse market territory.

Some of the interesting projects that Gary carried out include:

- installation of micro-piles in permafrost at radar stations in the Arctic North
- installation of GEWI®-Piles and anchors for a transmission line in Papua New Guinea
- installation of rock anchors for a dam in Iqualuit, Nunavut in Canada’s arctic north
- supply of multi-strand post-tensioning and form travelers for the Tsable River Bridge on Vancouver Island, BC
- supply of 92x0.6” strand anchors for the seismic upgrading of Seven Mile Dam
- Supply and installation of Stay Cables for Provencher Pedestrian Bridge in Winnipeg, Manitoba

On May 1, DSI held a celebration of Gary’s 40 year service and his retirement. Attendees included Kerry Allen, RCEO and Khaled Shawkaf, Chief Technical Officer as well as many of Gary’s colleagues, clients and friends.

As of January 1, 2009, the DSI business was reorganized into a combined Canadian business unit under the direction of Joe Li, formerly GM of Canada East. The new structure will bring synergy to the Canadian operations which are some 4,500kms apart.

We would like to thank Gary Kast for his great contributions during his time with us and wish him health, happiness and success in his well deserved retirement.
International fib Symposium, Amsterdam, Netherlands
May 19 - 22, 2008

The members of the international federation of concrete fib (Fédération Internationale du Béton) regularly come together for symposia to exchange scientific and practical knowledge in concrete technology. Further development of the construction material concrete with its technical, economic, aesthetic and environmentally friendly advantages are the main topics of the oral and written presentations.

Hence, the fib Symposium 2008 was themed “Tailor made concrete structures - New solutions for our society”. A total of 394 abstracts from 46 countries dealing with this topic were handed in. Out of this exceptionally high number, fib’s scientific committee chose 155 oral and 55 poster presentations that were animatedly discussed during the Symposium.

To make the program complete, a large exhibition as well as excursions took place. DYWIDAG-Systems International (DSI) participated in the exhibition with a generously designed booth. The comprehensive DSI product range was well received by the participants of the symposium. They were able to gather detailed information about the way DSI products foster and complement the further development of concrete as a construction material.
The Big 5 Show, Dubai, United Arab Emirates
November 23 - 27, 2008

Public interest in Dubai's Big 5 Show continues to be very high; in 2008, more than 57,000 people visited the booths of 3,200 exhibitors from 53 countries. The show's offer was more diversified than in previous years. For the first time, the PMV, the most important exhibition of construction equipment in the Middle East, was held at the same time as the Big 5.

The Big 5 is divided into 7 main areas that also include construction. This segment comprises products linked to the construction material concrete, as well as different kinds of anchorage systems. This setting was a welcome opportunity for DSI to present its broad range of products for the construction and underground markets.

DSI has several partner companies that specialize on the supply of Post-Tensioning Systems, including design and full installation, to the Middle East. The reinforced Dwydarg Flat Anchorage Post-Tensioning System was one of the systems which was upgraded and optimized by DSI and its local partners to suit requirements on Middle Eastern markets.

The Concrete Accessories Division was also present at the Big 5 Show. In addition to Form Tie Accessories, DSI exhibited chemical products and special mortars produced by Technique-Béton in Moissy, France, at the company booth. DYWIDAG Form Tie Systems were presented in cooperation with DSI's local partner, Protools LLC from Dubai.

With traffic steadily increasing in Dubai, the government is currently planning several infrastructure projects that also include the construction of new tunnels. That is why, for the first time, DSI also exhibited its special tunneling products.

Once again, DSI was not only able to renew existing business relations, but to impress many new contacts with their comprehensive product range.

IV. ACHE Congress, Valencia
November 24 - 27, 2008

The Spanish version of the fib Congress was held in Valencia at the end of 2008: the IV. ACHE Congress. The Scientific-Technical Association for Structural Concrete in Spain, ACHE, organizes this international event on a triennial basis.

The ACHE Congress is a combination of trade show and seminar and serves mainly to exchange know-how and experiences in the concrete and civil engineering sectors. This does not only include an exchange between business experts, but also a knowledge transfer between research and practical experience.

Approximately 500 participants attended the varied lectures and visited the 55 booths. As an active member of the ACHE, DYWIDAG Sistemas Constructivos (DSC), headquartered in Fuenlabrada, Madrid, participated with a company booth as well as by making presentations.

DSC presented three papers on recent developments in the field of Ductile Iron Piles, on the damper system that was used for the Alamillo Bridge and on the Monostrand Flat Slab Post-Tensioning System.

Feedback for DSC’s technical presentations was positive throughout, and DSC was able to renew existing contacts and to establish new business connections at their booth.
MINExpo INTERNATIONAL 2008, Las Vegas
September 22 - 24, 2008

■ MINExpo is the only Northern American mining exhibition and the biggest show of its kind on that continent. MINExpo is held every four years and is considered to be one of the most important exhibitions of the industry. From September 22nd to 24th, 2008, more than 1,285 companies exhibited their products and services for mining and tunneling in Las Vegas.

In 2008, MINExpo’s square footage was 30% larger than in previous years. Approximately 40,000 expert visitors collected information on recent product developments in mining and tunneling both at the exhibition and during accompanying educational sessions.

DSI, the specialist for mining and tunneling products, was also present at MINExpo. At the company booth, DSI presented special products of the DSI division Underground America to the interested expert public.

A large number of professional visitors showed great interest in the products of the DSI companies. DSI is very satisfied with the results of this year’s show and plans to be represented at the next MINExpo in Las Vegas in 2012.

DSI USA: Kris Kriofske Retires

■ After 9 successful years of working for DSI USA, Kris Kriofske retired in the summer of 2008. Mr. Kriofske started his career with DSI USA in June 1999 as Interim General Manager for the DSI/Strandtech Joint Venture while at the same time working as a sales engineer for DSI in Texas.

After the successful dissolution of the Joint Venture between DSI and Strandtech in October 1999, Kris Kriofske worked as a full-time Sales Engineer for what at the time was the South Central Division of USA.

Mr. Kriofske continued to work in this position until his well-earned retirement on June 15th 2008. We wish Kris all the best and good health for his future path of life.

Kris Kriofske and his wife Jaynie