Shortening construction time and ensuring quality with Peri

Two movable weather protection roofs span two incremental launching facilities for the construction of a bridge superstructure near Grudziadz in Poland. Photo Credit: PERI GmbH.

Currently, a new bridge is being constructed for the crossing of the Vistula River in Grudziądz, Poland. For the foreland bridge from the southeast direction, a so-called incremental launching method was used. The prefabrication of the individual repetitive bridge sections was carried out with stationary formwork.

A temporary protection roof on the basis of the PERI UP modular scaffold spanned the working area and allowed weather-independent construction of the individual sections for the superstructure. This is one of the factors that contributed to the fact, that the Skanska-NDI Joint Venture has been able to shorten the construction period by three months. Thanks to the rental concept for the weather protection roof, this solution was also particularly cost-effective.

Two lanes, each around 556-m-long, were constructed in 25 concreting cycles with standard lengths of 24 m. The formwork had a length of 25 m and is positioned behind the bridge abutments. The individual sections of the superstructure are concreted directly together here and connected by means of tensioning cables. Subsequently, the hardened bridge section was raised a few millimetres and moved forward together with the other finished segments by one cycle length in the direction of the bridge's longitudinal axis.

For the concreting work of the hollow box profile, a construction time of 12 months in total was originally planned. As work started in November 2009, minimum temperatures of up to -25°C were expected during the winter.

In order to provide protection against the effects of all types of weather, and especially the extremely low temperatures in winter, the contractor planned the erection of a temporary protection roof for the construction phase. The technical concept of PERI easily convinced the construction company. In addition, the possibility of renting the LGS protection roof for the period of use provided an economical solution.

Altogether, the jobsite team used four roof structures; two smaller, permanently installed tents are used for reinforcement work preparations, and two movable protection roofs on basis of the LGS lattice girder system span the formwork and concreting areas.

In order to ensure unhindered material and concrete installation, the design allows the protection roofs to be moved. For this purpose, the girder supports were also equipped with rails and extended over a length of 55.50 m – they were therefore more than twice as long as the protection roofs. The wheel facilitated the moving of the roofs in a longitudinal direction. In the plane of the girder, the static system of a single-span beam with one stationary and one movable support can be realised without any problems by means of system components.

The spatial arrangement of the two sets of incremental launching equipment gave the position of the weather protection roofs – the available space between the formwork for both lanes was very limited. Load transfer of the support construction of both weather protection roofs had to be guaranteed via a common central support.

This proved to be a challenge for the planning as the high loads can cause large deflections to the construction, which could make moving the roofs on the rails difficult. It therefore meant ensuring that resulting loads and deformations were to be accurately calculated during the planning phase and to be taken into consideration in the execution. The wind loads could be transferred through serial components. In order to secure the protection roofs against lifting, the support plates were provided with ballast and, in part, anchored in the bottom slab.

With Keder track and sheeting, the scaffold

The URW wheel allows moving to take place in a longitudinal direction and a horizontal sliding support at the level of the girder. Photo Credit: PERI GmbH.

For the reinforcement and concreting work, the weather protection roof is pushed over the permanently installed reinforcement tent. All required materials can then be craned in without any problems. Photo Credit: PERI GmbH.

constructions resulted in very light and translucent roofs. The solution in Grudziądz also included a side and gable covering. Overlapping of the sheeting at all joints ensured a tightly fitting enclosure that, at the same time, could be easily opened. With extremely low outside temperatures, the temporary tents were also heated.

Thanks to this protective roof construction, the building site team has been able to continue all working operations without stopping – in spite of the very low outdoor temperatures during the past winter. This has resulted in enormous time savings. An additional positive effect of the enclosure is the consistently high concrete quality achieved throughout due to the constantly good setting process. The improved working conditions for site personnel are an important factor as well.

For reinforcement installation and concreting work, the LGS protective roofs are moved into position over the reinforcement tents. A problem free operation due to the smooth running wheels from the PERI UP standard product programme. Despite the high loads and complex boundary conditions, a protective roof is easily moved by two to four persons without the need of any additional equipment. This fact confirms the high degree of stability and dimensional accuracy of the scaffold construction.

In addition to the technical solution, the contractor also considered the rental concept and constructive co-operation with PERI to be very positive. The sum of all points leads to an extremely cost-effective solution, which contributed to the success of the project.

Enquiry: redaktion@peri.com

LGS roofs can easily be moved by hand and are also equipped with brakes, ensuring a fast moving procedure. Photo Credit: PERI GmbH.

Roofing for the scaffold construction is provided through a Keder system whereby the integrated sheeting offers the best protection against wind and weather. Photo Credit: PERI GmbH.

Rapid-strength concrete moves pavement repairs into the fast lane

On this project the crews were able to work only Friday and Saturday nights.

The use of rapid-strength concrete has enabled the California Department of Transportation (Caltrans) to implement a Pavement Preservation Strategy that calls for fast-track replacement of individual damaged slabs. In most cases, the agency can avoid complete lane reconstruction since individual panels deteriorate at different times. Replacing only the damaged panels extends the service life of the existing pavement.

"We evaluate the damaged slabs and identify those to be removed and replaced," said Bill Reagan, Caltrans deputy District 7 director of design. "Our first strategy is to repair only the damaged portions without using an asphalt overlay. Asphalt is effective for a long, continuous run, but is not effective for the panel replacement approach."

The advantage of replacing individual slabs is that, using rapid-strength concrete, repairs can be achieved overnight and lanes opened to traffic in time for the morning commute. "The cure time for a conventional Portland-cement concrete mix generally takes a week," said Reagan. "With rapid-setting concrete you can pour the concrete and start the clock."

One method, which provides a curing time of less than two hours, uses a special fast-hardening cement to produce rapid-strength concrete in volumetric mixers. This combination has helped make overnight repairs a standard practice for Caltrans projects.

Volumetric mixers facilitate concrete production

onsite rather than in transit, which is critical given the fast setting time of the concrete. Although the mixers typically have a capacity of 10 cu yds, they make it practical and economical to produce smaller quantities of concrete, such as the 5 cu yds needed for each pavement slab. This capability is a plus on the Caltrans projects because the panels to be replaced are often spaced apart and poured at different times. It also helps control the flow and placement rate of concrete, making it possible for crews to work the rapid-strength concrete before it cures.

"The volumetric mixers mix just the amount that is needed, so there's no waste," said Ryan Vanderhook, president of Short Load Concrete, a concrete producer in Anaheim, California. "Combining that technology with rapid-setting concrete makes it possible to produce concrete that gains its ultimate strength faster than with conventional trucks."

Short Load recently supplied more than 16,000 cu yds of concrete to replace about 3200 panels on State Route 5 in Los Angeles County, California's busiest freeway accommodating over 80,000 vehicles daily. As is typical for Caltrans projects, the repairs had to be performed during a night shift to minimise lane closures.

"On this project the crews were able to work only Friday and Saturday nights," said Vanderhook. "Two of three lanes were closed at midnight, when removal of panels began using three backhoe loaders. The lanes reopened at 6 a.m."

With a penalty of US$6,400 per 10 minutes for late openings, achieving the flexural strength requirement was critical to the project's success. The reason for the penalty, explained Reagan, is that "every 10 minutes a lane is closed it translates into congestion, which represents a cost to the user." Another consideration is safety, he added, because during the night construction crews are not working

Volumetric mixers facilitate concrete production onsite rather than in transit, which is critical given the fast setting time of the concrete.

To ensure the advantage of replacing individual slabs is that using rapid-strength concrete repairs can be achieved overnight and lanes opened to traffic in time for the morning commute.

in heavy traffic.

The concrete for the project, produced in volumetric mixers, used Rapid Set® cement, a fast-hardening hydraulic cement made by CTS Cement Manufacturing Corporation. In less than two hours and often within one hour, the Rapid Set® concrete achieves the Caltrans opening to traffic flexural strength requirement of 2.8 MPa (406 psi) in less than two hours and often within one hour. The Caltrans 7-day flexural strength requirement of 4.2 MPa (608 psi) is typically achieved within eight hours.

The chemistry of this type of cement makes high early strength gains possible. When the cement hydrates with the addition of water, it forms a compound called ettringite. This crystalline compound forms quickly, producing rapid strength gains. The cement's high uptake of free water during hydration contributes to a low shrinkage rate, according to a study by engineering firm Wiss, Janney, Elstner Associates, Inc., Northbrook, Illinois. Lab tests demonstrated an average 28-day shrinkage of 0.027 percent for concrete produced with rapid-curing cement.

Twining's mobile testing lab conducts beam tests on the jobsite to verify and seven-day flexural strength values.

To ensure that everyone involved on pavement projects understands how to work with the unique properties of rapid-strength concrete, Caltrans requires all personnel to attend a formal Just In Time Training (JITT) program. The four-hour class covers material properties and uses, production processes, equipment usage, and proper handling and finishing the concrete.

Arranging the JITT program is the contractor's responsibility as part of the quality control/quality assurance (QC/QA) plan submitted with the bid. For the Route 5 project, contractor All American Asphalt (AAA), Corona, California, retained Twining Laboratories, Long Beach, California, to conduct the training. Instructor Boris Stein, vice president of materials engineering and research for Twining Labs, presented the fundamentals of building new pavement and replacing concrete slabs using different types of rapid-strength concrete. Topics addressed in the course, according to Stein, include the differences between rapid-strength and traditional concrete, construction methodology and correct techniques, and implications of each procedure involved.

The first step on Caltrans projects is to remove deteriorated concrete using a non-impact method to preserve the base and subgrade. Contractors are permitted to saw cut the perimeter of the damaged slabs up to two days before removal so the sawing operation will not hinder the fast-paced replacement process. Full-depth saw cuts are made to separate each segment of deteriorated concrete. Panels are cut into smaller sections, which are removed from the centre outward to protect adjacent panels.

Formwork for the replacement panel generally is not needed

The concrete for the project, produced in volumetric mixers, used Rapid Set® cement, a fast-hardening hydraulic cement made by CTS Cement Manufacturing Corporation.

because the space that remains after the damaged panel is removed can function as a form. In most cases, only minor repairs to the base are required and can be accomplished by using rapid-strength concrete to level surface depressions. After the old concrete is removed, a bond breaker is installed to separate the old base from the new concrete and allow free movement of the new concrete to prevent cracking.

On the Route 5 project, AAA required between five and eight short load volumetric mixers, which were loaded with aggregate, sand, and rapid-strength cement from a staging yard about two miles from the jobsite. At the jobsite, water was added to the dry materials in the mixing auger to produce only the volume of concrete needed for each pour.

To ensure that everyone involved on pavement projects understands how to work with the unique properties of rapid-strength concrete, Caltrans requires all personnel to attend a formal Just In Time Training (JITT) program.

"We were able to start pouring concrete within 45 minutes after starting to remove the panel," said Jim McGee, AAA project manager. "We had the volumetric mixers lined up and ready to go."

"At the time it was a gamble for us. We had never used volumetric mixers before," McGee added. "Now we'd never go any other way because the production was double what we originally figured." AAA based its project bid on a production rate of 90 cu yards per five-hour work shift. Instead, the average production was 190 cu yds per shift and the largest was 390 cu yds.

Since Caltrans began specifying rapid-strength concrete in 1994, more than 400,000 cu yds – the equivalent of 227 miles – have been placed on California highways. Caltrans writes performance specifications identifying properties of the cement as well as requirements for the mix design.

In general, rapid-setting cement can be directly substituted for Portland cement in mix proportioning. To ensure uniformity and accuracy of the mix design, volumetric mixers are held to the standard that applies to ready mix plants: California Test 109 Ready Mix Batch Plant Certification. A Caltrans weights-and-measures coordinator observes the calibration of each mixer according to the material proportions outlined in the mix design, thus verifying that the volumes produced and strengths are accurate.

For the Route 5 project, Short Load Concrete formulated a seven-sack, one-inch-rock rapid-setting concrete mix designed to achieve the required strength in two hours or less. The water-cement ratio was 0.45 or less and the slump was approximately 5 inches.

As is typical with rapid-strength concrete, chemical admixtures included a water reducer and a retarder. A superplasticiser was used to lower the water demand and thus increase ultimate strength and maintain a workable consistency. The retarder was added to control the setting characteristics and provide a window of 10 to 20 minutes for placing, consolidating, and finishing the concrete.

Contractors are permitted to saw cut the perimeter of the damaged slabs up to two days before removal so the sawing operation will not hinder the fast-paced replacement process.

"Without the retarder, the concrete can have a working time of less than two minutes," noted Vanderhook. He added that volumetric mixers use significantly less retarder – approximately 7 ounces per hundredweight (oz/cwt) of concrete, compared with 50 oz/cwt for conventional trucks.

This mix enabled the crew to distribute and consolidate the concrete evenly and quickly. "The workability was good," said McGee. "Two laborers worked with vibrating wands to keep the concrete from hardening as it was poured."

The AAA crew finished the concrete with a hydraulic roller screed that spanned the 12-ft panel width, thus levelling the panel in one pass. This capability enabled one operator to keep up with the rapid production pace and provided a consistent surface, requiring less time for the final grinding, noted McGee. A membrane forming curing compound was applied to the surface. Within 30 to 40 minutes, the concrete was hard enough for workers to saw cut joints.

The contractor's QC/QA plan must provide for sampling and testing the concrete according to Caltrans

As is typical for Caltrans projects, the repairs had to be performed during a night shift to minimise lane closures.

Test Method (CTM) 524, Flexural Strength of Concrete (Using Simple Beam with Centre-Point Loading).

At regular intervals, testing personnel cast composite samples in 6- by 6- by 18-inch plastic beam moulds. The beams are protected and placed on top of the last constructed curing slab to maintain the consistency of curing between the beam moulds and the fresh concrete. The concrete beams are allowed to set and then tested for flexural strength values, or modulus of rupture, based on the load at which the concrete breaks.

Caltrans requires beam tests on the first 32 cu yds of concrete, at least once every 130 cu yds, and for the final truckload. In addition, Caltrans requires aggregate sampling and testing every 650 cu yds to test for yield, penetration, air content, and unit weight.

For the Route 5 project, Twining Laboratories performed the beam tests on the jobsite in a mobile testing lab to verify early and seven-day flexural strength values. When Twining introduced its mobile testing laboratories about 10 years ago, Caltrans was first in line to take advantage of its capabilities.

Given the fast curing time of the concrete and the need to open lanes on schedule, "it is clear that to prove concrete has achieved the required strength testing must be performed immediately in the field," said Stein. The mobile lab makes it possible to obtain timely results by breaking the samples in an hour without having to transport them.

The curing methodology used in the test allows the temperature of the beam to match that of the slab. This is important because otherwise, explained Stein, due to their smaller mass the individual specimens would have a lower temperature and would hydrate at a slower rate than the pavement. Without the adjustment, the strength of the beams would not be representative of the strength of the slab.

"We consistently met the 400-psi requirement in the first hour after pouring," said McGee. "The test results were far and above what the state mandated."

Enquiry: info@ctscement.com

Speed on site with the Doka Table Lifting System TLS

Two TLS Table Lifting Systems are integrated in the protection shield and make for speed and efficiency in positioning the large-area Dokamatic tables without any crane assistance.

LOT 171 in Kuala Lumpur, Malaysia, is a high-rise project that sees Doka setting new standards in terms of safety and cost efficiency in formwork engineering. The residential and business tower will top out at 267 m and lead contractor Daewoo Engineering & Co. Ltd. is maintaining a steady average of five days per floor for its concreting cycle.

That rate of progress goes hand-in-hand with maximised safety on site, ensured by the automatic climbing Xclimb 60 protection shield that also enables maximum flexibility for manpower deployment. In combination with the made-for-speed Dokamatic tables for the floor-slab formwork and the Table Lifting System TLS, the 60 floors are being concreted in record time and without crane assistance.

The city of Kuala Lumpur, the Manhattan of Malaysia, is growing at a tremendous rate. LOT 171 is immediately adjacent to the Petronas Twin Towers and a 267-m residential and business tower with shopping mall is now under construction at this site. The structure will be 60 floors high. The first 30 aboveground levels have a rectangular footprint and will house the shopping mall and business complex, carrying a residential tower with a triangular floor plan. The top 30 floors soar

upward in solitary splendour and this slender tower will soon be another landmark building enriching the skyline of Kuala Lumpur.

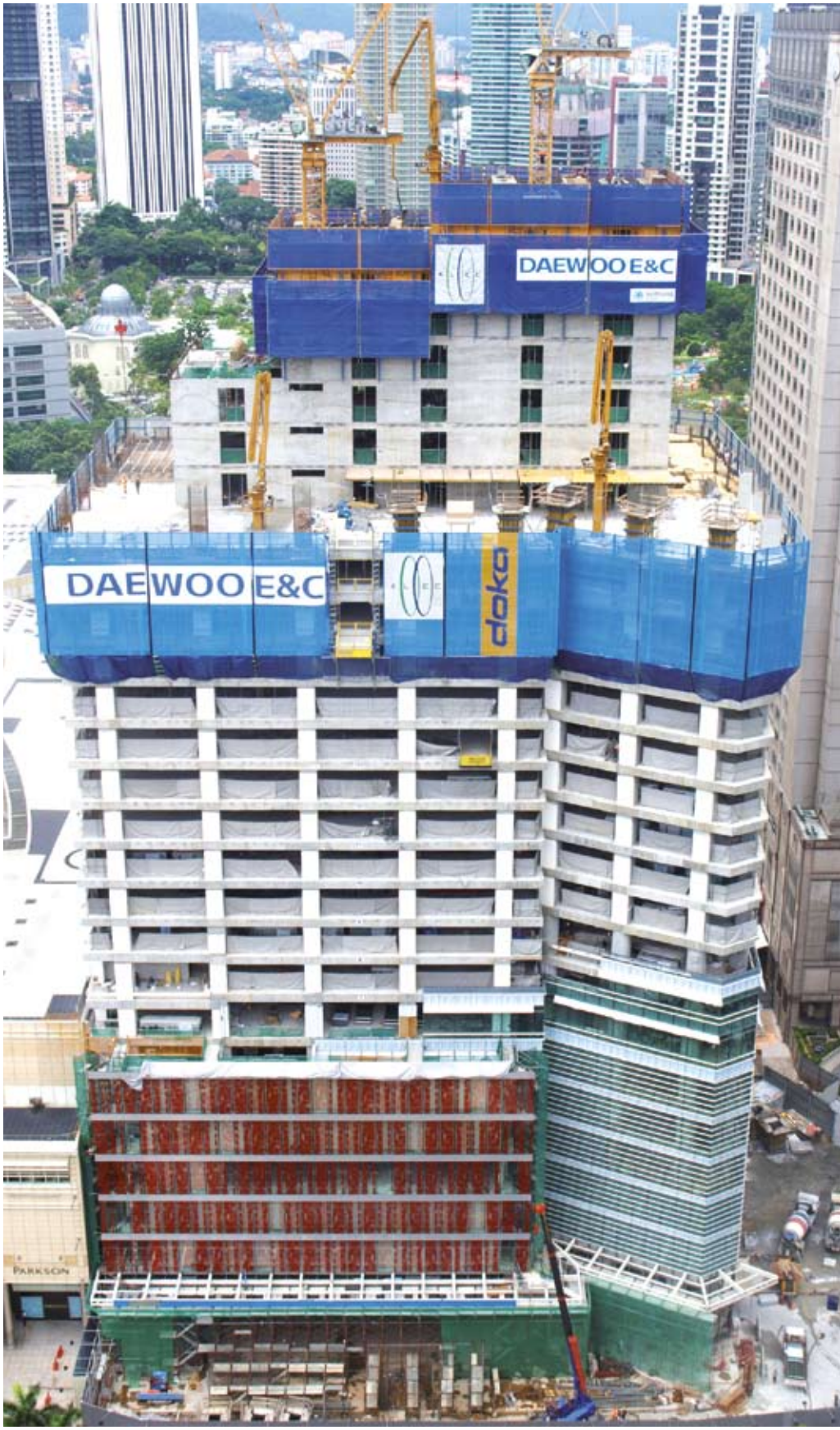
As on most major city builds, the construction schedule for the LOT 171 project is extremely tight. The project started in March 2009, the shopping mall occupying levels 1 through 6 is scheduled to open by the end of 2010 and final completion is planned for 2012. Only two cranes are available for the entire site, so an automatic climbing formwork solution was the obvious choice for the imposing footprint, averaging 2500 m² per floor.

Safety is a crunch factor, but lead contractor Daewoo Engineering & Co. Ltd. was also looking for flexibility in manpower deployment to avoid cost-intensive idle times in the overall workflow.

The project team from Doka Singapore as formwork partner delivered the end-to-end formwork solution that convinced the decision takers because it used the fast and dependable Dokamatic tables for slabbing and variably adjustable Top 50 column formwork for the CIP columns with their tapering sections.

All the moving and manoeuvring for the entire floor slab formwork is handled with the Table Lifting System TLS, so the solution is crane-independent. The automatic climbing Xclimb 60 protection shield, moreover, creates working conditions that are virtually the same as on ground level. “It wouldn’t be far wrong to call this a site-in-site situation. It’s an arrangement that enables us to make full use of the speed of our system components and optimise the working processes”, says Michael Eder, Engineering Director with Doka Singapore, when he describes the overall concept.

Michael Eder’s team had to allow for the numerous prestressing elements in the floor slabs, so they planned the Xclimb 60 with three working platforms to ensure the flexibility that would allow work to



The automatic climbing Xclimb 60 protection shield enables work to proceed efficiently and in safety at lofty heights.

Construction Manager Son Ho Joon from Daewoo Engineering & Co. Ltd. is very satisfied. The Doka systems enable his team to average of five days per floor on this build.

progress three different levels at any given time. The bottom-joist formwork is integrated into the Dokamatic tables so the joists can be concreted at the same time as the slabs without the need for major modifications.

Eye-catching as a banner advertising medium in its own right, the automatic climbing Doka Xclimb 60 protection shield is spectacular in other ways as well; the perforated trapezoidal metal sheeting of the Xclimb 60 was specially developed by Doka for hot-climate work and it allows cooling air to flow freely.

By comparison with the netting frequently used in other situations, Xclimb 60 is significantly stronger and therefore all the safer. That is a major consideration for the crew and also for everyone else on site, because this enclosure goes a long way toward minimising the danger of falling objects.

The automatic climbers for the protection shield in use on the LOT 171 build are designed to eliminate the need for modifications at the transition from the rectangular to the three-sided floor plan. Shifting the platforms to their new positions is the only process the change involves.

A total of 5000 m² of floor-slab formwork, enough for two levels, is on site for this build. The concrete is poured in four sections per level; the individual tables are moved quickly and safely from one level to the next with the Table Lifting System TLS. Two TLS systems were installed opposite each other in order to save even more time, and the arrangement keeps travelling times extremely short on this large-footprint build.

A real high-tech solution, it has to be employed correctly so that its rationalisation potential can be exploited to the full. That is why Doka knew as a matter of course that an experienced Doka site foreman would be needed in the field to assist the site crew with the first climbs. The crew is now well able to achieve cycle times of between 4 and 5 1/2 days per floor, as Daewoo Engineering & Co. Ltd. Construction Manager Son Ho Joon is delighted to report.

A much-acclaimed automatic climbing solution, it is well set to establish itself very rapidly in the Asian world. With the Gomac Tower, the Cua Tower and the LOT A high-rise, Doka Singapore is currently involved in three other major projects in Kuala Lumpur alone.

Enquiry: Stefan.Pruckmayr@doka.com

Completely preassembled Dokamatic-Tables are in use for the 60 floor high commercial and residential building.

Guaranteed waterproofing with Elastuff

Wall waterproofing application.

Situated at the northern end of the Persian Gulf, in the centre of the Middle East, lies the small nation of Kuwait. The blazing sun, which generates average summer temperatures of 45°C, beats down relentlessly, baking the dominant desert topography. Combine the searing hot climate with the fact that Kuwait has 499 km of coastline but no perennial lakes or rivers and the old adage, "An ocean of water, and not a drop to drink", is a reality that must be taken seriously. Although Kuwait has 10 percent of the world's proven oil reserves, the average annual rainfall is less than 10 cm, so potable water is at a premium.

To ensure that the nation's 2.4 million residents have enough water, the State of Kuwait Ministry of Energy – Electricity & Water (MOE), has constructed an impressive network of desalination plants. By the end of 2010, water production capacity is scheduled to be 661.5 million gallons per day.

To ensure that there is plenty of water in reserve, the MOE is also constructing a network of massive storage tanks. Approximately 120 km south of Kuwait, and 25 km north of the border with Saudi Arabia, the New Water Distribution Complex in Al-Zour is rising out of the Kuwaiti desert.

Awarded to First Kuwaiti General Trading and Contracting Co. in the fourth quarter of 2007, this three-year project includes the construction and maintenance of five each 55,000,000 Imperial Gallon reinforced concrete ground reservoirs for fresh water. Each tank consists of eight interconnected partitions, and is nearly the size of a football pitch. Approximately two-thirds of the vertical tank walls are below grade, although once the roof

Before applying Elastuff 120.

Membrane waterproofing application.

waterproofing is complete the entire reservoir complex will be buried under an earthen berm.

To ensure that the waterproof integrity of the concrete reservoirs is maintained, the specification calls for treatment of the 110,000 running meters of joints on the exterior of the roof, as well as all interior floors and exterior walls. The proposed product had to meet stringent performance properties, including National Sanitation Foundation (NSF) 61 testing and certification at 82°C (180°F). Liquid samples also had to be tested and approved by the Kuwaiti Ministry of Electricity & Water.

The successful subcontractor for the supply and application of the sealant and coating for waterproofing all of these joints was Ghaida Al-Kuwait General Trading & Contracting Co. The coating system they submitted was United Coatings' Elastuff 120, a versatile 100 percent solids polyurethane elastomer available in mastic, roller and spray grades.

The specification called for filling the control joint with mastic, then coating over the joint with a 40-cm-wide, fabric-reinforced strip of elastomeric coating at a total thickness of 4 mm. A scabbler was used to abrade the concrete approximately 20 cm to either side of each control joint, which increased the mechanical bond of the coating for maximum adhesion.

After thoroughly cleaning the joint to remove any loose concrete, laitance, dirt and dust, the joints, which measured approximately 3 cm across and 1 cm deep, were primed with a single coat of United Coatings' Uni-Tile Sealer LV, which is an NSF 61 approved, high solids penetrating epoxy.

After allowing the primer to dry, a strip of masking tape was applied along the bottom of the joint, creating a two-sided bond. The control joints were then filled, in a single application, with Elastuff 120 Mastic. The mastic was poured along the joint and levelled to the height of the adjacent concrete using a putty knife.

Once the Elastuff 120 Mastic had set, a strip of release tape, slightly wider than the width of the control joint, was applied over the top. The release tape created a slip-joint for the reinforced coating applied over the top to expand and contract as necessary.

On both the vertical and horizontal joints, the polyester reinforcement fabric was embedded into the first

Mastic application in the joints.

16 hours per day, with a crew of up to 80 people working two eight-hour shifts. Due to the extreme heat conditions through the summer, much of the coating application was done during the evening hours. High humidity conditions also created problems with the workers sweating into the uncured coating.

To prevent potential blistering, the workers were provided with headbands and wristbands to minimise this problem. In order to avoid potential problems associated with moisture contamination, Ghaida Al-Kuwait General Trading & Contracting Company also agreed with the General Contractor to suspend the coating application when the relative humidity exceeded 70 percent.

The coating work, which is scheduled for completion in the fourth quarter of this year, will involve a total of over 8000 gallons of Elastuff 120 Mastic, 42,100 gallons of Elastuff 120 Roller Grade and 2000 gallons of Uni-Tile Sealer LV Primer.

Several other water tanks have been waterproofed using Elastuff 120 for the State of Kuwait Ministry of Electricity & Water over the past six years, including some that have been fully coated using Elastuff 120 Sprays Grade. The spray grade requires heated, plural-component equipment, and is capable of achieving virtually unlimited film builds in a single, multi-pass application.

Enquiry: billm@unitedcoatings.com

coat of Elastuff 120 Roller Grade. A heavy coat of Roller Grade was first applied to the primed concrete. The polyester reinforcement was then rolled into the wet coating, using a brush or putty knife to work the fabric to ensure that it is completely saturated, eliminating any air pockets, gaps or wrinkles. Additional Elastuff 120 Roller Grade was then applied over the top of the saturated fabric so that it was completely encapsulated. A flat knife was used to level the coating on the horizontal joints, while a roller proved more effective on the vertical joints.

Elastuff 120 Roller Grade was manufactured with additional thickener for this project, which increased the vertical hold and enabled higher film builds. Once the reinforced coating layer was cured, one more coat was applied using a flat knife to the horizontal joints in order to achieve the specified 4 mm thickness. On the vertical joints, two additional coats were applied using a roller to achieve the required thickness.

The coating work was carried out

Overall waterproofing application.