COVER STORY:
CIVIL & STRUCTURAL ENGINEERING
Mixed development at Clementi Town Centre

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Prefabricating and precasting of structural components has become more and more common in the building and civil engineering / infrastructure projects, for several reasons.

By prefabricating and precasting of structural components offsite, in a controlled factory environment, their quality can be ensured and they can be produced faster and with less manpower; owing to the high levels of automation possible and because the prefabrication and precasting works will not be affected by the external weather conditions. Also, work on-site is reduced, requiring less manpower, thereby reducing on-site hazards as well as contributing to public safety and a cleaner environment, and minimising disturbance to the neighbourhood.

In this regard, the development of Integrated Construction and Precast Hubs, whilst intensifying the use of land, will lead to the integration of the production of precast components with prefabrication and other related construction activities, all within a multi-storey complex.

For a precast building project to be successful, there has to be a high degree of integration of the efforts of clients, architects, engineers, contractors and sub-contractors, and therefore all of them should be involved at an early stage in the project.

Facilitating such cooperation and thereby enabling the delivery of complex projects, safely and speedily, as well as cost-effectively and with high quality, is the adoption of Building Information Modelling (BIM). As a result, the information for designing, manufacturing, transporting and erecting precast components can be stored in a central 3D model and continuously updated.

The delivery of precast components to site is a challenge, due to heavy traffic, congested work sites and safety regulations governing transportation. This has to be addressed by careful planning and coordination among the various professional groups involved in the project.

Er. Dr Ho Kwong Meng
Chairman, Civil & Structural Engineering Technical Committee

The IES Council and Secretariat wish to extend to all IES Members, the Greetings of the Season and Best Wishes For a Happy New Year!

Er. Dr Ho Kwong Meng
Chairman, Civil & Structural Engineering Technical Committee
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CAFEO 31 concludes successfully

CAFEO 31, the 31st Conference of the ASEAN Federation of Engineering Organizations, which was held from 10 to 14 November 2013 at the Jakarta Convention Center, Jakarta, Indonesia, addressed the theme ‘Implementation of Green Infrastructure in ASEAN Countries’.

Ir. Heru Dewanto, Chairman of the 31st CAFEO Committee, hosted all the delegates at the Welcome Dinner and Conferment of AER Membership, held on the evening of 10 November at the Cendrawasih Room, Jakarta Convention Center.

The Guest-of-Honour at the CAFEO 31 Opening Ceremony was Dr Ir. Djoko Kirmanto, Public Works Minister, Indonesia.

The conference featured presentations of high quality technical papers relating to green environments, by speakers from different Southeast Asian countries, besides country updates from the secretaries of the engineering associations of each ASEAN nation.

The Institution of Engineers, Singapore (IES) was represented by Deputy President, Er. Chong Kee Sen; Honorary Secretary, Dr Boh Jaw Woei; Past Presidents, Er. Dr. Lee Bee Wah, Er. Chew Yong Tian and Er. Tan Seng Chuan; Council Members, Er. Ong See Ho and Er. Emily Tan; and IES CEO, Ms Angie Ng.

Er. Chong Kee Sen and Er. Emily Tan, representing IES, as well as representatives from other ASEAN countries, visited the Presidential Palace on 12 November, at the invitation of Indonesian President, Susilo Bambang Yudhoyono.

The closing ceremony concluded with the handing over of the flag to the representative from Myanmar, the host for CAFEO 32 in 2014.
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Forging a career in the technical sector with a Warwick master’s

Robert Stolz shares key take-aways from his MSc in Engineering Business Management programme at SIM Global Education. In January, he was promoted to Repair Engineering Manager at a major European aviation MRO and oversees his company’s repair development, shop engineering and infrastructure systems in the Aerospace Division.

Q Why did you decide to enrol in The University of Warwick’s Master of Science in Engineering Business Management?

The University of Warwick is well known and globally recognised. The Master’s programme provides a great combination of business, operations and technological-oriented modules. I was convinced that the curriculum and programme structure will prepare me for a future career path in the technical sector.

Q What do you like about your programme?

SIM GE has a unique collaboration with the Singapore Institute of Manufacturing Technology (SIMTech) and WMG, at the University of Warwick.

For this programme, there’s great administrative support, facility and infrastructure from SIM GE; access to comprehensive project-specific knowledge and industry-oriented mentorship from SIMTech’s academic supervisors; and extensive knowledge and support from WMG’s faculty.

Also, the part-time programme makes it possible for me to pursue a higher qualification while still working.

Q How has the programme structure helped you in your work-life balance?

The taught modules were well spaced out such that I can have family time as well. It also did not affect my regular working hours.

Q Which module(s) did you find most useful?

Each module was useful, as each had its own lessons which I could learn from. The modules provided best practices in academic approaches and strategies that equipped me with skills to solve issues in a bigger context. For example, at work it helps me with problem solving, where quick and rational decisions are often needed.

Q What are the hard/soft skills you acquired in your studies at SIM GE that is helping you in your career?

Group work during the modules gave me the opportunity to improve on my presentation skills. Being a part of an international cohort helped me to improve on my interaction with professionals of different nationalities, personalities and cultures, to solve problems and define roles of each individual. Only as a homogeneous group, were we able to perform and meet the objectives and timeline given by our tutor.

The Singapore Workforce Development Agency (WDA) is offering 70% course fee funding for 8 selected modules applicable to students taking the University of Warwick’s Engineering Business Management programmes. T & Cs apply.

For more information, visit www.simge.edu.sg

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Kuan BeeLan
Graduate, Class of 2010
Master of Science in Engineering Business Management
The University of Warwick, UK

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University Highlights
- Ranked 8th in The Times Good University Guide 2013
- Member of the prestigious Russell Group of Universities

Programmes Offered
- Master of Science in Engineering Business Management
- Master of Science in Supply Chain and Logistics Management
- Postgraduate Award in Engineering Business Management
- Postgraduate Award in Supply Chain and Logistics Management

Master’s programmes offered on full-time or part-time basis.
Postgraduate Award programmes offered on part-time basis.

Programme Highlights
- Projects are supervised by SIMTech, a research institute with strong industry links, to ensure relevance to the programme
- Full-time MSc students will be assigned project work by SIMTech to gain industry knowledge
- Postgraduate Award programmes to be completed in one year and modules may be transferred to the MSc programme
- 70% funding by WDA is available for the Engineering Business Management programmes. T&Cs apply.

UPCOMING EVENTS
Open House@SIM
Date: 14 & 15 Mar 2014
(Fri & Sat)
Time: 11am to 5pm
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Mixed development at Clementi Town Centre

HDB’s first mixed development, which consists of two 40-storey-high residential towers housing 388 units and a 5-storey commercial podium, also includes a two-level basement, multi-storey carparks and an air-conditioned bus interchange.

Among the accolades that this project has won are the HDB Housekeeping Award 2008 for outstanding housekeeping standards, the BCA Design & Engineering Safety Excellence Awards 2012 (Merit), the LTA Transport Excellence Award 2012, and the BCA CONSTRUCTION EXCELLENCE AWARD 2013.

STRUCTURAL SYSTEM TO MINIMISE IMPACT TO NEIGHBOURHOOD

Construction using precast technology is a ‘green’ and sustainable method of construction as less noise, dust and waste are generated. As most of the structural components are prefabricated off-site, less wet works are required and hence the impact of noise and dust on the surroundings is controlled.

CONCLUSION

Design and construction safety, as well as quality, were important considerations in this development. With proper planning and conceptualisation during the design stage, coupled with proper coordination and supervision of works, and implementation of safety measures on site, it was possible to complete a successful public housing high-rise development project with a zero fatal accident record, and to the satisfaction of the client, within a tight and densely populated site.

The builder was highly praised for efficiently rectifying the defects during the defects liability period.

The high workmanship standards were commended, with
had to comply strictly with the Land Transport Authority’s (LTA) Code of Practice for Railway Protection. Sensitivity studies on the effects of basement construction work on existing HDB blocks supported on footings were conducted and evaluated. Every design and construction effort was considered thoroughly before being utilised, to maximise efficiency as well as to create a safe working environment and increase buildability.

**STRUCTURAL DESIGN**

Due to the close proximity of the Clementi MRT and the need to comply with LTA’s Code of Practice for Railway Protection, the buildings were designed with the following objectives in mind:

- Creating a safe working environment
- Achieving optimal efficiency
- Achieving speedy construction

The basement wall was formed by a continuous closed ring of diaphragm wall panels with watertight joints. Diaphragm wall construction was adopted to prevent settlement issues for existing HDB blocks supported on footings, by cutting off potential ground water loss, and to create a safe, clean and water-free environment during construction. The top-down basement construction method was adopted, with the ground slab cast earlier to prop up the diaphragm wall, in order to stabilise and prevent diaphragm wall movement and settlement of existing blocks, as well as to speed up construction.
The basement floor structure system comprises piled rafts typically for Basement 2 and flat plates for Basement 1 and the 1st storey. These flat plates doubled up as strutting restraints for the diaphragm walls. A series of strutting beams were used at the ramp, down to the basement, during basement excavation works. An integral waterproofing admixture in the concrete design mix enhanced protection against water leakage in the basement slab, and increased construction productivity.

The commercial podium footprint covers the bus driveway and passenger concourse below. The column locations are spaced at regular grids. For the design of the podium, long span, post-tensioned beams were adopted, to span across the bus driveway. The beam depth was limited so that there was sufficient headroom, after taking into consideration the space taken up by M&E services/ducting. Precast prestressed planks were used to span over the beam supports and combined with cast-in-situ concrete topping, formed a rigid composite slab structure.
Typical block layout.

Blk 441A

(180° Rotated version of 4Room- Unit 01)

Blk 441B – Part A

(180° Rotated version of 5Room- Unit 03)

Blk 441B – Part B

(210° Rotated version of Part A)
In the design of the residential tower blocks, the approach was to adopt prefabrication and precast technology extensively, through modularisation and standardisation, to enhance the efficiency and speed of construction. The blocks and unit designs were repeated, hence facilitating high repetitive use of precast elements.

**BUILDING WORKS**

**Basement construction process**

As the development involved the construction of 12 m deep basements comprising two levels, rainwater sump and sewerage ejector pit, the excavation and construction works had to be executed in a safe manner to prevent damage to surrounding structures, in particular, the MRT station, the existing Blocks 442 and 443, and the surrounding roads Clementi Avenue 3 and Commonwealth Avenue West.

Before excavation for the basement works, diaphragm walls were installed around the site, in close proximity to the station, and ground movement was continuously monitored with various instruments and settlement markers. A combination of top-down and bottom up construction with soldier pile and strutting system was implemented for basement excavation works.

During the construction of the high-rise buildings, measures were taken to prevent damage to MRT structures and facilities, and the works were supervised closely by the site supervision team for the project. In order to safeguard the surrounding existing structures during basement works, clusters of instrument monitoring systems were installed around the site. Each cluster of instrumentation consisted of inclinometers, water standpipes, piezometers, tiltmeters, settlement markers and vibration sensors.

**First storey construction process**

The first storey was designed as a flat plate to support the suspended bus driveway, bus park and passenger concourse. Due to the tight site constraints, the first storey deck also served as a site access working platform during the construction period. Hence, the strategy was to cast the first storey deck first to facilitate access for site equipment, machinery and material transportation for construction efficiency.

**Podium construction process**

The podium was designed using post-tensioned beams and precast prestressed planks. Prestressed floor planks were used to span over the beam supports and, combined with cast in-situ concrete topping, formed a rigid composite slab structure. The use of precast planks reduced the need for extensive in-situ works such as slab formwork and propping works. Hence, construction cycle time was reduced.

Site access and movements.
Cluster of ground instrumentation and overall site excavation.
Precast technology for superstructure

The essential framing assemblage of the superstructure consisted of a high level of prefabrication which was adopted for buildability, ease of construction and high quality finishes. These were achieved by the following:

- Standardised design - Block and unit designs were repeatable, hence permitting high repetition of precast elements.
- Standardised precast elements - Permitted high repetitive use of moulds for precast elements such as household shelters, columns, beams, planks, external facades, staircases, refuse chutes, parapets and water tanks.
- Integration of precast components such as column/wall unit, canopy/facade unit, volumetric household shelter with integrated services.
- The use of prefabricated reinforcement cages.

The adoption of precast technology increased productivity and buildability. At the same time, it minimised materials usage and labour, and helped create a cleaner and safer working environment.

QUALITY IN DESIGN

The design procedure adopted by the Civil & Structural (C&S) project team complied with the C&S Engineer’s ISO requirements. It involved two stages of design reviews by a panel of Qualified Persons within the company. Stage 1 was carried out during the early part of the design phase, at which the design approach and the schematic framing system were presented and discussed. During this stage, the precast system and connection details were also reviewed. In Stage 2 of the design review, the panel reviewed the detailed drawings, to identify areas of improvement in the overall C&S design, taking into consideration the project’s buildability efficiency, constructability, safety and value engineering.

MODULARISING OF FAÇADE

In this project, the engineer worked closely with the architect to modularise the detailing for the façade windows, such that the details could be simplified and repeated.

PRECAST CONNECTIONS

Precast components were used extensively for the building envelope, particularly for the façade and gable end walls. Special attention was paid to the joints to ensure water tightness. A protection system, comprising backer rods, sealants, non-shrink grout and wet pour joints, was adopted to prevent leakage. As an added protection, internal waterproofing membranes were provided at the floor level, as a final barrier against the ingress of water. Functional tests were then conducted on these completed joints to verify the performance in terms of water-tightness.

Waterproofing details for precast joints.

Precast elements.
Precast planks, household shelters, columns, beams and walls.
COVER STORY

PRECAST COLUMN CONNECTIONS
Connections form the most vital part of precast concrete columns. The ingenuity of engineers, researchers and manufacturers has, over the years, resulted in the development of an extensive range of solutions. The performance of the connections must meet that of conventional cast-in-situ reinforcement, in terms of strength, ductility, creep, durability and fire resistance. In this development, the NMB Splice-Sleeve System was adopted.

PRECAST PRESTRESSED FLOOR PLANKS
Prestressed floor planks were used to span over the beam or column supports and, combined with cast-in-situ concrete topping, formed a rigid composite slab structure. The use of precast planks reduced the need for extensive slab formwork and propping works. Hence, construction cycle time was reduced.

DESIGN FOR SAFE OPERATIONS AND MAINTENANCE
During the design stage, future maintenance of the building was considered. As a result, several features were implemented in the design.

RC STUMPS AND ROOF FASCIA
The stumps and the roof fascia were designed to cater for the mounting of a gondola for future maintenance. This provision helps to ensure that future maintenance can be carried out in a safe and efficient manner.

Typical layout and cross-sectional view of floor planks.

Typical details of an NMB Splice-Sleeve.
INTEGRATION OF EXTERNAL COMPONENTS WITH FAÇADE
If external precast sunbreakers / canopies protruding out of the building, are cast in separate operations, there is a tendency for their edges to get chipped off. Sunbreakers / canopies in this development are integrated with the precast façade and erected as a whole component. External stainless steel clothes drying racks can corrode. Since they are located at height, it is difficult to check and maintain these components. Hence, there is a possibility that they may deteriorate over time and pose a potential hazard to the public. This problem was identified in the design stage and these components were specified to be hot-dip galvanized and cast into the precast façade panels.

PRECAST AND PREFABRICATION TECHNOLOGY
Production of precast components in a controlled precast plant environment allows for exact and good quality finished products. Hence, tedious and laborious plastering works were eliminated. This also helps to avoid the future maintenance problem of cracked and spalling plasters due to weathering. Also, by adopting prefabrication instead of cast in-situ elements, the risk of falling plaster debris from height is eliminated.

QUALITY AND SAFETY IN CONSTRUCTION

DESIGN MANAGEMENT TO ENHANCE SAFETY
Erection methods and construction sequence
The builder worked closely with the consultants to ensure delivery of this project within the scheduled time-frame, without compromising the quality of the works. The builder was made aware that precast construction requires advance planning and proper coordination with the precast supplier. All precast erection methods and work procedures were jointly reviewed with the consultants to ensure that a systematic way was in place for safe construction. A site quality control system, for both the pre-concreting and post-concreting stages, was also established, to ensure successful precast construction.

The precast components were delivered on schedule despite heavy traffic and site congestion.

Workers utilised the full netting, climbing scaffold system, to improve safety and speed of construction.

QA/QC TESTING AND MONITORING
The full-time site supervisory staff consisted of two Resident Engineers and four Resident Technical Officers.

An in-house Standard Operating Procedure (SOP), which provides a step-by-step supervision process, was issued to the Qualified Persons and Resident Engineers, for proper and efficient site supervision. Comprehensive in-house checklists and inspection forms were used on site. These formed part of the Quality Assurance System to enhance quality and safe construction.

Testing of materials was carried out strictly according to the specifications. Samples of the construction materials were selected by the supervisory staff for testing, and test reports were assessed to ensure compliance with the relevant standards and specifications.

The builder was required to carry out a detailed risk assessment and demonstration on every work method, in all stages of the construction process, to identify and mitigate probable construction risks. A safety officer was deployed to conduct and monitor safety practices on site.

Health and safety management was always emphasised during construction. Some of the provisions for site health and safety management are as follows:

- Weekly meetings between builder and consultants.
- Regular safety briefings conducted to address and discuss site safety issues.
- Weekly housekeeping and safety checks.
- Daily tool box meeting carried out by the builder before work commences.

With the full cooperation from the builder and subcontractors, this project achieved zero fatal accidents and zero demerit points, and there were no stop-work orders.

PUBLIC SAFETY

TRAFFIC PLANNING
Traffic planning, for the benefit of the public, included the provision of a side-covered walkway to handle heavy human traffic from Clementi MRT to the traffic junction outside the temporary bus interchange.

ENSURING A CLEAN ENVIRONMENT
During the construction stage, measures were taken to minimise the impact of construction activities on the surrounding environment. The measures included the following:

- Controlling emissions into the air through, for example, the use of newer equipment / plants; the use of electrical, hydraulic or petrol-driven rather than diesel-driven equipment / plants; and regular maintenance and servicing of equipment / plants.
- Controlling noise emissions through, for example, the use of newer equipment / plants; the use of electrical, hydraulic or petrol-driven rather than diesel-driven equipment / plants;
regular maintenance and servicing of equipment/plants; control of the working hours; and positioning of temporary structures such as site offices to serve as noise barriers.

• Controlling the discharge of effluents into surrounding land, water courses or public drains through, for example, implementing a comprehensive earth control system which includes minimising exposed earth, covering exposed earth with canvas or concrete, constructing perimeter cut-off drains and silt traps to reduce silt in the effluent before discharge, and the use of containment tanks for storage of hazardous fluids such as diesel.

• Controlling the generation of wastes through, for example, implementing just-in-time material delivery, providing proper storage to reduce damage, and controlling the quality of in-process work to avoid rectification or re-work.

• Controlling pests such as rodents, mosquitoes and flies, through a comprehensive system of regular housekeeping, inspections and follow-up remedial actions.

STRUCTURAL SYSTEM TO MINIMISE IMPACT TO NEIGHBOURHOOD

Construction using precast technology is a ‘green’ and sustainable method of construction as less noise, dust and waste are generated. As most of the structural components are prefabricated off-site, less wet works are required and hence the impact of noise and dust on the surroundings is controlled.

CONCLUSION

Design and construction safety, as well as quality, were important considerations in this development. With proper planning and conceptualisation during the design stage, coupled with proper coordination and supervision of works, and implementation of safety measures on site, it was possible to complete a successful public housing high-rise development project with a zero fatal accident record, and to the satisfaction of the client, within a tight and densely populated site.

The builder was highly praised for efficiently rectifying the defects during the defects liability period.

The high workmanship standards were commended, with two-thirds of occupants providing a rating of ‘Very Satisfied’ for the construction work done.

PROJECT DATA

Project
Mixed development at Clementi Town Centre

Site area
1.66 ha

GFA
88,629 m²

GFR
5.3

Description
Two blocks of 40-storey residential buildings (total 388 units) and a five-storey podium block with commercial facilities, library, carparks, bus interchange and two levels of basement.

Duration of work
November 2006 - May 2011

PROJECT CREDITS

Client
Housing & Development Board (HDB)

C&S Engineer
Surbana International Consultants Pte Ltd

Architect
Surbana International Consultants Pte Ltd

M&E Engineer
Surbana International Consultants Pte Ltd

Builder
China Construction (South Pacific) Dev Co Pte Ltd

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Singapore Sports Hub

Dragages Singapore, a subsidiary of Bouygues Construction and a member of SHPL, the developers of the project, is currently building the state-of-the-art integrated sports and leisure complex.

Located on a 35 hectare site, only 15 minutes from Changi Airport, the Singapore Sports Hub is the largest sports infrastructure Public-Private-Partnership (PPP) project in the world. In line with the Singapore Sports Council’s Vision 2030 master plan, the Singapore Sports Hub will offer a unique opportunity and access to live better through sports. It will be a platform for national athletes to hone their sporting talents and inspire participation in sports among the community.

Work began on the project in September 2010, with scheduled delivery 43 months later, in April 2014. The work, which is carried out entirely by Dragages Singapore, involves up to 4,000 employees.

SCOPE OF PROJECT

The Sports Hub project covers the design, financing, construction, maintenance and operation of an integrated commercially viable, world-class lifestyle hub for sports and entertainment in the heart of Singapore, to replace the old National Stadium built in 1974. It comprises:

• Demolition of the existing stadium.
• Construction of a stadium with a retractable roof (capacity up to 55,000 seats) and a bowl cooling system.
• Development of a 3,000 seat-capacity indoor world tournament standard Aquatic Centre, expandable to 6,000 seat-capacity for specific events.
• Development of a Water Sport Centre.
• Development of a 3,000 seat-capacity Multi-Purpose Indoor Arena which will be fully scalable and flexible in layout.
• Development of offices for the national, international and regional sports federations as well as a museum and a sports library.
• Development of 41,000 m² of commercial retail space.
• Take-over of the 13,000 seat-capacity Singapore Indoor Stadium.
• Maintenance and operation of the facilities for 25 years (including the construction period).

METHODS AND STRUCTURAL OPTIONS

The structure of the project is challenging with a broad variety of different structural elements, a complicated geometry with grid lines radiant in one direction and curved in the other, various heights between floors, and high ceiling heights and bays, which
are all different. The project has also to be delivered with a large proportion of high quality, fair-face concrete surfaces.

To meet these challenges, Dragages Singapore had to develop flexible solutions, including the use of:

- Specially made formwork.
- Cast in-situ main beams poured on ‘table forms’.
- Hollow core slabs as well as precast beams and precast planks, for the slab structure.
- Precast for other structural elements such as stairs, bleachers, planters and façades.

Due to the complexity of the project, about 600 method documents (excluding the revisions) have been issued since the beginning of the work.

THE WORLD’S LARGEST DOME ROOF

Steel roof structure

The new National Stadium is crowned by a 312 m diameter, spherical steel dome roof. The roof rises to a height of approximately 82 m from pitch level and spans across the bowl seating, with no support taken from the concrete superstructure.

The roof has an opening which is approximately 200 m (length) by 82 m (width), over the football pitch and athletic tracks. The retractable roof will partially cover this opening in the closed position.

The roof is supported on a post-tensioned concrete ring beam on the 3rd storey of the bowl structure, which acts to restrain the roof from spreading.

The dome-shaped structure is made of 3D triangular trusses fabricated from circular hollow sections, with a variable depth, from 2.5 m at the base nodes to approximately 5.0 m at the centre of the dome.

Retractable roof mechanism

It is now relatively common for stadiums to feature retractable roofs, to provide protection against inclement weather and support the programmatic requirements of multipurpose arenas.

The new National Stadium will, however, be unique, with its many innovative structural and architectural elements. Here, there are two spherically shaped, retractable roof segments, each weighing 1,100 tons. Each segment consists of a steel structure frame; a roof covering made of translucent ETFE cushions, over an area of 10,000 m²; a perimeter aluminium bullnose; and mechanical equipment needed to move it. The roof segments are supported on 40 bogies which are driven up or down sloped tracks on a spherical surface, in 20 minutes, by 16 cable drums mounted inside the retractable roof structure and activated by electrical motors. In the open position, the average slope is 20°. This results in a maximum pulling force of 360 tons per panel, to overcome the gravitational and wind effects. Supported on linear bearings installed on the top of the bogies, the moveable roof structure can absorb horizontal relative movements of 500 mm.

Safety

A combination of just three independent failures on critical safety components would lead to an unacceptable situation. Accordingly, a highly redundant system, with a multitude of fail-safe supports and control devices, has been provided. In addition to the brakes installed directly on the winch drums, the bogies will be equipped with rail clamps that will stop the roof in less than 150 milliseconds when it is driven at its maximum speed.

As an ultimate protection, end-stops and buffers will be provided at both the top and the bottom of the travel paths of the retractable roof panels.

A multitude of parameters will be instantaneously monitored and transferred from a central command room located in the bowl structure, to the control command system designed to operate the roof and troubleshoot.

Reliability

A minimum of 25% redundancy on the drive system and a design life of 60 years for components that cannot be replaced within a 12 hour maintenance window, ensure that the roof can be opened and closed at all times.

Specific access and hoisting equipment have been designed and installed within the moveable roof structure, for inspection,
maintenance and replacement of any part of the mechanism, 80 m above the pitch.

**Fabrication and erection**
The roof packages for the National Stadium are technically complex. Therefore, Dragages had to hire specialised staff with strong expertise in their fields. Their expertise was beneficial at all stages - design, procurement, and construction. Package managers were involved from the commencement of the design, which brought true added value. Dragages was therefore able to select the right options to minimise technical and financial risks for the project. This also helped reduce technical ‘grey’ areas when awarding major subcontracts.

The fabrication and erection contract was awarded to the leading Singapore steel fabricator Yongnam Engineering & Construction Pte Ltd.

The trusses were prefabricated in the workshop, transferred to site by road, assembled in sections of maximum 70 m (length) and 160 tons (weight) before being lifted with 600 ton crawler cranes. Primary trusses were supported on temporary supports before the dome structure was formed and the loads transferred to the ring beam.

On 1 September 2013, the loads resting of the last eight main temporary supports used for construction were removed simultaneously with 16 hydraulic jacks of 150 ton capacity, by VSL, a leader in the field of special construction systems and related engineering.

The roof is now acting fully as a structural dome with all the compression in the roof trusses transferred to the post-tensioned concrete ring beam.

**CLADDING**

**ETFE cladding**
A total of about 20,000 m² of inflated ETFE (Ethylene Tetra Fluoro Ethylene) cushions will be clad on the moveable roof of the National Stadium. ETFE is light (weighing less than 1.5 kg/m² including framing) and is able to stretch up to three times its length without loss of elasticity. By varying the thickness, layers and prints on the ETFE cushions, the following project specifications can be met:
- Solar Transmittance < 8%
- Light Transmittance > 4% but < 20%

The main challenges for the cladding system are having to accommodate the structural movements occurring when opening and closing the roof, being able to achieve the desired lighting levels, and also being able to project the Singapore Flag on the ETFE cushions.

**Fixed-roof cladding**
The fixed roof cladding for the National Stadium will cover an area of about 53,000 m² and will comprise 34,500 m² of a unitised aluminium standing seam roof system, 17,500 m² of recessed flat aluminium panels and 1,000 m² of aluminium grillage. The roofing system will be PVF2 coated and will also include perforated structural decking at specific locations for acoustic performance. The recessed cladding areas will have lights incorporated to express the diagonal trusses at night. The roofing system will also have a fall arrest system installed for ensuring safety during future maintenance work.

The main challenges in the construction of the roof are to achieve the desired curved dome geometry with the various systems, the
large amount of interfaces to finish, and the co-ordination with the main steel contractor for the required steel brackets.

**PTFE cladding**
A total of about 18,000 m² of giant PTFE (Poly Tetra Fluoro Ethylene) louvres cover the lower portion of the National Stadium. These louvres shelter the sports promenade area from rain and the glaring sun. Also, due to the unique properties of PTFE, sufficient ultraviolet light is transferred for the growth of plants beneath.

**PROJECT CREDITS**

**Project**
Singapore Sports Hub

**Developers**
The Singapore Sports Hub Consortium, incorporated as Sports Hub Pte Limited (SHPL), and comprising:
Dragages Singapore - Lead Partner / Design & Build Contractor
InfraRed Capital Partners - Majority Equity Partner
Global Spectrum Pico Pte Ltd - Equity Partner / Venue Operator
DTZ - Equity Partner / Facility Manager
World Sports Group - Commercial Rights and Sports Programming Partner

**Design team**
Arup - Sports Venue Design and Engineering
DP Architects - Master Plan and Non-Sport Architecture
AECOM - Landscape Design

All images by Singapore Sports Hub and Dragages Singapore
The engineering and construction highlights of the Ocean Financial Centre project include its emphasis on environmental management and occupation health & safety management, as well as the achievement of high construction quality.

INNOVATIVE DESIGN AND PRODUCTS

Caisson piling
The adoption of caisson piling instead of bored piling resulted in a reduction in the use of rebar and the achievement of higher quality and capacity.

Prefabricated tubular bar chair
The use of prefabricated tubular bar chairs for the raft foundation helped to reduce manpower requirements, save time and minimise safety hazards.

Post-tensioned beams and slabs
Post-tensioned beams and slabs contributed to a reduction in the amounts of concrete and rebar required.

Prefabricated rebar cages
The incorporation of prefabricated rebar cages as reinforcement enabled construction to proceed to the next stage, immediately after casting the slab. It improved productivity and reduced wastage.

Tie-back rods
Tie-back rods eliminated transfer beams and provided more headroom at the core.

Prefabricated metal formwork for staircases
Prefabricated metal formwork was used for the construction of the staircases. This system eliminated the need for formwork for the risers, which would have been necessary under the conventional system.

Self-auto-climbing formwork
By using self-auto-climbing formwork for the construction of columns and core walls, productivity was increased.

Self-auto-climbing safety screen
A self-auto-climbing metal safety screen protected the workers and the perimeter of the building, at all times. The self-climbing system helped to achieve seven-day floor cycles.

Table form lift
The installation of a separate table form lift eliminated the hazardous operation of hoisting table formwork using a hanging stage, thereby improving safety. It also freed up tower crane hook time.

Ocean Financial Centre
The project won the BCA Construction Excellence Award at BCA AWARDS 2013. It also garnered the Green Mark Platinum Award at BCA AWARDS 2008, as well as the MOM SHARP Award 2011 & 2012, the Keppel Land Safety GOLD Award 2009, 2010 & 2011, and the Keppel Group Safety Innovation Award 2009, 2010 & 2011.
Unitised glass curtain wall
The specification of a unitised glass curtain wall and installing it using a monorail system freed up tower crane hook time.

Tower crane tip camera
A tower crane tip camera enabled the crane operator to monitor the hoisting pathway and thereby lessened the safety hazards.

ENVIRONMENTAL / OH&S MANAGEMENT PROGRAMMES
The environmental / occupational health & safety hazards and risks onsite were first identified. These included noise and water pollution.

Necessary measures were taken to ensure environmental / occupational health & safety.

The adoption of caisson piling instead of bored piling, helped to reduce water consumption and muddy water discharges as well as CO₂ emissions. Other actions included installing noise meters for real-time measurements, incorporating earth control measures with real-time monitoring, vibration monitoring, adopting a fall protection plan, as well as organising in-house training for workers and holding daily toolbox meetings and safety inspections.

Temporary pedestrian access was provided and it did not cause an interruption of traffic during the construction stage and during the power and water supply connection stages.

As a result of good environmental management and occupation health & safety management, the project was completed safely and on time.

CONSTRUCTION QUALITY
Quality management programme
Quality Control was strictly implemented throughout the construction period. Quality Assessment / Quality Control issues were highlighted to subcontractors during the daily Sub-con Coordination Meeting, so that they could follow up and rectify the non-conformities.

Weekly meetings were attended by the client, project manager, consultants and builder, and regular site inspections were carried out, and these assisted the builder to manage Site Quality Control.

The root causes of internal non-conformities and feedback were analysed, in order to prevent re-occurrence of these issues.

Defects management programmes
Full-time staff were deployed during the construction and finishing period and during the defects liability period, for both building works and M&E works.

PROJECT DATA
Project
Ocean Financial Centre

Construction Period
February 2008 to March 2011

Site Area
6,109 m²

Building Area
1,293.45 m²

Floor Area (GFA/CFA)
94,056.75 m² / 119,725.50 m²

PROJECT CREDITS
Client
Ocean Properties LLP

Project Manager
Keppel Land

Design Consultant
Pelli Clarke Pelli Architects (USA)

Architect
Architects 61 Pte Ltd

Structural Engineer
Parsons Brinkerhoff Pte Ltd

M&E Engineer
Parsons Brinkerhoff Pte Ltd

Quantity Surveyor
Davis Langdon KPK (Singapore) Pte Ltd

Builder
Obayashi-Woh Hup Joint Venture

All images by Keppel Land
Digital Delta - a new wave of technology
by Suzanne Sweerman, Executive Director, South East Asia, Netherlands Foreign Investment Agency (NFIA), Singapore

By 2050, most of the world’s population will live in urban deltas. How do we face the many water challenges that will arise within these urban areas?

Urban settlements along the sea have been important concentrations of cultural, economic, and population growth for millennia. Today, some of the world’s largest megacities and suburbs, with growing populations of more than 10 million, are also those most vulnerable to rising sea levels. Over the next half century, urban coastal communities around the world will face a new reality, of dangerously amplified security risks, loss of life, and economic destruction from climate-change-induced flooding and storm surges.

Climate change combined with rapid population increases, economic growth and land subsidence could lead to a more than nine-fold increase in the global risk of floods in large port cities, between now and 2050, according to a study published in the journal ‘Nature Climate Change’, in August 2013. Coastal flooding in cities around the world could cause damage totalling US$ 1 trillion annually, by the year 2050, if no mitigating steps are taken, the study reports. Almost all cities facing the worst damage are in Asia and North America.

The cities ranked ‘most at risk’ today, as measured by annual average losses due to floods, span developed and developing countries, and include Guangzhou, Miami, New York, New Orleans, Mumbai, Nagoya, Tampa-St. Petersburg, Boston, Shenzhen, Osaka-Kobe, and Vancouver.

Many countries in Europe are at or below the sea level, and could face sea level rises of a metre or more by the end of the century when storm surges are factored in. A mix of melting ice sheets, warming oceans, storm surges and other drivers, means places such as Sheerness, at the mouth of London’s Thames river, face rises reaching just under 1 metre by 2100. Denmark’s seaport of Esbjerg could experience even higher rises of up to 1.15 metres, according to a four-year programme of study by scientists from 24 leading EU institutions, known as Ice2Sea. The EU-funded research indicates that sea level rises are likely to differ around the world, sometimes by tens of centimetres. The overall increase around European coastlines is expected be 10% to 20% less than the global average, though regional variations mean some parts face much higher rises.

In Asian as well as other global cities, rapid urbanisation has led to settlements of floodplains, resulting in widespread vulnerability of livelihoods. Since traditional approaches are no longer sufficient, a more integrated flood management approach is needed.

The Dutch are, of course, no strangers to floods and are seen worldwide as experts on water management. Their innovative flood control and management systems have proven to be important models for other countries around the world to follow. The country is home to the Maeslantkering, the world’s largest storm surge barrier, located on the NieuweWaterweg (New Waterway) canal between the towns Hoek van Holland and Maassluis, and built to protect the Port of Rotterdam.

Delta Works, a series of dams and storm surge barriers, and Zuiderzee Works in the north, comprising a man-made system of dams, land reclamation and drainage works, are considered to be among the seven modern engineering wonders of the world.

An integrated approach

With 55% of the Dutch population living in areas prone to large-scale flooding, the Netherlands has immense experience in preventing floods and managing water. The Netherlands
is renowned for its integrated water management and multi-disciplinary approach that balances social, economic, environmental and engineering needs. The country invests heavily in innovation and R&D through public-private partnerships that align the interests and resources of government, business and research partners. These include renowned institutes such as Deltares and Wetsus. Large Dutch private firms are also recognised for their cutting-edge R&D.

In the Netherlands, there is strong institutional support and active public-private cooperation that focuses on international cooperation and the creation of water networks. The Dutch government is party to several bilateral agreements to advance integrated water management in countries across the globe. Ongoing projects include the sustainable development of low-lying urban agglomerations such as Jakarta and Bangladesh, and coastal development in areas such as Dubai, Vietnam and Romania.

Flood protection and climate change remain important issues for the Dutch. While the country seems to have the situation relating to flood protection, well under control, it is already looking to the future to determine the next phase of action.

Harnessing Big Data

While the construction of the Maeslantkering may have been one of the high points in the Netherlands’ traditional water management strategy, the annual test closing of the barrier, which seals the entrance to Europe’s busiest port, costs up to 30 million Euros (US$ 40 million). The spiralling costs have prompted the Dutch to think deeper, in order to come up with new solutions, and they may just have.

Earlier this year, IBM announced the launch of ‘Digital Delta’ in the Netherlands. The break-through innovation programme will harness insights from Big Data to transform flood control and the management of the entire Dutch water system. Collaborators for the project include Rijkswaterstaat (Ministry of Infrastructure and the Environment), local Water Authority Delfland, Deltares Science Institute and the University of Delft. The organisations involved will explore effective information-sharing platforms, and the use of intelligent re-use of ICT applications that can bring improvements to water management in the Netherlands.

Digital Delta is a 12-month research programme investigating how to integrate and analyse water data from a wide range of existing and new data sources, in order to reduce the cost of future water projects by 20% to 30%. These include precipitation measurements, water level and water quality monitors, levee sensors, radar data, model predictions as well as current and historic maintenance data from sluices, pumping stations, locks and dams.

At Digital Delta’s core is an intelligent, cloud-based system built on IBM’s Intelligent Water software and Smarter Water Resource Management solution as well as consulting expertise. Every water-related event in the Netherlands is critical and can impact businesses, agriculture and citizens’ daily lives. The ongoing cost of managing water, including anticipating flooding, droughts and low water levels, adds up to 7 billion Euros (US$ 9.3 billion) each year. These costs are expected to increase 1 billion Euros to 2 billion Euros (US$ 1.3 billion to US$ 2.6 billion), by 2020, unless urgent action is taken.

The new management system will address concerns ranging from the quality of drinking water and the increasing frequency and impact of extreme weather-related events to the risk not only of floods but also of droughts. By modelling weather events,
the Netherlands will be able to determine the best course of action including storing water and diverting it from low-lying areas, as well as the best way to avoid saltwater intrusion into drinking water, sewage overflows and water contamination.

**Smarter water management**

Despite having one of the best-monitored water systems in the world, relevant data can be difficult to find, data quality can be uncertain and with data in many different formats, this creates costly integration issues for water managing authorities. Solving these Big Data challenges is an important step towards a smarter water management approach.

Digital Delta will provide water experts with a real-time intelligent dashboard to harness information, so it can be shared immediately across organisations and agencies. Using data visualisation and deep analytics, these insights can help prepare for imminent difficulties, enabling authorities to coordinate and manage response efforts and, over the longer term, to enhance the ongoing efficiency of overall water management. With better-integrated information, water authorities will be able to prevent disasters and environmental degradation, while reducing the cost of managing water by up to 15%.

The initiative will combine data and technology from several new and existing water management projects:

- **The Delft University of Technology** will use IBM’s Intelligent Water software to access weather predictions, real-time sensor data, topography and information about asset service history to make more informed and timely decisions on maintenance schedules to save costs while preventing flooding of tunnels, buildings and streets.

- **Rijkswaterstaat** and local water authorities will manage water balance data and share the information centrally through the Digital Delta platform, making it possible for the Dutch water system to optimise the discharge of water, improve the containment of water during dry periods, and prevent damage to agriculture.

- **HydroLogic Research**, IBM and the Delfland Water Board will develop a scalable early flood warning method, through integration of a large amount of real-time measurement data from the water system as well as weather information and water system simulation models.

- **Next Generation Hydro Software** facilitates the numerical modelling of rivers, seas and deltas, but requires access to large volumes of data found in multiple formats. The Digital Delta initiative will solve this problem by maintaining a catalogue of frequently used data and converting data formats to a standardised form, thereby providing a unified view of the data needed to make more accurate predictions.

Aggregating, integrating and analysing data on weather conditions, tides, and levee integrity will provide the Dutch government with detailed information to help protect its citizens and business, as well as homes, livestock and infrastructure.

The implications for this work are global, as cities around the world move swiftly to adopt smarter solutions to better manage the water cycle. With this innovative collaboration, IBM is demonstrating the power of Big Data, analytics and optimisation to better manage water quality, flood risk and drought impact, while also stimulating new innovations in this crucial area of technology.

As flooding is an increasing problem in many regions of the world, the Digital Delta project in the Netherlands can serve as a replicable solution for better water management anywhere.

(The Netherlands Foreign Investment Agency (NFIA), based in Singapore, is an operational unit of the Dutch Ministry of Economic Affairs. The agency assists foreign companies planning to establish, expand and/or diversify their business operations in the Netherlands and Europe.

More information on innovative water solutions and investment opportunities in the Netherlands can be obtained from NFIA, by contacting Ms Suzanne Sweerman, Executive Director, South East Asia, at Tel: +65 67391135, Email: sweerman@nfia-singapore.com or Ms Adeline Tan, Senior Project Manager, at Tel: +65 67391137, Email: tan@nfia-singapore.com or by visiting www.nfia-singapore.com).
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Because we learnt more, did more and achieved more in Polytechnic. For us, there’s only one university that sees more in us. For us, there’s only one university, where everything falls into place. That’s why we’re with SIT, Singapore’s fifth University.
BIM for infrastructure

Autodesk InfraWorks software helps to create civil infrastructure design models quickly and easily, which, in turn accelerates the design process and enhances understanding of project constraints for better decisions. The software can also be used to generate data-rich proposals to better predict how design alternatives may perform in the existing environment and to more effectively communicate with stakeholders.

Design software company Autodesk has been engaged directly in the development of Building Information Modelling (BIM), driving initiatives across the world, in private and public organisations, to improve efficiency, transparency and productivity across project and building life-cycles. As a model-based process, BIM enables the exploration of the physical and functional characteristics of projects, throughout their life-cycle. Although the whole concept started with buildings, today it is not confined to this space.

Over the last 10 years, since the word ‘BIM’ was coined, there has been a lot of enrichment of the concept itself, coming both from the industry and from companies like Autodesk, resulting in vast amounts of information being made available to stakeholders.

Through its InfraWorks product, Autodesk has extended the concept of BIM over a much larger scale, to include infrastructure, urban planning and land development, as well.

“About four or five years ago, we started looking at what we currently have as our BIM technology on the building side, and then what it would take to reimagine what it might look like for infrastructure. So we really set out with some existing technology and then with the inclusion of some of the newer technologies around, we started to reimagine the delivery of infrastructure”, said Mr Paul McRoberts, Vice President, Infrastructure Collaboration Products, Autodesk Inc, who is based in Boston, USA.

Mr McRoberts highlighted the challenges due to the crumbling infrastructure in the developed countries and the demand for new infrastructure in the emerging economies. In both cases, the problems are the same - time and cost over-runs, not just due to materials and labour but also on account of other complexities that have to do with land ownership, land use, environmental concerns and other issues surrounding these types of projects.

“We started looking at some of the fundamental things that we could be doing differently and that could help to accelerate the whole idea of infrastructure planning and take this to a whole different level. We found that there are a lot more constituents in the infrastructure space than, for example, in the building and manufacturing spaces. In the infrastructure space, we have to take into consideration, agencies, the public, government, land use, and ownership”, he said.

“So tackling this idea of ‘big’ was a very important part for us - big projects and big data. There is also the idea of ‘big reach’, as we have millions of people who want to know about these projects that are going on. We looked at this and said it is not just bits and bytes, it is different types of information. We have information on physical aspects, such as land masses, and on non-physical aspects, such as the taxes associated with the land masses”, Mr McRoberts continued.

There is an aggregate of data that have to be absorbed, including high resolution photogrammetric images and point clouds created from LiDAR data. When the point clouds are layered with the photogrammetric images, true views of the project environments are obtained, not just at the pixel level but at the actual location level, which is critically important. And there is additional digital information, such as on the weather conditions.

With the help of Autodesk’s InfraWorks, models can be created by visualising data from a database, with each feature ‘geolocated’, that is, each building or structure is positioned at its correct location. With these ‘true view’ building models, various types of analyses can be done, such as floor-by-floor vacancy analysis or floor-by-floor hazard analysis.

Modelling existing cities, using InfraWorks, enables utility companies, for example, to know what is underneath the ground, so that they can coordinate construction activities, as well as share this information with other stakeholders.

A hydrodam project in China, employing 160,000 people, will deliver water from the south to the north of China. When completed, it will benefit 200 million people who therefore might want access to information on the project.

CAD, GIS, photogrammetry and some LiDAR data are all put together to help understand how the construction of the hydrodam might take place.

“It is not tens and twenties, it is not the hundreds, at some point, we have to get to millions of people who want access to this
data. We are not just thinking big data, we are thinking about a lot of people, a lot of complex environments, and big areas and types of applications that have to be addressed, as well”, said Mr McRoberts.

**Mobile access to information**

With the increasing popularity of mobile devices, the idea is to enable people to view the model on products such as the iPad. “This is where we see this going. In the past, people might get on the phone and call somebody up. What we envision is being able to respond to this in a more collaborative way”, said Mr McRoberts.

**Creation of proposals**

Another application of InfraWorks is in the creation of proposals, using all the data that is available. It is possible to share data or combine proposals. Several people can work from the same database and data structure, at the same time, using one model, and create proposals and visualisations of what the project might look like.

In the traditional CAD environment, people are creating multiple files, sharing them and trying to merge them. For example, in the design of an 80 mile stretch of road, using CAD products, the road would be divided into 80 different segments and it would be layered with analyses that have to be done and with visualisations, resulting in hundreds of files for a single project. “We looked at that and said there is going to be a better way of doing this. If we want to convey what is actually going on in a project, we can create a model and create a ‘storyboard’ around it, within the InfraWorks environment”, said Mr McRoberts.

**Creating new infrastructure**

Using InfraWorks, it is possible to create not only digital environments from existing data, but also new cities, just as quickly, in order to get a grasp of what the future is going to look like, in the context of today. In addition to placing buildings, infrastructure can be sketched in and design rules can be applied to create the actual geometries.

**Construction and management**

The data provided by the models created with InfraWorks is useful for the construction phase and also for the management of the assets. “InfraWorks is really a re-definition of large-scale BIM in the area of infrastructure, leveraging the best of CAD and GIS in the world. It provides a view of what the future looks like in the context of what the world looks like today. It helps to manage the real world today and design for the future, in both emerging and complex urban environments”, said Mr McRoberts.

*InfraWorks is a model-based design tool.*

*InfraWorks makes it possible to communicate visually rich proposals.*
One development over three sites

In Levallois, to the north-west of Paris, in France, a large urban area of around 100,000 m² has had a facelift. A large building, the Courcellor II Tower, has been restructured and a new shopping centre and underground car-park have been built. Mapei products contributed to the successful completion of this technically challenging project.

A 24-storey facelift

In this area, known as SoOuest, green parks and modern buildings interact in perfect harmony.

The Courcellor II Tower, with 24 floors including three below ground level, is a building typical of the 1960s and 1970s. Since there was asbestos in the load-bearing structure, it had to be completely restructured. The structure of the building was rebuilt in concrete and the top four floors were demolished and rebuilt, just like the floors from the third floor below ground level up to the fifth floor were all rebuilt with reinforced cement. The central body of the building was also involved, with the lift shaft and stairwell rebuilt to comply with current legislation.

To repair the deteriorated concrete, the compensated-shrinkage thixotropic mortars PLANITOP 400 F, PLANITOP 450 and MAPEGROUT T60F were applied on the piles, beams and stairs. These products comply with CE EN 1504-3 standards and are marketed in France by Mapei France. The corresponding products on the international market are PLANITOP 400 and MAPEGROUT T60.

The light cracks in the concrete were then filled by injecting EPOJET epoxy resin, while the larger cracks were filled with EPORIP epoxy adhesive. In some areas, where steel and concrete elements needed to be sealed, MAPEFILL F fluid expansive anchoring mortar, compliant with CE EN 1504-6 standards, was used (its corresponding product on the Italian market is MAPEFILL). To make the internal and external walls flat and guarantee a perfectly smooth surface, the levelling mortars NIVOPLAN and NIVOPATE in powder and paste form were applied (the latter product is produced and
SoOuest: the new ‘urban chic’ shopping centre

Next to the Courcellor II Tower, today there is the new SoOuest shopping centre, with an area of 53,000 m², making it one of the largest to the west of Paris. There are 102 boutiques and a Leclerc hypermarket covering an area of 15,300 m². In the access area for the fork-lifts, ULTRATOP STANDARD self-levelling, ultra rapid-hardening mortar (available on the French market) was used for the flooring. It was chosen for its high resistance to abrasion, which makes it particularly suitable for the intense traffic encountered in industrial and commercial areas. Some of the structures under the escalators also had to be strengthened, and Mapei’s carbon fibre-reinforced polymer (FRP) systems were chosen for this purpose. Light and resistant to corrosion and tensile forces, these systems are an efficient substitute for traditional metal reinforcement. The intervention started by applying MAPEWRAP PRIMER I two-component epoxy primer, followed by MAPEWRAP 11 epoxy grout. As a result, the porosity of the concrete substrate was evened out and imperfections in the surface were smoothed over. MAPEWRAP C UNI AX 300 mono-directional carbon fibre fabric was then overlaid and the various layers were bonded using MAPEWRAP 31 adhesive. To withstand the supplementary flexural stresses, CARBOPLATE pultruded carbon fibre sheets were also installed.
Underground carpark
A three-storey underground carpark was built under the shopping centre. To cover the lift well and waterproof the structure, IDROSILEX PRONTO cementitious mortar was chosen, while LAMPOSILEX ultra rapid-setting and hardening hydraulic binder was used to instantaneously block infiltrations of water which are often found in walls below ground level. Lastly, to guarantee the flatness and create a perfect finish, the compensated-shrinkage, thixotropic mortars PLANITOP 400 F and PLANITOP 450 were applied.

INTERVENTION BY MAPEI
Period of Intervention
September 2011 - April 2012
Contribution by Mapei
Supply of products to repair and smoothen concrete, reinforce structures, seal, waterproof, block water infiltration and level-off substrates.

Mapei Distributor
Triomat, Villeneuve le Roi, France
Applications for Mapei Products
Filling cracks - EPOJET, EPORIP
Repairing concrete - PLANITOP 400 F, PLANITOP 450, MAPEGROUT T60 F
Sealing - MAPEFILL F
Preparing substrates - NIVOPATE F, NIVOPATE G, NIVOPLAN F, NIVOPLAN G, MAPECEM PRONTO, PLANICRETE LATEX, PRIMER G, ULTRAPLAN MAXI
Waterproofing - IDROSILEX PRONTO, LAMPOSILEX
Structural reinforcement - CARBOPLATE, MAPEWRAP
Flooring - ULTRATOP STANDARD

PROJECT CREDITS
Project
Courcellor II project, Levallois-Perret, France

Clients
Semalrep, Levallois, France
Nexity, Paris, France

Works Management
SNC Lavalin SAS, Paris, France

Architects and General Works Management
Calq Architecture, Paris, France
Epstein and Glaiman, Levallois, France
Recevki Architecture, Levallois, France

Contractor
GCC, Paris, France

Mapei Co-ordinators
Benoit Le Coz and Cédric Le Page (Mapei France)

Images by Stéphane Levy and JM Giraudeau for GCC

This editorial feature is based on an article from Réalita Mapei INTERNATIONAL no 44.
Mapefloor Parking System

Elastomeric Polyurethane System specially for multi-storey car parks subject to heavy traffic. Also suitable for bridges and walkways.

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WR 2400 rehabilitates motorway in ‘Golden Quadrilateral’

The ‘Golden Quadrilateral’ is a gigantic motorway network stretching 5,846 km, it connects the Indian metropolises of New Delhi, Chennai, Mumbai and Calcutta. The four-lane sections are currently being rehabilitated and extended to six lanes. Indian construction company Larsen & Toubro (L&T) is carrying out this work as part of a PPP project on the south-eastern section, the NH-5 near Chennai.

L&T will operate the stretch for 15 years. The company consequently opted for technically advanced yet cost-effective rehabilitation using cold recycling technologies from the Wirtgen Group. L&T processed a total of approximately 142,000 m² from October 2012 to April 2013 with a WR 2400 cold recycler and Hamm 3520 and 311 compactors. In the process, the company used the resources from the extremely worn road surface to carefully create a durable, solid base course that only required covering with an asphalt layer 4 cm to 5 cm thick.

India’s Ministry of Transport has been expanding the national motorway network for many years. The focus is on expanding existing sections and improving the quality of the existing roadways. In this context, the NHAI (National Highway Authority of India) also investigated the option of using cold recycling. The results were impressive from technical, organisational and ecological viewpoints, prompting the authorities to recommend the use of this innovative road construction method.

One-stop contract
The contract for expanding the 43 km long section between Chennai in the state of Tamil Nadu and Tada in the state of Andhra Pradesh was awarded to L&T Chennai Tada Tollway Ltd, or L&T CTTL. The 100% subsidiary of Larsen & Toubro Infrastructure Developments Projects Ltd is responsible for the planning, construction, operation and maintenance of the stretch. Because L&T CTTL will operate the motorway as a licence holder for a period of 15 years after construction, the responsible parties were very keen to use a construction method that permits long-term economical use. This is ensured by in-situ cold recycling with the WR 2400 from Wirtgen.

Cold recycling
There are many reasons why this method is cost-effective, one of which is the low requirement for construction materials. In-situ recycling requires only small amounts of new aggregates or asphalt. This was a crucial advantage in rehabilitating the NH-5 as there are no quarries in the Chennai region. Also, only small amounts of cement, water and bitumen are needed. This yields tremendous savings in transport costs. There are other advantages, too. The energy requirement for heating is also very low due to the materials being processed cold. Only the bitumen is processed on site at a temperature of 175°C. The cost-effectiveness and environment-friendliness also convinced the responsible parties at L&T.

Initial evaluation
The NH-5 was not the first cold recycling project for L&T. Consequently, they knew what needed to be done - a thorough survey of the road surface condition is crucial to the success of in-situ recycling projects. This task was assigned to the specialists of the Indian Institute of Technology, Chennai. They conducted a visual inspection of the section and took samples from along the entire stretch of motorway. The results were a mixed bag. In some places, the pavement was still fit for traffic, but about 12 km displayed massive damage to the entire bituminous surface - crazing as well as block, transverse and longitudinal cracks were discovered, as were deep ruts.

Large numbers of vehicles
The cause for the heavy localised damage was readily identifiable. In 2012, some 30,000 vehicles used this stretch every day, approximately 30% of which were heavy goods traffic to and from the busy ports of Chennai and Ennore.

All transport to northern India is routed from those ports via the NH-5. In light of these baseline conditions, the planners decided on a design with 84 million ESALs (ESAL = Equivalent Standard Axle Load) that can meet the most challenging demands. They also stipulated a minimum useful life of 20 years.

Recycling in action
As soon as the formula for the cold recycling mix was finalised, it was time for the Wirtgen WR 2400 recycler to take centre-stage. This machine granulates the road surface with a robust 2.40 m wide milling and mixing rotor, mixing the granulate with binding agents and other additives. In this way, it transforms a ramshackle road surface into a high quality and hard-wearing base course in a single pass. And it achieves this with minimal energy and transport costs.

The addition of the binding agent and other additives is a simple task. On the NH-5, a grader in front of the recycler spread the prepared base course. And it achieves this with minimal energy and transport costs.

Precise addition of binding agent
The WR 2400 is a true all-rounder. Depending on the equipment version, it can process soil or road surfaces with water, bitumen, cement or lime. On the NH-5, it was equipped with a foamed
bitumen system. This produces a foam consisting of hot bitumen, water and air in special-purpose expansion chambers. The requisite quantities of additive are precisely metered via the control system, to produce a foam with the specified properties. This is then injected via a spray bar directly into the milling and mixing chamber.

The total quantity of foamed bitumen required is determined by microprocessors, as is the quantity of water. The operator simply enters the desired quantities and the requisite parameters on a control panel in the cab. The intelligent workhorse from Wirtgen then handles everything else itself and doses the materials with precision, depending on the pre-configured volume, the working depth and the feed rate.

**Variable recycling width**

The width of the milling and mixing rotor cannot be altered. However, the addition of water and binding agents can be varied across the width, by deactivating individual nozzles in the spray bar. The 9 m wide surface of the NH-5 for example was recycled in four lanes.

To this end, the WR 2400 processed the first lane at its full working width of 2.40 m and the next two lanes at a width of 2.30 m (full working width + 10 cm overlap). On the final lane, water and foamed bitumen were applied only across a width of 2.10 m.

**Compaction crucial to success**

The tremendously important compaction work directly behind the cold recycler was handled on the Chennai job site by a Hamm 3520 P vibrating padfoot compactor. The aim of this compaction process is to reduce the cavities filled with air and water and thus increase the density and load-bearing capacity of the layers. The 20 t Hamm compactor was chosen because it boasts high compaction and penetration.

**The 311 compactor**

The subsequent compaction phase was carried out with a 311 compactor from Hamm. This compactor was developed by Wirtgen India and has been in series production at its factory in Pune since 2012. The 311 was able to demonstrate its capabilities on the job site. All of the experts were impressed by the ease of operation and the high level of compaction.
Completion of base course

In the final pass, the moist surface was sealed with tandem and rubber-tyred rollers. Then everything had to be cleared away. The freshly recycled section serves as a new base course and was subsequently re-opened to traffic - in some places, just a few hours after being recycled.

Final asphalt surface course

Last but not least, a fleet of Wirtgen Group machines moved onto the job site following completion of the recycling work, to produce the 4 cm to 5 cm surface course above the recycled base course. M/S GVR Pvt Ltd, a subcontractor of L&T IDPL, used a Super 1800-2 from Vögele together with a fleet of Hamm rollers.

Service team provides support

A team from Wirtgen India provided support for the job site during the entire project, assisting, advising and helping with the configuration and maintenance of the recycler and rollers. As a result, all machines worked perfectly during the entire course of the project.

Trainers from the service team of Wirtgen India had already taken care of training the machine operators in advance. At the headquarters in Pune, the machine operators were familiarised in depth with the special characteristics of cold recycling and the operation and maintenance of the machines from Wirtgen, Hamm and Streumaster. This ensured a successful project.

An ideal construction method for India

The quality of the new road surface, the speed of the construction work and the huge savings in fuel and construction materials impressed everybody involved in the cold recycling project. With minimum costs, it was possible to create a highly durable base course that will serve for a long time. There is also potential for this road construction method to be used for many other roads on the subcontinent. With cold recycling, infrastructure can be upgraded to a high technical level in an environmentally compatible manner.
The West Kowloon Terminus (WKT), currently under construction in Kowloon, will be the only Hong Kong station on the Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL).

The main tunnels of the 26 km long Hong Kong Section of the XRL run from West Kowloon to the boundary of Hong Kong and Shenzhen. They are being constructed in a variety of techniques, depending on the ground, with drill and blast, cut and cover, and tunnel boring machines, all being used by different contractors working under nine principal underground packages.

Trains will glide under a mountain range, beneath villages, wetlands and the Shenzhen River, and finally link with the mainland section at the boundary, from where passengers will be able to travel on to Shenzhen and Guangzhou.

An international mega-hub complete with 15 platforms - nine for long haul trains and six for short distance shuttle trains - connecting passageways, customs and immigration facilities, departure lounges, retail outlets, and a large entrance hall over which a curved steel and glass roof structure will be placed, the WKT will serve as an international gateway to the mainland, with a daily pass-through of almost 99,000 passengers.

The Hong Kong section of the XRL is being constructed by the MTR Corporation, with the Leighton-Gammon JV contracted to build the West Kowloon Terminus Station North and the Southern Approach Tunnel.

Construction requires the open cut excavation of approximately 1.7 million m³ of earth to a depth of 33 m and the use of 600,000 m³ of concrete and 150,000 tonnes of reinforcement steel.

The contractors are excavating around 5,000 m³ of earth per day, which equates to 800 truckloads.

The terminus is surrounded by a diaphragm wall and is built on a foundation of piles, with the underground works requiring 2,500 m of diaphragm walling, about 500 bored piles of 3.6 m diameter and 40 m depth, and 5,000 socket H-piles.

The Leighton-Gammon JV is relying on the Liebherr HS 885 duty cycle crawler cranes with a fleet of more than 10 units on its Southern Approach Tunnel contract together with other units on the Terminus contract including a unit delivered late last year to sub-contractor Kin Wing - extending its fleet to 13 HS 885s. The Gammon fleet comprises more than 16 units of HS 885s in use on a variety of projects across Hong Kong.

On both projects, the units are fitted with material handling grabs removing excavated soil to the surface.

The Liebherr HS 885 duty cycle crawler crane has been designed for all types of material handling and features a wide range of attachments, including grabs, drag buckets, diaphragm wall grabs and pipe laying ancillaries, and has been designed also for demolition and dynamic compaction.

It offers a 120 t maximum lift with a 74 m maximum main boom and a 33 m boom length with clamshell.

The Southern Approach Tunnel includes a 430 m long cut and cover reinforced concrete piled tunnel leading into the Terminus. A 1.5 m thick diaphragm wall and approximately 710 m long with a founding level at -25 to -46 mPD has been completed.

Despite the enormous size of the WKT, the terminus when complete will occupy relatively little space above ground. The glass structure itself is dramatic in design, and will form a distinctive landmark supported by just nine 30 m high columns. Other than this, much of the space will be used as a public park.

The trains leaving the WKT will be able to hit speeds of 200 km/h, and the expected travel time to Shenzhen’s Futian Station is just 14 minutes. Travel time to Guangzhou will take an estimated 48 minutes. Total length of the XRL is 142 km.

Construction of the terminus is scheduled for completion in 2015.
Vector Aerospace establishes new MRO facility in Singapore

Vector Aerospace Corporation, a global independent provider of aviation maintenance, repair and overhaul (MRO) services recently held a groundbreaking ceremony for its new engine facility at Singapore’s Seletar Aerospace Park, which will be specially built for Pratt & Whitney Canada’s PW150A turboprop engine.

The new 8,000 m² engine centre, housing a 5,200 m² state-of-the-art facility represents Vector Aerospace’s appointment as a Pratt and Whitney Designated Overhaul Facility (DOF) and will be equipped with full engine overhaul and test capability.

Vector Aerospace will be investing more than S$ 50 million in the construction, tooling and equipping of this facility.

By locating the facility in Singapore, the company will be able to provide owners of PW150A engines and operators of Bombardier Q400 aircraft, in the Southeast Asian region, a cost-effective, viable, easily accessible MRO alternative.

The new Vector Aerospace Asia engine centre is scheduled for completion in late 2014. When fully operational, the facility is expected to have up to 140 employees in a variety of repair, testing, engineering, commercial and support roles. In addition, the facility will be able to support the expansion of the company’s products, capacity and services in the longer term.

Vector Aerospace recently received approval from Transport Canada to perform maintenance and overhaul for the Pratt & Whitney Canada PW150A series of engines at its facility in Summerside, Prince Edward Island.

The company holds approvals from some of the world’s leading OEMs including Pratt & Whitney Canada, Rolls-Royce, Turbomeca, General Electric and Honeywell. Engines supported by Vector Aerospace include the Pratt & Whitney Canada PT6T, PT6A, JT15D, PW100, PW307 and PW308A; Rolls-Royce M250 and T56/501D; Turbomeca Arriel 1 and Arriel 2; General Electric T58 / CT58 and CT-7A / T700; and Honeywell TFE731 and Honeywell ALF S02/LS07. All engine lines include complete test capability.

Vector Aerospace also has full-service avionics capability, up to and including glass cockpit engineering, and provides services relating to development and integration and complete aircraft rewires, as well as airframe and major inspection support for a variety of Eurocopter, Sikorsky, Boeing and AgustaWestland helicopter models.

**Vector Aerospace**

Vector Aerospace is a global provider of aviation MRO services. Through facilities in Canada, the United States, the United Kingdom, France, Australia, South Africa, and Kenya, the company provides services to commercial and military customers for gas turbine engines, components and helicopter airframes. Vector Aerospace employs over 2,700 people.

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*Exterior view of Vector Aerospace’s engine overhaul facility at Seletar Aerospace Park (artist’s impression).*
Boeing recently announced that low-speed wind tunnel tests have begun for the Boeing 777X, a major milestone in airplane development.

“This is the first major development milestone for the programme since we launched the programme”, said Mr Terry Beezhold, Vice President and Chief Project Engineer of the 777X programme.

“Wind tunnel testing will validate our performance models and generate a vast amount of data that our engineering teams will use to design the airplane in this phase of development”, he added.

Testing started on 5 December at QinetiQ’s test facility in Farnborough, UK. Wind tunnel models allow experts to test many different configurations for the airplane. Low-speed tests measure airplane performance with a variety of high-lift surface settings to simulate takeoff and landing conditions.

The low-speed model currently being tested is a 0.05% scale model of the baseline 777X, measuring about 4.22 m (166 inches) long with a wing span of 3.92 m (154 inches). Hundreds of sensors are embedded in the model to measure pressure to determine the in-flight loads as well as provide valuable diagnostics of the aerodynamic performance of a given design.

Low-speed testing at the QinetiQ facility is expected to last approximately five months. Testing will also be done next year at the Boeing Transonic Wind Tunnel in Seattle, USA, to further validate 777X high-speed performance projections.

“We are on track to complete our top-level design in 2014 and reach firm configuration in 2015”, said Mr Beezhold.

The 777X family includes the 777-8X and the 777-9X, both designed to respond to market needs and customer preferences. The airplane introduces the latest technologies in multiple places, including the GE9X by GE Aviation, said to be the most advanced commercial engine ever, and an all-new, high-efficiency composite wing that has a longer span than today’s 777.

Boeing and QinetiQ recently concluded an agreement that will extend the wind tunnel partnership at Farnborough for an additional five years.

The 777X programme was launched with 259 orders and commitments from Emirates, Etihad, Lufthansa and Qatar Airways.

US is first-ever ‘Feature Country’ at Singapore Airshow

Singapore Airshow 2014 will introduce a new highlight known as the ‘Feature Country’, and the United States has been designated as the first ‘Feature Country’ at the show, scheduled to take place from 11 to 16 February 2014, at the Changi Exhibition Centre.

In line with the theme ‘Iconically American’, Singapore Airshow 2014 will see the largest US presence yet with more than 150 US companies, including 70 of them in the US pavilion, along with a larger contingent of US government and private sector visitors and VIP guests. The US pavilion is also the largest country pavilion at Singapore Airshow 2014, forming about a third of the total number of exhibitors.

The US, a world leader in aviation and defence, is home to renowned companies including Boeing, Raytheon, Lockheed Martin, Northrop Grumman, Honeywell, Rockwell Collins and United Technologies Corporation, who are among the top 50 aerospace and defence companies globally.

Singapore Airshow

Singapore Airshow is Asia’s largest and one of the most important aerospace and defence exhibitions in the world. Held biennially, Singapore Airshow is organised and managed by Experia Events. It is a platform of choice for industry leaders and high-level government and military delegations to network, forge partnerships and do business, and provides a springboard into the thriving Asia-Pacific region.

Held at the purpose-built Changi Exhibition Centre, Singapore Airshow offers 40,000 m² of indoor exhibition space and 100,000 m² of outdoor display area, against a backdrop of some 400 m of picturesque coastline.

Singapore Airshow also features a series of high level conferences dedicated to leading players in the global aviation industry, including the Singapore Airshow Aviation Leadership Summit (SAALS) and the Asia Pacific Security Conference (APSEC).

Mr Jimmy Lau, Managing Director of Experia Events, said, “We are delighted that the United States will be the first-ever ‘Feature Country’ at Singapore Airshow. The United States’ choice of Singapore Airshow and their increased presence at the 2014 edition demonstrate the value that Singapore Airshow brings to its exhibitors and visitors. We hope that more countries will come forward to use the ‘Feature Country’ platform to pursue strategic collaborations and joint ventures within the international aerospace and defence arena”. 
CONEXPO-CON/AGG 2014 to be held in March 2014

CONEXPO-CON/AGG 2014 will be held from 4 March to 8 March 2014 at the Las Vegas Convention Center, Las Vegas, USA. CONEXPO-CON/AGG 2014 will be co-located with the 2014 IFPE exposition for fluid power / motion control / power transmission.

Held every three years, CONEXPO-CON/AGG is the international gathering place for the construction industries, with a focus on construction, aggregates and ready mixed concrete.

Attendees
CONEXPO-CON/AGG attracts persons involved in all segments of the construction, aggregates and ready mixed concrete industries, including contractors, materials producers, and government and institutional sector officials.

Exhibits
CONEXPO-CON/AGG exhibits showcase the latest technologies and innovations in equipment, products and services for the construction industries. Product concentration areas make it easy for visitors to locate specific products, services and exhibitors of interest. The show also features specialised exhibit pavilions including those highlighting information technology / management, and international exhibit pavilions.

Education
CONEXPO-CON/AGG offers a comprehensive education programme during the five-day exposition, with seminars emphasising industry issues and trends, management and applied technology.

Industry support
Leading industry organisations from around the world participate as supporting organisations, and leading industry publications / media worldwide participate as supporting publications / media. CONEXPO-CON/AGG is recognised as a gathering place for the worldwide construction and construction materials industries, and hundreds of industry meetings, including annual conventions of industry associations, are held in conjunction with the show.

Show sponsors and producer
Principal sponsors are the following US organisations: Association of Equipment Manufacturers (AEM); National Ready Mixed Concrete Association; and National Stone, Sand & Gravel Association. The show sponsor is Associated General Contractors of America. AEM is the show producer.
indometal set for bigger return in 2014

Co-organised by Messe Düsseldorf Asia and PT Wahana Kemalaniaga Makmur (WAKENI), indometal 2014 will be held from 11 to 13 December 2014, over an area of 10,000 m², across three exhibition halls at the Jakarta International Expo Kemayoran, Indonesia. The exhibition is expected to attract more than 300 top international exhibiting companies from more than 30 countries.

After a successful debut in 2013, and with many of the exhibiting companies in the 2013 edition expected to return, indometal 2014 will feature national pavilions and country groups from Austria, China, Germany, Italy, South Korea, Taiwan, United Kingdom and United States of America.

As a specialist trade fair focused on the synergistic inter-relations between foundry technology, casting products, metallurgy and thermoprocess technology, indometal 2014 is the ideal platform for producers, equipment manufacturers, product distributors from international markets and local Indonesian steel businesses, to present their latest machinery and innovations.

A special feature at the trade fair is indotools - a dedicated showcase, focused on high-technology tooling solutions, precision tooling, and cost-effective tooling systems, that will synergistically complement indometal 2014.

“After a highly successful inaugural edition which attracted more than 250 international exhibitors and over 6,000 trade visitors, we are confident that with indometal 2014 strategically timed amidst Indonesia’s buoyant market conditions, it will offer metal and steel industry players opportunities to tap into Indonesia and the region’s vast business and investment potential”, said Mr Gernot Ringling, Managing Director, Messe Düsseldorf Asia.

Indonesia’s buoyant industry growth

Latest industry statistics from Indonesia's Ministry of Industry indicate a US$ 400 million investment for infrastructure projects that include construction of roads, seaports, airports, railroads and power plants to support its economic developments. Expansion of manufacturing, processing and other production activities at key economic corridors with metal industry developments (such as Banten, South and West Kalimantan, North Sumatera, Sulawesi, North Maluku, Papua etc) will benefit global and domestic industry players across the steel, aluminium, nickel and copper industries.

After the establishment of the ASEAN Economic Community (AEC) in 2015, steel demand in the region is expected to be further boosted with the implementation of large-scale infrastructure projects to enhance ASEAN connectivity.

“With its own dynamic market and industry potential, Indonesia is also well-positioned for leading companies to anchor their business here and be the gateway for them to venture ahead into Indonesia’s growing metal and steel industries”, added Ms Rini Sumardi, Director, WAKENI.

indometal 2014 is expected to attract some 10,000 trade visitors across various job functions, including government officials, production engineers, procurement and purchasing officers, and industrial analysts, from the mining, metallurgical, machinery manufacturing and processing, shipbuilding and marine engineering, automotive, aerospace, logistics, building and construction, and electronics sectors.

indometal 2014 is supported by the Ministry of Industry, Republic of Indonesia; Ministry of Trade, Republic of Indonesia; Federation of Indonesian Metalworks & Machinery Industries Association (GAMMA); Association of Metalwork and Machinery (ASPEP); Association of Indonesian Metal Foundry (APLINDO); Indonesian Foundrymen’s Association (HAPLI); Indonesian Electric Cable Manufacturer’s Association (APKABEL); Indonesian Iron & Steel Industry Association (IISIA); Indonesian Automotive Parts & Components Industries Association (GIAMM); The Indonesian Packaging Federation (IPF); Indonesian Exhibition Companies Association (IECA); and Indonesian Chamber of Commerce and Industry (KADIN).
PUB embarks on 36 new drainage improvement projects

PUB, the national water agency, is embarking on new drainage improvement projects at 36 locations, adding to its on-going drainage projects at 176 locations around Singapore. These drainage improvement projects are part of a holistic ‘source-pathway-receptor’ strategy to improve flood protection for Singapore.

Besides ‘pathway’ solutions, PUB will also implement a ‘source’ measure – the construction of the Stamford Detention Tank, which is scheduled to start by end of this year. Sited near the junction of Tyersall Avenue and Tyersall Road, the detention tank will help to reduce the peak flow of stormwater into the public drains and better protect the Stamford Canal catchment against floods during intense storms. With a storage capacity of about 38,000 m³ or 15 Olympic-sized pools, the Stamford Detention Tank will be built underground. Occupying a subterranean footprint of about 0.5 hectares, the tank will be sited directly beneath a nursery and a coach bay at the upcoming Singapore Botanic Gardens’ Learning Forest extension.

Once completed in 2016, the detention tank will be able to temporarily hold excess stormwater from the drains along Holland Road, which is upstream of the Stamford Canal catchment. After the rain subsides, the water will be pumped back into the drains for subsequent discharge into the Marina Reservoir.

Besides the detention tank, PUB will be constructing the Stamford Diversion Canal which will divert stormwater from the upstream section of the Stamford Canal catchment to the Singapore River. The work will be carried out in phases, with two tenders to be called. The first tender will be called in the fourth quarter of 2013 and the other tender will be called in the first quarter of 2014. Work on the entire diversion canal is expected to be completed by 2017.

Under the long-term drainage upgrading of Sungei Pandan Kechil, PUB will be carrying out the detailed design in 2014, followed by the widening and deepening of the canal in 2015. In the interim, PUB has enlarged the inlet and outlet points of the culvert crossing at AYE 9.6 km to improve the flow of water. The agency will also be calling a tender for the construction of a tidal gate.

Other drainage upgrading works at Alexandra Canal Subsidiary Drain F (between Tiong Bahru Road to Havelock Road) and Siglap Canal (between ECP to the sea) will also start in the second and third quarters of 2014, respectively.

Drainage improvement projects at 176 locations are also on-going across the island. These include works at major canals or outlet drains like Bukit Timah 1st Diversion Canal, Rochor Canal, Alexandra Canal, and Sin Ming Outlet drain / Marymount Rd Culvert.

In the last two years, PUB has completed drainage improvement projects at 90 locations. Some of these completed projects include works at Geylang River from Guillemand to Dunman Road, Bukit Timah Canal from Maple Avenue to Kampong Chantek, and upgrading of roadside drains across the island such as at Meyer Rd and Sunset Drive/Way.

Northeast Monsoon season

According to the Meteorological Services Singapore (MSS), the Northeast Monsoon is expected to set in around mid-November 2013 and last till March 2014.

During the Northeast Monsoon season, short duration thundery showers, heavy at times, are expected mainly in the afternoon and evening. Heavy rain, coinciding with high tides, typically ranging from 3.0 m to 3.4 m, could lead to localised flash floods in low-lying areas.

In addition, during the season, there could be two to four episodes of monsoon surges. Monsoon surges refer to the steady strengthening of north easterly winds blowing from the South China Sea. These monsoon surges usually bring periods of prolonged widespread moderate to heavy rain lasting between two and five days, occasionally windy conditions and cooler temperatures. On average, for Singapore, there are 19 rain days each in November and December and 15 rain days in January. December and January are typically the wettest months of the year.

Besides the regular weather forecast, MSS will issue warnings through the media when heavy rain or a monsoon surge is expected. This will help the public to better prepare for heavy rain.

Enhanced operational readiness

One of the measures PUB has adopted to respond to the Northeast Monsoon season and to minimise the risks of flash floods is to work together with the National Environment Agency’s Department of Public Cleanliness (DPC) to step up efforts in drainage maintenance and monitoring to keep the drains free-flowing.

At the same time, PUB has intensified inspections at some 100 construction worksites around the island to check for obstructions in the drains. As part of the day-to-day operations, PUB continues to work closely with other agencies like LTA, NParks, NEA and Town Councils to ensure that drainage systems are functioning effectively.

PUB has also replaced 6,000 scupper holes/drain inlets at flood prone areas and hotspots with improved design Drop Inlet Chambers (DICs). Scupper holes are semi-circular holes located on the side of the road, next to the kerb, that channel stormwater into the drain. The vertical gratings in the modified DICs provide an additional vertical opening that will enable rainwater to be
drained from the roads should the main horizontal gratings be partially blocked. DICs can at times be partially blocked by leaves and other debris washed down by heavy rain.

Extensive online monitoring

PUB has in place a network of 136 closed circuit television (CCTV) camera feeds for real-time monitoring of road conditions, which is part of PUB’s flood monitoring efforts. The CCTVs are installed mostly at low-lying areas and hotspots, enabling the public to assess road conditions during storm events.

PUB will also be increasing the number of water level sensors from 158 to 198 by the end of 2014. Locations are extended to places such as Macpherson Road / Harvey Road, Cambridge Road and Thomson Road / Novena Rise for enhanced coverage. These water level sensors sited in the drains and canals enhance the monitoring of real-time site conditions during heavy storms and enable quick response. Information from these water level sensors is also available for public viewing.

Holistic approach to drainage management

Recognising the impact of greater weather uncertainties on drainage management, PUB has revamped its drainage management approach to strengthen Singapore’s flood resilience.

This ‘source-pathway-receptor’ approach looks at catchment-wide solutions to achieve higher drainage and flood protection standards. This holistic approach covers the entire drainage system, addressing not just the pathway over which the rainwater travels (ie ‘Pathway’ solutions), but also controlling rainwater at where it falls onto the ground (ie ‘Source’ solutions) and at the areas where floods may occur (ie ‘Receptor’ solutions).

In 2011, to strengthen ‘pathway’ solutions, PUB raised design standards for new drains to cater for more intense extreme rainfall events. Depending on the size of the catchment, this could vary from between a 15% to a 50% increase in drainage capacity.

In June 2013, PUB further included a new requirement for developers to implement ‘source solutions’ to slow down surface runoff and reduce peak flow of stormwater into the public drainage system. These on-site measures could include detention tanks and/or ABC Waters design features which will help introduce more flexibility within the existing drainage system to meet the challenges of more intense rainfall.

‘Source’ solutions like rain gardens have since been implemented at the Livia Condominium, while at Boon Lay Meadow, an HDB development, runoff is detained in mini tanks and used for irrigation of the community garden.

In 2011, PUB also raised the minimum height of platform, land reclamation and crest protection levels for new developments and redevelopment sites under its revised Code of Practice on Surface Water Drainage. These ‘Receptor’ measures provide additional flood protection for buildings and key infrastructure.

PUB conferred Presidential Award by IDA

National water agency PUB has been conferred the Presidential Award by the International Desalination Association (IDA) for its long-standing commitment to the sustainability of water and desalination, and in recognition of the special relationship between PUB and IDA.

The world’s leading resource for information and professional development for the global desalination industry, and the only global association focused exclusively on desalination and desalination technologies, the IDA has been collaborating with PUB on a number of important events and initiatives.

These include organisation of the 2005 IDA World Congress in Singapore, PUB’s leadership as the first host agency for IDA’s Fellowship Award, the successful launch of the IDA Desalination Academy, and continuing cooperation on Singapore International Water Week.

PUB Chief Executive Mr Chew Men Leong received the award from Dr Corrado Sommariva, President of IDA at the gala dinner of the IDA World Congress 2013 held in Tianjin, China, on 21 October 2013.

‘We are honoured to receive the Presidential award from IDA. This is a testimony of the progress we have made in the field of water and desalination, as well as the good working relationship we have enjoyed with IDA in the last 12 years’, said Mr Chew Men Leong.

“It is with great pleasure that we present this Award to our colleagues at PUB, with whom we share a long-standing and meaningful relationship. Recognised around the world as a pioneer in water initiatives, PUB has always promoted sustainability, environmental stewardship and innovation in its programmes in Singapore as well as worldwide. There is great synergy between PUB and IDA. Both our organisations share a deep commitment to promoting water management strategies that help ensure the health and well-being of people and economies. PUB has also been a great partner of IDA in organising events, including our 2005 World Congress, that facilitate the advancement of knowledge and exchange of ideas within our industry”, said Dr Corrado Sommariva, President of IDA.

PUB has been a member of IDA since 2001. This membership has allowed PUB to connect with global leaders in desalination, bringing vast networking opportunities and advancing its professional knowledge.

Desalinated water is one of Singapore’s Four National Taps, along with local catchment water, imported water and NEWater, Singapore’s own brand of reclaimed water. With the opening of Singapore’s second and largest desalination plant with a capacity of 70 mgd in September 2013, desalinated water can meet up to 25% of Singapore’s current water demand.
Tekla enters into partnership with NTU

Tekla SEA Pte Ltd recently signed a Memorandum of Agreement (MoA) with Nanyang Technological University’s (NTU) Centre for Infrastructure Systems, to collaborate in research and development activities aimed at increasing the number of local graduates equipped with Building Information Modelling (BIM) skills, as well as boosting the adoption of BIM technology in the building and construction industry.

Through the agreement, Tekla will support the training of NTU staff and students, and industry professionals, that will help to develop their capabilities in the field of BIM solutions for building and construction designs. The MoA will also provide a platform for mutual sharing of best practices in the application of BIM solutions on buildable design and constructability, and ultimately increasing the adoption of BIM technology in the construction industry.

“At Tekla, we are championing talent development by educating the next generation of our workforce - our students. As these students graduate, they will grow the local talent pool in the years to come. Students who familiarise themselves with BIM at school will carry the skills with them as they enter the workforce”, said Mr Thomas Phang, Area Director, Tekla SEA.

With this growing talent pool, Singapore’s BIM industry will develop and mature over the next few years. We see this as a worthy investment that will amount to a bigger advantage for the industry”, he added.

“We are delighted to work with Tekla, to equip our students with industry-relevant skills and experience in Building Information Modelling which is a crucial skill-set for Singapore now, and in the future”, said Assoc Prof Robert Tiong Lee Kong, School of Civil and Environmental Engineering, NTU.

More organisations are adopting BIM in the design and construction process, creating a large demand for BIM professionals in the industry. Looking towards the future, the adoption of new technologies such as BIM is expected to contribute towards the Singapore government’s goal of raising construction productivity.

Tekla Structures is one of the most advanced BIM software on the market. It provides an accurate, dynamic, and data-rich 3D environment that can be shared by contractors, structural engineers, steel detailers and fabricators, as well as concrete detailers and manufacturers.

With its software, Tekla Corporation drives the evolution of digital information models and provides greater competitive advantage to the construction and infrastructure industries. Tekla has customers in nearly 100 countries, offices in 15 countries and a worldwide partner network. The company was established in 1966. Tekla Corporation became part of Trimble in 2011.

The MoA is a continuation of Tekla’s holistic education efforts in Singapore, which currently includes a scholarship programme with ITE and the creation of an Authorised Training Centre at ITE College Central.

CSC acquires structural software developer CSC

CSC, a leading structural software developer, announced recently that it has been acquired by Trimble, a leader in positioning technology and a specialist in construction project optimisation across the design-build-operate lifecycle. CSC is a strategic Analysis and Design partner of Tekla, a part of Trimble, since 2011.

“The acquisition of CSC reinforces our goal of connecting key workflows across the design, build and operate continuum. It extends our offering to provide the complete workflow solutions from design to rebar fabrication. Together with CSC, we are looking forward to providing an extended solution to our engineering clients”, said Mr Risto Raty, General Manager, Trimble Buildings Structures Division and Executive Vice President, Tekla Corporation.

“Being acquired by Trimble will help CSC strengthen our presence in existing markets and accelerate growth in strategically important emerging markets where we currently have limited presence. This offers an exciting opportunity for our products and our people to become part of a truly global business. Trimble will help CSC realise our ambitions far quicker than we could have done by organic growth”, said Mr Mark Roberts, CEO, CSC.

CSC will continue to provide high-quality software and post-sales technical support and training for its Solve, Fastrak, Orion, Tedds, Struds and ESR-GSR solutions.

CSC will become part of the Trimble Buildings Structures Division in the Engineering and Construction segment.
Bentley’s ProjectWise Construction Work Package Server undergoes validation

Bentley Systems Incorporated, a leading company dedicated to providing comprehensive software solutions for sustaining infrastructure, has announced that its forthcoming ProjectWise Construction Work Package Server, said to be the first commercial off-the-shelf system for managing the lifecycle of construction work packages, has been shaped and is now being validated by leading engineering, procurement, and construction firms through their participation in Bentley’s early access programme. The software is scheduled for commercial release in early 2014.

The ProjectWise Construction Work Package Server ‘completes the reach’ for construction information mobility by spanning software and process gaps between engineering content and workplace planning. The importance of addressing and improving construction work packaging information flows was confirmed in the annual survey of priorities of the global project delivery offices of leading EPCs and EPCMs at the Bentley Project Delivery Forum held recently in California, USA. The 33 attending executives ranked initiatives related to work packaging as highest on the scales of meriting their ‘critical and urgent’ attention, and on which they would most like to focus for better project delivery performance.

The software’s innovative capabilities serve as a response to the call from the Construction Industry Institute (CII), USA, for ‘advanced work packaging’ to become an industry best practice for defining the flow of information exchange between engineering, procurement, construction, commissioning, and handover.

In the July 2013 Research Team 272 report ‘Advanced Work Packaging: Design through Workface Execution’, CII includes a case study that assesses the value of Advanced Work Packaging as enabling a 10% reduction in total installed cost, with increased safety, in comparison to typical practice today. The key is an integrated enabling a 10% reduction in total installed cost, with increased safety, case study that assesses the value of Advanced Work Packaging as highest on the scales of meriting their ‘critical and urgent’ attention, and on which they would most like to focus for better project delivery performance.

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Mr Greg Bentley, CEO, Bentley Systems, said, “The timing is auspicious for our major new construction offering, as we are now bringing to market what I believe to be the only software that can enable the new recommendations, and consequent project performance improvements, of CII RT 272 for Advanced Work Packaging. The addition of Construction Work Package Server extends the reach of ProjectWise functionality all the way through ConstructSim workface planning, made possible by leveraging our i-model deliverables and our eB/Information Manager (eB/IM) to maintain the relationships and changes at the level of construction component instances, across EWPs, CWPs, IWPs, and related enterprise systems for procurement and crafts. And I think only Bentley Systems could make this work for projects that start with our own design tools or others - including SmartPlant 3D and/or PDMS - in any combination”.

He added, “By addressing construction work packaging this comprehensively, projects can now go beyond merely visualisation for statusing to ‘proactively progressing’, and hence, from schedule simulation to schedule improvement. With Construction Work Packaging Server and, in conjunction with Bentley Navigator and ConstructSim, we complete the reach of ProjectWise from ‘Workhorse for Work Packaging’ to ‘Powerhouse for Project Performance.’ Connected by Bentley CONNECT cloud services and our field apps, these comprehensive new offerings will complete the reach of consumerisation-enabled information mobility, to accelerate the ongoing and important industrialisation of infrastructure construction”.

ProjectWise in Construction

ProjectWise is playing a key role in Consolidated Contractors Company’s Midfield Terminal Building in the Abu Dhabi Airport project. This US$ 3.2 billion, 750,000 m² project will provide passenger and cargo facilities, duty-free shops, and restaurants for up to 40 million people per year. The X-shaped structure is located between two runways, and the complexity of the structure in both design and shape presented challenges in terms of engineering, construction, and procurement. Consolidated Contractors Company met these challenges using ProjectWise, Bentley’s AECOsim Building Designer; and other Bentley BIM solutions. The client had a set of demanding, ambitious and quite unique specifications. Completion required a totally BIM-driven project and with several decades of experience with Bentley’s products, Consolidated Contractors Company knew that they were robust and capable of handling a mega project of this nature.

ConstructSim and Bentley Navigator

ConstructSim, which is enabled by Bentley Navigator for dynamic project review and analysis, provides for the visual creation of work packages, workface planning, and progress status visualisation. Through its integration with ProjectWise Construction Work Package Server, ConstructSim becomes even more dynamic and is able to provide immersive status updates that lead to status progression.

Comprehensive work packaging

The capabilities of Bentley’s ProjectWise Construction Work Package Server are comprehensively combined with and augmented by other Bentley offerings, including:

- i-models - pervasive enablers of information mobility serving as conveyors for AECO deliverables. i-models are the core means for bringing data into the new server.
- SpecWave Composer - providing specifications and engineering standards inputs into construction workflows that can be personalised to the viewer’s role in the project.
- Bentley Transmittal Services - empowering infrastructure organisations to intelligently manage the distribution of work packages to subcontractors and other relevant personnel.
- Mobile apps, such as Field Supervisor and Navigator Mobile - enabling workers in the field to access, review, and/or act on work packages on site, and to easily provide progression and inspection information back into the server, where it will be used to update the real-time status of the project.
**Hill Asia completes 25 years in Asia**

Hill Asia celebrated its 25th year in Asia anniversary on 23 October 2013 at the Raffles Hotel in Singapore. The event was graced by more than 40 invited clients and business associates.

The programme commenced with a colloquium featuring presentations by four distinguished speakers – Mr Christopher Chuah, Partner, WongPartnership LLP; Ms Wendy MacLaughlin, Vice President, McLachlan Lister; Dr Philip Chan, Associate Professor, National University of Singapore; and Mr Rodman Bundy, Partner, Eversheds.

This was followed by a cocktail and networking session, and then by a Chinese banquet. During dinner, Mr Roderick Noble, Director of Asian Business, Thirty Nine Essex Street, and Mr Johnny Tan Cheng Hye, Managing Partner, LT&T Architects, entertained the guests with their tales and experiences.

In conjunction with the anniversary, Hill Singapore also published a limited edition Hill Compendium, containing 33 selected articles and white papers, written by Hill professionals across the world, over the years. The book, which is divided into four sections (Delay, Disruption, Acceleration; Contracts; Claims, Quantum; and Risk Management), was distributed to guests at the event.

‘We provide expertise that is focused on identifying our clients’ business problems and finding solutions. For prospective clients that have not had the benefit of working with us previously, that can be an intangible proposition. We took the opportunity on our anniversary to not only underscore Hill’s longevity in the region but also showcase our expertise and our collaborative approach to working, by hosting a colloquium and publishing a compendium of papers penned by Hill’s staff from around the world’, said Mr Derek Nelson, Senior Vice President and Managing Director - Asia, Hill International.

Hill International offers a full spectrum of project management and construction consultancy services.

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**Yongnam secures subcontract for Marina One**

Yongnam Engineering & Construction Pte Ltd, a wholly-owned subsidiary of Yongnam Holdings Limited and a leading and well established structural steel contractor and specialist civil engineering solutions provider, has secured a structural steel subcontract worth S$ 168 million for works at Marina One, a mixed-use development located at Marina South, Singapore’s new Central Business District.

The contracts were awarded by the main contractor, a joint-venture between Hyundai Engineering and Construction Co Ltd and GS Engineering & Construction Corporation.

The subcontract covers three packages, under which Yongnam is expected to fabricate and construct almost 30,000 tonnes of structural steelwork. One of the three packages involves the conversion of the original reinforced concrete design of the office towers to a composite structural steel design. The subcontract also includes the application of fire-proofing as well as the supply and installation of a specialist floor damping system on the linkway floors connecting the two office towers, at the 28th to 30th storeys.

The Marina One project is being developed by M+S Pte Ltd, a company owned 60:40 by Khazanah Nasional Bhd and Temasek Holdings Pte Ltd, respectively. The development will comprise two 30-storey office blocks, two 34-storey residential blocks, four basement levels, an underground pedestrian network, and an ancillary road network. With lush greenery and waterfalls expected to feature in the building design, the project is expected to be a landmark feature at Singapore’s new Central Business District, when completed in 2017.
Newcastle University in Singapore

Newcastle University is delighted to offer the following specialist two-year degree programmes taught in collaboration with the Singapore Institute of Technology (SIT).

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- Naval Architecture
- Offshore Engineering
- Mechanical Design and Manufacturing Engineering
- Electrical Power Engineering

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- Programmes specially designed to build on the strengths of Singaporean polytechnic education
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For further information contact Janice Trewick at janice.trewick@ncl.ac.uk or visit ncl.ac.uk/singapore
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