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Major production

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All eyes may have been on opening night, but the first major production of The Esplanade – Theatres on the Bay was the co-ordination of the construction. This involved the expertise of a number of specialist companies

In any large construction project, success is dependent on the successful co-ordination of a great number of contractors - and their ability to meet a stringent set of design requirements. For The Esplanade - Theatres on the Bay, a key feature of the project is the design of the large, curved structures that house the 2000-seat Lyric Theatre and 1600-seat Concert Hall. These structures, composed of steel, glass and aluminium cladding, were fabricated, supplied and installed by Mero Systems GmbH and Mero Asia Pacific.

The company says each of the steel structures is a double-layered space frame with a triangular external grid that follows a predefined network of rhombi. In two directions, the rhombi have constant edge lengths of approximately 1.5m. Rhombi in a third direction are of varying size, which allows the grid to be adapted to create the free-form surface. The external grid of each structure has been built using the Mero bowl-node system, with square hollow sections of 60mm x 60mm in various wall thicknesses. The sparse internal grid and the bracing elements connecting internal and external layers feature the Mero spherical node and circular tubes system. Mero Asia Pacific director Harald Paetz says the overall geometry of the roof envelopes falls into a category of free-form surfaces known as nurbs surfaces, which are common in the computer-aided design of cars and aircraft fuselages. The glazing within the grid features triangular panes of 29mm-thick insulating glass. These are laid directly onto the external rhombic sections utilising a fixing, sealing and draining system. Additional aluminium fixtures are placed at the corners and intermediate points.

Mero says more than 10,500 panes were used to cover 10,731m². The linear joints between the panels amount to 27km of sealing sections.

More than 7000 aluminium shading pyramids were placed 20cm above the glazing.

"Rhombic-shaped aluminium sheets of varying sizes were bent diagonally into different angles, which were designed to fit the varying shapes and slopes of the structural meshes," says Paetz.

"The entire shading envelope of pyramids needed to meet light and thermal transfer requirements, as well as aesthetic aspects. These included the smoothness of grid lines in various directions, and gradual opening, closing, rising and falling of the shade pyramids."

Paetz says Mero's computer-based technical processing capabilities allowed the company to optimise the design to minimise the number of different elements and rationalise construction.

"The large scale and filigree nature of the double-layered structure, glazing grid and shading elements led to thousands of similar components, which posed a strategic and planning challenge," says Paetz. "Mero's comprehensive computer processing streamlined the entire project."

For more details, contact Mero Asia Pacific Pte Ltd, 25



Aluminium pyramids provide a shading envelope for the interior of the complex.



Each dome is a double-layered space frame featuring a triangular grid of rhombi. The Mero spherical node and circular tubes system connects the internal and external layers.

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While The Esplanade's concert hall and theatre create considerable attention, other roofing elements demanded an equally high standard of materials and workmanship. BHP Steel was responsible for the design, supply and installation of the roof systems of the public concourse, chorus rehearsal building, Raffles Ave canopy and J-shaped food court. These buildings are roofed with Lysaght Locked Seam in zinc titanium, which is supplied by the French company VM Zinc. Part of the building commonly referred to as the flying saucer is clad in the BHP steel-manufactured Colorbond Kliplok.

BHP Steel project manager Francis Chua says working with the zinc titanium was a challenge for several reasons.

"While it is a very long-lasting material, it can be difficult to work with," he says. "For this project, many of the panels were tapered or curved, with the roof of the chorus rehearsal building requiring panels that were both tapered and curved." Chua says BHP Steel was able to liaise with the other contractors on site to meet the exacting demands of the architects.

"This involved the co-ordination of many subcontractors to ensure a high standard of workmanship and to meet crucial deadlines."

Chua says BHP Steel has the expertise and the technology to work with many different materials.

"The company is not only a steel provider, but also an experienced designer and installer of other roofing systems in stainless steel, copper and painted aluminium," he says. "In this project BHP Steel also installed the entrance zinc titanium ceiling of the public concourse."

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Accessibility is a key design requirement for any major public complex. At The Esplanade sheltered walkways and underpasses link the theatres to Marina Square, Millenia Walk, Suntec City, Raffles City and the City Hall MRT station. The five underpasses and the basement esplanade were completed by Tew Kim Thai Construction. Contracts and project manager Raymond Teo says the company was proud to have contributed some alternative proposals to DP Architects.

"This included co-designing a lightweight, aluminium, modular roof, which could provide the necessary waterproofing without detracting from the designer's intent," he says. "Entrance Four, which is the Arts Centre entrance is the most dramatic portal, presenting a clear, unobstructed glass facade. Its deconstruction style has a graphic quality reminiscent of the work of Escher."

Tew Kim Thai supplied and installed all the finishes for the underpasses, which included different types of granite, enamel panels, glass cladding and Foster-designed iGuzzini spider lights. The company was also responsible for the supply and installation of all mechanical and electrical systems for the basement esplanade.

"We interfaced with both government and private entities," says Teo. "The company worked as a direct contractor for the Esplanade developer that commissioned two of the entrances, and as the main contractor that completed the remaining transit structures for the Land Transport Authority. We are particularly appreciative of the help provided by



More than 10,500 panes of glass were used to cover 10,731m².



The glazing within the structural grid of the domes features triangular panes of 29mm-thick insulating glass.

Vikas Gore and Edwin Makil of DP Architects."

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Mero Asia Pacific says these were laid directly onto the external sections utilising a fixing, sealing and draining system.



Tew Kim Thai also supplied granite and enamel panels. In addition, the company supplied and installed all the mechanical and electrical systems for these areas.



The curved domes of The Esplanade complex dominate Singapore's waterfront sky line.



Mero Asia Pacific says the shading envelope was designed to ensure it would fulfil light and thermal transfer requirements, as well as aesthetic aspects, with the gradual opening, closing, rising and falling of the shading elements.



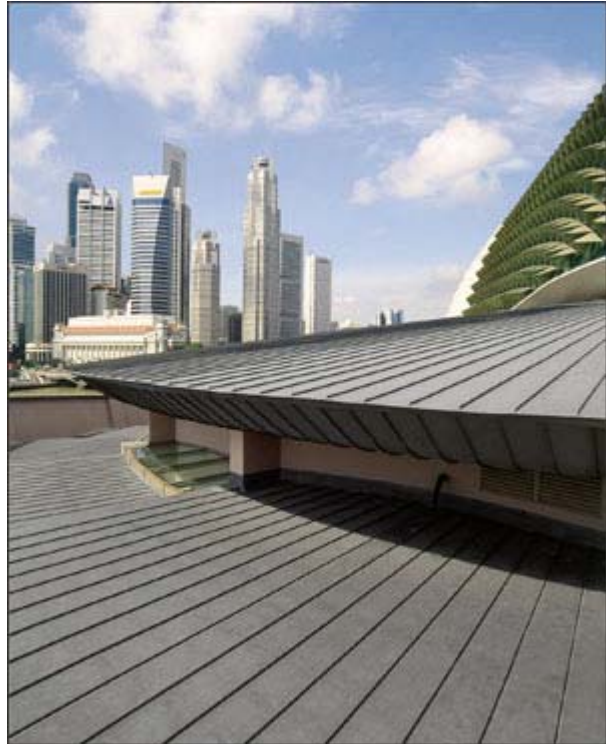
With its multi-faceted dome structure, The Esplanade - Theatres on the Bay makes a bold architectural statement. The steel, glass and aluminium structures were fabricated by Mero Asia Pacific.



Other roofing elements in The Esplanade were supplied and installed by BHP Steel. These included the Lysaght Locked Seam roofing in zinc titanium, which features on several buildings, including the Raffles Ave canopy. The company says this is a very durable material that requires highly skilled engineering, which was made possible through the collaboration with French supplier VM Zinc.



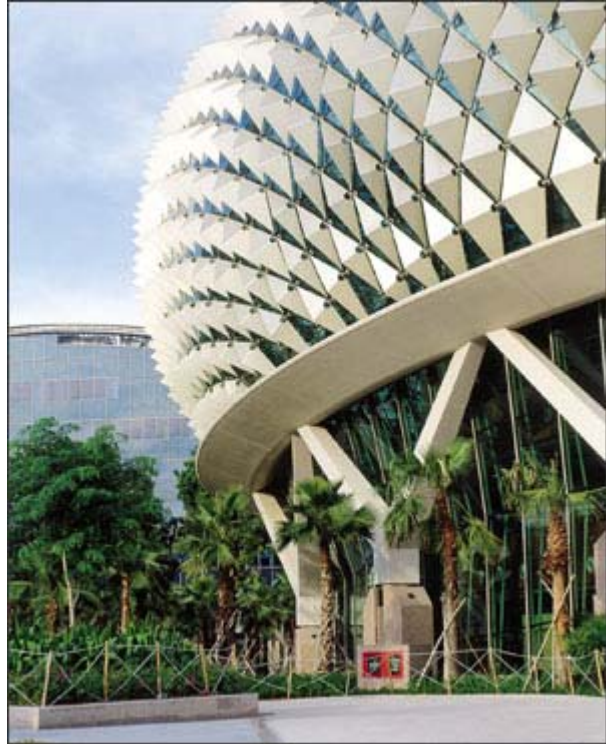
Tew Kim Thai supplied and installed all the finishes for the underpasses and basement esplanade.



BHP Steel supplied and installed zinc titanium roofing for the Chorus Rehearsal building.



BHP Steel also supplied and installed the top roof of the J-shaped food court. Other roofing manufactured and installed by BHP Steel includes Colorbond Kliplok roofing.



The shading envelope was designed to ensure it would fulfil light and thermal transfer requirements.



BHP Steel supplied and installed zinc titanium roofing for the public concourse. This standing seam roofing can be roll-formed as shown.



Pedestrian underpasses at The Esplanade were completed by Tew Kim Thai Construction.



Foster-designed iGuzzini spider lights are a feature of the walkway interiors.