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Engineering Innovations for Tuas Port Phase 1 Reclamation Project Recognised with Triple Awards

For the engineering innovations behind the Tuas Port Phase 1 (TPP1) Reclamation, Wharf Construction & Dredging Project, the Maritime and Port Authority of Singapore (MPA) and project partners were awarded the 2022 World Federation of Engineering Organizations (WFEO) H.J. Sabbagh Prize for Excellence in Engineering Construction. The ceremony for the WFEO award will be held later this year.

2. Key design innovations included large-scale reuse of recyclable materials such as dredged seabed material and land-excavated materials, which accounted for more than half of the reclamation fill for TPP1. The reclamation filling, which included clay, was treated to ensure stability of the reclaimed land is within the stringent limits for operating the driverless automated guided vehicles.

3. The stability of the reclamation fill is maintained using 10 storey-high caissons as earth-retaining walls. These caissons also form the foundations of Tuas port and wharf structures for vessels to berth alongside. The caissons were fabricated at a nearby casting yard, towed out to sea, and submerged on the prepared foundation in the seabed.

4. 221 caissons were used for the reclamation of TPP1 and the deep-water berths will be capable of accommodating future container ships with a draught of up to 21 metres. In addition, MPA, as the port planner, designed Tuas Port as finger-piers so that the linear wharf layout maximises the land-sea space while providing flexibility for ships with different lengths to berth.

5. TPP1 was built five metres above mean sea level to adapt to rising sea levels. Dredged hard rocks beneath the seabed were reused for shore protection and reclamation fill to enhance resource circularity.

6. The TPP1 project was also awarded the Prestigious Engineering Achievement Award 2022 by The Institution of Engineers, Singapore (IES) at the IES 56th Annual Dinner on 17 January 2023, and the ASEAN Outstanding Engineering Achievement Awards 2022 by the ASEAN Federation of Engineering Organisations (AFEO) at the

40th Conference of the ASEAN Federation of Engineering Organisations (CAFEO40) on 7 December 2022.

7. These accolades recognise and celebrate the outstanding achievements of MPA's engineering teams, amidst the challenges from the COVID-19 pandemic, in driving innovation, adoption of state-of-art technologies to improve efficiency and construction safety and incorporating environmental sustainability and climate adaptation engineering in the design and construction of TPP1.

8. "Developed in four phases, Tuas Port will be a fully automated port. These awards affirm the commitment to engineering excellence and the dedication of the entire MPA team. As a greenfield site, Tuas Port offers opportunities for innovation, enhancing energy and operational efficiency so that we can deliver a port which will continue to secure Singapore's connectivity to the world and its future as global trading hub port," said Mr Teo Eng Dih, Chief Executive of MPA.

9. The WFEO's H.J. Sabbagh Prize for Excellence in Engineering Construction aims to promote the important role of engineering in sustainable development, especially in the construction and infrastructure fields. The ASEAN Outstanding Engineering Achievement Awards and the IES Prestigious Engineering Awards recognise exceptional engineering achievements that demonstrate outstanding engineering skills which have made a significant contribution to the engineering progress and quality of life in ASEAN and Singapore, respectively.

10. Please refer to the Annex for details of the TPP1 project.

- End of release –

About the Maritime and Port Authority of Singapore (MPA)

MPA was established on 2 February 1996 with the mission to develop Singapore as a premier global hub port and international maritime centre, and to advance and safeguard Singapore's strategic maritime interests. MPA is the driving force behind Singapore's port and maritime development, taking on the roles of maritime and port regulator and planner, international maritime centre champion and national maritime representative. MPA partners with industry, research community and other agencies to enhance safety, security and environmental protection in our waters, facilitate maritime and port operations and growth, expand the cluster of maritime ancillary services, and promote maritime digitalisation and decarbonisation, R&D and manpower development. MPA is responsible for the overall development and growth of the maritime domain and Port of Singapore. In 2022, Singapore remained one of the world's busiest transshipment hubs with a container throughput of 37.3 million 20-foot equivalent units (TEUs).

For more information, please visit https://www.mpa.gov.sg

For media queries, please contact:
Ms Serene Liu
Assistant Director, Corporate Communications Department, Maritime and Port Authority of Singapore
Mobile: (65) 9824 6525
Email: serene_liu@mpa.gov.sg

Annex:

- Completed in November 2021, the Tuas Port Phase 1 (TPP1) project marked a major milestone in Singapore's long-term plan to develop the Tuas next-generation port. Tuas Port will be developed over four phases. When fully completed in the 2040s, Tuas Port will be fully automated.

- Sustainability is integral to the construction of Tuas Port. TPP1 is recognised for adopting several innovative and sustainable engineering solutions, as well as green initiatives to protect the environment and reduce carbon footprint.

- The initiatives included:

  - All 4 phases of Tuas Port will be built at least five metres above mean sea level to adapt to sea level rise in the coming decades.

  - Prior to the commencement of works in February 2015, MPA together with nature volunteers and non-governmental organisations, relocated 2,300 coral colonies from Sultan Shoal to St John's and Sisters' Islands. The coral conservation program, which included coral relocation and setting up of coral nurseries at suitable habitats, was part of MPA's efforts to ensure sustainable development of Tuas port.

  - Implementation of an Environmental Impact Assessment prior to the reclamation to establish Environmental Quality Objectives (EQOs) to ensure no impact on marine intakes, seagrass and mangroves, etc. An Environmental Management and Monitoring Programme was then put in place to ensure strict compliance of the established EQOs.

  - Reuse of recyclable materials, such as dredged seabed material and land-excavated material for reclamation filling and caisson infilling, thus reducing the need for imported fill and sustaining resource circularity. Reusing these materials for reclamation also eliminated long distance haulage of disposing such materials to offshore disposal sites.

  - Design of soil improvement works such as prefabricated vertical drains, preloading, and sand drains to expedite and reduce the time taken for the consolidation of the soft clay reclamation filling.

  - Caissons perform a dual function. As a vertical seawall, more land was created up to the water's edge, and functioned as a wharf structure where ships can berth alongside the caisson. Concrete caissons were designed and fabricated on a site nearby under a sheltered factory-controlled environment, thus ensuring consistency of quality and strength for concrete,

and providing a conducive working environment for the workers. The dual-lane production of caissons using an innovative slip-form method led to increased productivity and early completion of caisson construction.

- The adoption of Automatic Rebar Machine using Robotics System (ARMS) to automate bending and cutting of reinforcement steel bars to the desired design specifications, before transferring them safely onto an adjacent stacking area. This innovative solution eliminated the risk of exposing workers to mechanical hazards if they were to operate the rebar-cutting and bar-bending machines by conventional method.

- The use of Temarock, a customised all-in-one marine equipment/vessel to install rock laying, rock compaction and underwater surveying for caisson foundation, thus enhancing safety and productivity.

- Dredged hard rocks beneath the seabed were reused for shore protection and crushed for use as reclamation fill which increase resource circularity.

- The scope of work for the project teams from MPA, Surbana Jurong Corporation, and MPA's appointed main contractor 'Dredging International Asia Pacific – Daelim Industrial Joint Venture Pte Ltd, entailed soil improvement works for 414 hectares of land, including 294 hectares measuring 412 football fields of newly reclaimed land; the fabrication and installation of 221 10-storey tall caissons, each weighing 15,000 tons to form 8.6km of seawall; and the deepening of seabed to cater for larger ships of the future. The project involved 34 million man-hours, with the support of over 450 companies. TPP1 has 21 deep-water berths that can handle 20 million twenty-foot equivalent units (TEUs) annually when fully operationalised.