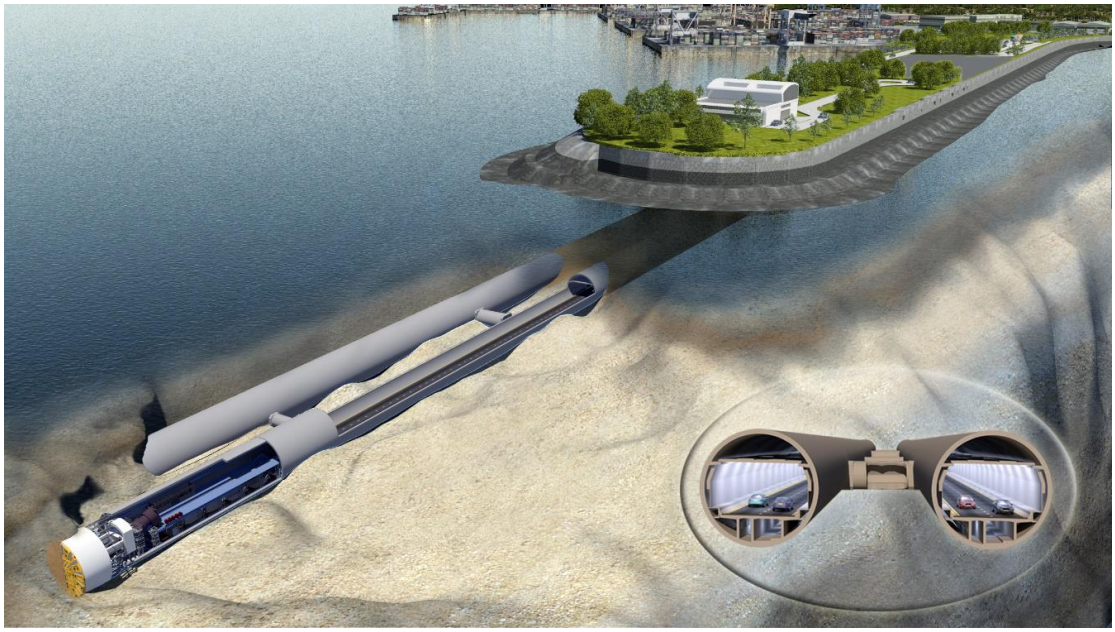
Tuen Mun- Chek Lap Kok Link Engineering Features

In the course of the implementation of this mega-scale project, members of the project team from the Highways Department, consultants and contractors had to overcome many technical challenges by adopting various innovative and sustainable engineering solutions in the design and construction stages. They brought tremendous benefits to the project in the areas of works progress and quality, site safety, environment, marine traffic, emergency rescue as well as future maintenance and operations.

Video: Deep Sea Challenge: Tuen Mun - Chek Lap Kok Link Northern Connection

Sub-sea Tunnel

Tuen Mun-Chek Lap Kok Tunnel is the first sub-sea road tunnel in Hong Kong constructed by Tunnel Boring Machines (TBMs). As compared with the traditional immersed tube method, the use of TBM for the sub-sea tunnel construction can reduce the amount of dredging and disposal of some 11 million cubic metres of marine sediment, which is equivalent to the capacity of about 4,900 standard swimming pools, significantly reducing the impact of the project on the environment. The adoption of TBM minimises the impact on the habitat of Chinese White Dolphins and other water flora and fauna in the region, reduces the impact on heavy marine traffic along Urmston Road during construction, and also avoids the need to divert the existing submarine power cables serving the Hong Kong International Airport (HKIA).



First Sub-sea Road Tunnel in Hong Kong Constructed by TBM

The World's Largest TBM

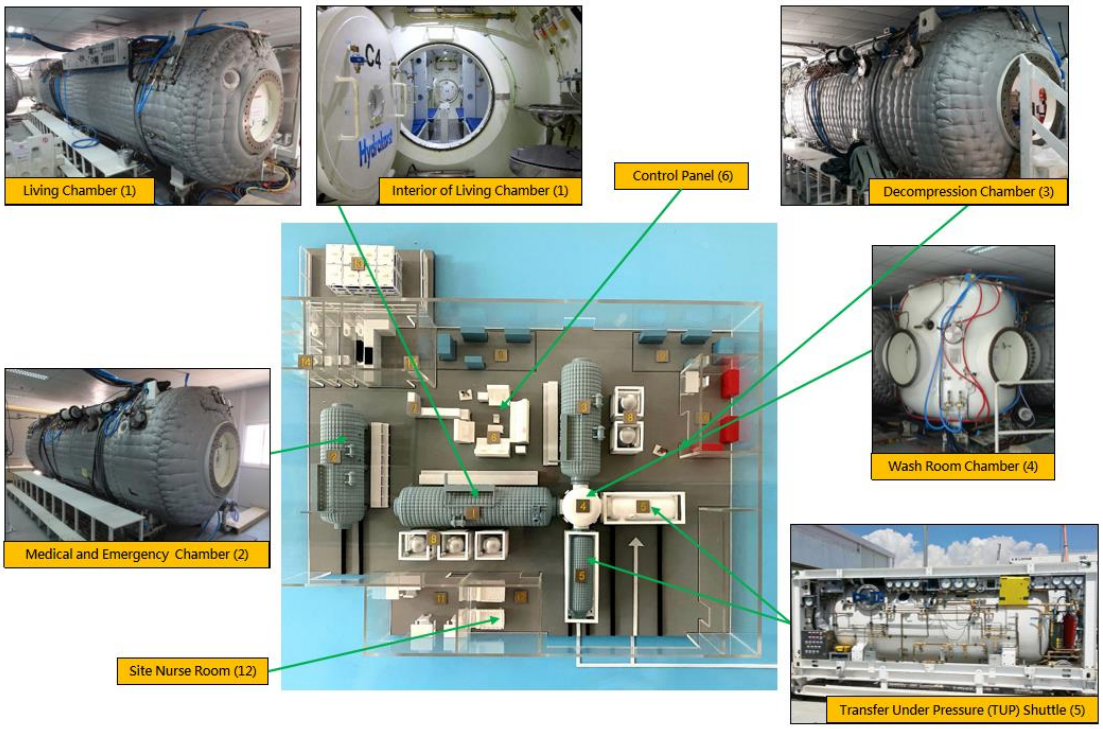
At the Northern Landfall of the sub-sea tunnel section near River Trade Terminal in Tuen Mun, a 17.6m diameter TBM (named Qin Liangyu "秦良玉"), being the largest TBM in the world at the time of construction, was deployed for the road tunnel section of 3-lane configuration. This TBM was as tall as a 6-storey building. Adopting this mega-scale TBM not only shortened the construction time but also minimise the environmental impacts.

17.6-metre Diameter TBM

Innovative Solutions

High water pressure would be encountered in the course of excavation underneath the seabed, necessitating the use of compressed air of up to about 6 bar for carrying out excavation works. To cope with the frequent and time-consuming high-pressure maintenance works during the construction of the Tuen Mun-Chek Lap Kok Tunnel, the

project team introduced the saturation technique and pressurised living chambers. Technicians could live in a pressurised habitat within a 28-day work cycle, substantially reduced the frequency of decompression operation for technicians during the cycle and the risk of decompression sickness. The health of technicians was thus fully protected.



Facilities of the Pressurised Chamber

To further enhance the effectiveness of each intervention, the cutter heads of the TBMs were equipped with innovative technologies Mobydic, Snake and Telemach. These innovative systems proved to be effective and crucial to the optimal operation of the TBMs while minimising human interventions, which thus not only shortened the construction time but also improved construction safety.

Innovations for Maintenance and Replacement of TBM Cutting Tools

Modular Construction Technique

The construction of the Tuen Mun-Chek Lap Kok Tunnel widely adopted modular construction technique. For example, the tunnel internal structure, the overhead ventilation duct slab, the parapet and the service gallery etc., all comprised a large number of prefabricated modules which greatly improved the construction efficiency and safety.

Assembling of Precast Slabs for Overhead Ventilation Ducts inside Tunnel

Service Gallery

To make good use of the space under the tunnel carriageway, a service gallery was provided under the carriageway to house public and also electrical and mechanical facilities. Drainage pipes, fire mains, power supply and control systems for some of the tunnel facilities were installed in the service gallery, so that part of the daily maintenance work can be carried out at the same time during the tunnel operation. This arrangement allows more flexibility for regular maintenance and greatly reduces the risk of tunnel closure due to emergency repairs. Besides, electric vehicles are provided for commuting inside the gallery to improve the efficiency of regular maintenance of the utilities.

First Sub-sea Tunnel with Service Gallery for Electrical and Mechanical Installations in HK

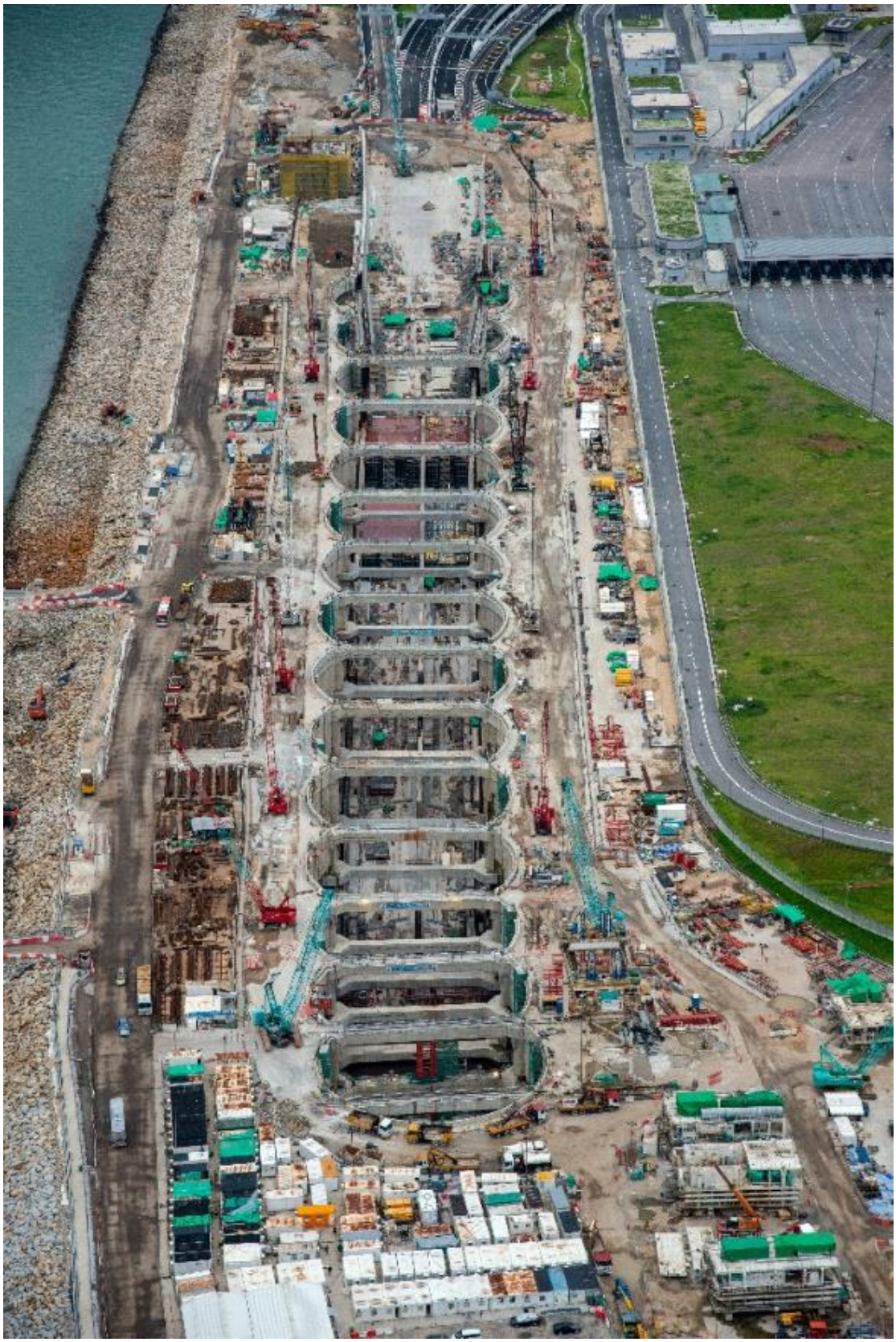
Cross Passage Construction

To provide a safe means of egress for road users in case of an emergency, a total of 57 cross passages linking the two tunnel tubes of varying length from 8 m to 13m were provided every 100 m. The construction of cross passages was particularly challenging as they had to be built under the sea at a pressure of up to about 6 bar. Instead of adopting a ground freezing technique, the project team developed an innovative pipe-jacking method using, for the first time in the world, a 'mini' (3.6 m diameter) slurry TBM for the construction. This ground-breaking mechanised solution allowed controlling the production schedule while minimising exposure to geological risks. Construction time was also greatly reduced.

Breakthrough of Mini-Tunnel Boring Machine at Cross Passage

Caterpillar Cofferdam

The project team adopted the largest caterpillar diaphragm wall structure in Hong Kong. It resisted the lateral pressure, transferring the force to the heavy duty “Y-Panels” as temporary lateral supports. As compared to the conventional diaphragm wall, the caterpillar diaphragm wall reduced large amount of temporary supports, maximised unobstructed construction space and minimised the need for ground treatment works.



Largest Caterpillar Cofferdam Structure in Hong Kong – Cut and Cover Tunnel at Southern Landfall

Structural Health Monitoring System

A structural health monitoring system (SHMS) consisting of the sensory system and auto alert system was installed in the Tuen Mun-Chek Lap Kok Tunnel to allow rapid and real-time assessment of its state of health and to optimise the operational and maintenance activities of the tunnels.

Mobile Application for Monitoring Fire Status

The project team developed a mobile application for fire event notification of the tunnel as an enhancement to the communication and emergency response for fire incidents. As soon as a fire is detected in the main fire alarm panel, the system automatically generates notifications to the relevant frontline staff of the tunnel operator indicating the location of the fire via the mobile application for prompt actions.