

全球首創「智能隧道質量檢測系統」

The World's First Smart Tunnel Inspection System



The "3S Tunnel Defect Inspector", jointly developed by the CEDD's Trunk Road T2 project team, their consultants Hyder-Meinhardt Joint Venture, and the Hong Kong Productivity Council, is the world's first tunnel inspection system using drones coupled with on-board artificial intelligence processing technologies. The invention was conferred a Silver Medal at the International Exhibition of Inventions of Geneva 2022, and won the 2022 R&D (Research and Development) 100 Awards ("Software/Services" category), the latter widely referred to as "the Oscars of Innovation". The parties are granted a patent for the technology.

The lining of the 2.4 km long T2 twin subsea tunnels, which constitutes the main structure, is composed of precast concrete segments. To ensure construction quality, conventionally the inspection team needs to conduct close visual checking of the installed lining segments one by one at height on elevated platforms, and record the findings manually.

With the innovative "3S Tunnel Defect Inspector" system, inspectors can stay on the ground, fly the drone and activate the automatic camera-positioning and photo-shooting functions to capture high-resolution images of each segment. The on-board micro-computer equipped with artificial intelligence (AI) capabilities carries out instant defect identification, and exports the inspection outcome to the tunnel BIM (Building Information Modelling) model to compile digital inspection reports. The innovation greatly enhances the efficiency, precision and safety of the inspection operations.

「智能隧道質量檢測系統」由土木工程拓展署「T2主幹路及茶果嶺隧道」工程團隊、安誠—邁進聯營顧問公司及香港生產力促進局共同研發，是全球首個採用無人機搭載人工智能處理技術的隧道檢測系統，榮獲2022年「日內瓦國際發明展」銀獎，及有「創科界奧斯卡」美譽的2022年「百大科技研發獎」(「軟件/服務」類別)，研發隊伍並取得該技術的應用專利。

T2主幹路一段長約2.4公里雙管海底隧道的主結構(又名「隧道襯砌」)，是以混凝土預製組件砌建而成。為確保施工質量，在裝設完成後，工程人員一般需置身高台，近距離以目測方式逐一檢測襯砌件，並以人手記錄檢測結果。

利用「智能隧道質量檢測系統」，工程人員可於地面控制無人機，在襯砌件前面啟動自動相機定位及拍攝功能，高清拍攝整塊襯砌件的表面，並即時以無人機上的人工智能微型電腦進行缺損偵測，及連接隧道的建築信息模型，整合出數碼檢測報告。這項創新技術能大大提升檢測工序的精準度、效率及安全性。



T2主幹路 悉心籌劃 用心推展

Trunk Road T2 Meticulous Planning Thoughtful Implementation

啟德發展與T2主幹路 Kai Tak Development and Trunk Road T2

啟德發展計劃規模龐大，項目多元。土木工程拓展署致力落實各項基礎建設，及統籌發展項目，令其相互配合，有序推展。

連繫啟德發展區與東九龍的T2主幹路及茶果嶺隧道(合稱「T2主幹路」)，是上述基建的關鍵一環。T2主幹路屬六號幹線的中間部分，全長3.4公里，當中3.1公里為隧道，隧道走線緊貼現已投入服務的香港兒童醫院。

因應T2主幹路工程龐大，加上施工時間與毗鄰的新急症醫院相約，T2工程團隊特別作出了悉心安排，盡量減少工程對香港兒童醫院及市民可能構成的影響。

Kai Tak Development (KTD) is a project of mammoth scale and multiplicity. The Civil Engineering and Development Department (CEDD) oversees the delivery of various infrastructure items, and coordinates the developments for project implementation in a holistic manner.

Connecting Kai Tak Development Area with East Kowloon, Trunk Road T2 and Cha Kwo Ling Tunnel (collectively "Trunk Road T2") is a key element of the aforementioned infrastructure. Trunk Road T2 constitutes the middle section of Route 6. A 3.4 km long dual two-lane road, 3.1 km of it is in tunnels. The tunnel alignment runs closely along the Hong Kong Children's Hospital (HKCH) already in service now.

In view of the construction complexity of Trunk Road T2, and its concurrency in time with the adjacent New Acute Hospital, the T2 project team has made special arrangements to minimise the potential impact of the project on the HKCH and the public.





物流暢通 便利工程

T2主幹路的海底隧道以大量預製組件建造，施工關鍵之一，是確保順暢的工地物流，使預製組件及物料能源源不斷由前南面停機坪的存放區，運送至位於觀塘避風塘海底下推進的隧道鑽挖機。

承建商充分利用承昌道下已預先建成的地下道路，作為主要運輸通道。整條路線無需佔用地面公路，有效減免施工對區內道路的交通負荷，及對香港兒童醫院和公眾的影響。

Logistics for Efficient Construction

The subsea tunnels of Trunk Road T2 is constructed with a large number of prefabricated components. A key factor for efficient construction is to ensure smooth site logistics for unhindered delivery of tunnel lining segments and materials from the storage area at the former south apron to the tunnel boring machines (TBM) pressing ahead beneath the Kwun Tong Typhoon Shelter.

The contractor makes full use of the already constructed underground carriageway under Shing Cheong Road as the main transportation avenue. The entire route is separate from public roads, reducing very effectively the burden on local traffic and the impacts on the HKCH arising from the construction.

現時預製組件及物料運送路線 [需時僅3分鐘]

(經承昌道下已預先建成的地下道路，利用特別設計的多用途工程車，每次可運載九件預製組件，直達前方的隧道鑽挖機。)

Present tunnel lining segment and materials delivery route [travel time only 3 minutes]

(Through the already constructed underground carriageway under Shing Cheong Road, with specially-designed multi-purpose vehicles that can carry 9 prefabricated segments per trip directly to the TBMs at the forefront.)

若地下通道尚未建成，需途經公共道路的運送路線 [需時約15分鐘]

(受道路交通限制，運送卡車在公路上每程只能承載兩件預製組件，組件需先運至隧道鑽挖機啟動豎井，從地面逐一吊運至豎井底部後，再轉由多用途工程車送往隧道鑽挖機。)

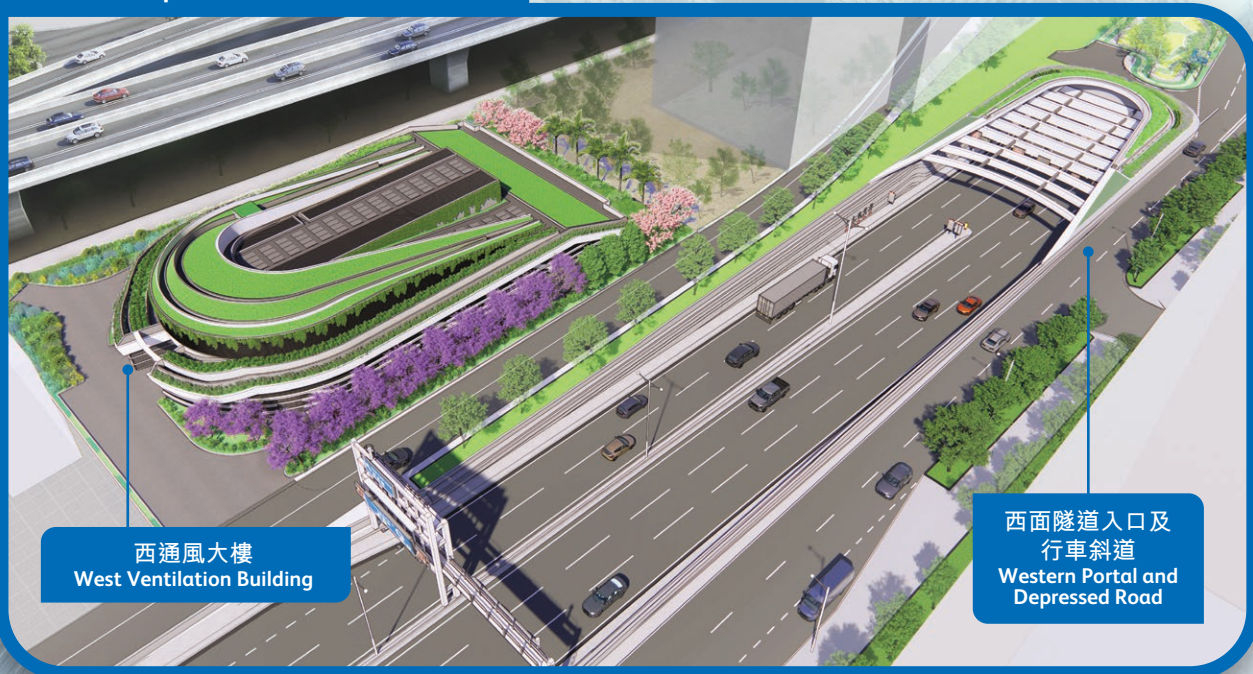
Delivery route via public roads in the absence of the underground carriageway [travel time about 15 minutes]

(Owing to road traffic restrictions, each delivery truck can only carry 2 segments per trip. The segments will first be delivered to the TBM launching shaft, to be hoisted down one by one to the bottom, for onward delivery by the multi-purpose vehicles to the TBMs.)

T2主幹路工程 Construction of Trunk Road T2



T2主幹路工程構想圖 Artist's Impression of Trunk Road T2



西通風大樓
West Ventilation Building

西面隧道入口及
行車斜道
Western Portal and
Depressed Road

2 預製組件存放區 Precast Segments Storage Area



運送預製組件的多用途工程車，穿梭於物料存放區及隧道鑽挖機之間
Multi-purpose construction vehicle that shuttles between the material storage area and the TBMs for delivery of prefabricated components and materials

3 設置屏罩 緩解噪音 Noise Enclosure



3 設置屏罩 緩解噪音 Noise Enclosure

設置屏罩 緩解噪音

隧道鑽挖機工程24小時無間進行，為減少對香港兒童醫院及附近設施的噪音滋擾，工程團隊於連接承昌道地下道路的行車斜道上加設了長28米、闊9米及高7米的隔音罩，有效降低音量。

Noise Enclosure for Impact Mitigation

TBM tunnelling is a 24-hour operation. In order to reduce noise nuisance to the HKCH, a large enclosure 28m in length, 9m in width and 7m in height has been erected over the depressed road leading to the underground carriageway beneath Shing Cheong Road, to control the noise level.

4 有蓋行人通道 Covered Walkway



4

加強連繫 提升暢達

- 在新急症醫院落成之前，行人從九龍灣往來香港兒童醫院需途經祥業街。工程團隊特意沿T2主幹路工地旁設置一條臨時有蓋行人通道，連接承昌道與啟福道大型商場附近的休憩公園，以加強香港兒童醫院與九龍灣一帶的連繫。
- 利用行人通道，從香港兒童醫院步行到九龍灣大型商場的時間可縮短約10分鐘。
- 通道備有通風和照明設施，為行人提供舒適的步行環境。

Pedestrian Connectivity Enhancement

- Until the completion of the New Acute Hospital, pedestrians travelling between Kowloon Bay and the HKCH have to route through Cheung Yip Street. To enhance connectivity, the Trunk Road T2 project team put in place a temporary covered walkway along the boundary of the Trunk Road T2 construction site, linking Shing Cheong Road and an amenity area on Kai Fuk Road near the large shopping mall.
- With this walkway, travel time from the HKCH to the major shopping mall in Kowloon Bay is shortened by some 10 minutes.
- The walkway is equipped with ventilation and lighting to enhance user comfort.

1 地下通道 Underground Passage



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周詳策劃 睦鄰共融

- 配合香港兒童醫院於2018年底啟用，工程團隊早於2015年先行展開擴闊承昌道和祥業街的工程，並提前建造T2主幹路位於承昌道下面長420米的部分，免卻香港兒童醫院啟用後在近距離施工的需要，亦免除相關滋擾。
- 有關工程已於2018年11月依期完成。

Thoughtful Planning for Impact Mitigation

- To dovetail with the 2018 commissioning schedule of the HKCH, the T2 project team commenced in 2015 the widening of Shing Cheong Road and Cheung Yip Street, as well as the advance construction of a 420-metre long underground segment of Trunk Road T2 beneath Shing Cheong Road, to avoid carrying out such works in close vicinity to the HKCH after its commissioning, and the related impacts arising.
- The above works were completed on time in November 2018.

T2主幹路走線
Trunk Road T2
Alignment