The Construction of Deep and Complex Basements and underground structures within extremely difficult urban environment

(Part 1)

by **Raymond W M Wong**

Examples of underground structures include:

- Basement of buildings
- Semi-basement with slope stabilization purpose
- Transport facilities such as railway station, tunnel and pedestrian subway
- Access or services shaft

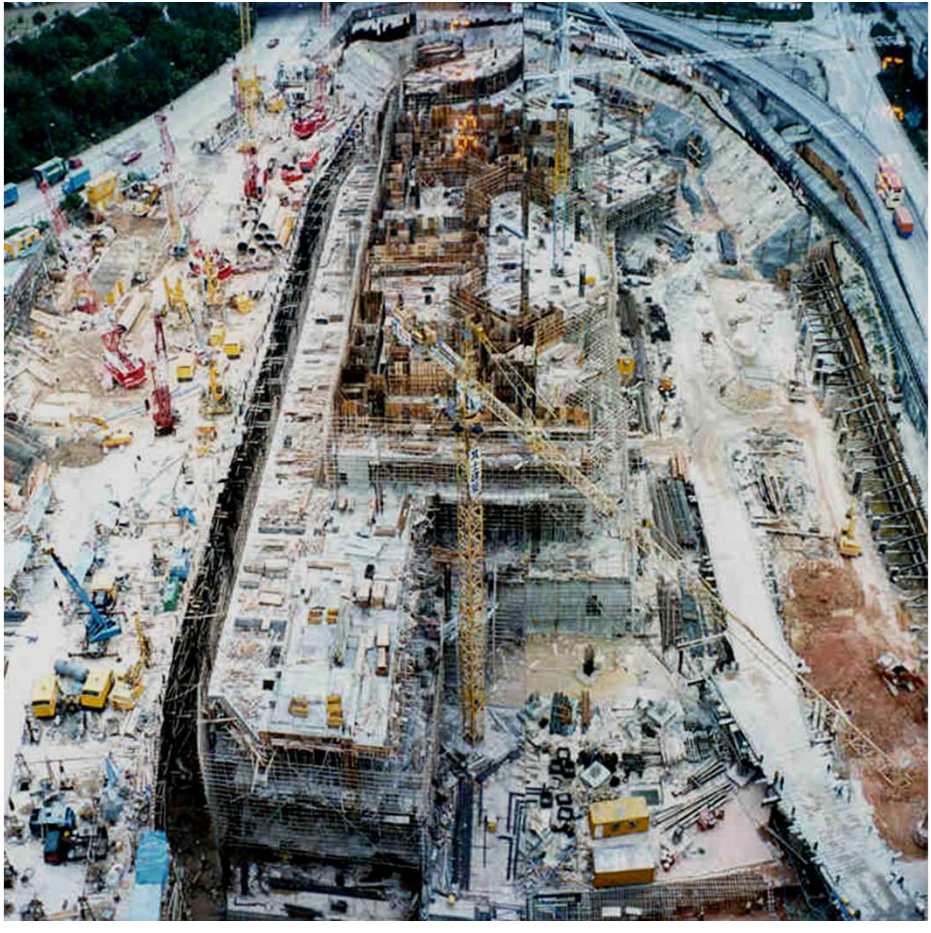
Attributes that affect the construction of deep basement:

1. Size of a site
2. Volume of work
3. Shape and Typographical conditions of site
4. Neighbourhood conditions of a site
5. Geotechnical conditions
6. Internal layout of the basement or other related structures
7. Availability of resources for the project
8. Availability of expertise skill
9. Appropriateness of the methods selected for the construction
10. Special performance requirements imposed

Under the built-environment of Hong Kong, a basement often may have other factors that make the work more complex, such as:

- working under very fast-track schedule.
- The location of the structure in extremely congested built-up area.
- Close to existing structures with potential hazards like old buildings, busy roadways, elevated carriageways, slopes or retaining structures.
- Close to sensitive underground facilities like the main drain, utility trenches, vehicular underpasses, pedestrian subways, or a metro line.
- Located in close proximity to a river bank, sea wall or harbour-front.
- Requiring to carry out several construction activities at the same time within the site. In some cases works like site formation, slope work, foundation, basement construction, or even part of the super-structures may be required to be carried out at the same.
- Sometimes, even a new basement is required to construct simultaneously to replace an old one

This situations will create very difficult coordination problems that involve various contractors and complicate the contractual position of the entire job.



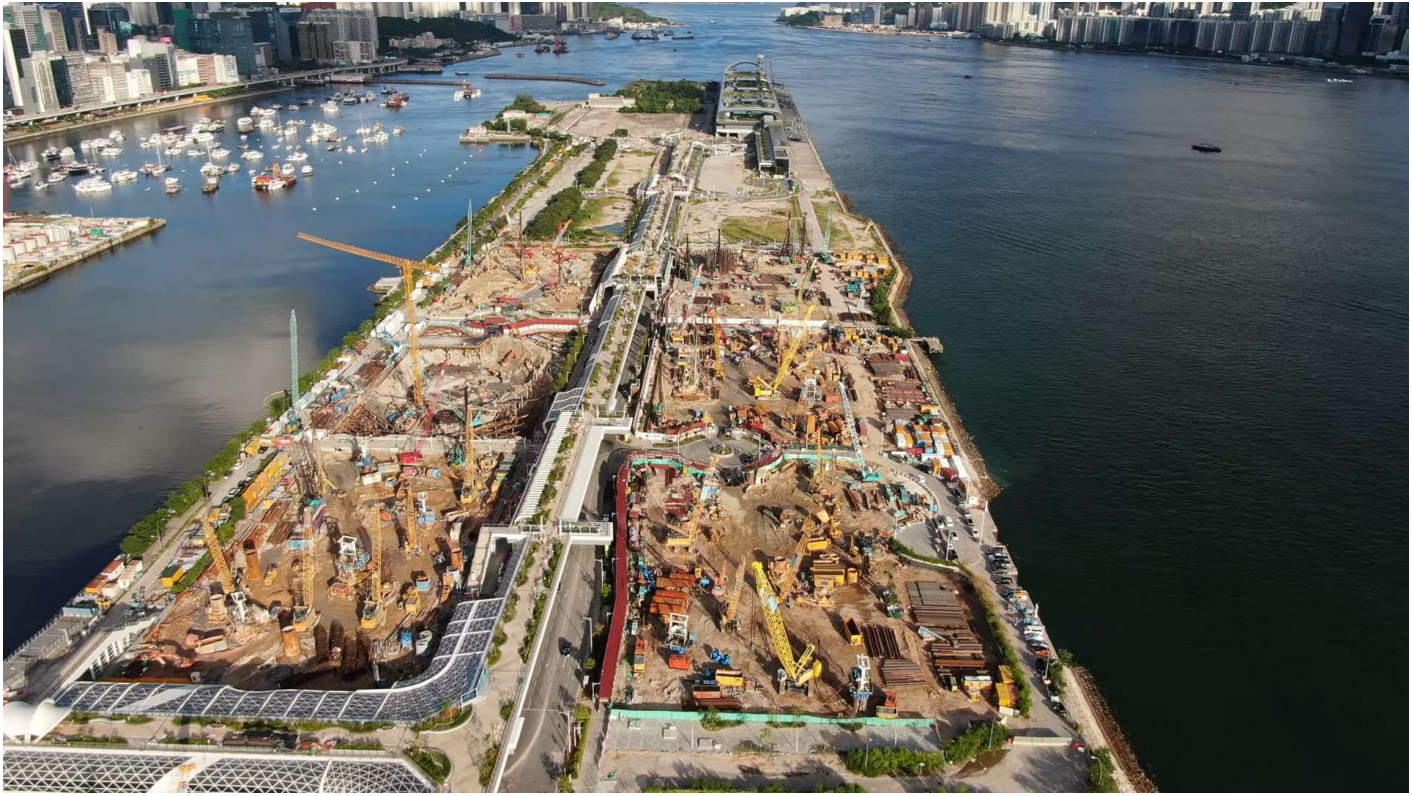
Examples of projects – working in close proximity of sensitive and unstable slope- the case of Hollywood Plaza

Basement Project in very congested urban environment – the Redevelopment of Kwong On Bank in Queen's Road Central, Central District, Hong Kong

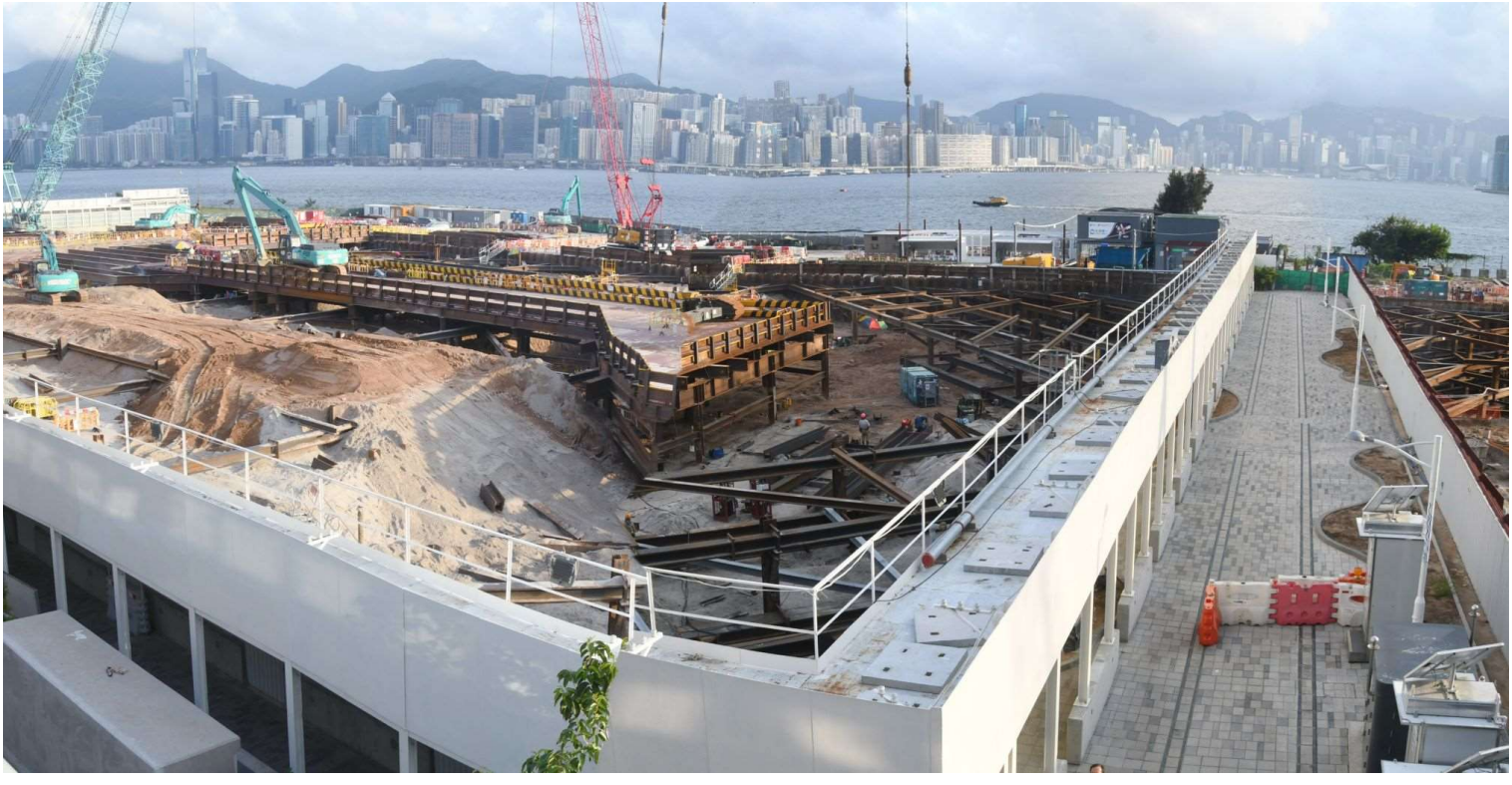
Basement Project in very congested and complicated urban environment

Examples of very difficult environment for constructing a substructure - Work in close proximity to seawall

Work in close proximity to seawall



Work in close proximity to seawall



Examples of very difficult environment for constructing a substructure - Work in extremely small site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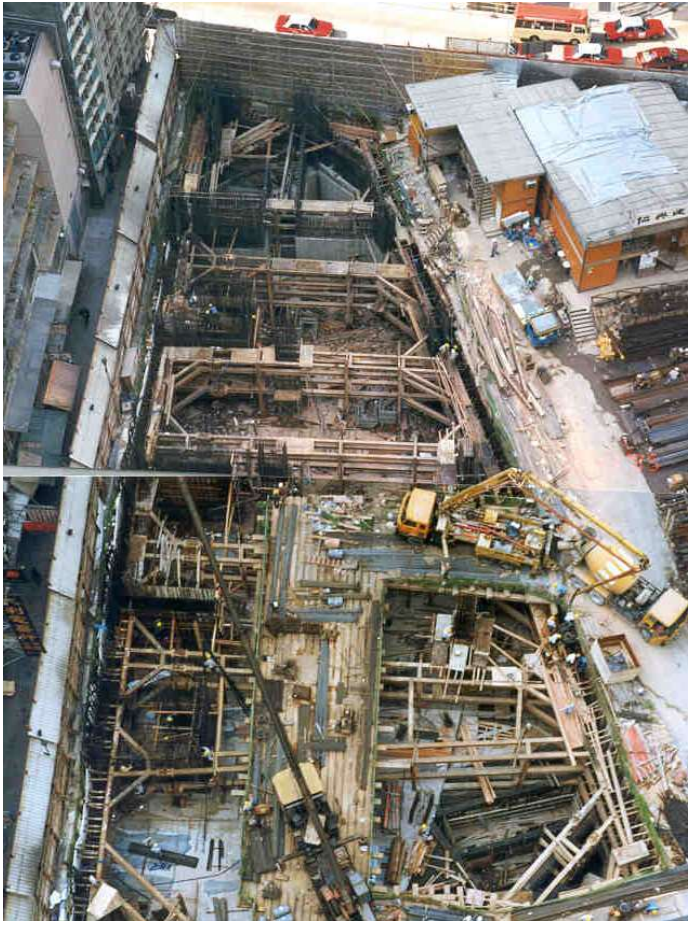
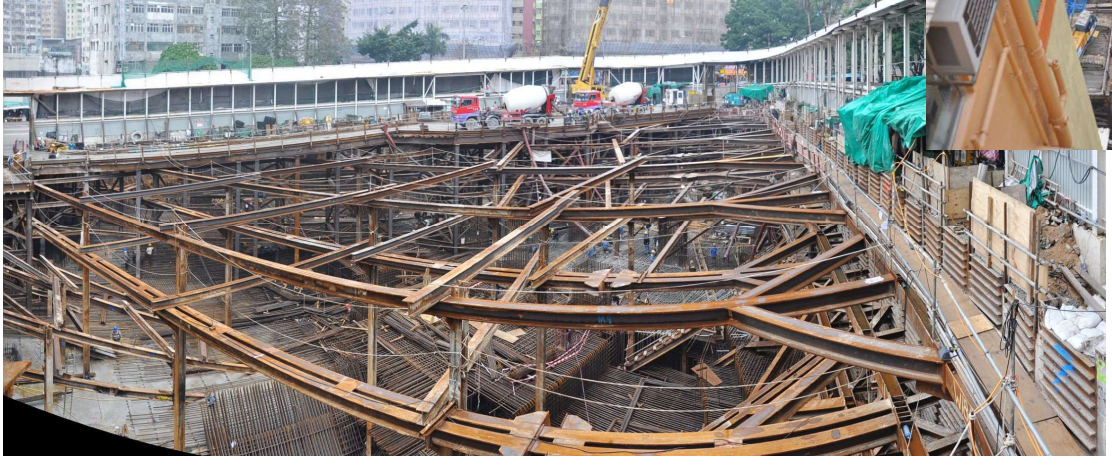
PARIS



Complicated soil support arrangement



Large-scale basement project involved very complex phasing planning

Site formation, slope work and basement construction work at the same time under carefully planned phasing arrangement

Yue Man Fong


信和置業
27218388

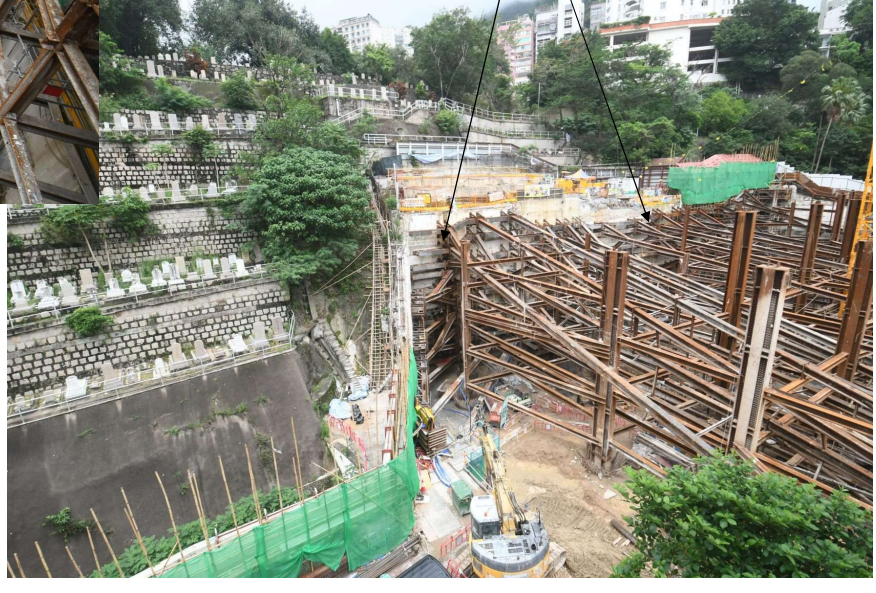
Complicated phasing arrangement in constructing a basement – demolition of the old basement and construct the new basement at the same time (Lee Garden Hotel redevelopment)

Demolish the old basement before construction of the new one – the case of Cheung Kong Center (former Hilton Hotel redevelopment)

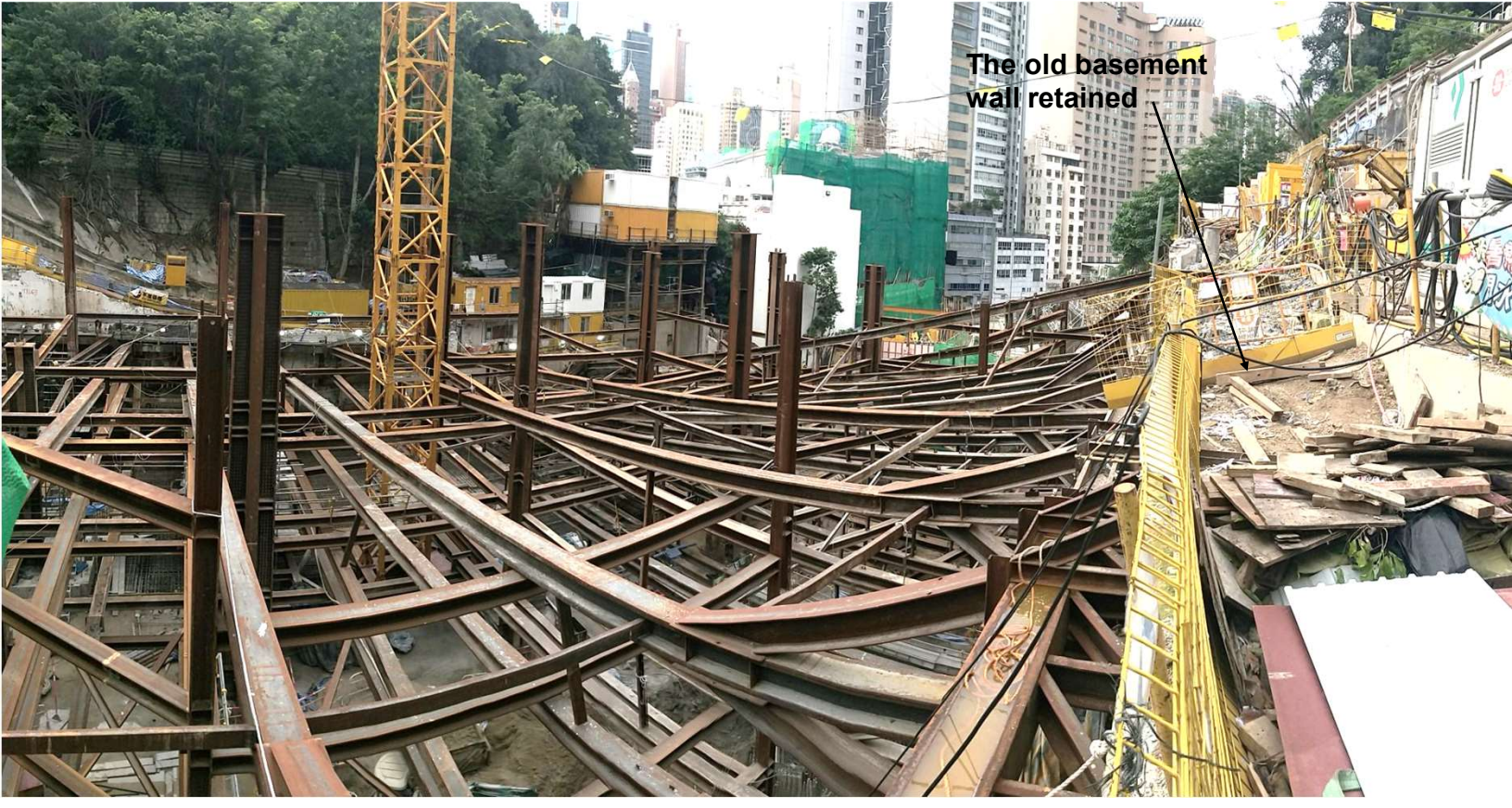
AIA HQ building in Stubbs Road before demolition in 2018

The case of AIA HQ building redevelopment in Stubbs Road

The old basement
wall retained



The case of AIA HQ
building redevelopment
in Stubbs Road


The old basement
wall retained

The new basement structure under construction within rows of strut frame

Cheung Kong Center - Foundation and Basement construction arrangement

A 60m diameter cofferdam lined with 1m-thick diaphragm wall was provided for the construction of the building core in advance. The cofferdam would be removed when constructing the basement structure

The main structure of CKC uprising from the cofferdam pit

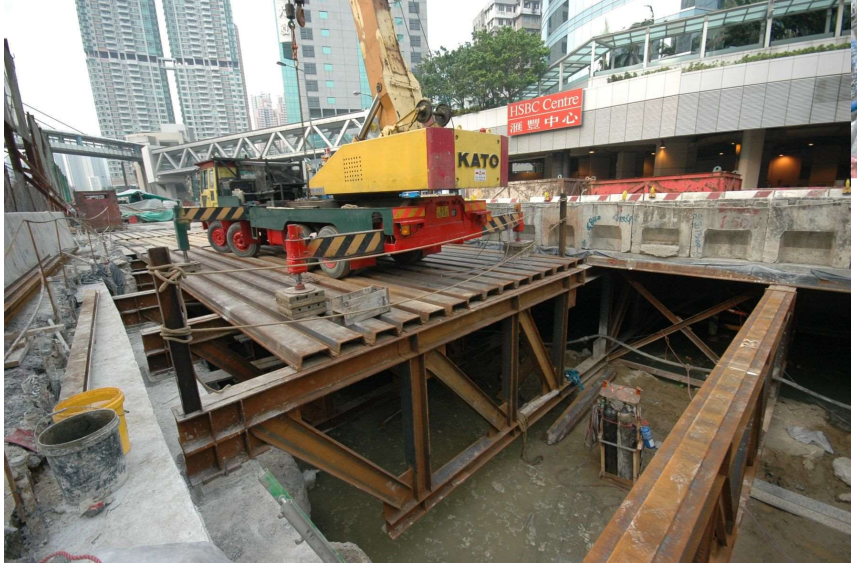
The Center - Foundation and Basement construction arrangement

The Center - Foundation and Basement construction arrangement

The main structure of The Center uprising from the cofferdam pit. The basement on the side was constructed afterward using top-down approach

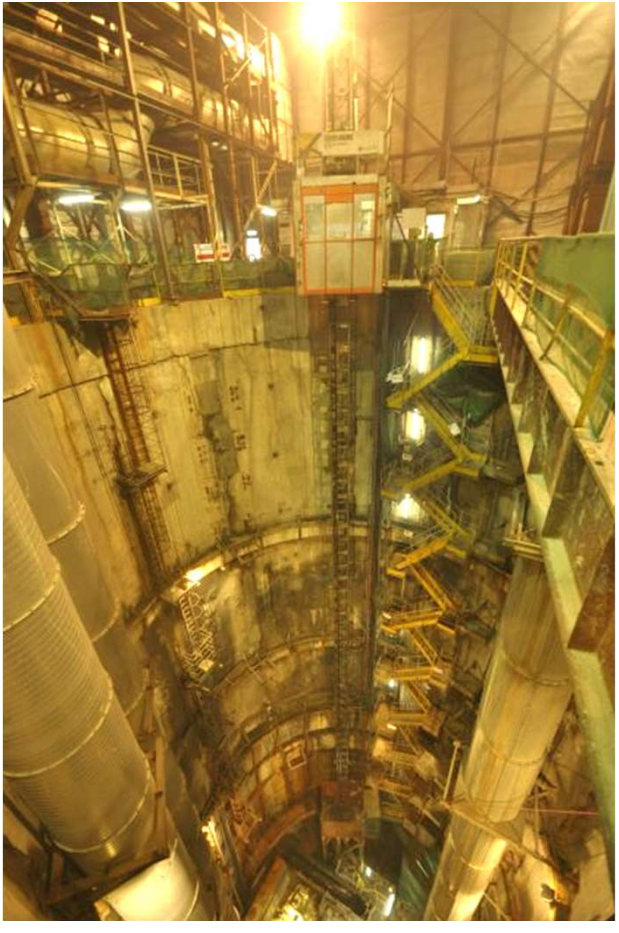
Complicated surrounding environment as seen in the TST East Station – underpinning to a section of pedestrian subway

Complicated surrounding environment as seen in the MTR Southern Kowloon Link (Jordon Section)



Example of servicing shaft providing access point usually from ground to work area deep below

Example of a servicing shaft providing access point usually from ground to work area deep below

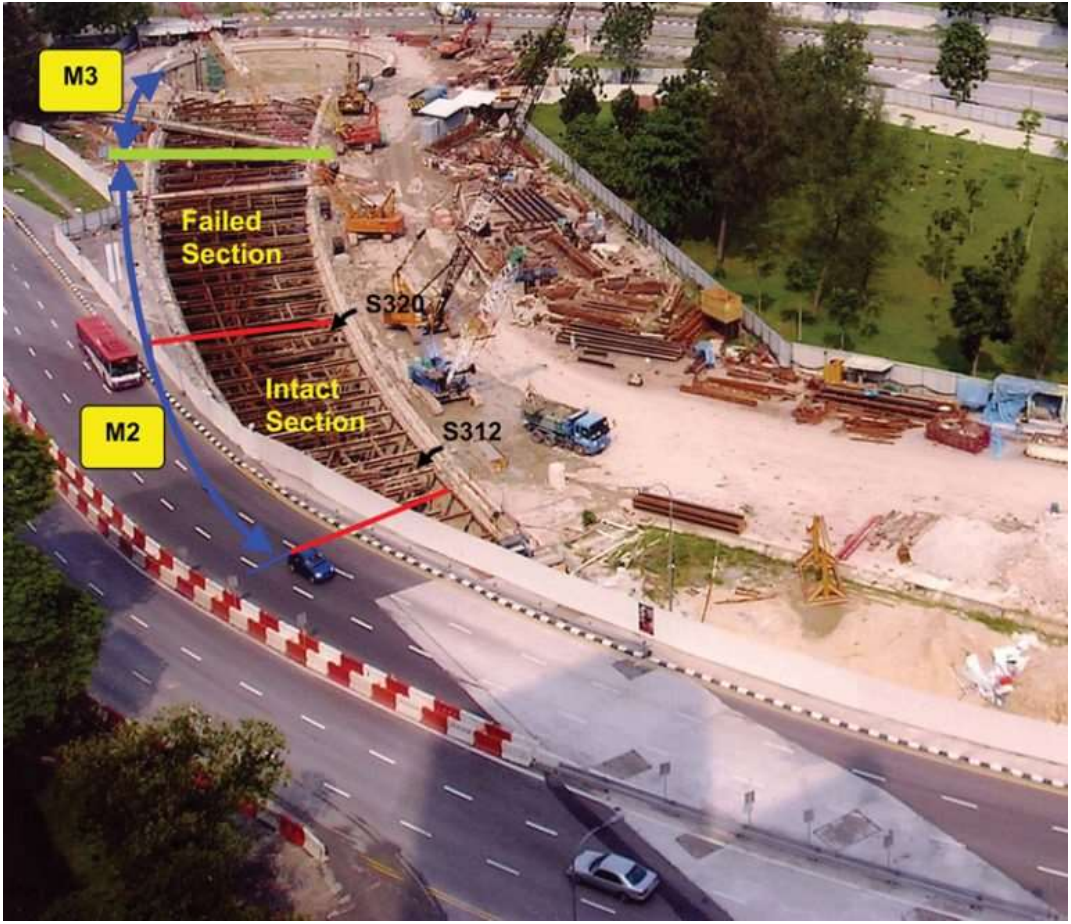


Launching shaft for T2 TBM

Common managerial problems identified in the construction of deep basement:

1. -Very expensive and time consuming in nature, often involved huge amount of work resources.
2. -Inconsistent and sensitive to the quality of planning and management of individual projects.
3. -Works are highly hazardous, both to human operatives working within and the life and properties of third parties that within the vicinity.
4. -Works involved a lot of managerial challenges. Such as, in the preparation of a highly efficient working programme, monitoring and rectifying the progress of works in case problems arising, or in resources planning where materials, labours & plant equipment are involved.


A row of sheet pile wall about 40min length and 5m deep collapsed during excavation for the basement
DES VOEUX ROAD CENTRAL
QUEEN'S ROAD CENTRAL
CHATER ROAD
Pedder Street
Ice House Street
Duddell Street
Wellington Street
Stanley Street
D'aguilar St
Lan Kwai Fong
Wyndham St
Arbuthnot Road
JACKSON ROAD
EDINBURGH PLACE
Jardine House
World Wide House
Chater House
St George's Building
Mandarin Oriental, HK
Statue Square
The Cenotaph
Alexandra House
Prince's Building
Gloucester Tower
Central Building
The Landmark
Mandarin Oriental Hotel
Bank of East Asia
HSBC Main Building
Bank of China
The Court of Final Appeal
New World Tower
(with car park)
Shanghai Tang
Dina House
Ruttonjee House
Printing Hse
Justice Place (West Wing)
Cheung Kong Centre
The Centrium
Fringe Club
The Bishop's House
St Paul's Church
Theological College
Star Ferry Car Park
Wheelock House
Tak Shing House
Chinachem
Melbourne Plaza
Manning Hse
Loke Yew
The Loop
Sitting-out Area
Entertainment Building
South China
Central Tower
Yip Fung
The Plaza
LKF Tower
Mini Hotel
Arcade Under



A temporary retaining wall for the Nicoll Highway MRT project under construction collapsed (2004)

There are many methods to construct large-scaled and deep basement/underground structures

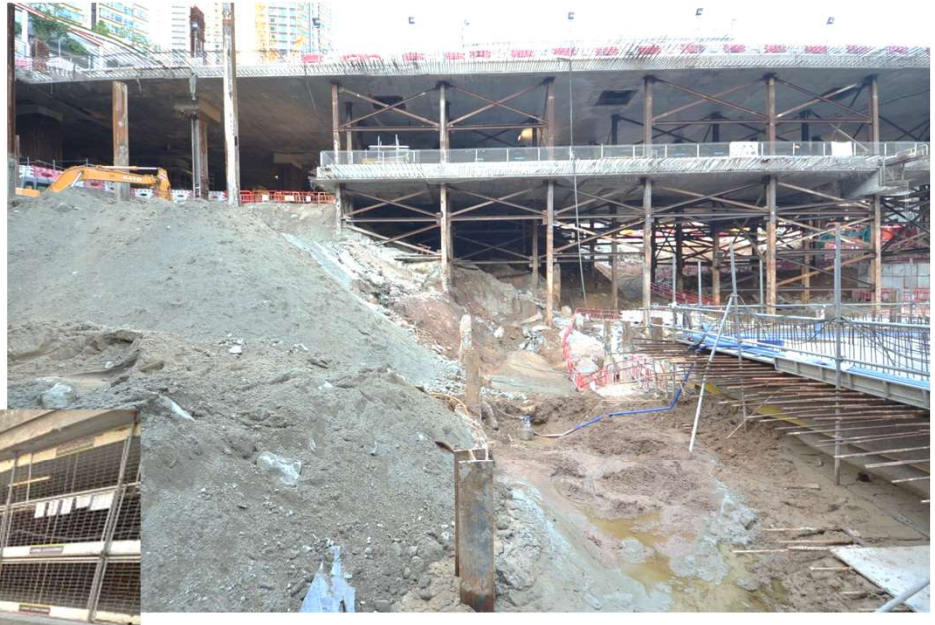
1. -Deep basement can be constructed using some traditional ways such as **cut & fill or bottom up methods**. These methods are relatively economical and effective when dealing with certain jobs which are simpler in nature.
2. -On the other hand where basement is going deeper and the surrounding environment getting more complex and sensitive, **top-down or combined method** may be a more appropriate option to construct.


Open-cut method to construct

Open-cut method to construct the MTR linking tunnel to the Kowloon Station

Open-cut followed by top-down method to construct the MTR Kowloon Station

Construction using top-down arrangement, in various segmented sections



An extremely large-scale and complex project –

Central Reclamation in 1995

An extremely large-scale and complex project – Construction of the International Finance Centre Phase II

(Top-down for the podium portion and bottom up for the building core portion)

An extremely large-scale and complex project – Construction of Terminus for HK Express Rail (combination of open-cut, bottom-up and top-down)

The terminus site (south) as seen in mid 2012

Aerial view of the Express Rail Terminal at West Kowloon in late 2014

Overview of site as in August 2012

Overview of site as in May 2013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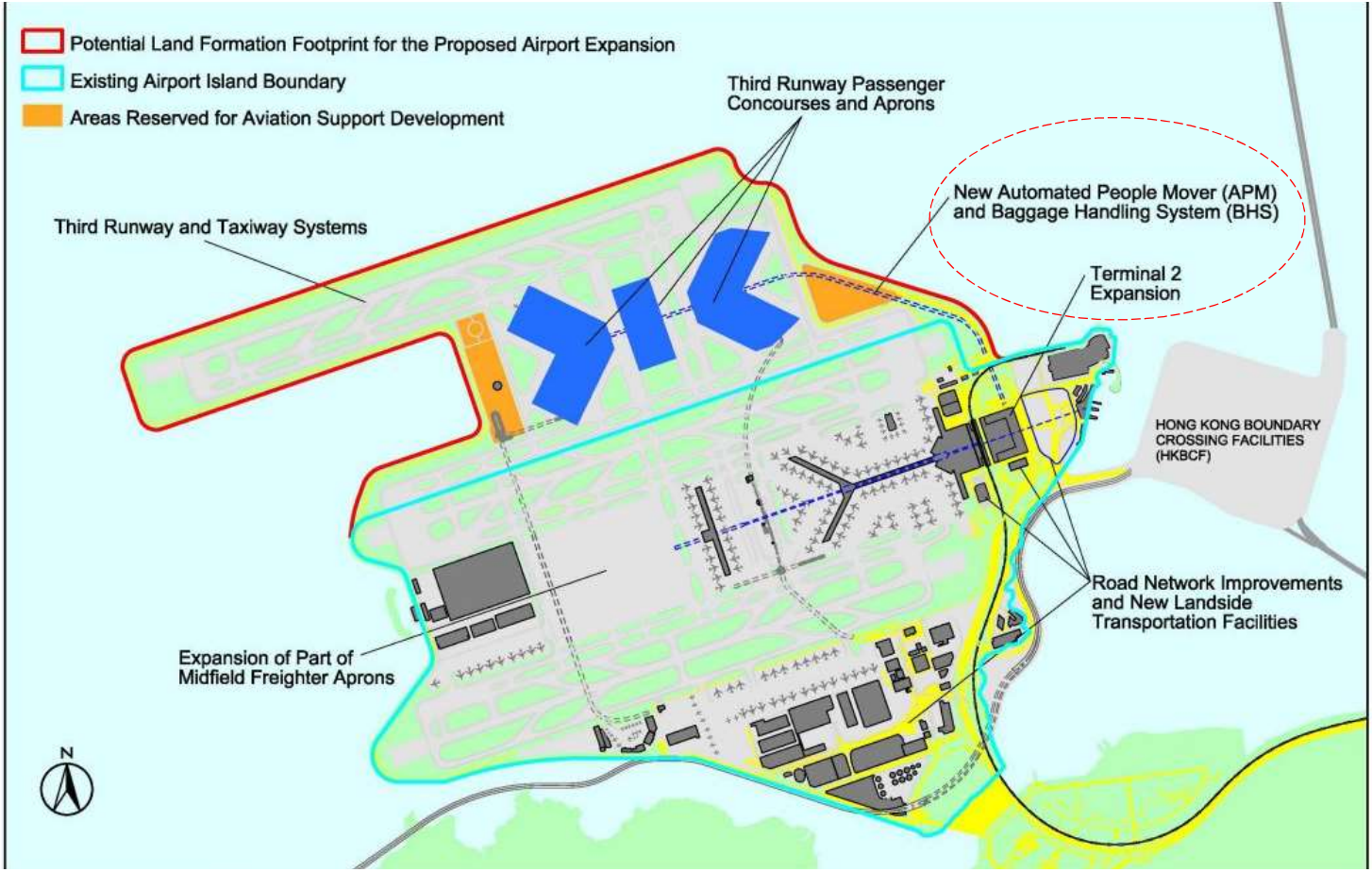
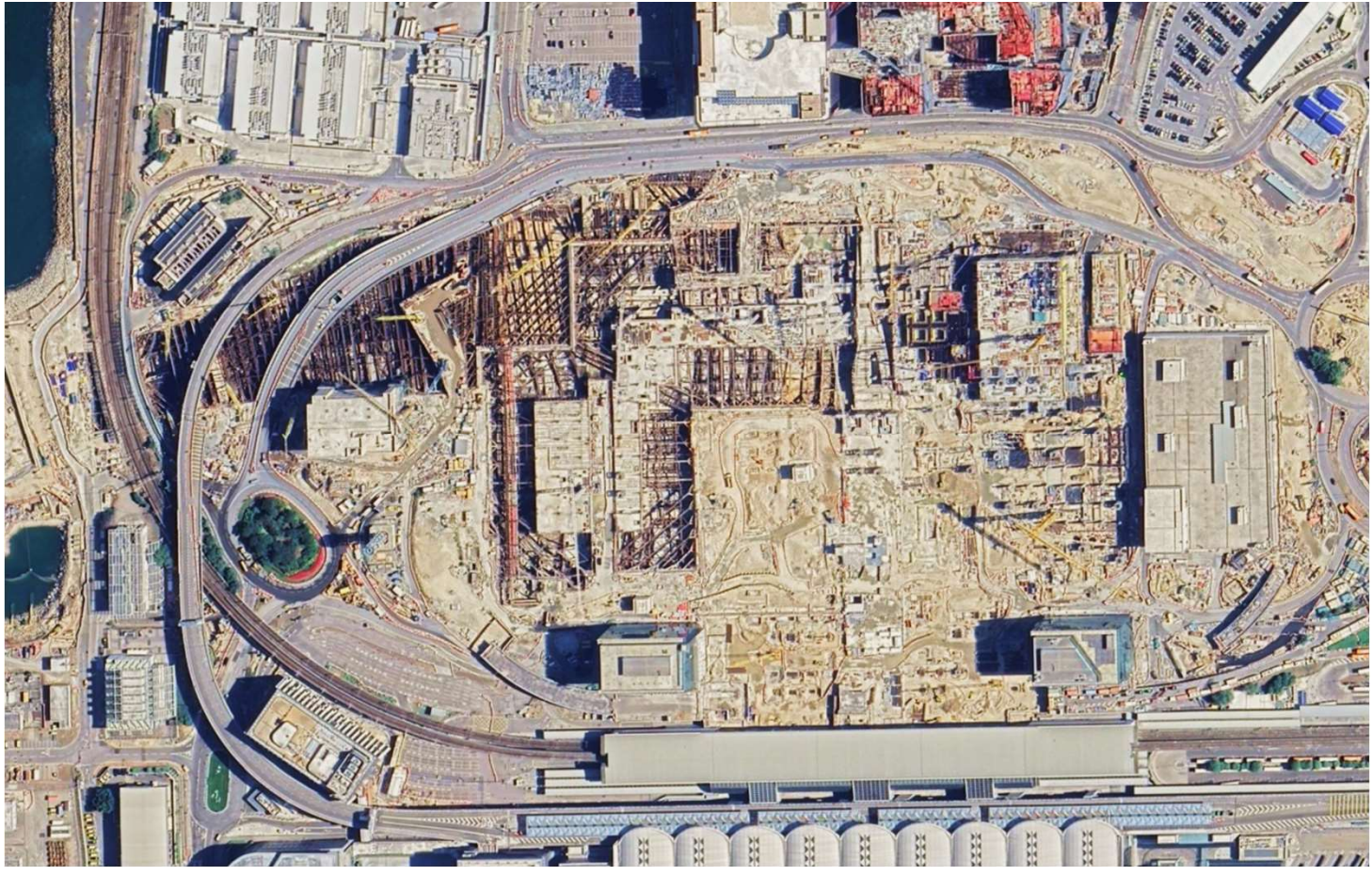

Potential Land Formation Footprint for the Proposed Airport Expansion
Existing Airport Island Boundary
Areas Reserved for Aviation Support Development
Third Runway Passenger Concourses and Aprons
New Automated People Mover (APM) and Baggage Handling System (BHS)
Third Runway and Taxiway Systems
Terminal 2 Expansion
HONG KONG BOUNDARY CROSSING FACILITIES (HKBCF)
Road Network Improvements and New Landside Transportation Facilities
Expansion of Part of Midfield Freighter Aprons
N


Hong Kong-Zhuhai-
Macao Bridge
T2 Concourse
Terminal 1
Terminal 2
11 SKIES
Airport City Link
Hong Kong-Zhuhai-
Macao Bridge
Hong Kong Port


Previous Terminal 2

An extremely large-scale and complex project – Construction of Terminal 2 building in CLK
(combination of open-cut, bottom-up and top-down)



An extremely large-scale and complex project – Re-Construction of Terminal 2 building in CLK
(demolition of existing T2, later combination of open-cut, bottom-up and top-down to construct the new structure)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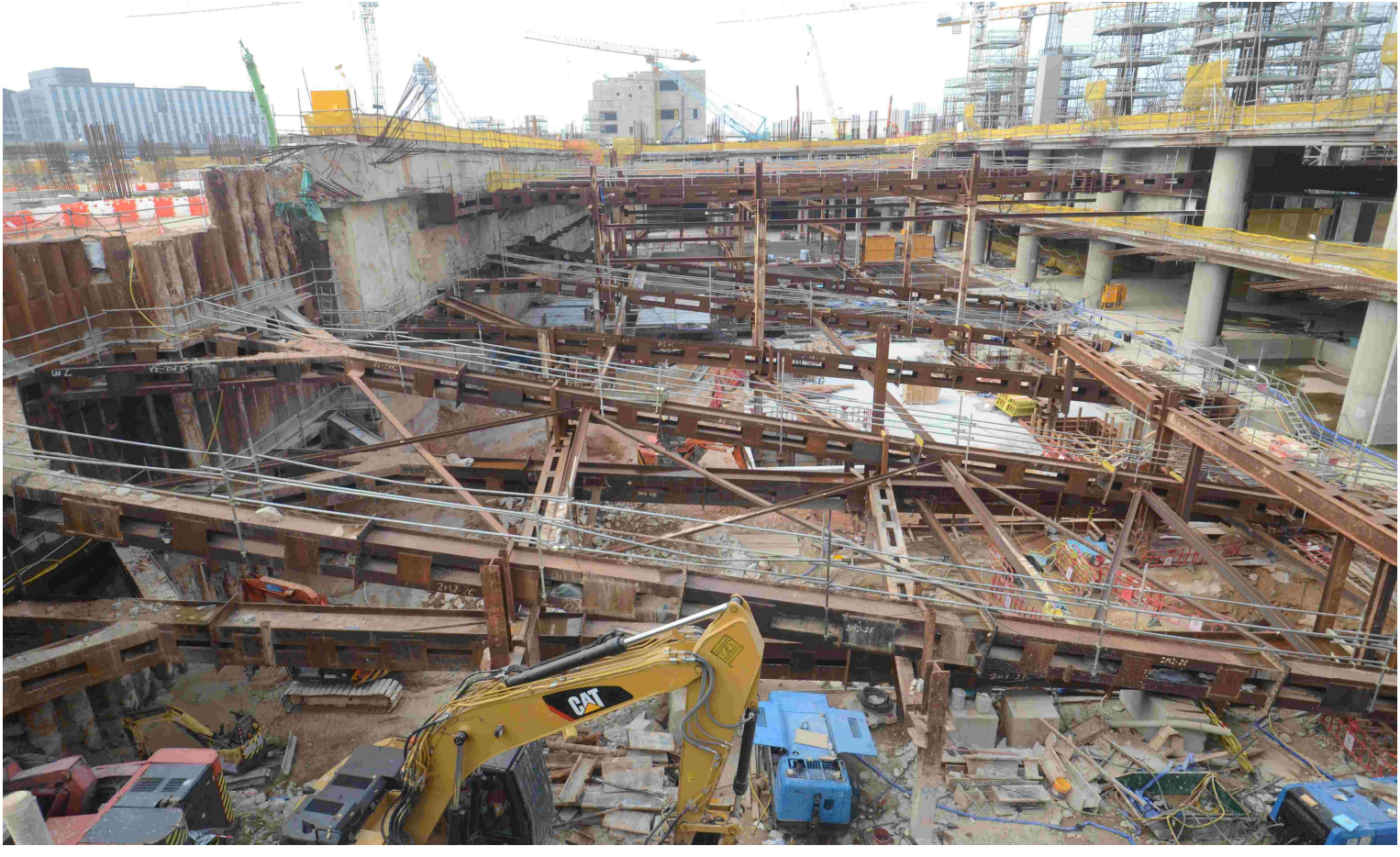
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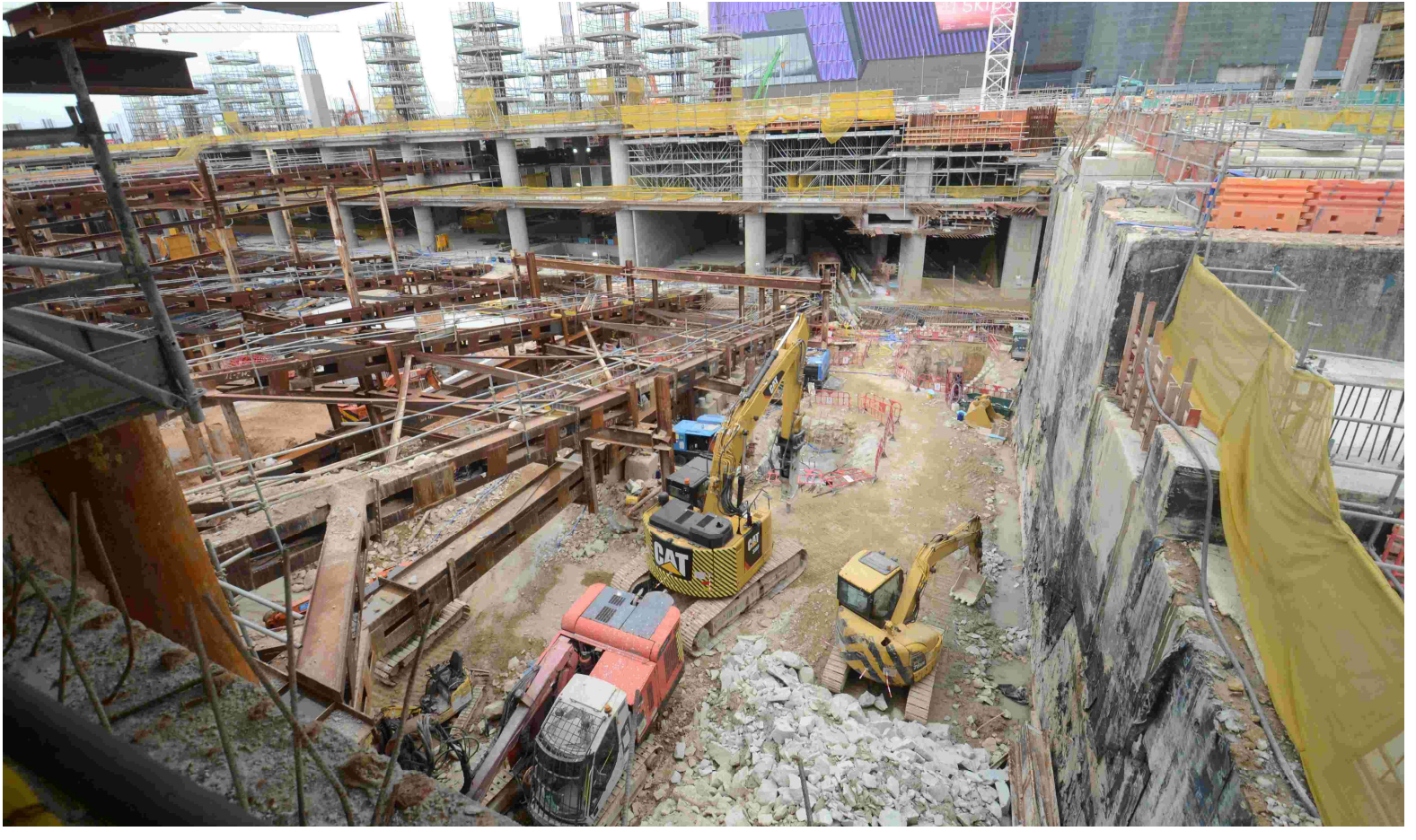
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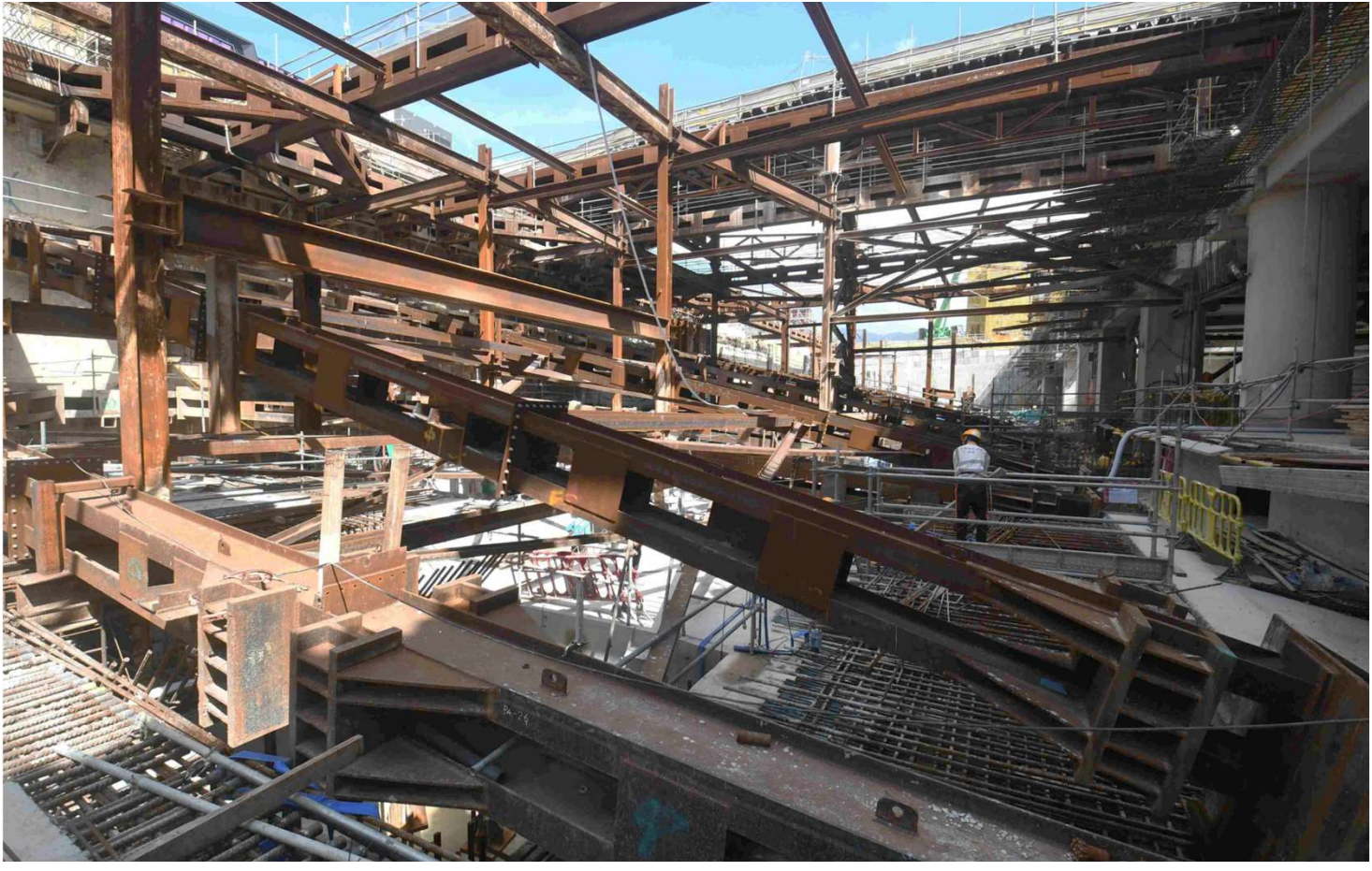
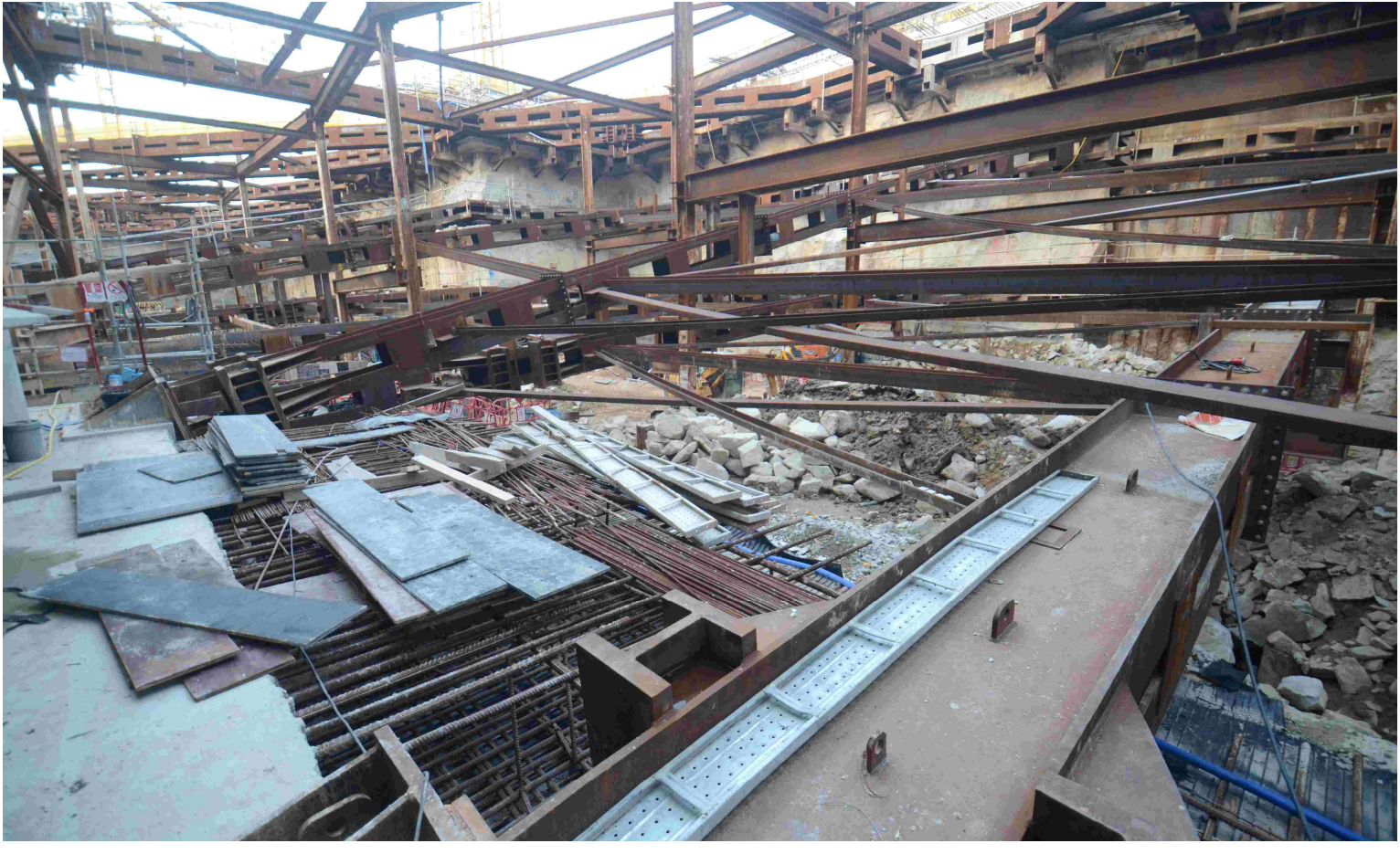
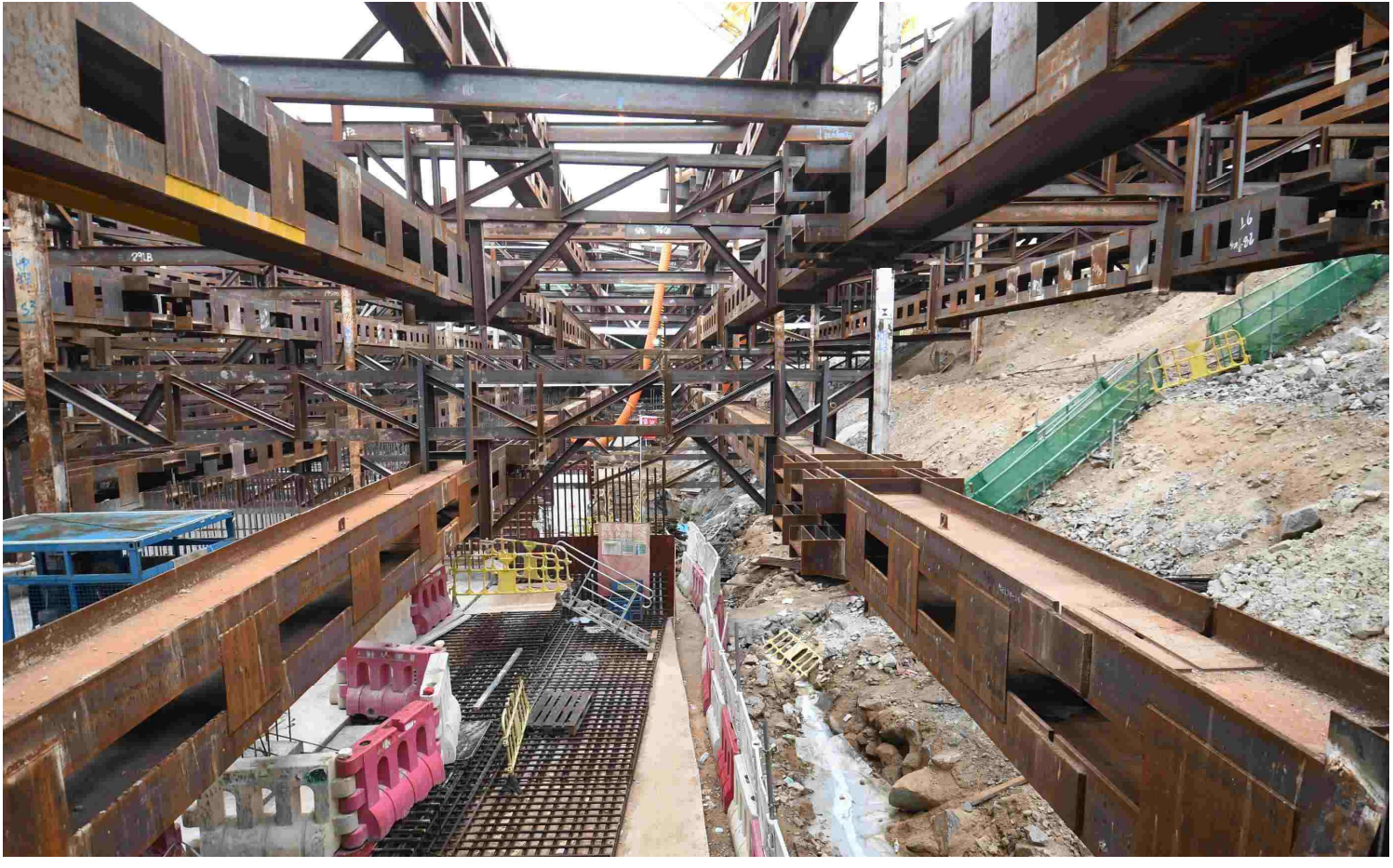
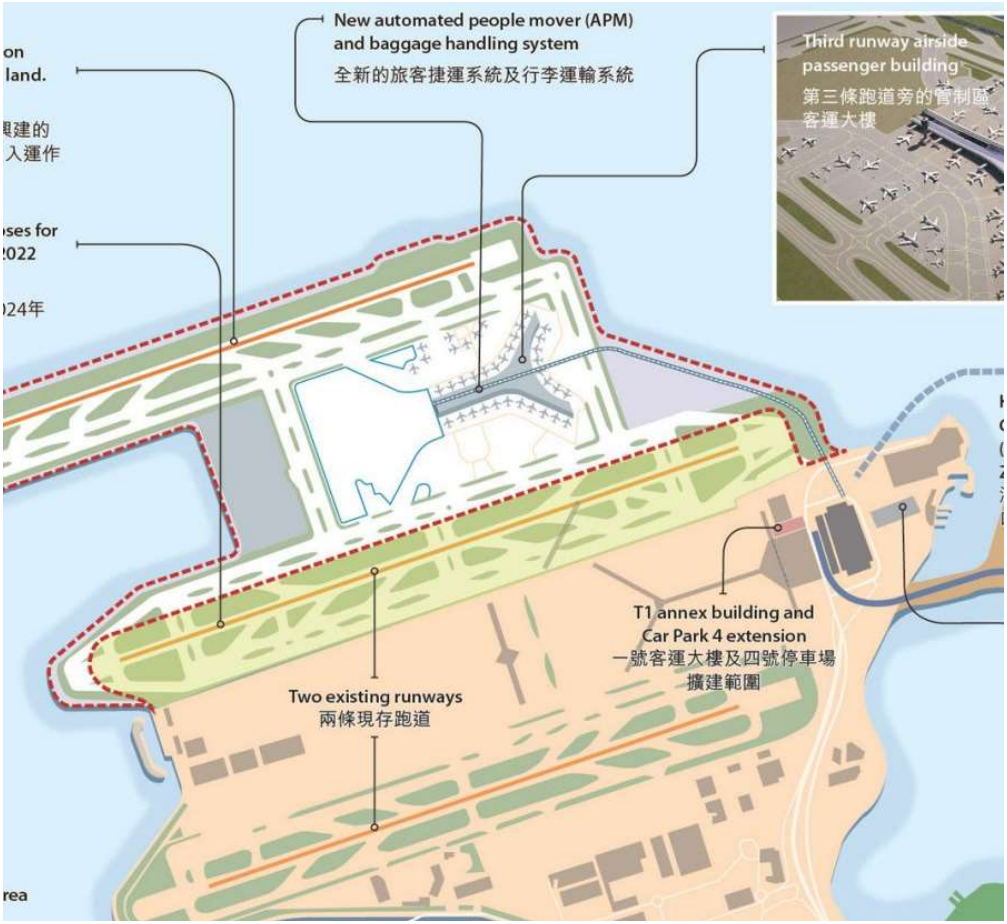
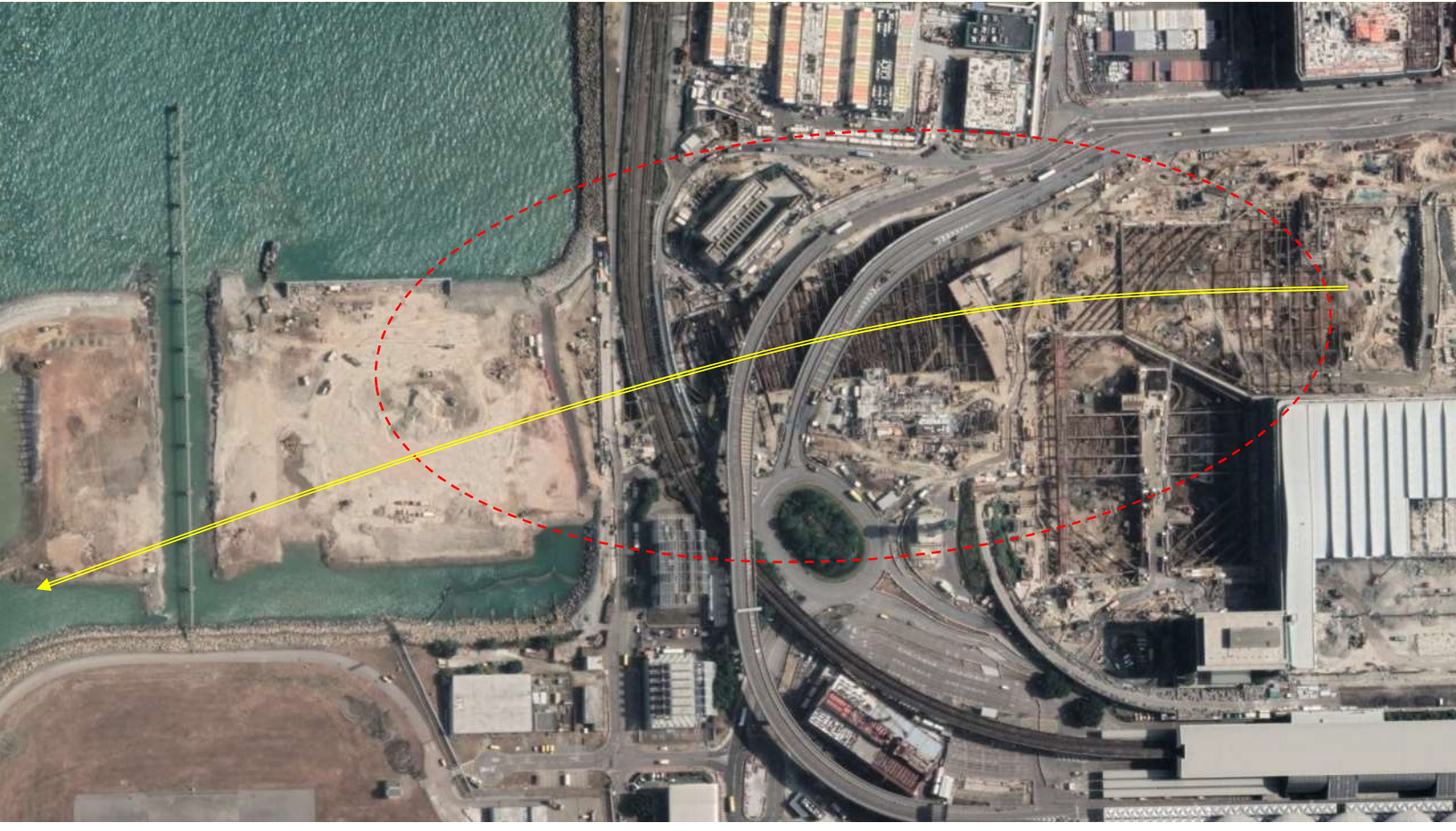
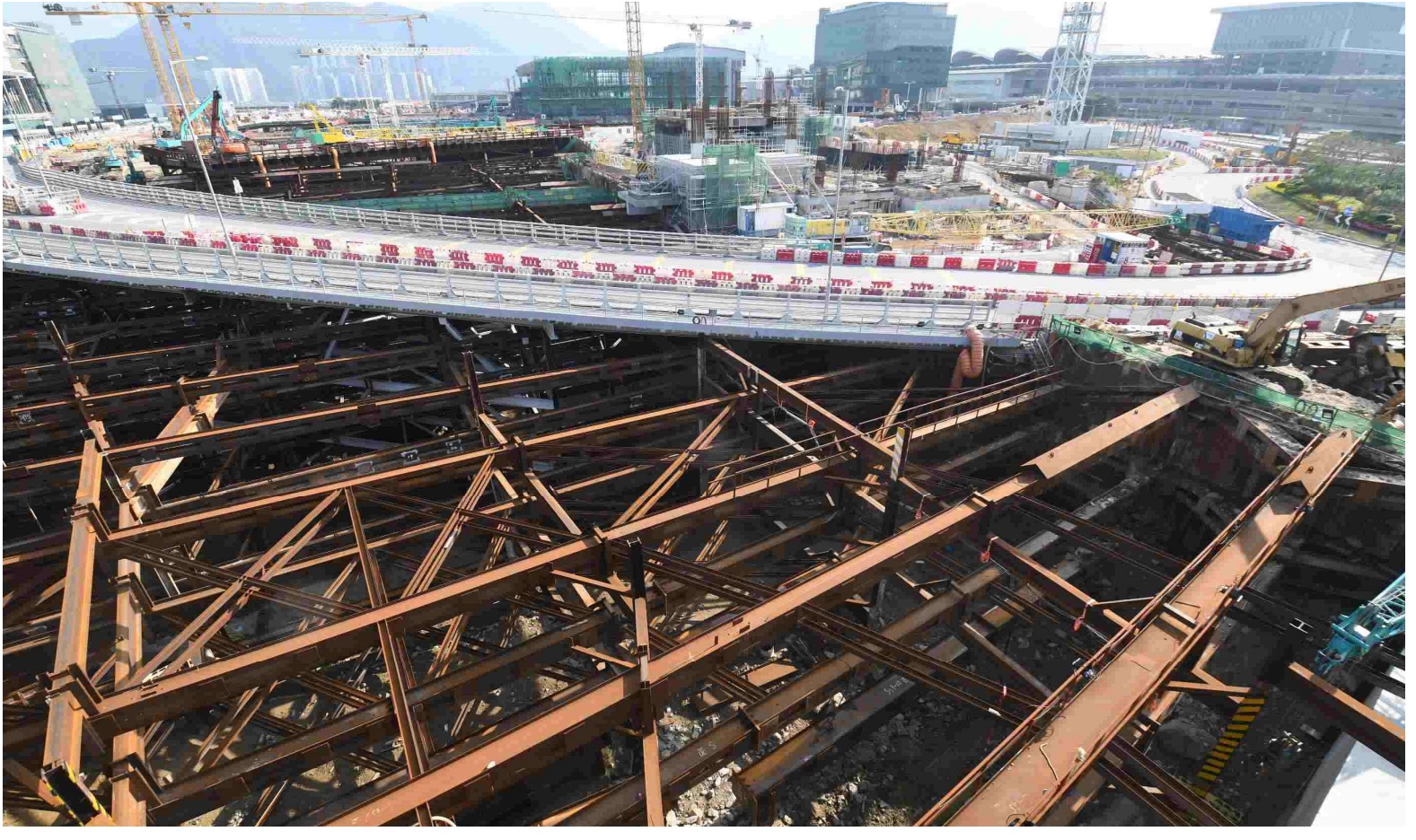







New automated people mover (APM) and baggage handling system
全新的旅客捷運系統及行李運輸系統
Third runway airside passenger building
第三條跑道旁的管制區客運大樓
T1 annex building and Car Park 4 extension
一號客運大樓及四號停車場擴建範圍
Two existing runways
兩條現存跑道

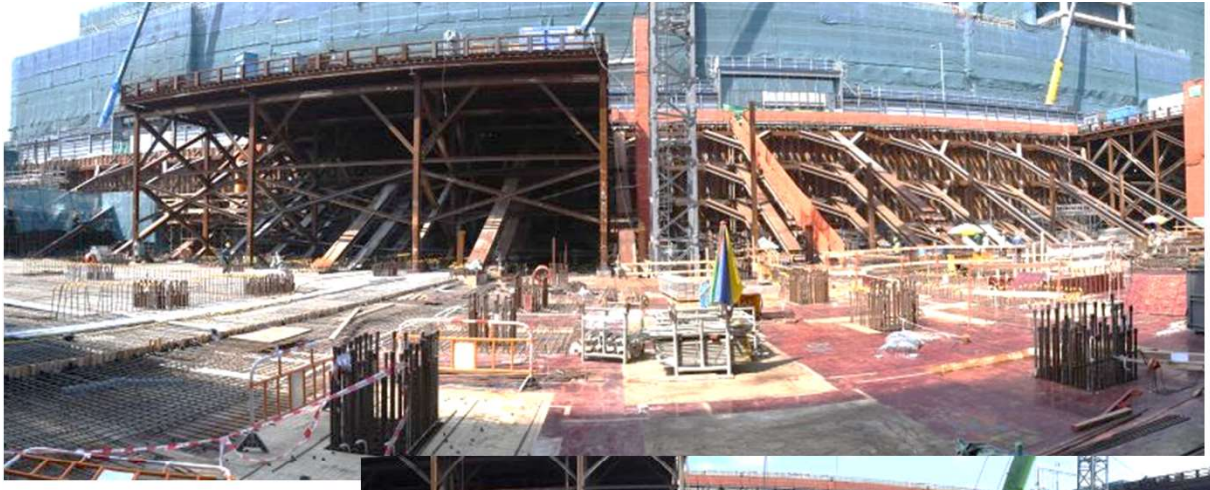





Examples of very complicated phasing arrangement during basement construction, the Sky Pier (海天碼頭) in CLK


Marriott

2017



Examples of very complicated phasing arrangement during the basement construction – Sky City in Chek Lap Kok

End of Part 1 Presentation