MTR Shatin to Central Link
Contract 1121
Immersed Tube Tunnels
Hong Kong, China

Fumihiro Aikawa
Construction Manager – MTR Corporation Limited

John McLeod
Project Director, Penta-Ocean – China State JV
Introduction of SCL

Existing Journey Time

<table>
<thead>
<tr>
<th>Route</th>
<th>Existing Journey Time</th>
<th>Estimated Journey Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hung Hom &lt;-&gt; Admiralty</td>
<td>About 18 mins</td>
<td>About 5 mins</td>
</tr>
</tbody>
</table>

Miami, USA 18th November 2019
Procurement Process
Early Contractor’s Involvement

Stage 1 Tender (Feb-Apr 2014)
- Technical Submission
- Periodical Workshop with Each Tenderer

Stage 2 Tender (Jun – Sep 2014)
- Technical Submission + Financial Submission
- Select 3 Tenderers from 4
- Periodical Workshop with Each Tenderer

Early Liaison with Each Government Authority for Contractor’s Alternative Proposals keeping confidentiality

Award Contract (Dec 2014)
Scope of works: Design and Construction of 1.66km of Immersed Tube Tunnel under Victoria Harbour including 94m of cut and cover tunnel at the Northern Landfall and associated ventilation building.

Client: MTR Corporation Limited
Owner: Hong Kong SAR Government
Client’s Designer: AECOM
Contractor: Penta-Ocean – China State JV
Contractor’s Designer: Arcadis supported by Capita
Contract Value: HKD 4,350M (€500M)
Contract Duration: Dec 2014 – April 2019

Other key stakeholders: Marine Department / Cross Harbour Tunnel / Central Wanchai Bypass Project / Royal Hong Kong Yacht Club & other typhoon shelter users
Contractor’s Alternative Scheme

- Stage 1 (6 months)
  - Original Form: Cut and Cover
  - Central Wanchai Bypass (CWB) Under Construction
  - Temporary Marine Cofferdam

- Stage 2 (14 months)
  - Changed to Immersed Tunnels
  - ME4

- Stage 3 (8 months)
- Stage 4 (10 months)

Legend:
- Reclamation for SCL works
- Works area on sea

Breakwater to be replaced

Central Wanchai Bypass (CWB)
Central - Wanchai Bypass

Replaced CBTS CCT by IMT extension (269m)

Radius = 350m

Cross Harbour Tunnel

Total Immersed Tube Tunnel

1334 + 269 + 60 = 1663

Shortened HUH Cut & Cover Tunnel (From 154m to 94m)

Finger Pier

Hung Hom Bypass

Causeway Bay Typhoon Shelter

Fairway

Contract awarded based on Alternative Tender

KCRC Freight Head Office
A. Immersion Joint at HUH cut and cover tunnel.

B. Under Water Closure Joint at ME4.

C. Under Water Closure Joint between E9 and E10.

Final IMT Configuration
Understanding the Geology

**Contract requirement:** Dredging profile based on Specification $q_c < 2\text{MPa}$

**Alternative approach:** Dredging profile based on settlement analysis

Soil to be dredged with $q_c < 2\text{MPa}$

Soil to be dredged based on settlement analysis
Gravel replacement of soft deposits

Section A-A (Typical Section)

Section B-B (Section at soft deposits)
Shek O casting basin
### Major Equipment List

<table>
<thead>
<tr>
<th>Number</th>
<th>Equipment Description</th>
<th>Quantity Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GPS-RTK</td>
<td>2 Rovers, 1 Base (Z +/- 15mm)</td>
</tr>
<tr>
<td>2</td>
<td>Inclinometer</td>
<td>2 nos (0.005%)</td>
</tr>
<tr>
<td>3</td>
<td>Water pressure sensors</td>
<td>4 nos (0.01% FS)</td>
</tr>
<tr>
<td>4</td>
<td>Proximity sensor</td>
<td>6 nos (Hopper position check)</td>
</tr>
<tr>
<td>5</td>
<td>Encoder</td>
<td>4 nos (Hopper position check)</td>
</tr>
<tr>
<td>6</td>
<td>Stroke sensor</td>
<td>4 nos (Hydraulic jack stroke check)</td>
</tr>
<tr>
<td>7</td>
<td>Altimeter</td>
<td>2 nos (For survey)</td>
</tr>
<tr>
<td>8</td>
<td>Light sensor</td>
<td>4 nos (Check gravel content in hopper)</td>
</tr>
<tr>
<td>9</td>
<td>Subsea camera</td>
<td>4 no. (Monitoring)</td>
</tr>
</tbody>
</table>

### Gravel Spreader Overview
Guidance Display for Gravel Placement

Gravel Level inside Tremie Pipe
Frame Position
Survey Data
Altimeter Readout

1st layer

2nd layer

Pre-survey
Gravel spreader in operation at E10

Initial Placement of gravel spreader

Hydrographic survey before sinking unit
1a. Tunnel elements prefabrication

1b. Dredging at Victoria Harbour

2. Towing-out to Junk Bay

3. Fitting out at Junk Bay

4. Towing to Victoria Harbour

5. IMT installation & Backfilling
Backfill

Diaphragm wall to be removed

IMT unit placed on sea bed

Existing packing concrete Of ME4 Tunnel
ME4 Terminal Joint after dewatering

Diaphragm Wall

Demolition line
Environmental/Sustainability measure in the project

• Saving in reclamation in CBTS=> significant reduction in waste disposal
• On site batching plant and marine deliveries at Shek O
• IMT Precast construction in Hong Kong rather than in China => Achieve tight quality control
• Extensive CPT and analysis to save dredging and disposal quantities
Engagement of the community

- Good relationship with the stakeholders in the Typhoon shelter
- Upgrading of the yacht club pontoon and facilities
- Regular stakeholder engagement meetings and briefings
- No complaint for any of the fairway diversions
Safety

- The safety awards received during the project
  - MTR Gold Safety Award (2018)
  - MTR The Best Site Condition Award (2016)
  - MTR “Hands Off” Safety Innovation Awards - Bronze Award (2016)
  - Development Bureau Considerate Contractors Site Award Scheme in “Merit” (2016)
Behavioural Based Safety

- Implementation of a behavioural based safety initiative which is now being used by other clients on other projects in Hong Kong
- Daily observation and engagement with workers
- Build mutual respect and trust
- 360° engagement (not top down or bottom up)
Client Satisfaction

- Completed the installation of 11 IMT units including the works through the breakwater within a 10 month period
- No adverse impact to the adjacent sensitive structures, Cross Harbour Tunnel and Hung Hom bypass
- Handed over to all of the designated and interfacing contractors on time.
- Delivered a high quality product with no leakage inside the IMT tunnels
- Co-located in the office to achieve a successful collaborative working environment.
In Summary

• Alternative solution to the cut and cover works inside the typhoon shelter delivering time and cost savings to the client and reducing disruption to the stakeholders
• Through design and analysis process reduced the amount of dredging required.
• Quality in construction – achieved to the tight tolerances to ensure no re-work required and each of the units placed right first time every time
• Designed and built an automatic gravel spreader to ensure successful placement of the gravel bed prior to positioning the IMT units
• Successfully implemented temporary works scheme for the very challenging Terminal Joint consisting of tremie concrete and dome formwork
• Completed the works to the original schedule
THANKYOU