International Panel Discussion
Climate Change and Adaptive Management
- Challenges and Issues -

Innovative Urban Storm Water Management
- adapting to climate change -

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Climate Change Impacts in Hong Kong

Record-breaking hourly rainfall events (1885-2016) (Source: Hong Kong Observatory) (Mean sea level rise: + 31 mm/decade)
Introduction

- Hong Kong, annual rainfall: ~ 2400mm/yr
- Global climate change - More extreme rainfall events (> 100 mm/hr)
- Sea level rise – urban areas on low lying reclaimed land are more vulnerable to flooding
SPONGE CITY: CLIMATE CHANGE ADAPTATION

1. Runoff intercepted into drainage tunnel
2. Stormwater storage
3. Upgrade of existing drainage system

Over 30% Reduction in Stormwater Runoff by Upstream Interception
Diversion of storm flow into a 10.5 km deep tunnel system via 34 vertical supercritical vortex drop shafts. Total discharge: 135 m$^3$/s
Engineering Challenges for HKWDT

- Steep hillslope watercourses (average slope 40%)
- Supercritical flow with velocities in the order of 10 m/s (Fr = 3 – 8)
- Adjacent to densely-populated residential area (premium properties!)
- Land constraints (cannot use large stilling structures)
- Minimize public disruption
- Traffic & environmental impact

Compact intake structures have to be designed to dissipate the energy and transfer the flow into the drainage tunnel smoothly
STORM WATER FLOW AT INTAKES

- Drop shaft + Vortex Chamber
- Adit tunnel
- Bottom rack chamber
- Bottom rack
Happy Valley Underground Stormwater Storage Scheme

2018 Da Yu Award, Chinese Hydraulic Engineering Society

<table>
<thead>
<tr>
<th>Contract Name</th>
<th>Happy Valley Underground Stormwater Storage Scheme</th>
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<tbody>
<tr>
<td>Project Sum</td>
<td>HK$1,065.8M (US$ 137M)</td>
</tr>
<tr>
<td>Duration</td>
<td>Sep 2012 – Dec 2017</td>
</tr>
<tr>
<td>Contractor</td>
<td>Chun Wo Construction &amp; Engineering Co. Ltd.</td>
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Climate Change Considerations in Drainage Design
- Rainfall and Sea Level

Based on results of simulations of global climate models in the IPCC Fifth Assessment Report the Hong Kong Observatory has made projections of rainfall increase due to climate change in Hong Kong up to the late 21st century.

To consider the effect of climate change in the drainage design, the projected percentage increases in rainfall and sea level rise have been adopted in the design rainfall intensities/synthetic rainstorm profiles and design extreme sea levels.

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<tr>
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<th>Rainfall Increase</th>
<th>Sea level rise (m)</th>
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<tbody>
<tr>
<td><strong>Mid 21\textsuperscript{st} Century (2041 – 2060)</strong></td>
<td>10.4%</td>
<td>0.23</td>
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<tr>
<td><strong>End of 21\textsuperscript{st} Century (2081 – 2100)</strong></td>
<td>13.8%</td>
<td>0.49</td>
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CONCLUSIONS

1. An integrated supercritical storm water interception, transfer and storage system has been successfully developed for the Hong Kong Island Drainage Scheme with proven post operation performance since 2013.

2. Hydro-environment engineering is at the core of sustainability and urban resilience in a world class city.

3. The innovative urban storm water management strategy has ensured uninterrupted smooth running of the central business district and urban areas in Northern Hong Kong Island.

4. Hong Kong was well-protected from flooding during the super-typhoon Mangkhut in 2018 with maximum sustained winds of 175 km/h.