

土木工程拓展署
Civil Engineering and
Development Department

安全設計工作坊 - 最佳實踐

Design for Safety Pilot Run Workshop – Best Practices

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土木工程拓展署
Civil Engineering and
Development Department



改善碼頭計劃

Pier Improvement Programme (PIP)

[illegible]

改善碼頭計劃 PIPPier Improvement Programme (PIP)

二零一七年施政報告

改善公共運輸配套設施

158. 政府將改善多個偏遠的公共碼頭，方便市民往來一些郊遊景點和自然遺產，首階段包括約10個位於新界及離島區的公共碼頭。

- 提升現有公共碼頭的結構安全
- 改善碼頭設施
- 方便市民前往郊遊景點和自然遺產
- 照顧一些主要倚靠船隻出入的村民及漁民作業的基本需要

Phase 1 第一階段計劃

已完成 x2

工程進行中 x6

詳細設計進行中 x2

PIPP 改善碼頭計劃
Pier Improvement Programme (PIP)

荔枝窩碼頭



東平洲公眾碼頭



荔枝莊碼頭



深涌碼頭



糧船灣碼頭



濶西村碼頭



石仔灣碼頭



二澳碼頭



北角碼頭



榕樹灣公眾碼頭



第二階段計劃

Phase 2

工程進行中 x5

技術研究進行中 x8

改善碼頭計劃
Pier Improvement Programme (PIP)



碼頭使用量

公共安全

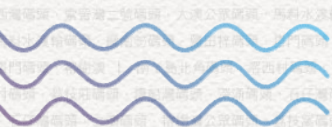
環境

地區訴求

土地

通往郊遊景點
和自然遺產的暢達性

 **改善碼頭計劃**
Pier Improvement Programme (PIP)



Pier Improvement Programme (PIP)

項目各階段採用的安全設計

Best Practices in Design for Safety Across Project Phases



項目各階段採用的安全設計

Integrated Design for Safety Throughout the Project Lifecycle

我們已將**安全設計**應用於碼頭項目的各個階段，以優化設計的安全性，採取的措施如下：

We have integrated **Design for Safety** to ensure optimal safety across various phases in our pier projects, as summarized below:

Construction 施工

Operation 營運

Maintenance 維修保養

應用科技 Technology Integration

- **氣象監測系統**
Weather Monitoring System Integration
- **建築信息模型的應用**
Application of BIM
- **無人船及無人機設備作測量等用途**
Unmanned Vessels and Drones for Surveys
- **使用人工智能及4S系統**
Adoption of 4S System with AI
- **廣泛使用預製混凝土組件**
Extensive Use of Precast Concrete Units

預製施工 Precast Construction

改進材料 Material Improvements

安全提升 Safety Enhancements

- **在斜道和登岸梯級的表面塗上防滑油**
Anti-Slip Paint on Stair and Ramp Surfaces

- **減浪板**
Wave Reduction Panels
- **使用浮動平台**
Adoption of Floating Platform
- **視障人士引路徑**
Tactile Guide Path for Visually Impaired

- **玻璃纖維增強復材 (GFRP) 的應用**
Application of Glass Fibre Reinforced Polymer (GFRP)
- **使用海洋混凝土和環氧塗層**
Use of Marine Concrete and Epoxy Coating

- **平板結構設計**
Flat Slab Design for Maintenance Safety
- **於碼頭上蓋安裝防墮繩**
Safety Harness and Cable on Pier Rooftop



施工階段的安全設計

Design for Construction Safety

氣象監測系統

Weather Monitoring System Integration



天氣信息顯示在信息管理系統中

Weather information shown in Information Management System

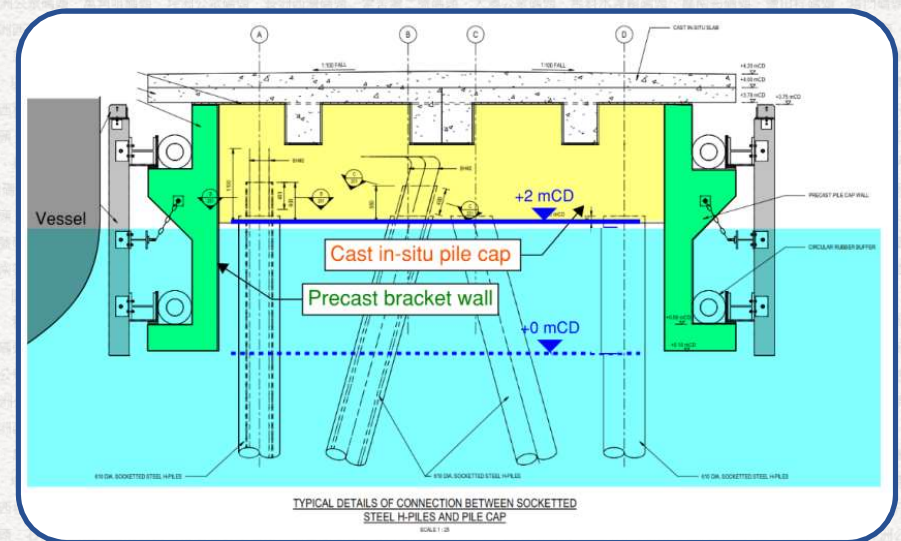
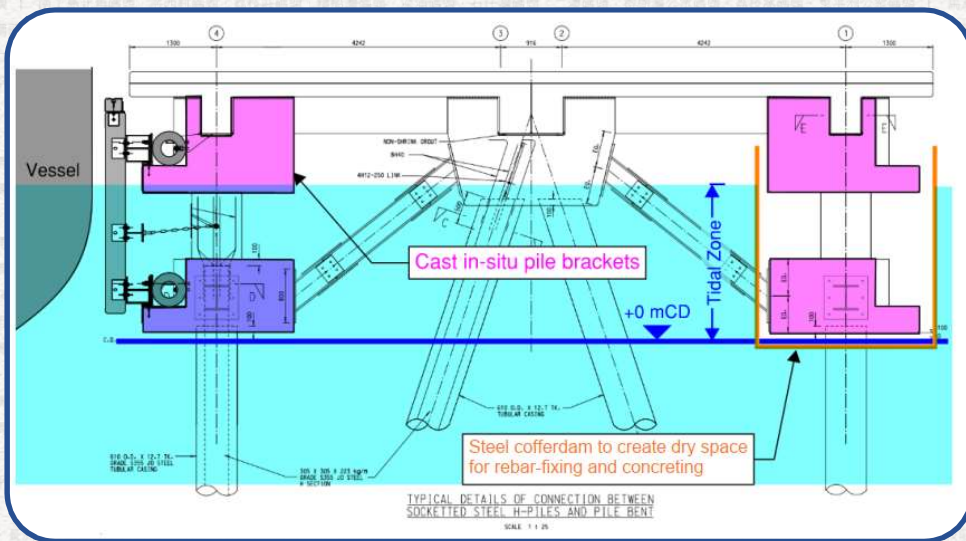
改善碼頭計劃
PIIP Pier Improvement Programme (PIP)

廣泛使用預製混凝土組件 (1/3)

Extensive Use of Precast Concrete Units

以下是使用預製混凝土組件的例子

Below are examples of **extensive use of precast concrete units**



傳統的樁架設計

- 現澆上下托架
- 需要圍堰以提供乾燥的環境
- 受到潮位限制

Traditional Form of Pile Brackets

- Cast in-situ upper and lower brackets
- Requires a cofferdam to provide dry condition
- Constrained by tide level

北角碼頭採用的設計

- 使用預製組件作為托架牆
- 以吊運進行安裝
- 降低受潮位變化帶來的影響

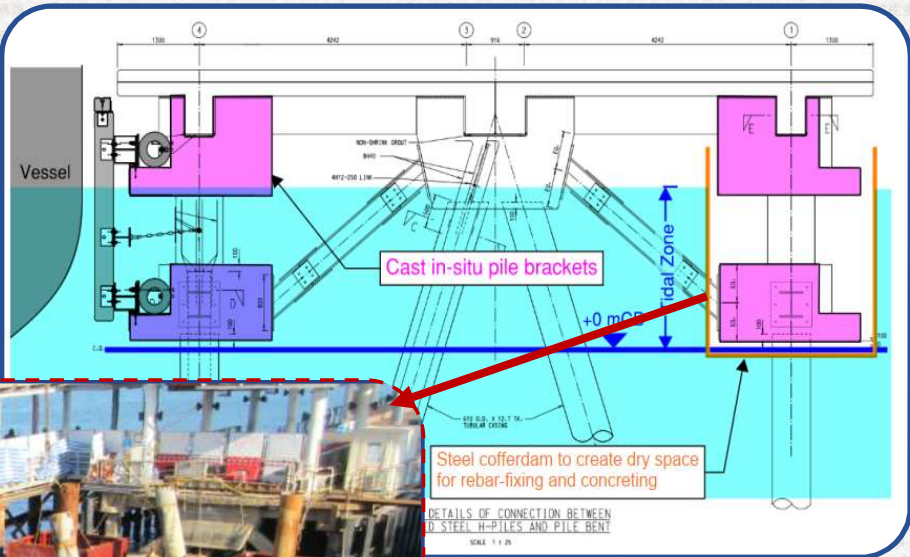
Design Adopted in Pak Kok Pier

- Precast bracket walls
- Requires lifting operation for installation
- Reduced impact from tide level

廣泛使用預製混凝土組件 (2/3)

Extensive Use of Precast Concrete Units

圍堰對於現場澆築樁帽至關重要，但潮汐區施工**受潮位限制**，存在以下風險：
The cofferdam is essential for in-situ construction of pile caps. However, construction in tidal zones is **constrained by tide levels**, associated with the following risks



水位影響 Flooding

漲潮時會淹沒圍堰，導致施
工中斷並需要排水處理。
High tides can flood the
cofferdam, disrupting work and
requiring water removal.

結構挑戰 Structural Challenges

需謹慎考慮潮汐力，
以避免圍堰失穩。
Tidal forces should be carefully
considered to avoid destabilising
the cofferdam.

施工時間受限 Limited Work Windows

施工僅限於低潮期間，
以確保安全和可達性。
Construction is restricted to low-
tide periods for
safety and accessibility.

材料的脆弱性 Material Vulnerability

新拌混凝土及鋼筋容易受到
海水侵蝕，降低其耐用性。
Fresh concrete and rebar are at
risk of water contamination,
reducing durability.

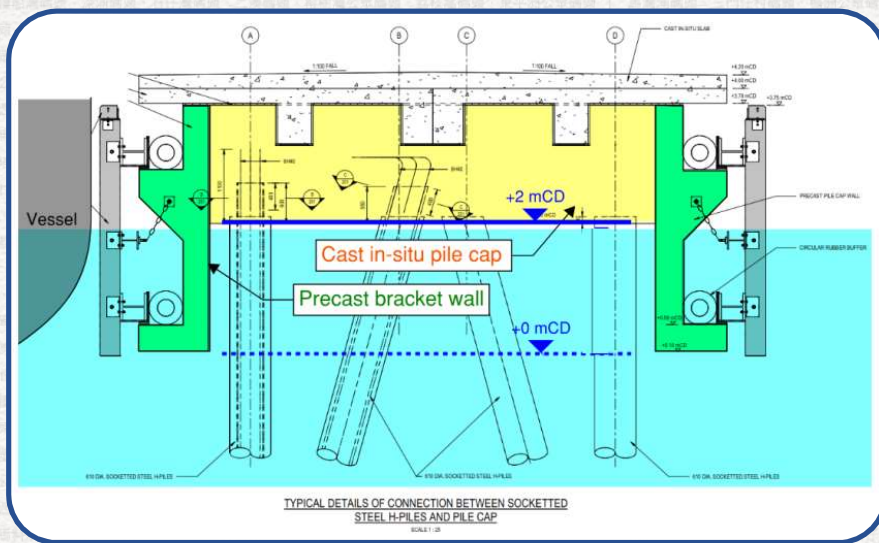
廣泛使用預製混凝土組件 (3/3)

Extensive Use of Precast Concrete Units

採用預製組件可提高**施工速度、品質、安全性和環境績效**，同時**減少對潮汐條件的依賴**。改善包括：

Utilising precast units enhances **speed, quality, safety, and environmental performance** while **reducing dependence on tidal conditions**.

The improvements include:



提升安全性 Increased Safety

降低工人暴露於潮汐帶的風險。

Reduces exposure to tidal zones for worker safety.

提升施工速度 Faster Construction

透過並行作業，提升施工速度。

Speeds up the construction process through parallel work fronts.

質量控制更優 Better Quality Control

確保質量和耐用性。

Ensures consistent quality and durability.

北角碼頭採用的設計

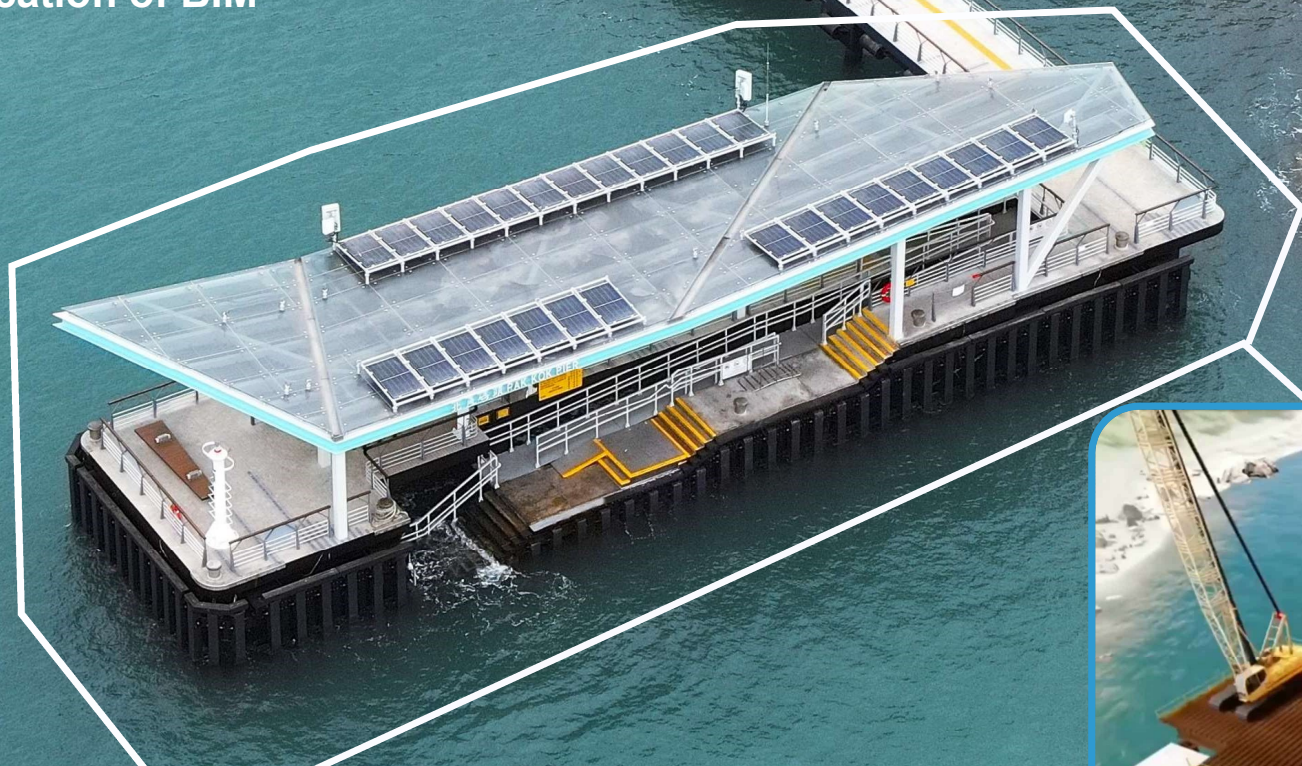
- 使用預製組件作為托架牆
- 以吊運進行安裝
- 降低受潮位變化帶來的影響

Design Adopted in Pak Kok Pier

- Precast bracket walls
- Requires lifting operation for installation
- Reduced impact from tide level

建築信息模型的應用

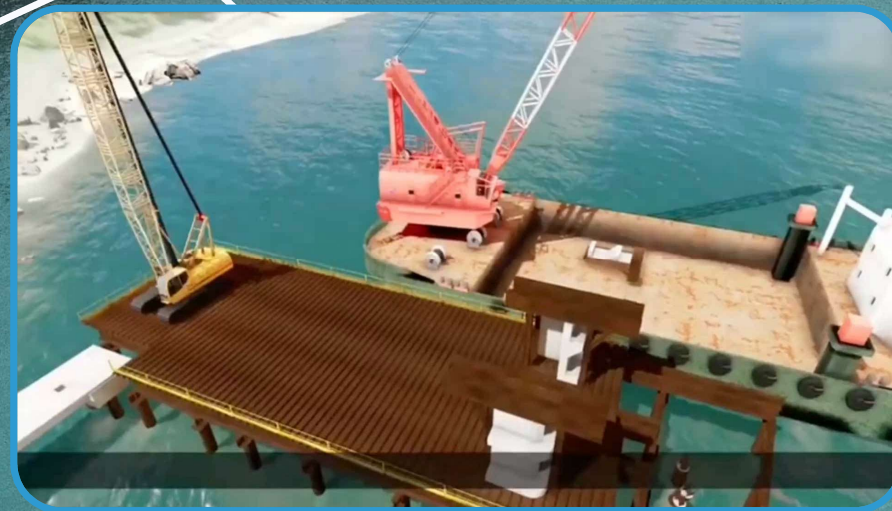
Application of BIM



數碼化 Digitalisation

應用建築信息模型 (BIM)

Application of Building Information Modeling (BIM)



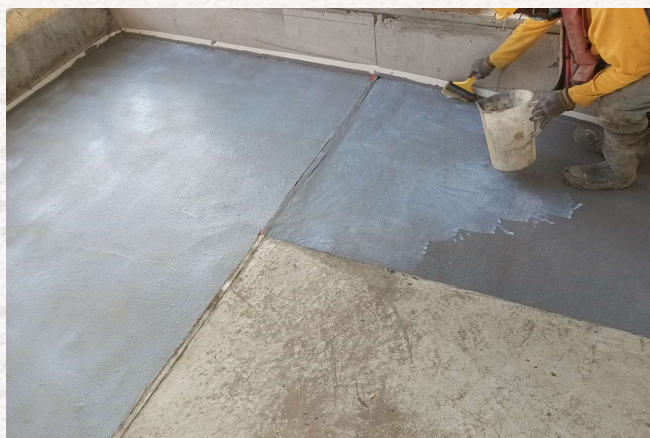
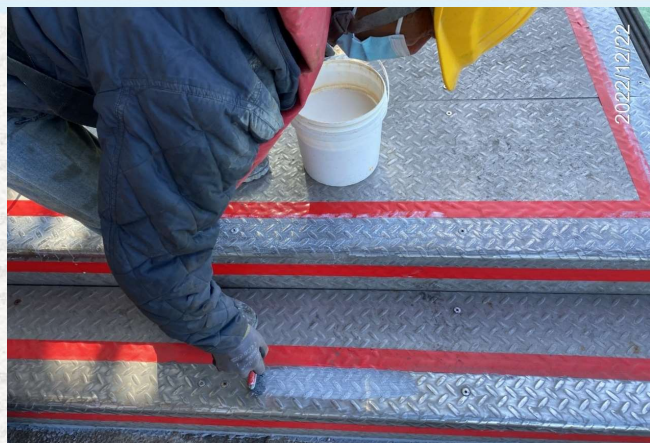


營運階段的安全設計

Design for Operational Safety

在斜道和登岸梯級的表面塗上防滑油

Anti-Slip Paint on Stair and Ramp Surfaces



斜道只延伸至中間平台，以防止苔蘚生長。
Ramp extended to intermediate platform only to prevent the growth of moss

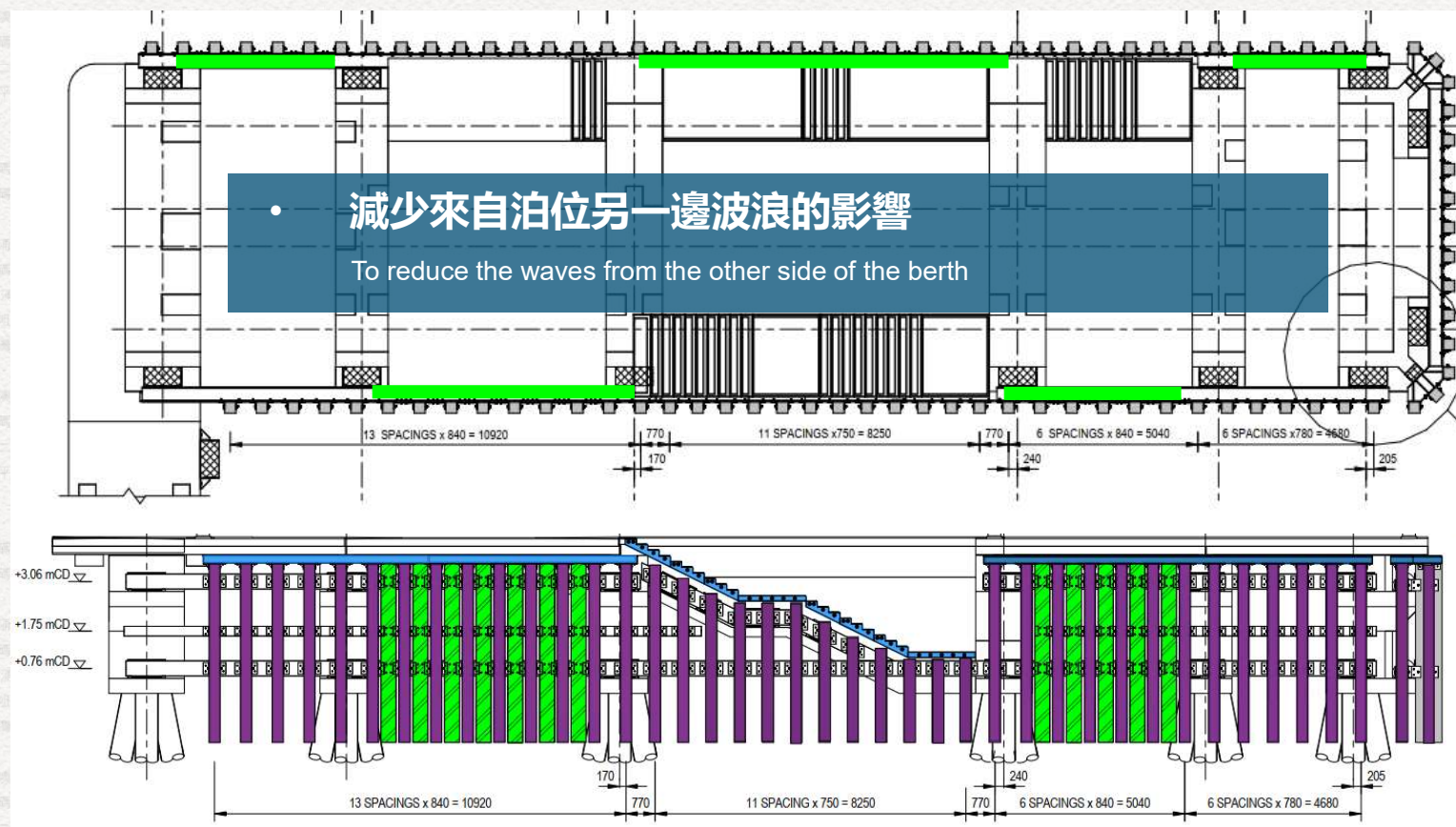
在斜道和登岸梯級的表面塗上防滑油
Anti-slip paints applied on stair and ramp surfaces

減浪板 (1/2)

Wave Reduction Panels

安裝在南丫島北角碼頭的減浪板可提升船隻停靠時的穩定性，使乘客上下船更安全和便利。

Wave reduction panels installed at Pak Kok Pier on Lamma Island **improve the stability** of docking vessels, making berthing safer and more convenient for passenger boarding and alighting.

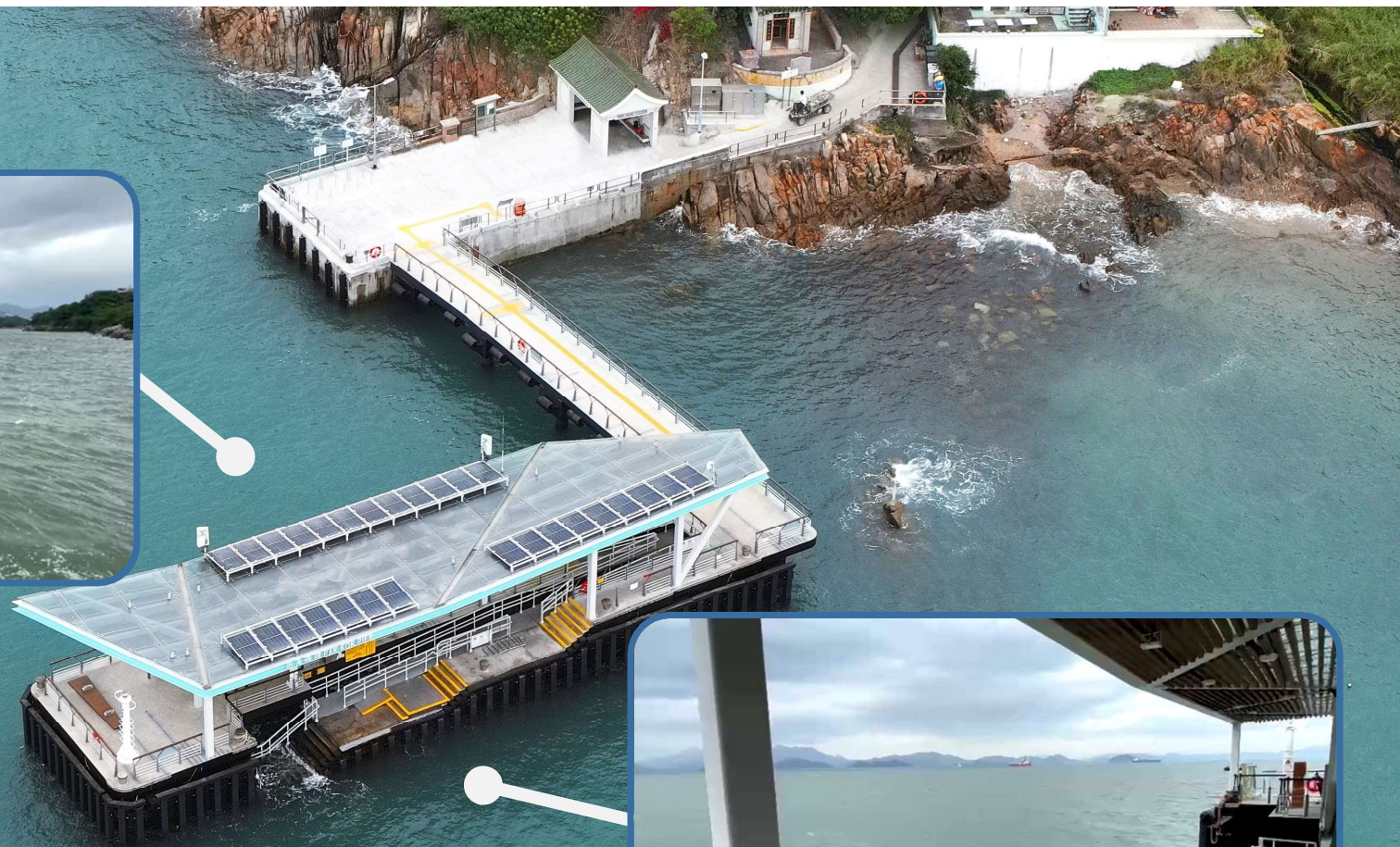
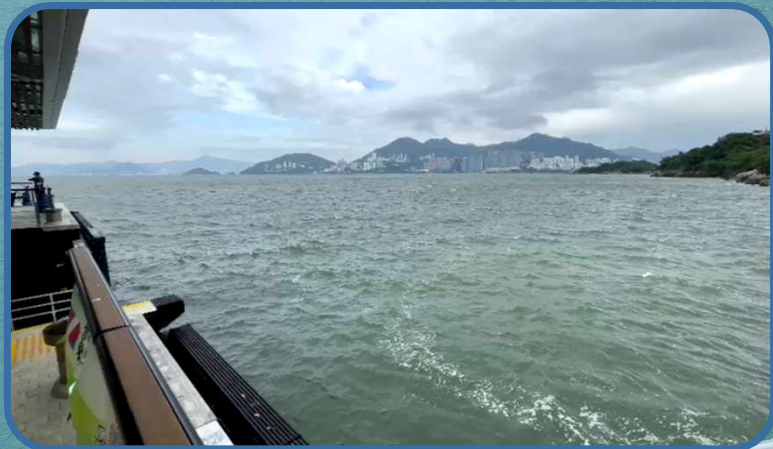


安裝在南丫島北角碼頭的減浪板

Wave reduction panels installed in Pak Kok Pier

減浪板 (2/2)

Wave Reduction Panels



最新應用 **New Application**

設計及安裝減浪板

Design and Install Wave Reduction Panel



使用浮動平台

Adoption of Floating Platform

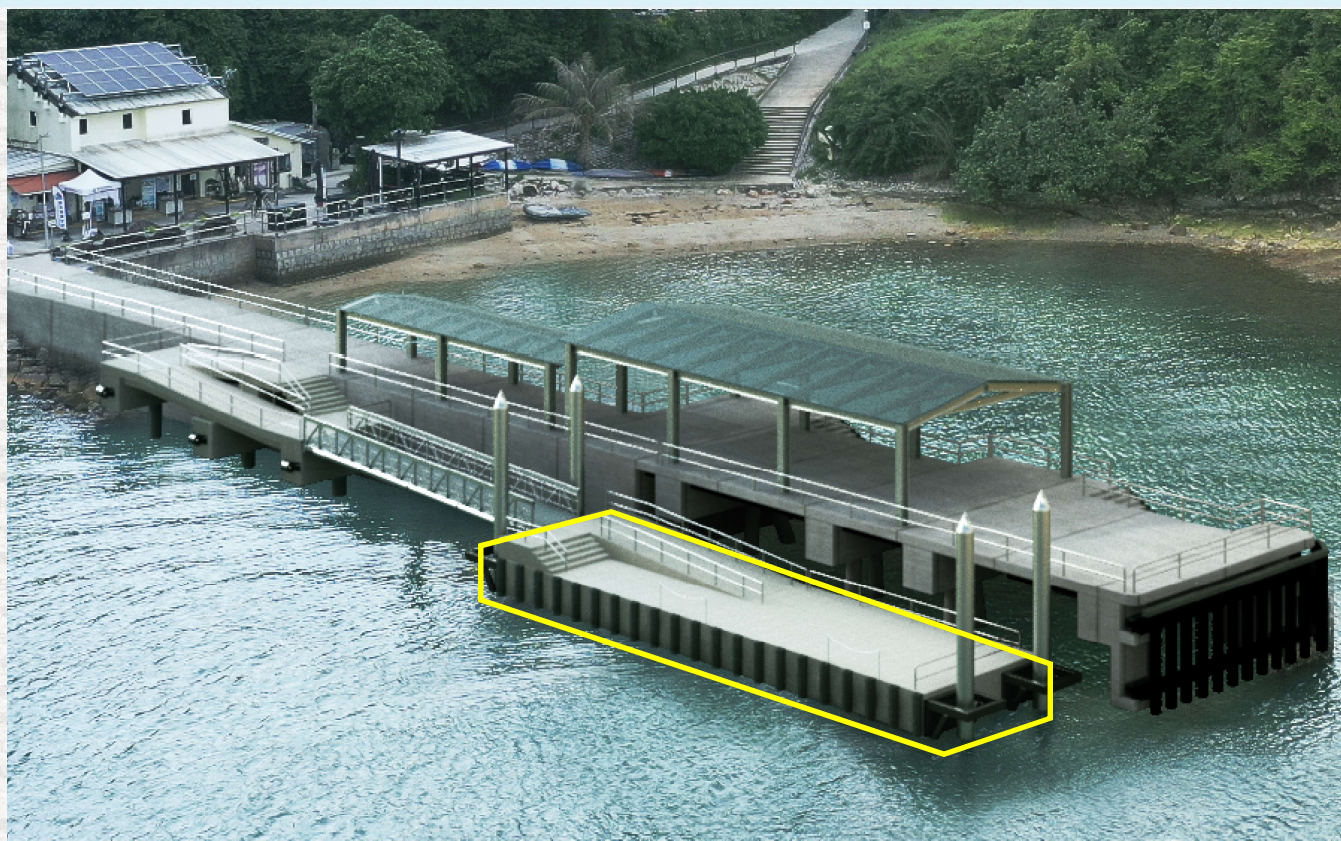
保持與潮水的水位一致

Maintains Level Alignment with Tide

平台隨水位上下浮動調節，與船隻保持一致的*乾舷高度，方便乘客上下船。

*船隻的乾舷是從水線到上層甲板的距離

The Platform adjusts up and down with the water level, providing **constant freeboard** for passenger to board or alight.



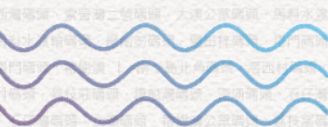
浮動平台的構想圖

Photomontage of floating pontoon



位於屯門第27區的浮動平台

Floating pontoon at Tuen Mun Area 27



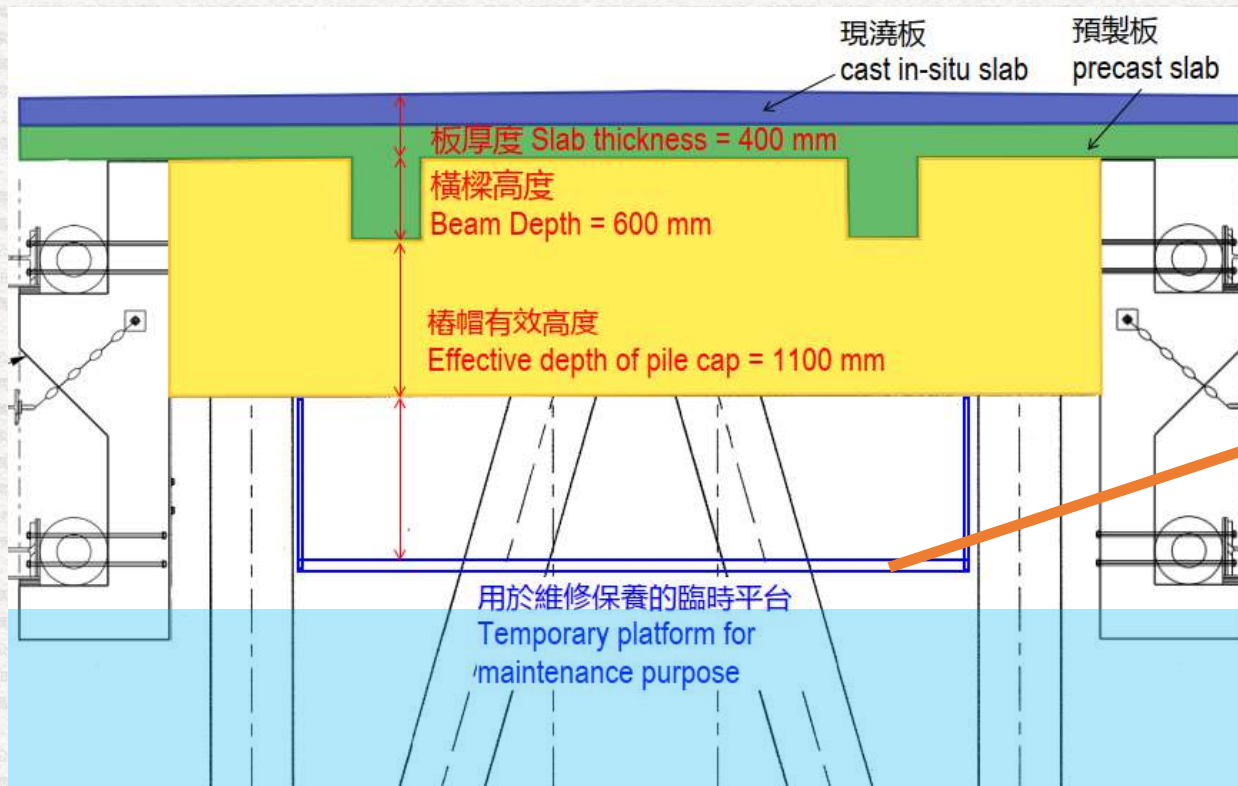
維修保養階段的安全設計

Design for Maintenance Safety



平板結構設計 (1/2)

Flat Slab Design



- 由於碼頭結構底部與水面距離較小，**維修保養難度增加**

Maintenance difficulties increase due to low soffit level

- 只能提供約 1 米的淨空高度

Only ~1 m of headroom can be provided

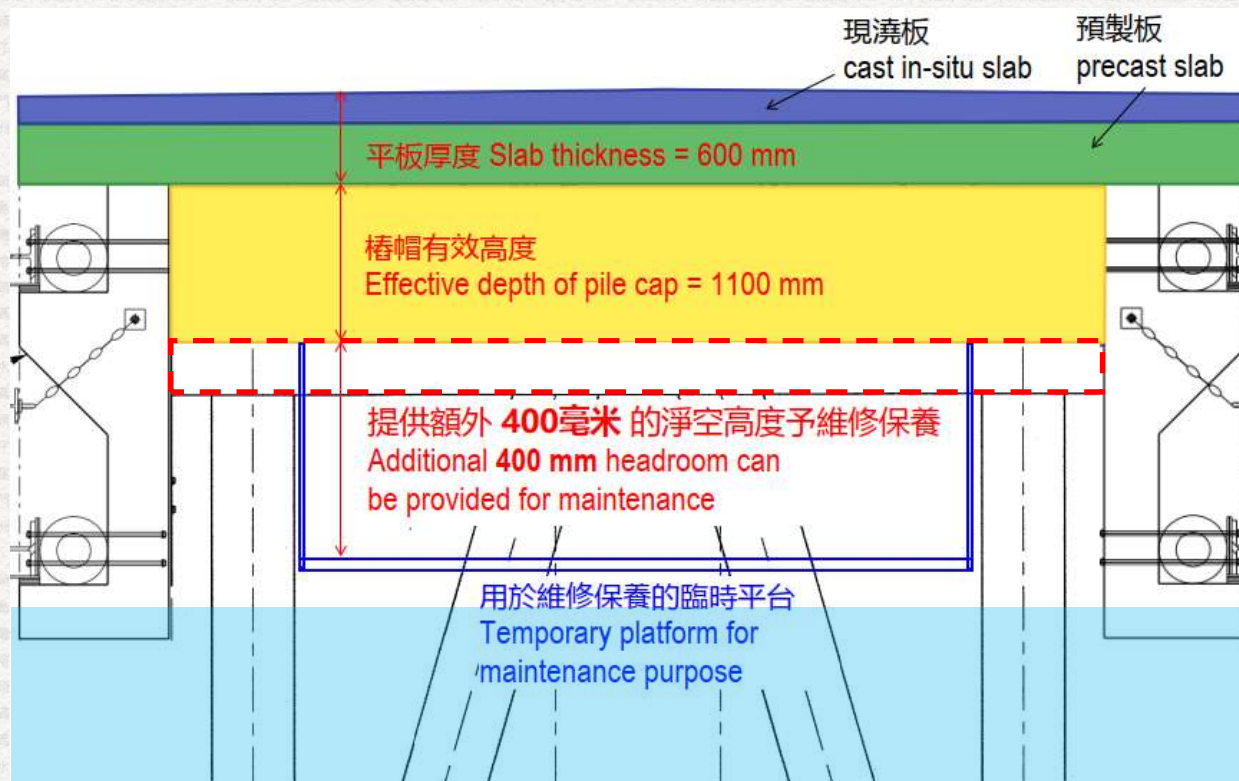
傳統樑板設計 Traditional Beam Slab Design

平板結構設計 (2/2)

Flat Slab Design

新設計主要增加了在維修保養時可用的淨空高度。主要改進包括：

The main improvement of the new design is the **increased headroom available** for maintenance. Some specific enhancements are as follows:



增加工人和檢查員的作業空間 Increased Headroom for Maintenance

可為工人和檢查員提供額外 400 毫米的淨空高度，使檢查和維修更安全、更高效。

Additional 400 mm headroom can be provided to maintenance workers and inspectors, making inspection and repairs safer and more efficient.

簡化的結構佈置 Simplified Structural Arrangement

新設計通過使用更厚的平板代替橫樑，降低結構複雜性。

The new design **reduces structural complexity** by utilising a thicker slab in place of the beam.

平板結構設計 Flat Slab Design

玻璃纖維增強複材的應用

Application of Glass Fiber Reinforced Polymer

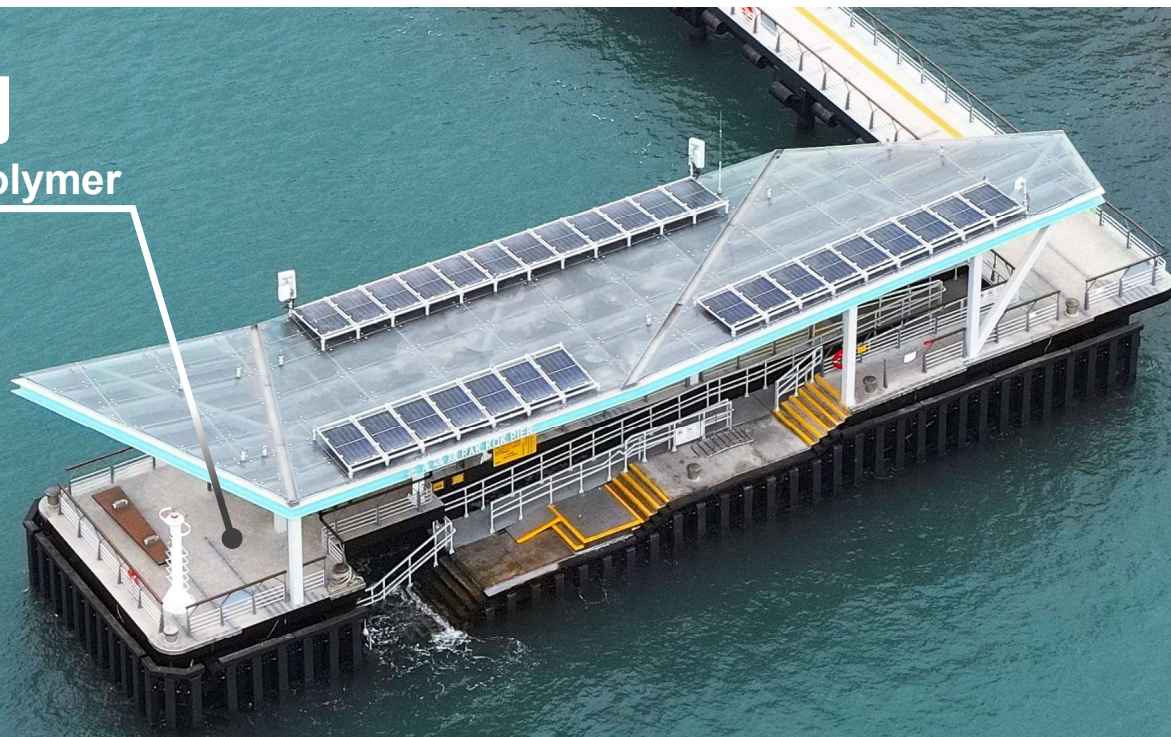
新物料 New Materials

玻璃纖維增強複材

Glass Fiber Reinforced Polymer

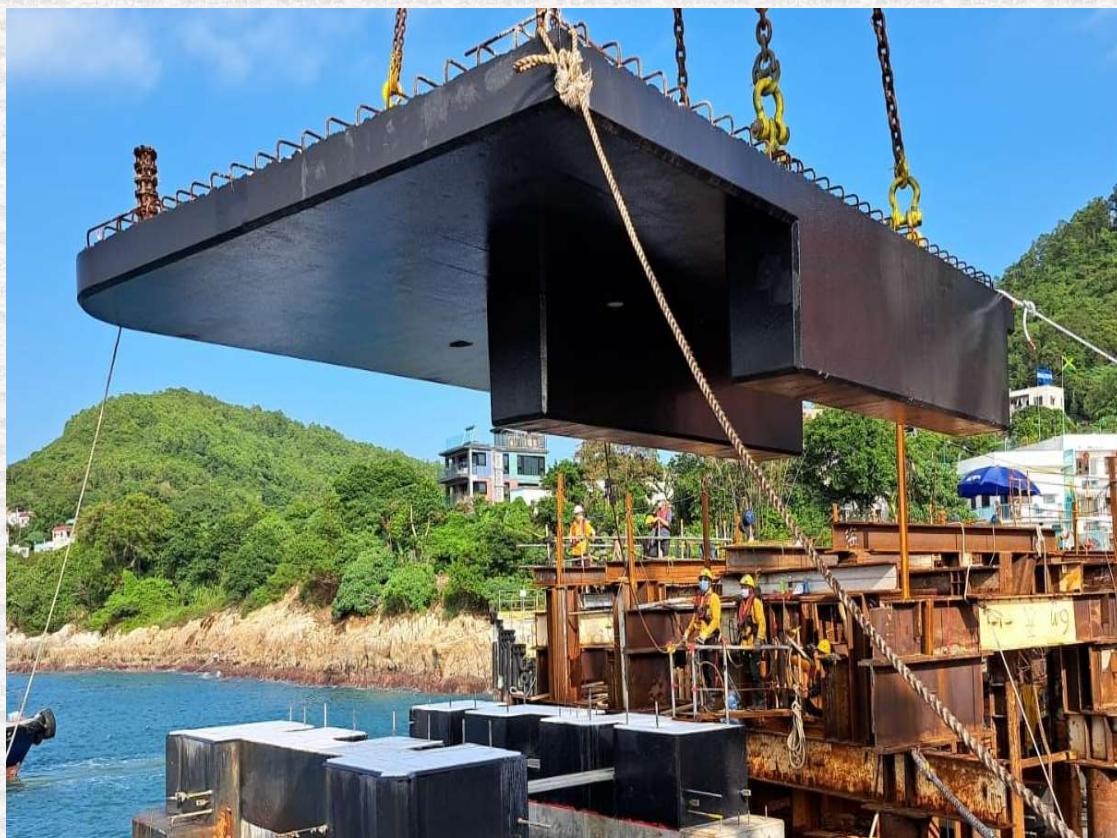
GFRP在海洋環境中具有優異的耐腐蝕性和耐久性能

GFRP is excellent in durability and corrosion resistance, making it suitable in marine environment.



使用海洋混凝土和環氧塗層

Use of Marine Concrete and Epoxy Coating



規定在海洋混凝土中使用矽灰 (CSF) 以及粉煤灰 (PFA) 或粒化高爐礦渣粉 (GGBS)，並配合環氧塗層，以提高混凝土耐久性、耐腐蝕性、強度和可持續性，同時降低維修保養頻率。

The specified use of CSF, PFA, or GGBS with epoxy coating enhances durability, corrosion resistance, strength, and sustainability in marine structures, reducing the maintenance frequency.

- (6) For reinforced concrete in marine environment, CSF and either PFA or GGBS shall be incorporated into the concrete as separate materials complying with the following requirements:
- (a) The proportion of CSF replacement shall be within the 5-10% range by mass of the cementitious content.
 - (b) The proportion of PFA replacement shall be within the 25-40% range by mass of the cementitious content for normal applications, or if GGBS is used instead of PFA, the proportion of GGBS replacement shall be within 60-75% range by mass of the cementitious content.

在帶有環氧樹脂塗層的海洋混凝土中指定使用矽灰 (CSF) 以及粉煤灰 (PFA) 或粒化高爐礦渣粉 (GGBS)

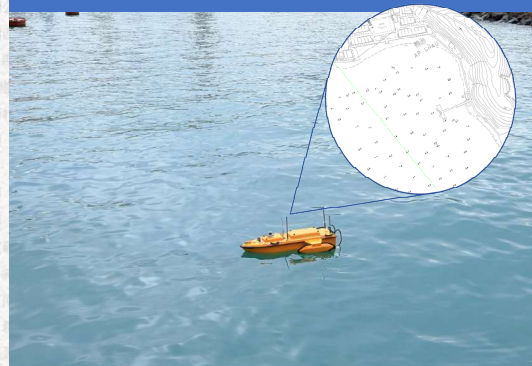
Specified use of CSF and either PFA or GGBS in marine concrete with epoxy coating

其他安全設計的應用 Other Design for Safety Applications

改善碼頭計劃 Pier Improvement Programme (PIP)

謝謝!
Thank You

無人船及無人機設備作測量等用途 Unmanned Vessels and Drones for Surveys



使用人工智能及4S系統 Adoption of 4S System with AI



視障人士引路徑 Tactile Paving for the Visually Impaired



於碼頭上蓋安裝防墮繩 Safety Harness and Cable on Pier Rooftop

