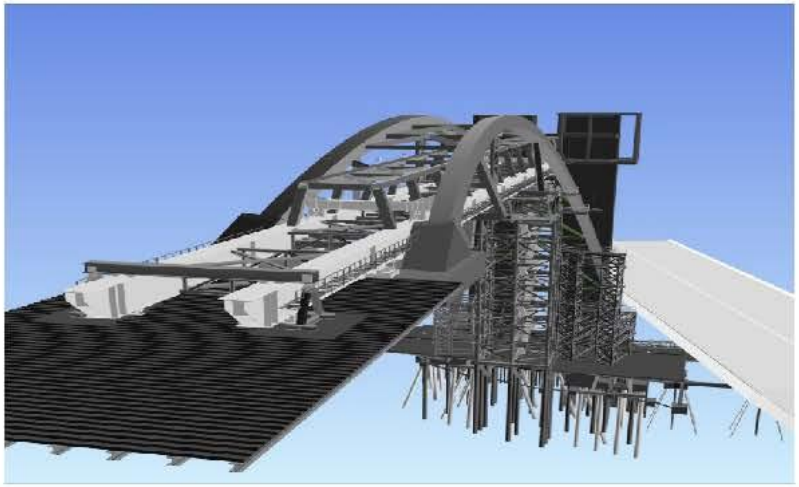
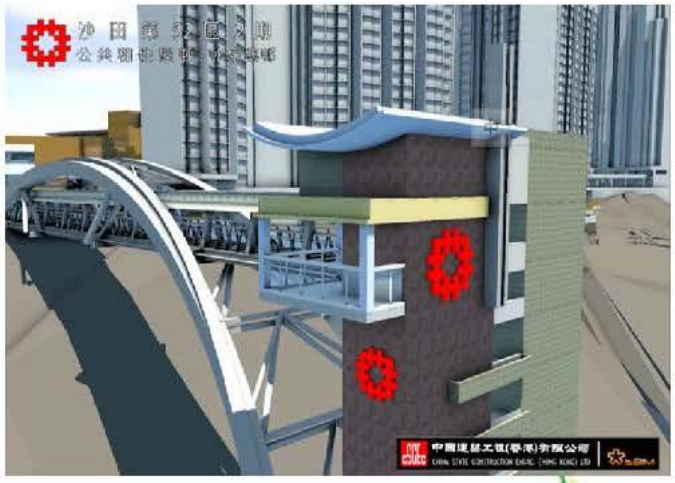
中國建築
CHINA STATE CONSTRUCTION

Think Act Safe Be

應用建築信息模擬(BIM)
於水泉澳興建大跨度行人天橋的風險管理





何志偉博士
安全環保部副總經理

2020年11月2日

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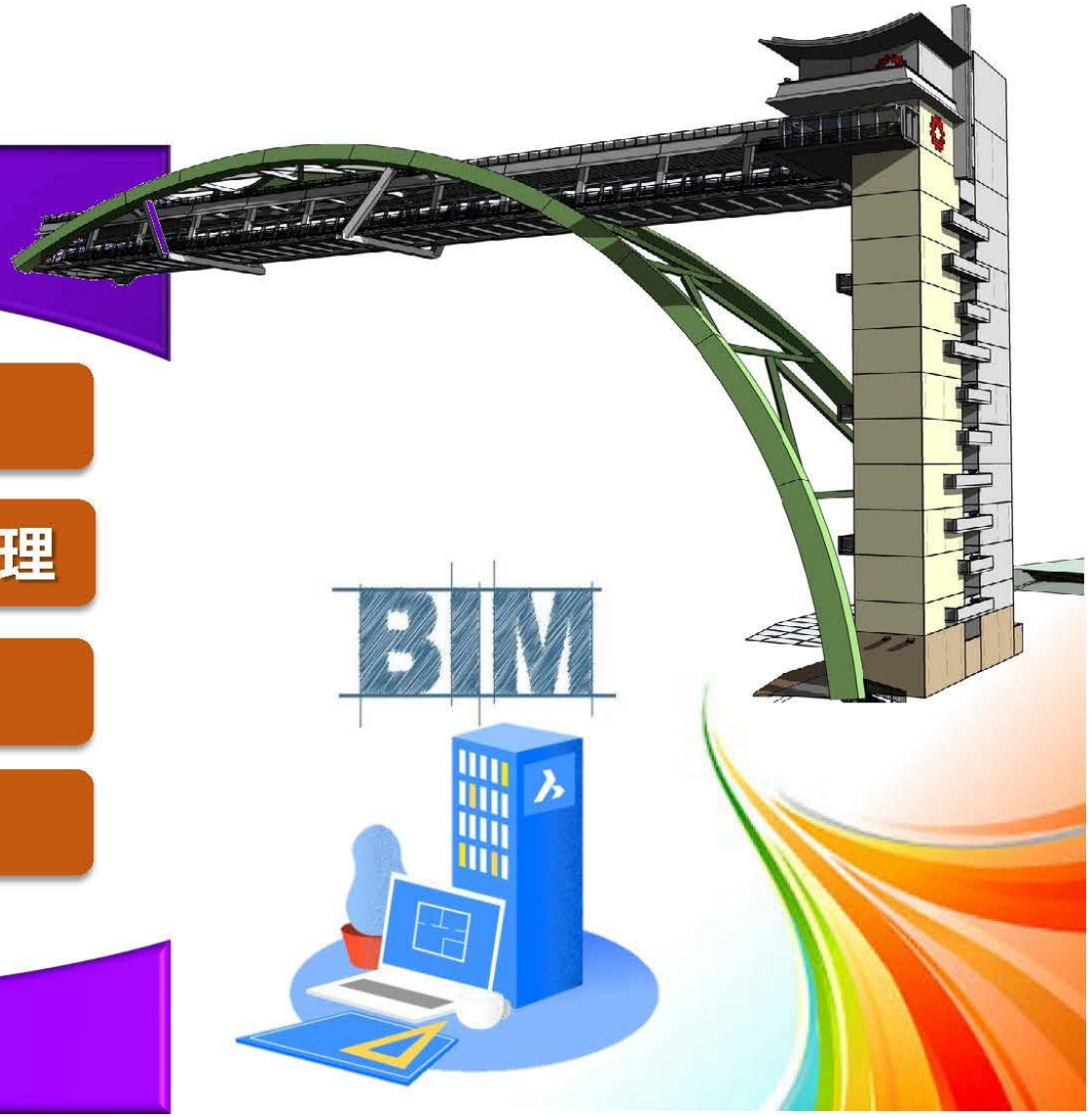

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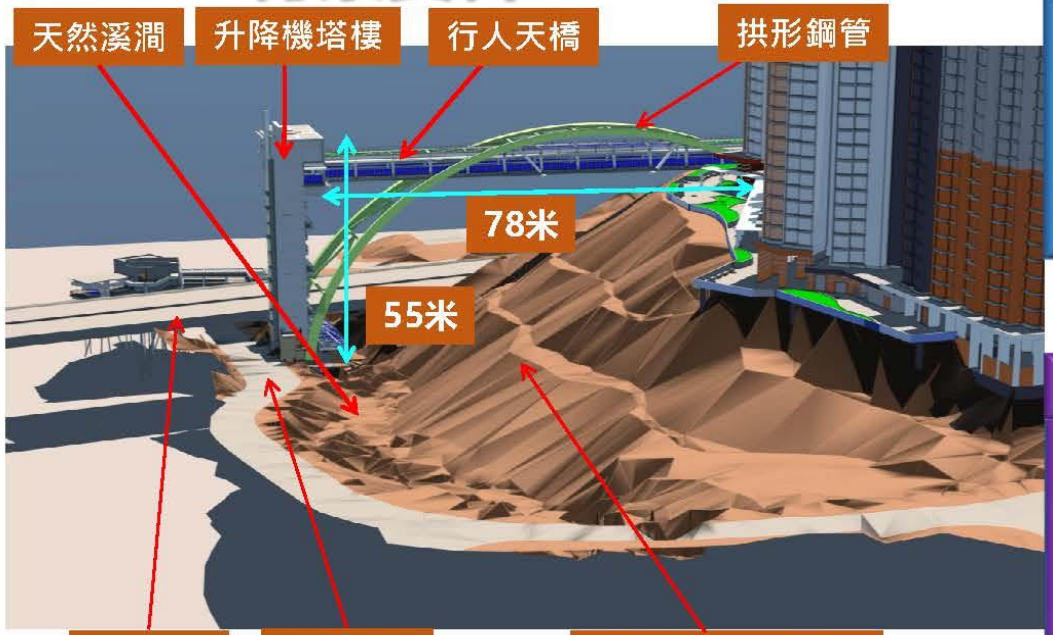
1. 工程概況

1.1 背景資料



項目小檔案

工程項目名稱：水泉澳邨二期工程

業主：房屋署

工程內容：興建共5幢住宅大樓，樓高26至30層，合共3459個單位，其中**包括興建一條大跨度行人天橋**連接水泉澳商場及水泉坳街(毗鄰沙田圍港鐵站)

行人天橋施工內容

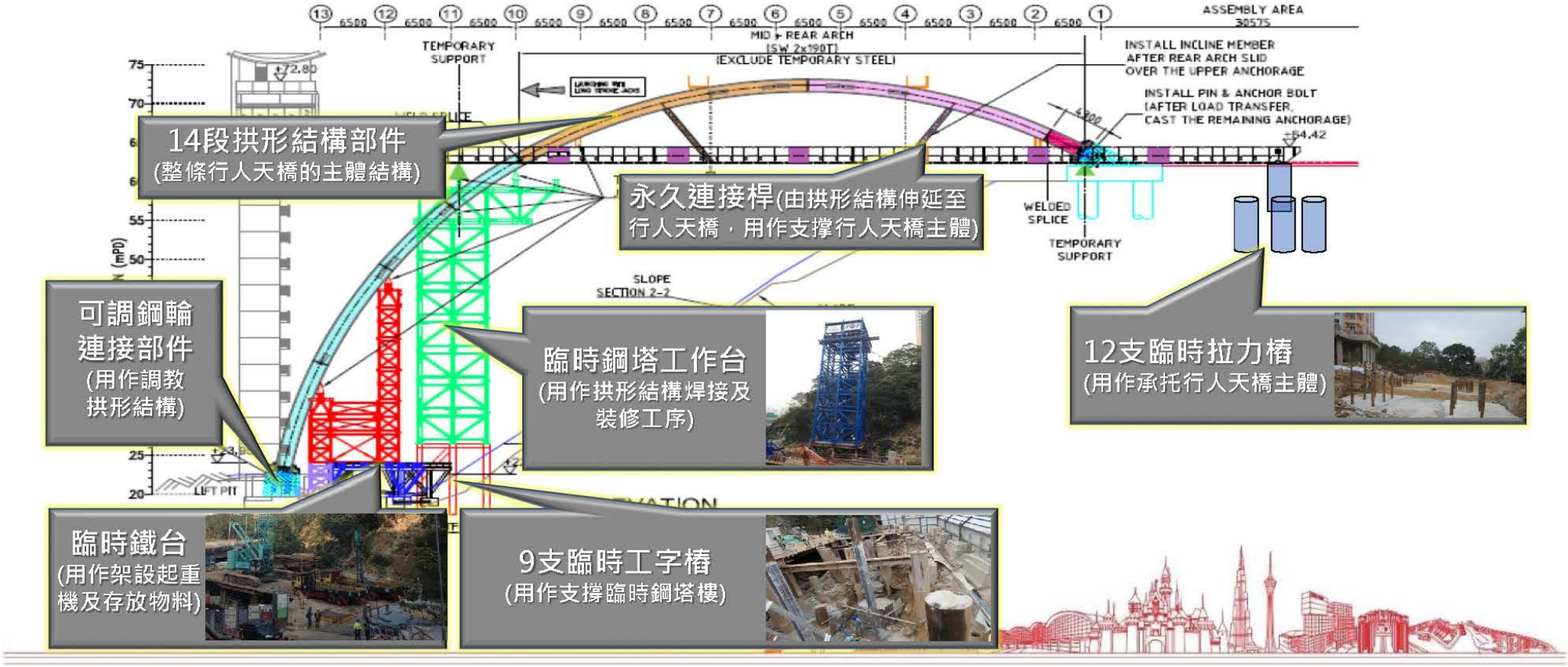
工程內容：

1. 天橋的主體結構是**由兩條對稱傾斜的拱形鋼管**承托一條從山頂通往升降機塔樓的鋼結構組成
2. 升降機塔樓共15層高(**約55米高**)，由53支工字樁承托
3. 共需耗用**2400公噸鋼材**(永久及臨時結構各佔50%)
4. 工期**約24個月**，並於2017年第二季順利竣工

施工難點：

1. 該天橋的升降機塔樓是興建**在狹窄的雙線雙程車路與一條受保護的天然溪澗之間**
2. 行人天橋**垮越天然溪澗及險峭山坡**，令工程建造複雜

1.2 工程概況 – 結構簡述


ASSEMBLY AREA
TEMPORARY SUPPORT
MID - REAR ARCH (SW 2x190T) (EXCLUDE TEMPORARY STEEL)
INSTALL INCLINE MEMBER AFTER REAR ARCH SLID OVER THE UPPER ANCHORAGE
INSTALL PIN & ANCHOR BOLT (AFTER LOAD TRANSFER, CAST THE REMAINING ANCHORAGE)
WELDED SPLICE
TEMPORARY SUPPORT
SLOPE SECTION 2-2
LIFT PIT
14段拱形結構部件
(整條行人天橋的主體結構)
永久連接桿(由拱形結構伸延至行人天橋，用作支撐行人天橋主體)
可調鋼輪連接部件
(用作調教拱形結構)
臨時鋼塔工作台
(用作拱形結構焊接及裝修工序)
12支臨時拉力樁
(用作承托行人天橋主體)
臨時鐵台
(用作架設起重機及存放物料)
9支臨時工字樁
(用作支撐臨時鋼塔樓)

1.3 施工過程中涉及的安全風險

吊運 - 運送臨時及永久結構材料

高空工作 - 安裝、裝修及檢查工序

物料下墮 - 臨時/永久構件/物料 、工具

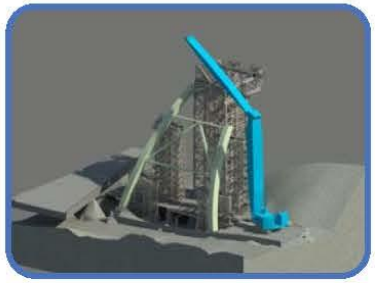
觸電	火警	體力處理	撞倒、絆倒	其他
• 電力焊接 • 手電工具使用	• 焊接工作 • 易燃物品儲存(油漆/隔熱物料/木板)	• 搬運鐵器/物料 • 搭建大型棚架	• 突出物保護 • 物料擺放	• 交通運輸 • 施工對公衆的影響

2.1 應用BIM優化安全管理

- 利用3D動畫模擬施工流程及安排，逐步解釋，令施工人員易於明白安全措施執行要求
- 階段性、針對性培訓不同專業工種人員相關的安全要求

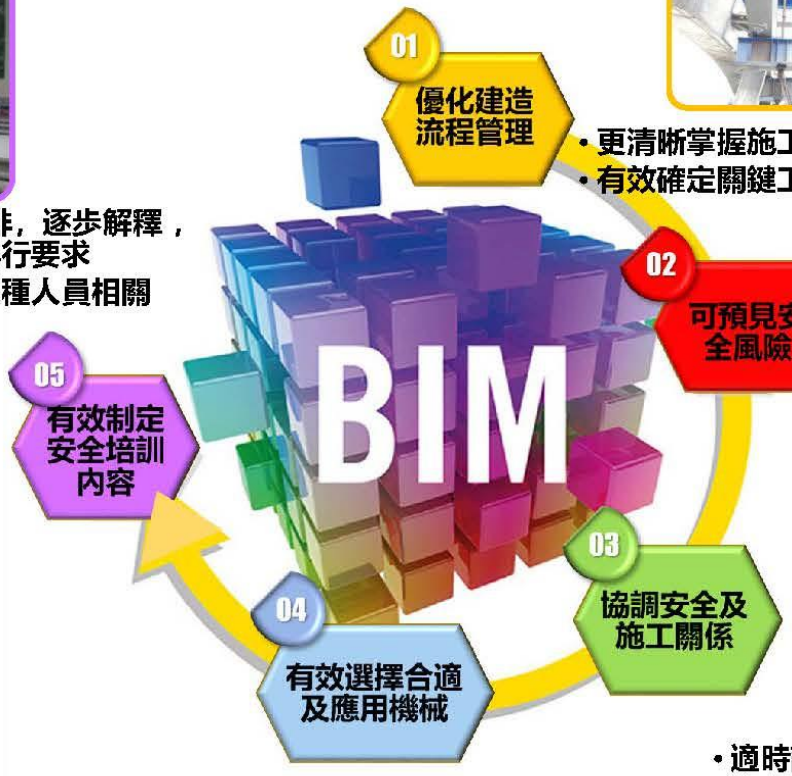
- 更清晰掌握施工環境、工序及時序之間關係
- 有效確定關鍵工序及其緊急應變安排

- 更有效進行綜合性危害識別及風險評估
- 制定針對性風險管制措施及安全施工計劃



- 選取合適的機械
- 模擬實際操作 (如制定機械操作位置、 吊運路徑、物料運送的安排等)

- 適時設置合適防護設施如工作台、護欄、安全進出通道、防墮設施等
- 確定關鍵工序檢查點，提升監管成效



2.2 安全管理工作亮點

吊運安全計劃

- 制定吊運安全計劃書，內容包括吊運管理制度、機械選用、吊運流程、團隊分工及監管要求等

吊運人員安全培訓

- 吊運訊號員/ 吊運監督員/起重機操作員書面委任，進行定期培訓及現場表現評估
- BIM動畫用作安全培訓材料
- 使用‘吊運應用表’,優化吊運操作安全

安全管理工作實施

- 施工方案培訓、風險評估培訓、吊具檢查表及工作安排記錄

現場監督檢查

現場施工前安全培訓

起重機械每月由公司機械部檢查

吊運監督員站崗

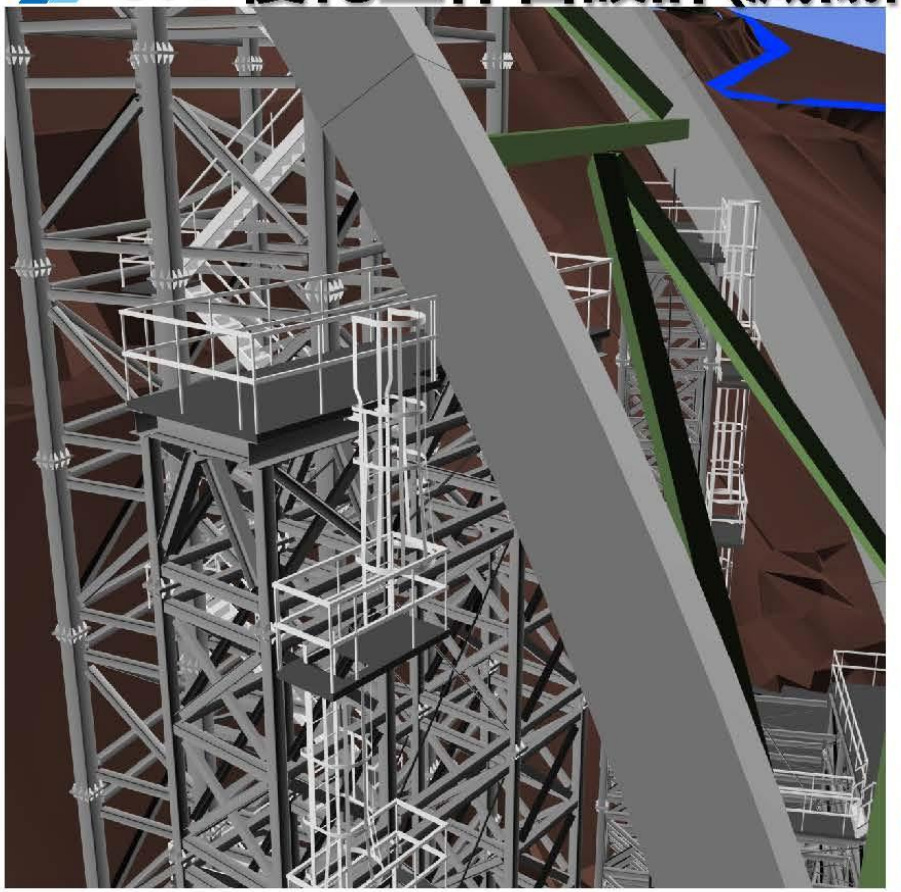
緊急應變計劃

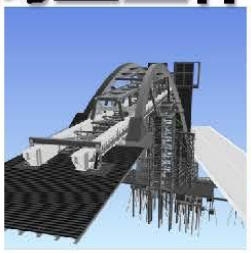
- 制定緊急應變措施
- 報告9天天氣預告
- 風速監察 23Km/h
- 每次吊運前實地進行天氣狀況評估

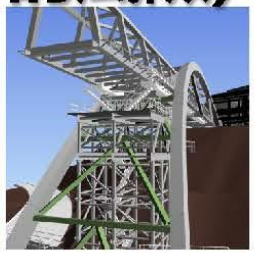
緊急應變演習

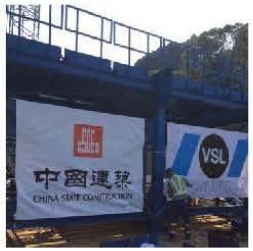
颱風前後安全檢查

3.1 優化工作台設計(減低高空工作的風險)









工作台的設計

- BIM模擬斜拱橋接駁需要焊接的位置細節，有效設計合適工作台及安全進出通道

3.2天橋拱型結構安裝(提升吊運及高空工作安全管理)

當導樑架設完成後

- 在導樑上搭建臨時工作台
- 利用250噸大型起重機逐步分段組裝拱橋結構部分
- 完成第一分段後，將整個分段推出
- 重覆架設臨時工作台
- 組裝第二分段拱橋後再次推出
- 完成接駁

3.3 安裝天橋主體結構(提升吊運及高空工作安全管理)

- 利用250噸大型起重機吊運第一段橋身組件於導樑上進行組裝
- 推出第一段橋身組件，吊運第二段橋身組件於導樑上
- 組裝第一及第二段橋身組件
- 推出已連接的橋身組件,吊運第三段橋身組件於導樑上
- 重覆上述工序直至所有橋身組件安裝完成
- 所有駁口均為以半自動焊方法進行

3.4橋身裝修工序 (防止高空工作及墮物風險)

- 在橋身底部搭建混合吊棚，以密網墊底再以厚木板妥善覆蓋
- 主結構及所有工作位置以竹棚架和雙層棚網妥善覆蓋
- 全職棚架合資格人士，每週對棚架進行法定檢查

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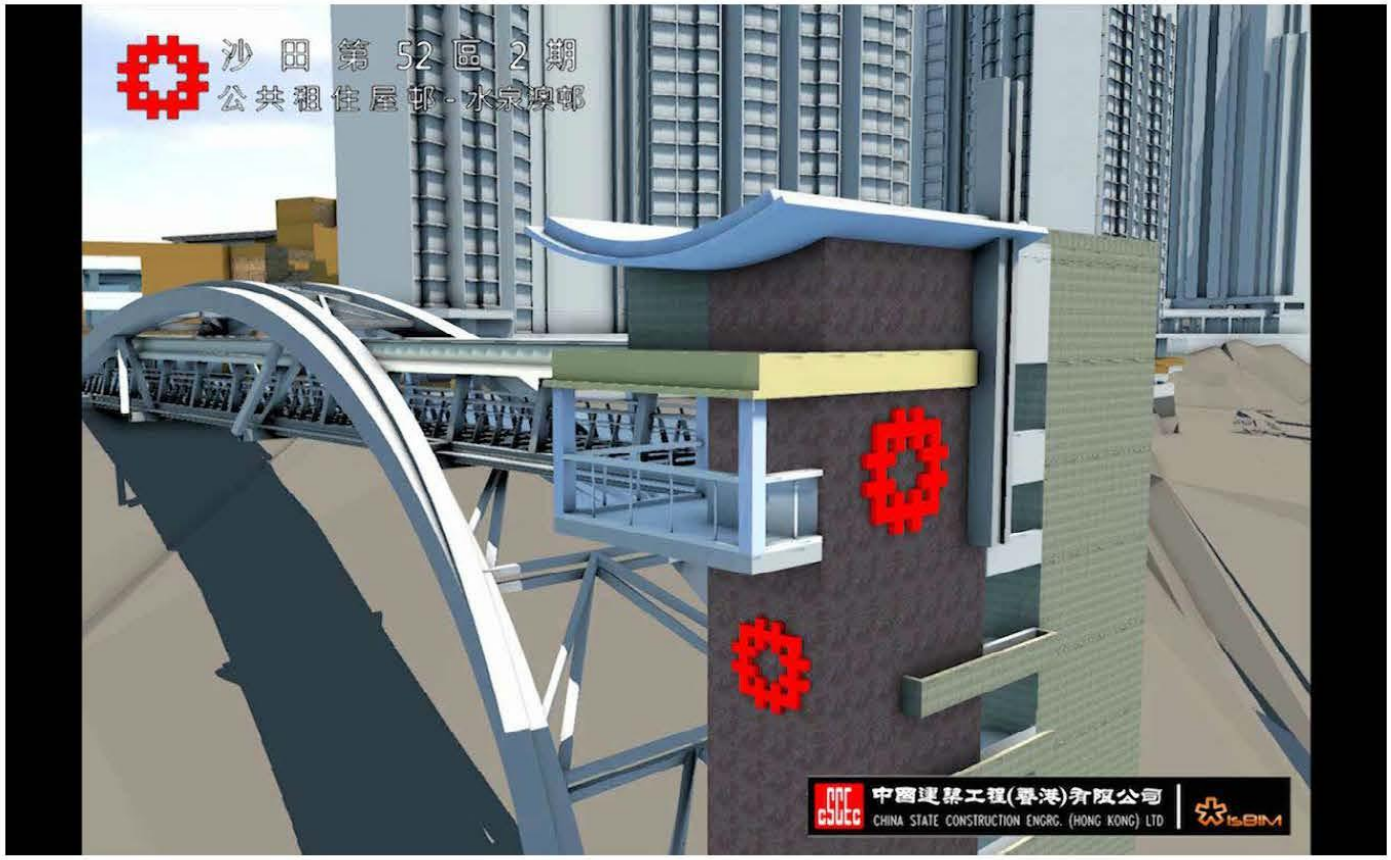
4. 成效



- 在整個建造工程實現**零**事故、**零**檢控
- 上下拱橋接駁位置**誤差少**於合約要求的20毫米
- 施工期間對公眾影響減至**最少**

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~完~

謝謝

Title: Safety Forum 2020 for Works Contracts and Property Management Services Contracts

Super Safety Forum 2020 for Works Contracts
and Property Management Services Contracts
2 November 2020

VO: Here is the footage from
"Safety Forum 2020 for Works Contracts and Property Management Services Contracts"
which was held on 2 November 2020

Super Dr. Ben HO
Deputy General Manager, Safety & Environmental Protection Department of
China State construction Engineering (Hong Kong) Limited
Topic: "Use of Building Information Modelling (BIM) for
Risk Management of Erection of Long Span Footbridge at Shui Chuen O Estate"

VO: The Speaker is Dr. Ben HO
Deputy General Manager, Safety & Environmental Protection Department of
China State construction Engineering (Hong Kong) Limited
His presentation topic is
"Use of Building Information Modelling (BIM) for Risk Management
of Erection of Long Span Footbridge at Shui Chuen O Estate"

Dr. HO: Hello, guests and
Friends of the industry who are joining us online
Today, I am representing my company to share with you
a project that we completed a few years ago
It was the construction of a long-span footbridge at Shui Chuen O
In the process, we used Building Information Modelling (BIM) for safety management
Today, I am going to introduce briefly the project

and talk about during the planning and construction stages
how we dealt with various high-risk items and how
we carried out the planning work for the construction project

In view of time, I have extracted a clip to share with you
It was the BIM animation of the footbridge when it was built
This project was completed smoothly a few years ago
Sharing with you the BIM results
This was a project of the Housing Authority (HA) at Shui Chuen O Estate Phase 2
where there were 5 residential buildings
Each of them ranged from 26 to 30 floors high, with a total of 3459 units
This project included constructing a long-span footbridge
which connected Shui Chuen O Plaza with Shui Chuen Au Street
Next to where the current Sha Tin Wai MTR station situated
You can see here the construction works of this footbridge
Its main structure consisted of a pair of symmetrically tilted steel arches
which supported a steel structure
that led from the top of the mountain to the lift tower
The lift tower was 15 floors high, about 55 m in height
It was supported by 53 I-beams
In total, the project used 2,400 tonnes of steel
Permanent and temporary structures each took up around 50%
The project lasted for around two years
It was completed successfully in Q2 of 2017, three years ago

As you can see in the picture on the left
where was the lift tower of the footbridge built?
Actually, it was between a narrow road with two-lane two-way traffic and
a natural stream that was under protection
The main part of this footbridge spanned over
this natural stream and a steep slope
All these environmental factors
added to the complexity of the construction works
This image shows the basic structure of the footbridge
There were 14 arch-shaped structural components
The footbridge itself was the main structure and
these permanent connecting rods were extended from the arch structures
They provided support for the entire footbridge
There were also some pile foundation and other temporary works
including 12 temporary tension piles on the side of the slope
which helped to support the main structure of the footbridge
There were also 9 temporary H-piles at the bottom of the tower
that helped support this temporary steel tower
Here you can see a temporary metal platform that was mainly used for
setting up the cranes and for depositing materials
As you can see a temporary steel tower platform marked in green

This platform was mainly for the welding of the arch structures
and some other finishing work processes in the later stages of the project
Also, there was a steel gear that could be adjusted
The connecting part was used for making minor adjustments
On the a whole, the construction of this footbridge
involved certain safety hazards
coincided with the theme of forum today
There were safety risks related to the lifting operations
the transport processes for temporary and permanent components and materials
There was work at height, some processes of installation and checks

and there were also risks of falling objects
that could hit the vehicles on the road underneath
Both the temporary and permanent components and materials could fall
the workers' tools may also fall
There were also other risks in the entire construction works
such as electrical shock, fire, manual handling issues
Given tight work environment, workers risked bumping into things or tripping
There were also risks relating to the impact of
the transport of construction materials into and out of the site on the public
The above was a summary of the risks involved
When planning for construction
the team had used BIM to enhance safety management of the project
This was done in a few ways
First, when planning for construction
BIM was introduced to let the construction team get a clear grasp of
the surrounding environment of the footbridge during construction as well as
the relationships between certain works procedures and sequencing
In the work planning process, this helped to identify the critical path effectively
and to devise relevant emergency arrangements

The use of BIM also helped the team
to carry out comprehensive hazard identification and risk assessment

which in turn helped with devising specific risk management measures
and the safety plan
The biggest advantage BIM provided was that
it helped to co-ordinate safety measures with the construction works
and let the team know when was the most appropriate time
to add protective measures such as working platforms
guard rails, safe access or egress routes or fall protection measures, etc
It helped the team to recognise the key processes in the construction works
so then checks were better conducted, and monitoring was more effective
BIM also let us see how the whole works would be carried out on site
so it helped us select the appropriate plant
Through BIM, site team could pick the suitable crane and
also model how a particular model could work in future work processes
such as its position and its lifting route
We could also model how certain materials are transported
In terms of training, the team could use 3D animations
to model the work processes and relevant work arrangements
to better explain them to our workers
Workers could better understand the requirements of safety measures involved
3D modelling allows the team to carry out specific training

at different stages, for different professionals
We could devise the most suitable safety training for employees of the same job nature
Here, I would also like to introduce to you
some of the highlights in safety management for this construction project
A lifting safety plan had been devised and implemented
Some lifting personnel were appointed
such as signallers, lifting supervisors and crane operators
Signallers had to satisfy the training requirements stipulated by our company
Every month, safety personnel and lifting supervisors
would evaluate these appointed signallers practically on site
to see if they had any bad habits
or if the performance of the signaller can satisfy the requirements of our company

We really carried out this work
As I mentioned just now, we used BIM animation for training purposes
We used lifting cards like the one here
to let signallers and lifting supervisors clearly know
different cranes are for different loads and what the angle requirements are
This also let them know what the safe working loads are
and helped and enhanced their monitoring work
For some of the basic works
we carried out training on the method statement and risk assessment
as well as the checklists for lifting gear and records of works
We would ensure everyone is clear of their responsibilities in the work process
Furthermore, in terms of monitoring and checking on site
We had a safety training for workers every day before starting work

The machinery team of our company
would conduct monthly safety checks for the cranes being used on site
We arranged for a lifting supervisor to station
at each key position in our lifting operations
This lifting supervisor would monitor the work of the signaller
Also, in emergency cases, we had some contingency measures
including the site foremen to check the weather and wind speed daily

to decide whether lifting operations would be carried out that day
I have some examples here for you
We did BIM for some working platform designs
to model the details related to the welding positions for the arches
This helped our team design proper working platforms more effectively
as well as the safe access and egress routes
Another example shows
how we made special arrangements
for the installation of the arch-shaped footbridge
It enhanced the safety management of lifting operations and working at height
This animation shows that after the launching beam was designed
we modelled constructing a temporary working platform on top of it
Then, using this 250-tonne crane
we assembled this arch structure piece by piece in various phases
After the first part had been completed, we pushed it out part by part
Next, we repeated these steps to connect a temporary working platform
After assembling the second part, we pushed it out to merge with the first part
This example shows how we installed the main structure of the footbridge
The site used a 250-tonne crane to lift some of the footbridge components
assembled them at the launching beam, then pushed out the first part of the bridge
Then, we lifted the components of the second part onto the launching beam
and then assembled the first and second parts of the footbridge together
We pushed it out and repeated the process with the third part and so on and so forth
As for the welding of the main structure of the bridge,
all the connections were welded together via semi-automatic welding
Here you can also see some of the renovation procedures for the bridge deck
A metal and bamboo scaffold was erected at the bottom of the deck
Considering weight limitation, we added a mesh at the bottom
and then covered it securely with a thick wooden plank
This main structure and all the working positions of
the double-row bamboo scaffolding were securely covered with nets
We arranged a competent person of bamboo scaffolding to be full time on site
to supervise the erection of the bamboo scaffolding
We also asked this competent person
to do weekly checks for the bamboo scaffolding and to sign a Form No. 5
In view of time constraints, I will conclude here
Over the course of around two years
this construction contract had zero incidents and zero prosecutions
In terms of quality, we achieved seamless welding
of the top and bottom arches, which was very hard to achieve
Our margin of error was less than the 20 mm allowed in our contract
Also, throughout the construction process
we strived to minimise any impact on the general public
This brings me to the end of my sharing today, thank you

VO: Thank You For Watching