2 Murray Road
(Central)
中環美利道2號

20240525 HKIE Technical Visit (BUD)

The Henderson

協興 HIP HING
新鴻基集團成員
Member of NWS Holdings

恒基

Content

Project Information – Client & Consultant Team

2 Murray Road
(Central)
中環美利道2號

Employer	恒基兆業地產有限公司 HENDERSON LAND DEVELOPMENT COMPANY LIMITED
Architect	Zaha Hadid Architects; RONALD LU & PARTNERS
Structural Engineer	CMA C M WONG & ASSOCIATES LTD
E&M Engineer	wsp
Facade Consultant	MEINHARDT
Facade Consultant (Banquet Hall & Footbridges)	Eckersley O'Callaghan
Quantity Surveyor	RLB Rider Levett Bucknall
Landscape Architect	eadg 泛亞國際
Environnemental Consultant – BEAM PLUS	ARUP

An ICON AMONGST ICONS

2 Murray Road
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The Henderson
(Render by Arqui9

- Location: Murray Road, Central, Hong Kong
  (Key Central Business District in Hong Kong)
  Nature: A-Grade Commercial Tower/ Office Commercial
- Site Area: 2,880 m². G.F.A.: 43,200 m².
  Land Price: HKD 50,000 per sq. ft.
  (World record at the time)

The HENDERSON:

Designed by Zaha Hadid Architects;
Anticipated to complete in 2023; Targeted as
The future *"ICON AMONGST ICONS"* in Central Hong Kong.

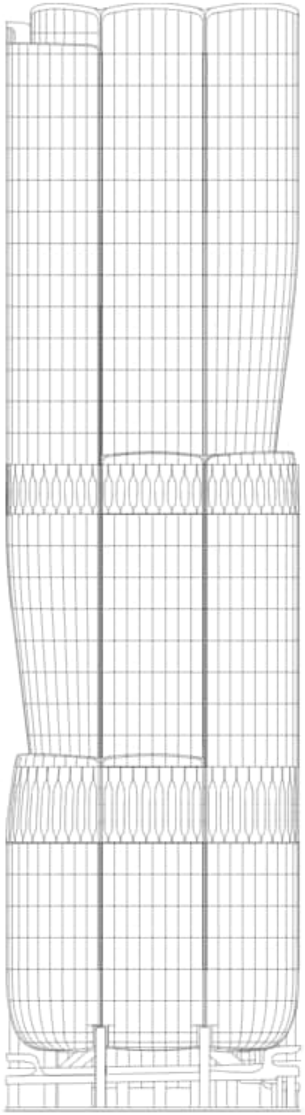
The Amenities

Full-glass banquet hall

24 -storey Grade AAA office

Podium with
Shopping arcade &
curvy footbridge

5-storey basement
carparks



Rooftop Banquet Hall	39/F
High Zone	26/F - 38/F
Sky Garden	22/F
Low Zone	6/F - 25/F
Restaurant	5/F
Lobby & Coffee Kiosk	3/F
Walkway to MTR	1/F
Lobby & VIP Drop Off	G/F
Loading / Unloading	B1
Car Park	B2
265 (with EV Chargers)	B3
78	B4
	B5

The Henderson

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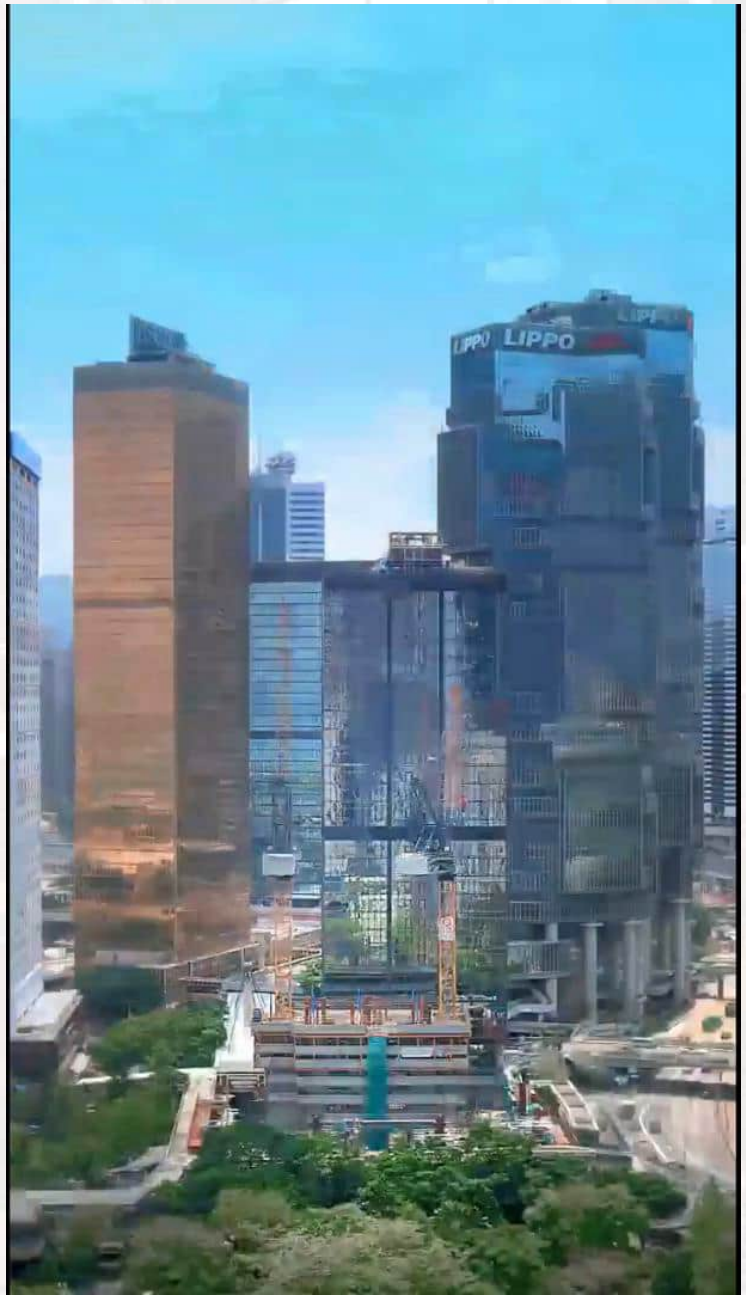
Superstructure Construction



Project Challenge & Action Taken

Risk Management Workshop

Event:	28 May 2020
Participant:	80 Guests
Client & Consultant:	10 firms
MC & Contractor:	10 Companies

Identified 61 Project Risk Items

Risk Management Workshop

- Major Risks for The Project
  1. The site is enclosed by three MTR tunnels and three footbridge where sensitive MTR tunnel imposed stringent settlement control
  2. Leakage of groundwater & unstable ground during basement excavation
  3. Rock breaking impact on vibration control
  4. Capping Beam Design
  5. Different floor footprint on each floor
  6. Limited site area to handle long span truss and large cantilever steel segment
  7. Safety risk during structural steel erection
  8. Double curve external façade impose tighten QC on production glass panel and less construction tolerance
  9. Building Lean

Project Challenge for Basement Construction

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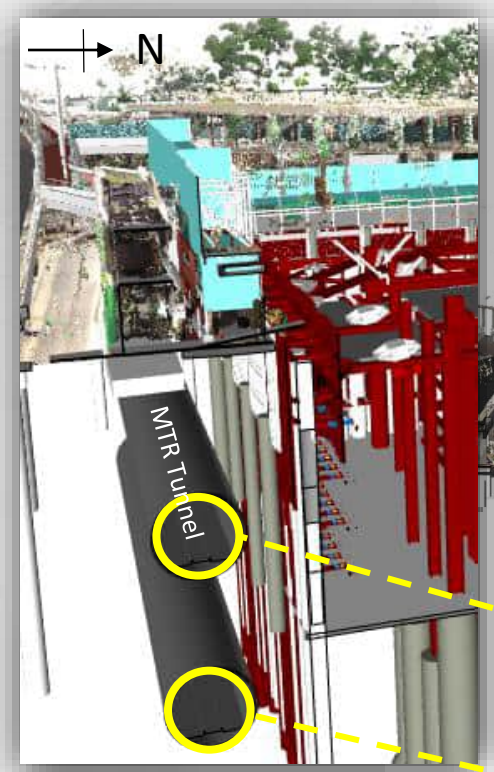
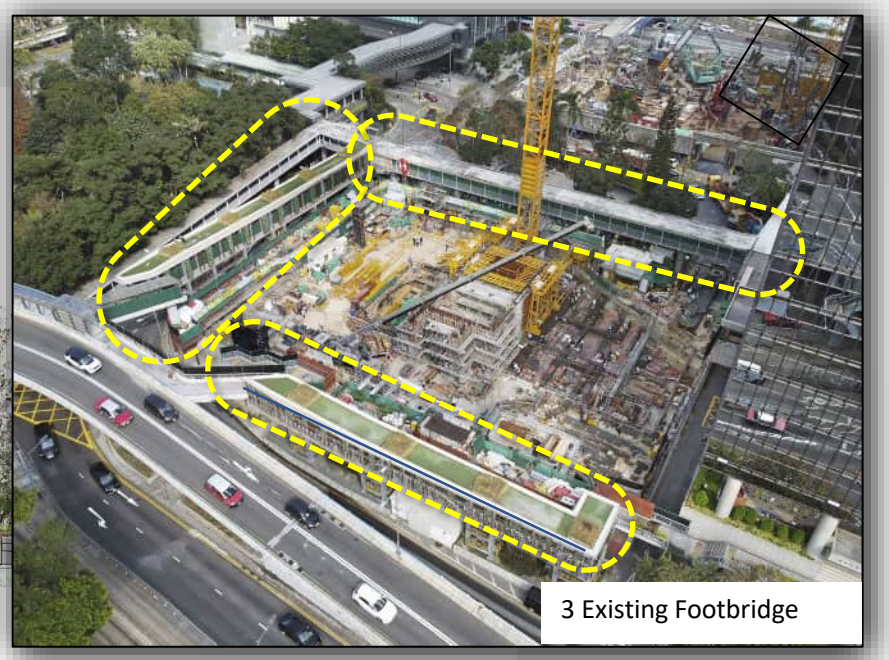
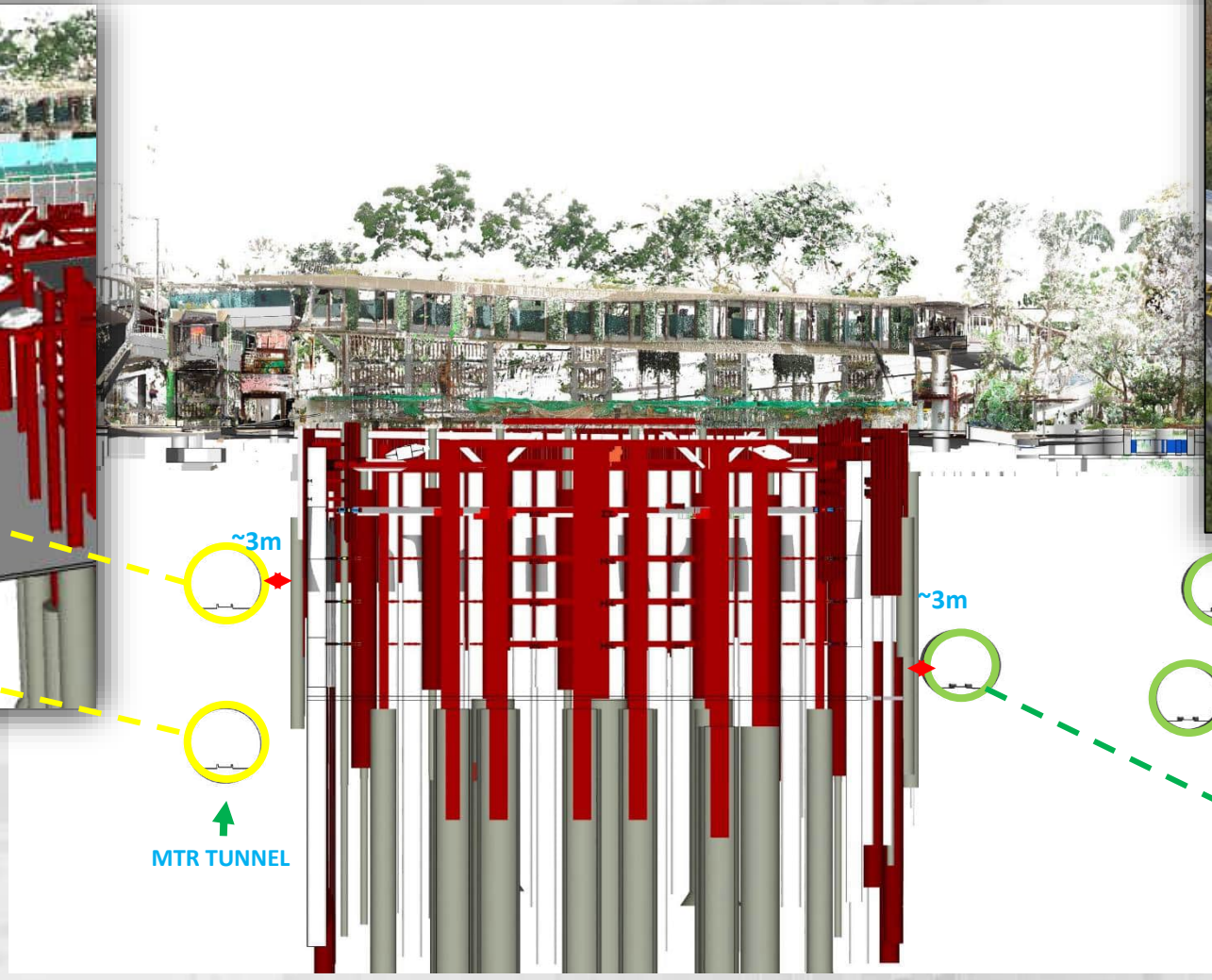
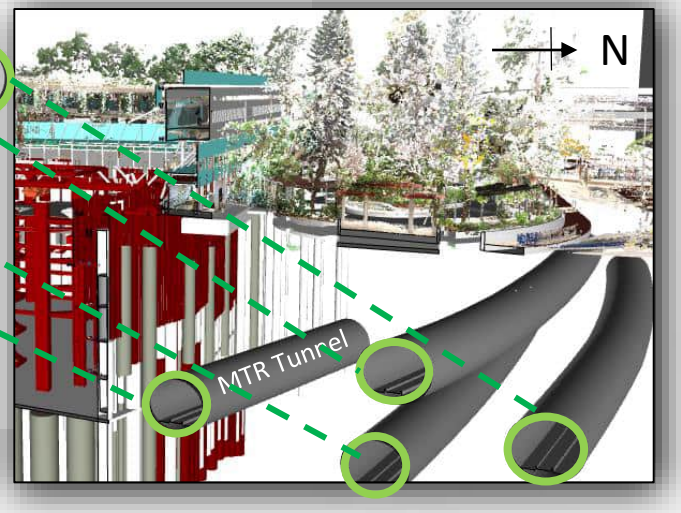
1. The site is enclosed by 6 MTR tunnels and 3 footbridges where sensitive MTR tunnel imposed stringent settlement control







Section at East



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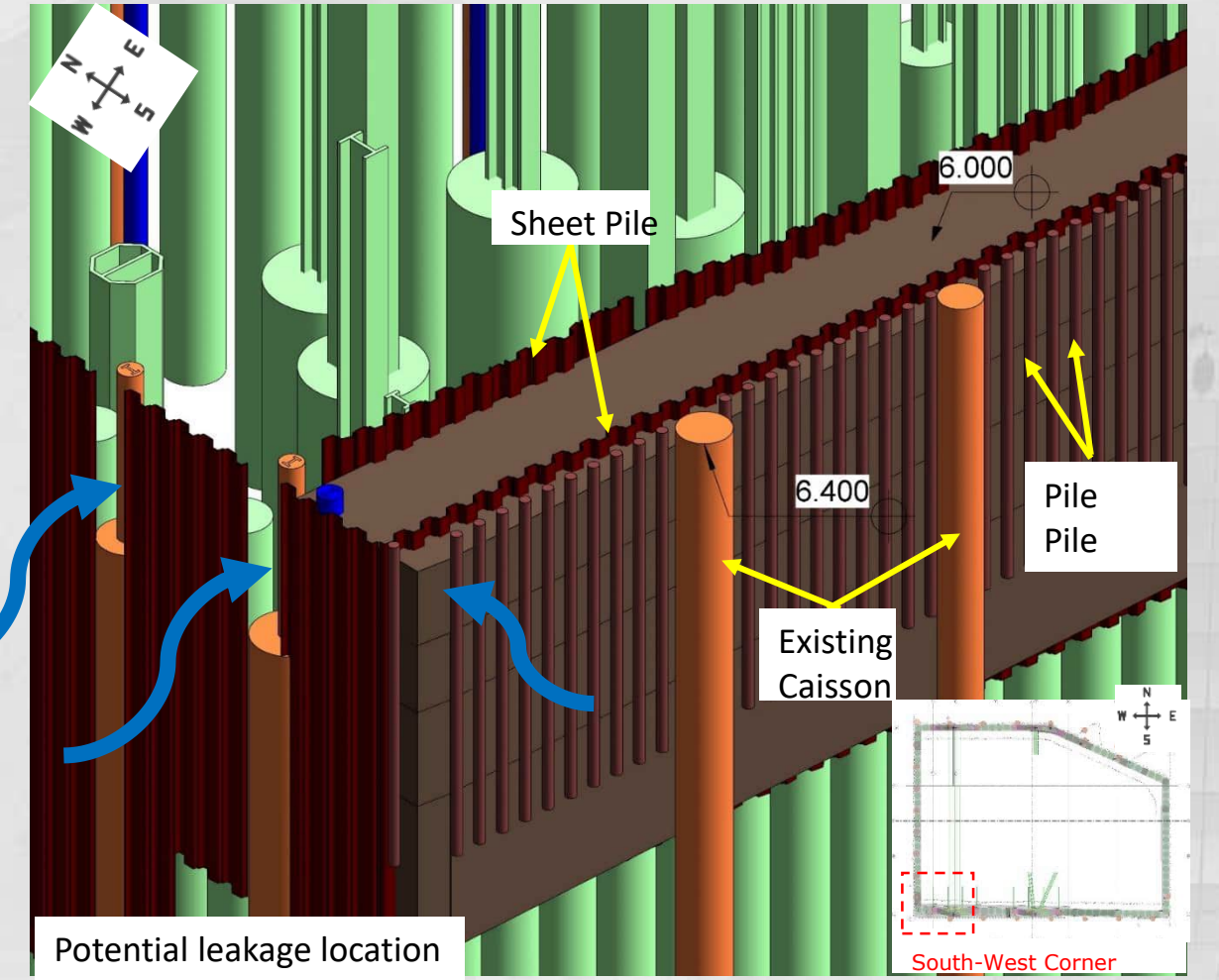
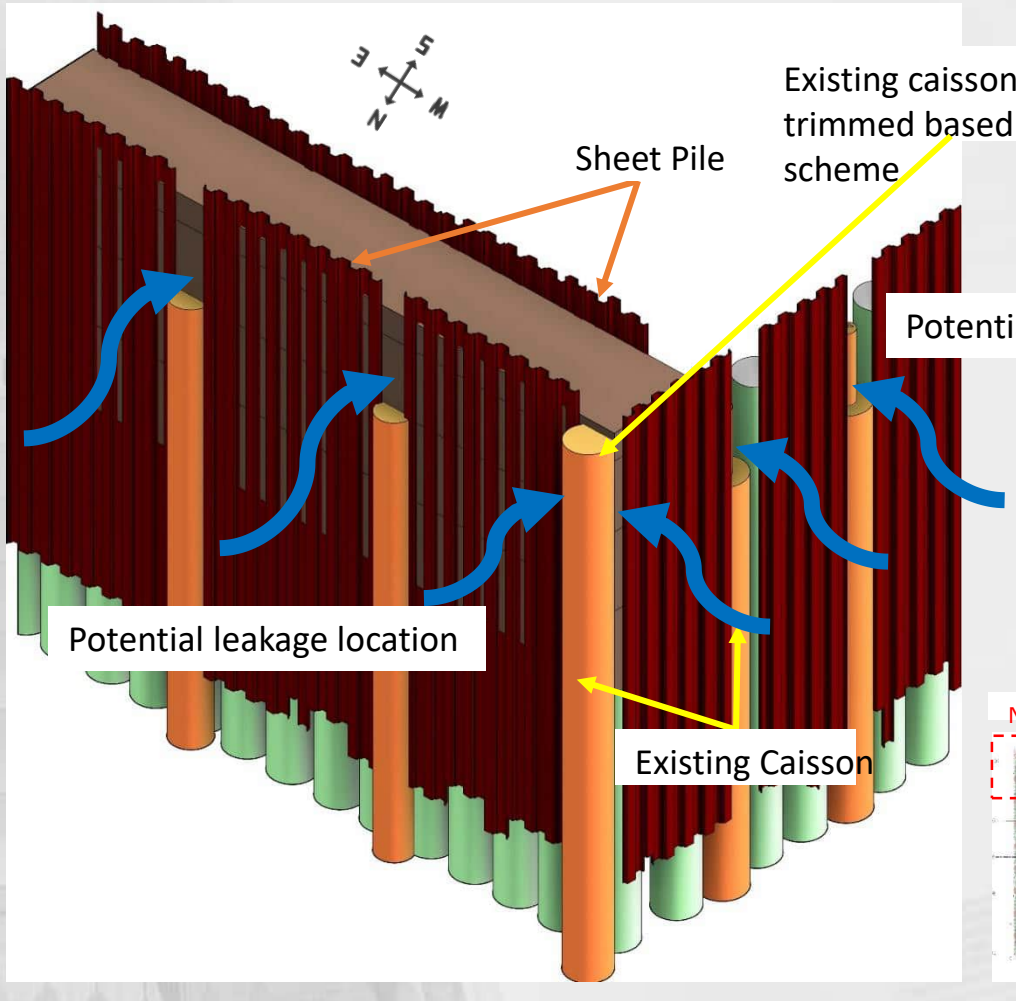
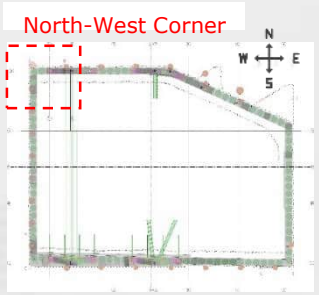
2. Leakage of groundwater & unstable ground during excavation







Project Challenge for Basement Construction

Water Ingression from Sheet pile

Water Ingression from Sheet Pile

Water Ingression from Sheet Pile

Project Challenge for Basement Construction

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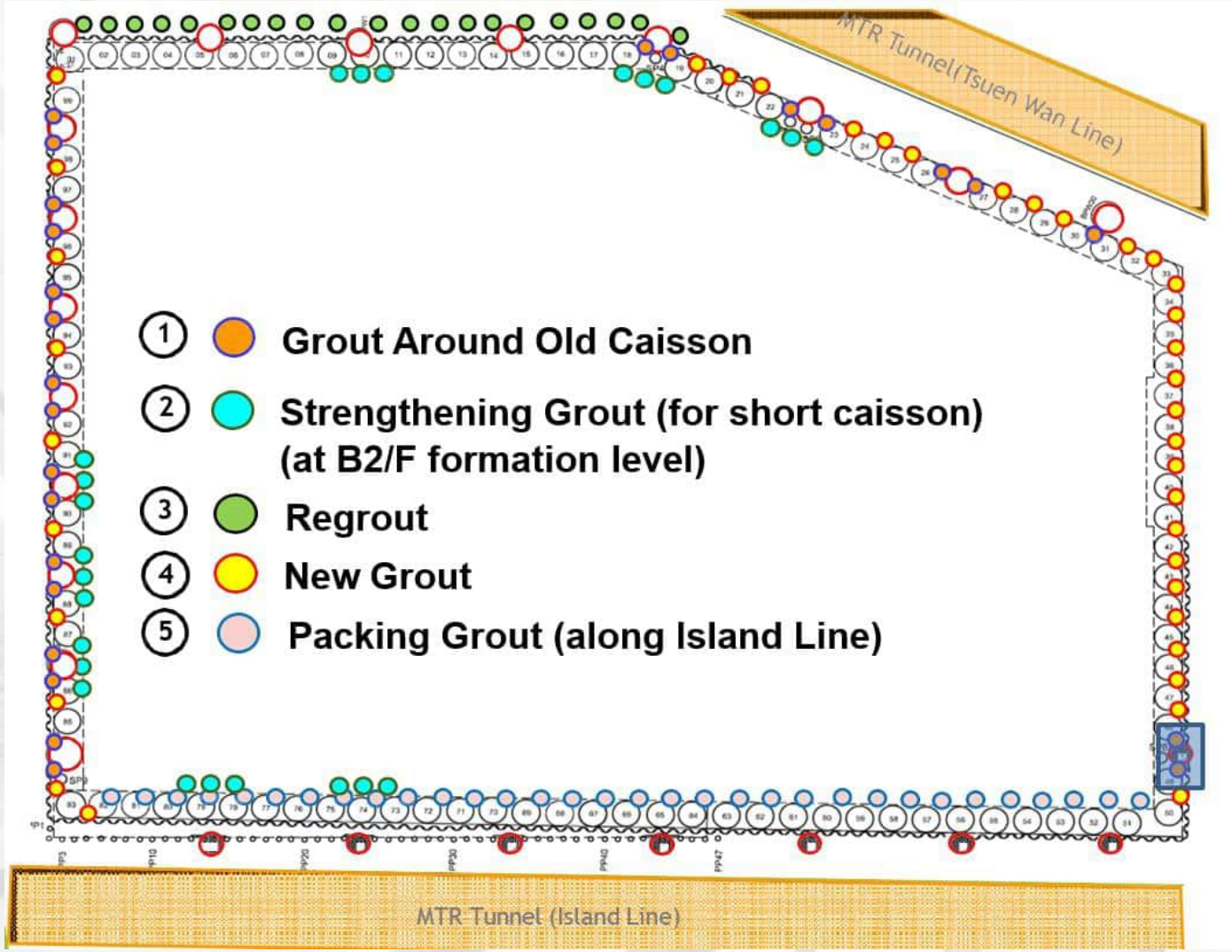
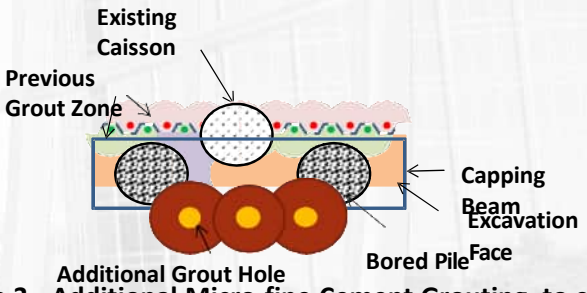
Proactive Preventive Measure for Water Ingression and Tunnel Settlement





Case 3 - Additional Micro-fine Cement Grouting to enhance strength of soil in front of Vulnerable Caisson Location

Project Challenge for Basement Construction

Proactive Measure for Ground settlement by Ground Radar Scan Survey

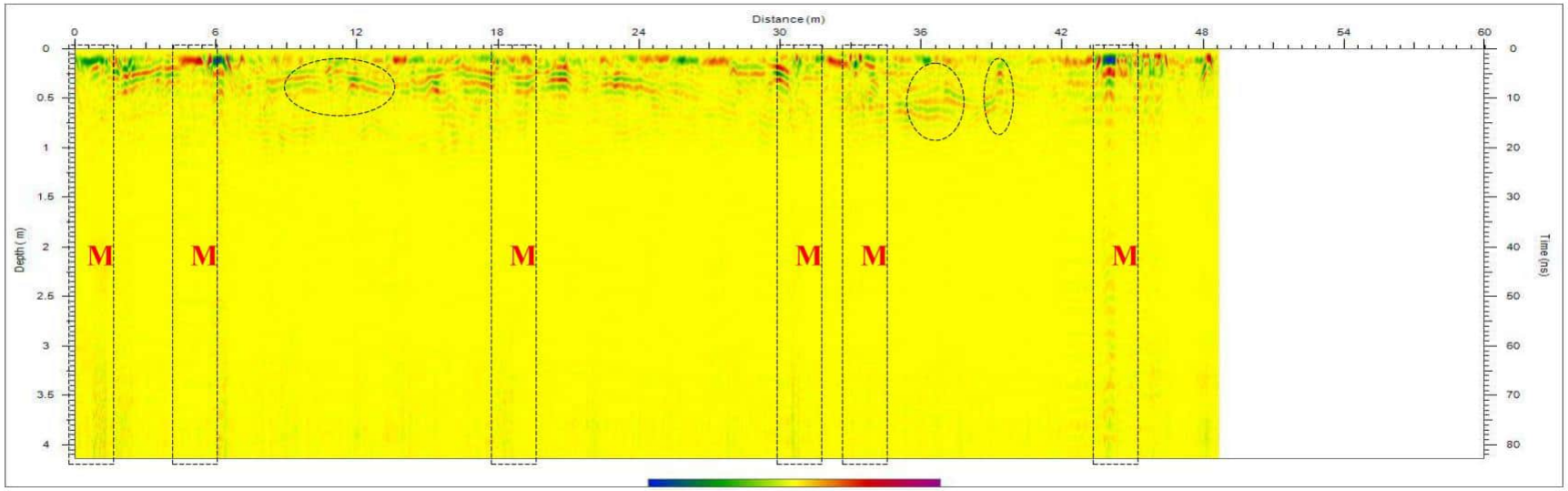
- **Regular inspection for underground void by using ground penetrating radar**
- **After each floor preloading and excavation, ground radar survey will carryout to review the ground situation**

Scan#28

Total distance: 48.75m

M: Manhole Surface

◯: Signal of abnormity, suspected void or void inside pipe duct



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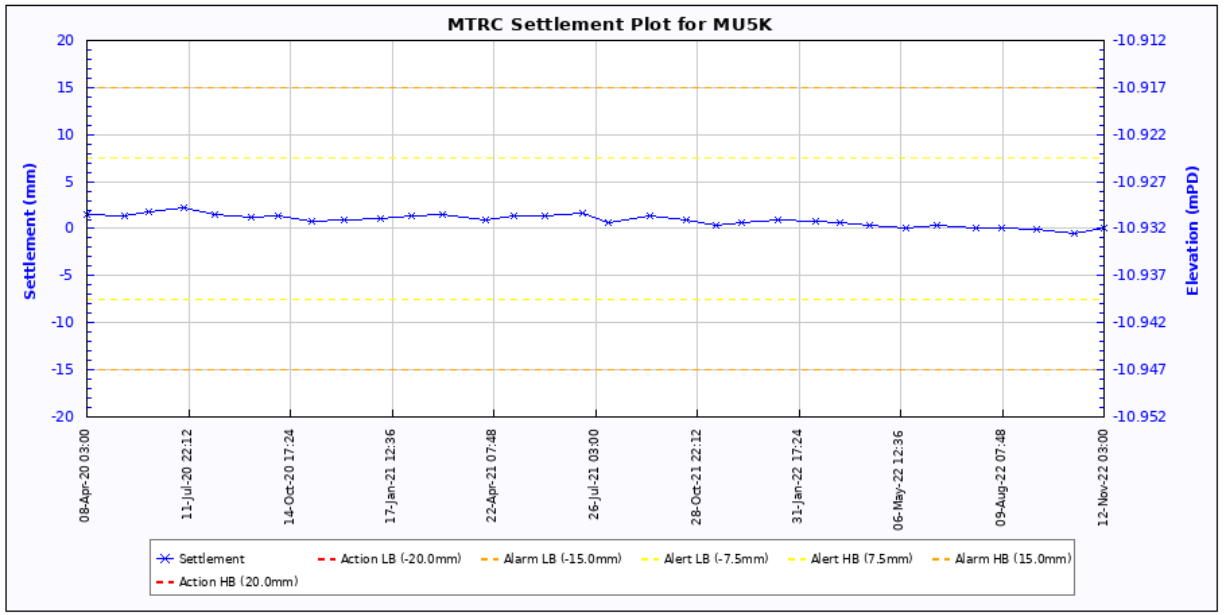
Settlement Data After Completion of the excavation work

1. Max. Tunnel Settlement is 20mm.
2. All the monitoring check point could keep within the alert level (**-7.5mm**).
3. The whole excavation work create less than **3.5**mm tunnel settlement



BD Approval AAA Value

Instrument	Alert	Alarm	Action
Tunnel settlement	-7.5	-15	-20

Summary for MTR Tunnel Settlement

Date of Survey	MTR Tunnel	Field Reading
10/01/2023	TWL Tunnel	0.2mm
04/02/2023	Island Line (Up track)	-4.0mm
04/02/2023	Island Line (Down track)	-1.0mm

* Background Correction Value = 2mm

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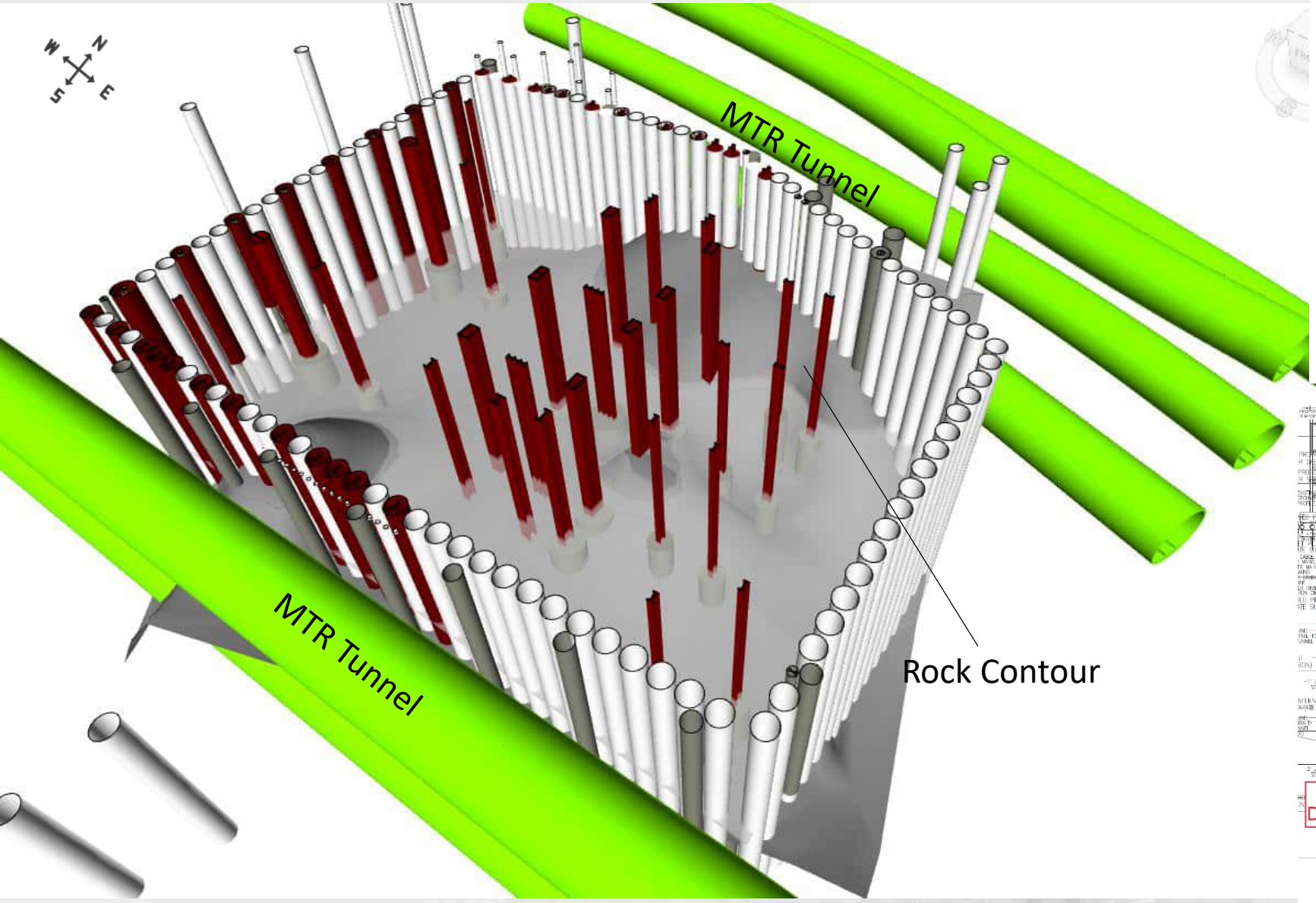
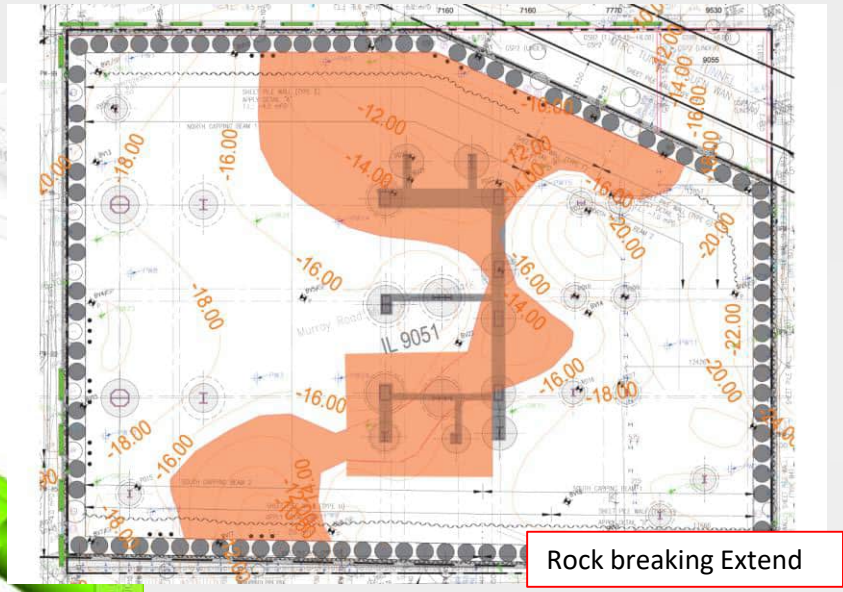
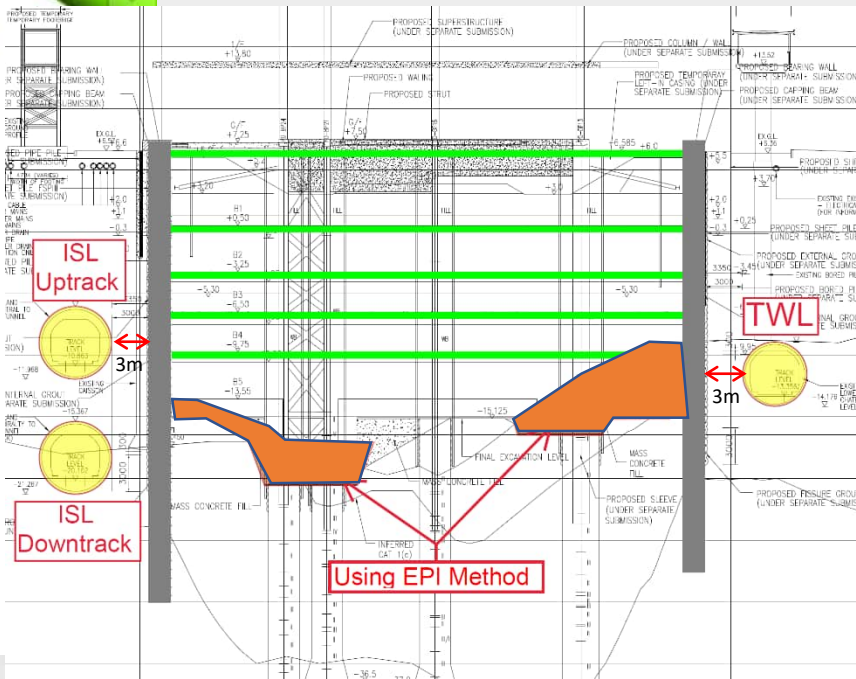
3. Rock breaking impact on vibration control







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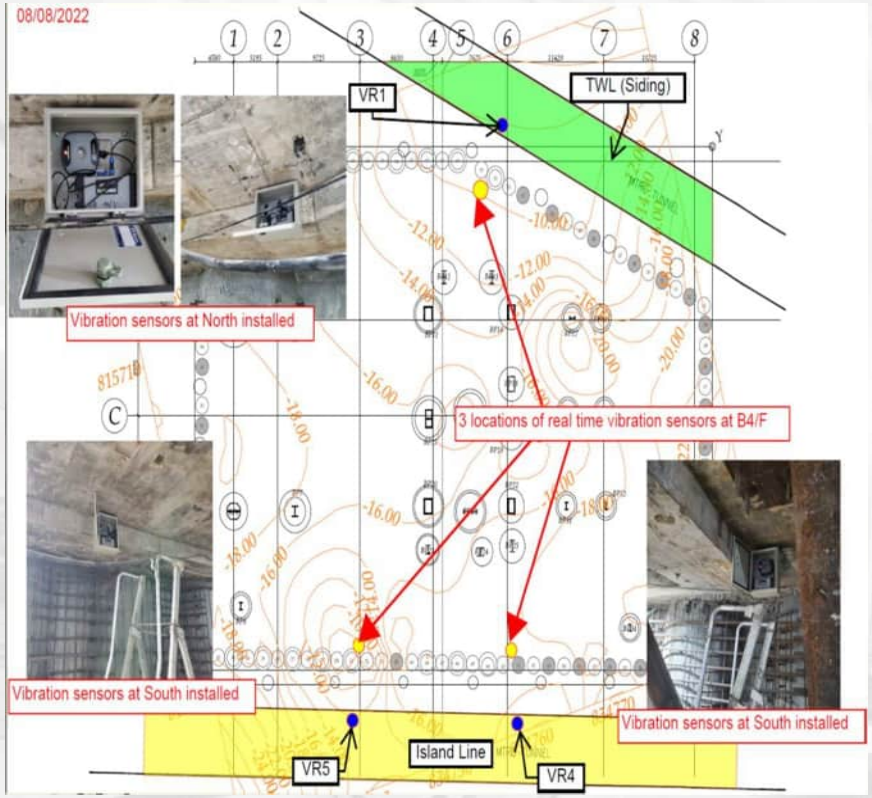
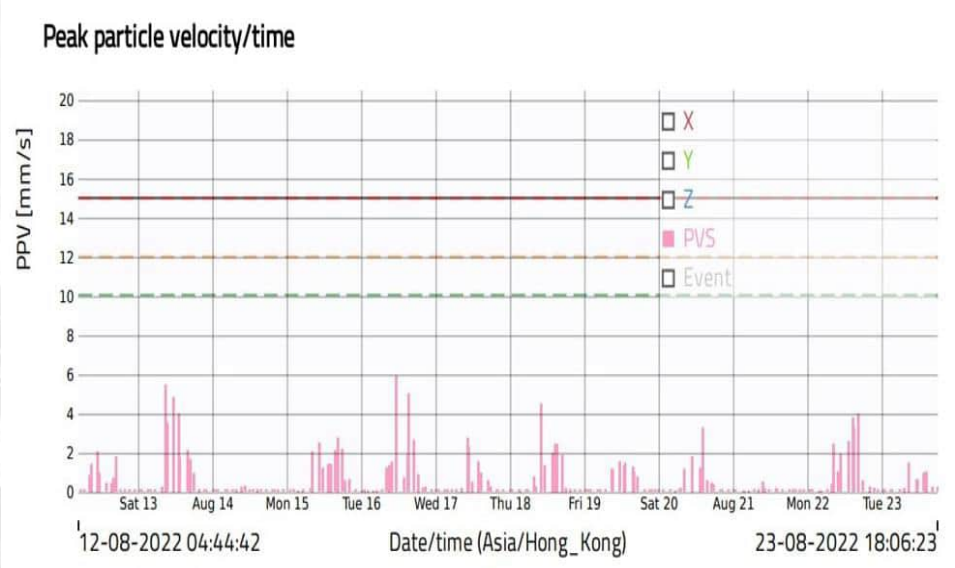
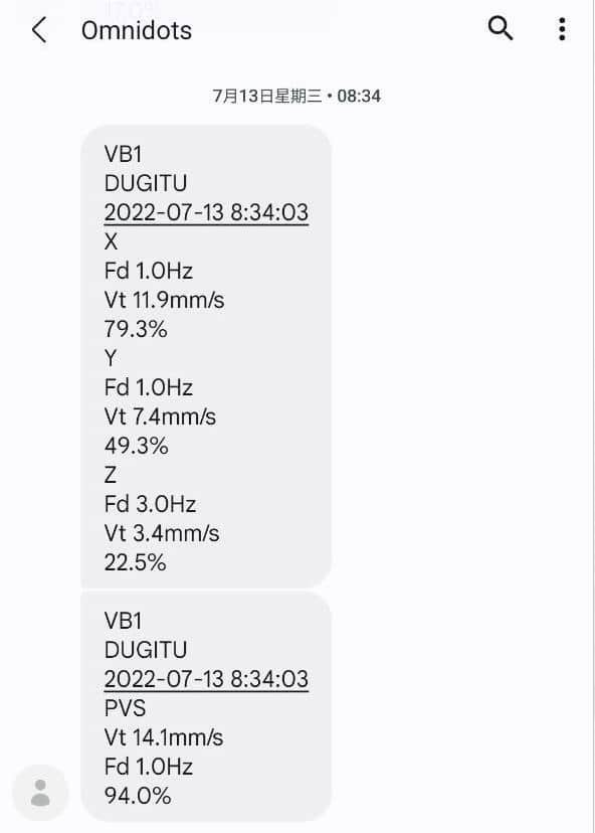
Control Measure for Rock breaking Vibration

- **Max. allowable vibration level is 15mm/s**
- **Additional real time vibration Sensor for self checking which have more strictly control (10mm/s) than approval plan**







Real Time Notification for frontline

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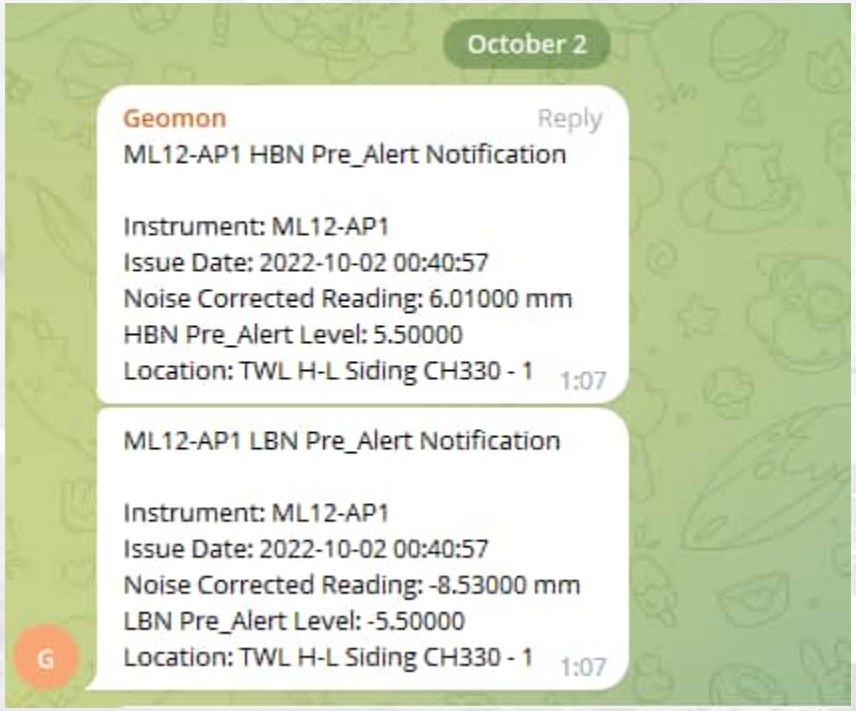
Control Measure for Rock breaking Vibration



Pre-alert warning system from GEOMON for site staff

Pre-determine action plan

Stage 1: Mechanical Breaker Method

Stage 2: Pre-splitting Method

Stage 3: Saw-cut Method

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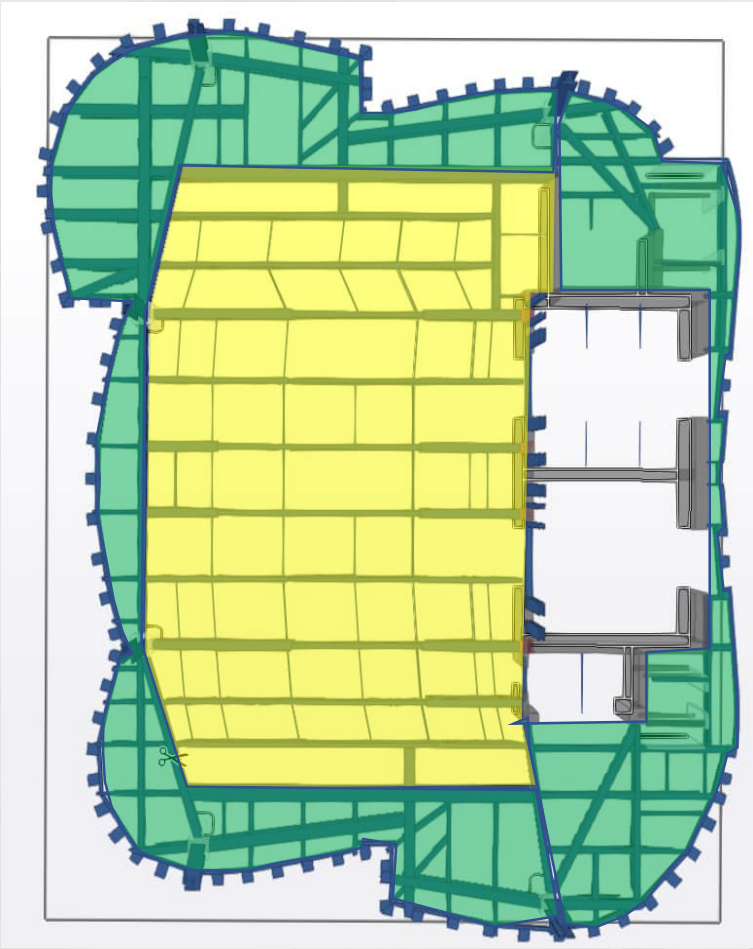
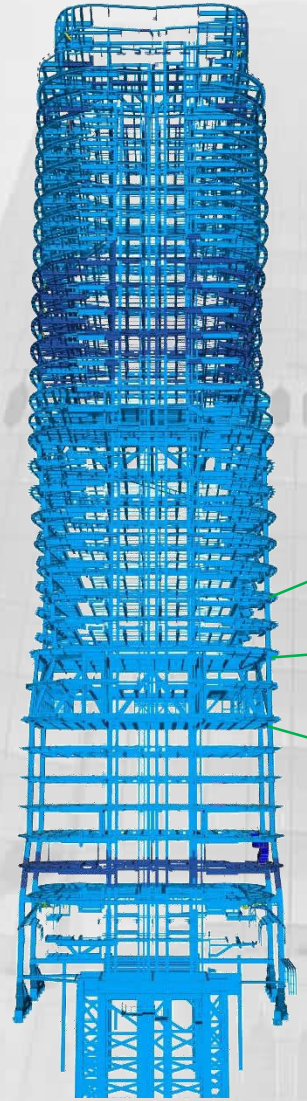
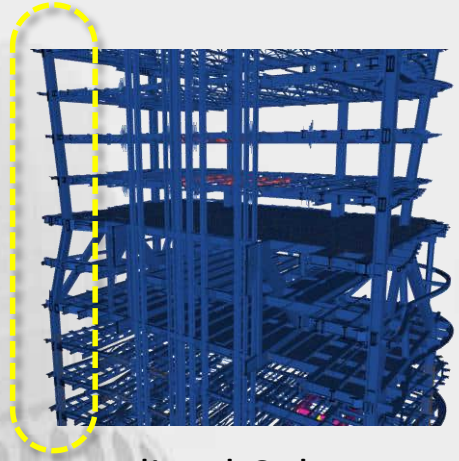
5. Different floor footprint on each floor



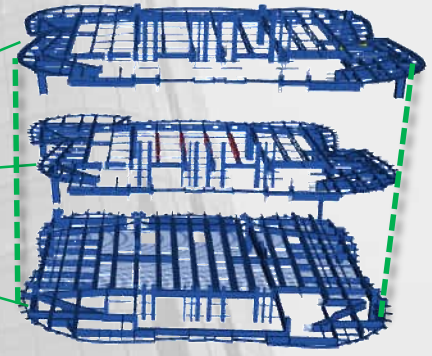
Long Span Truss Beam (22m)

Non-typical Cantilever Edge Structure (8.7mx7.5m approx.)





Inclined Column



Different footprint

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5. Different floor footprint on each floor

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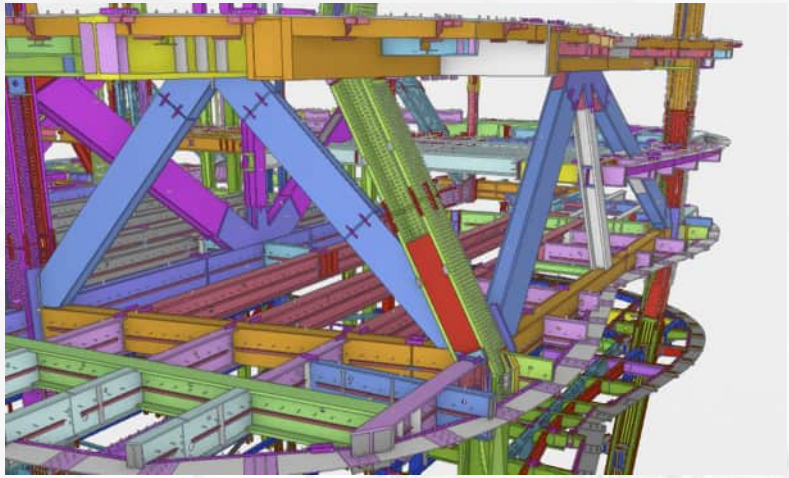
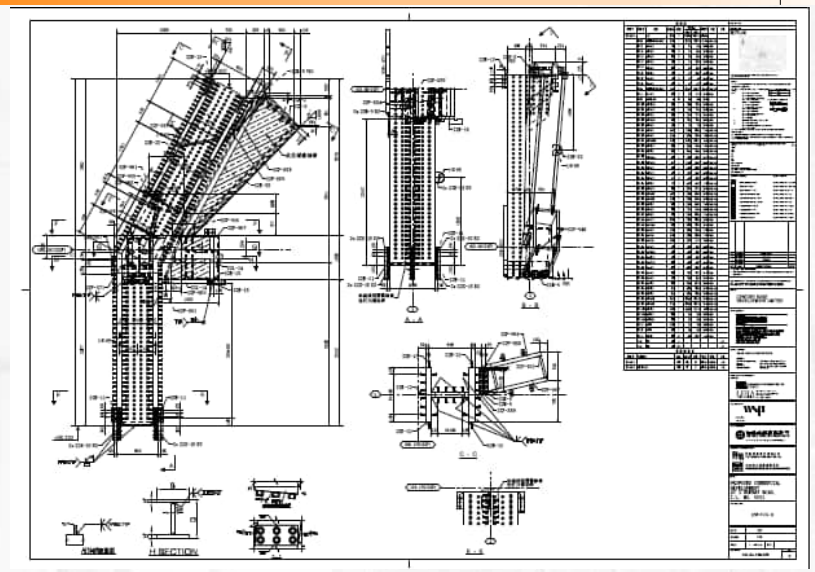
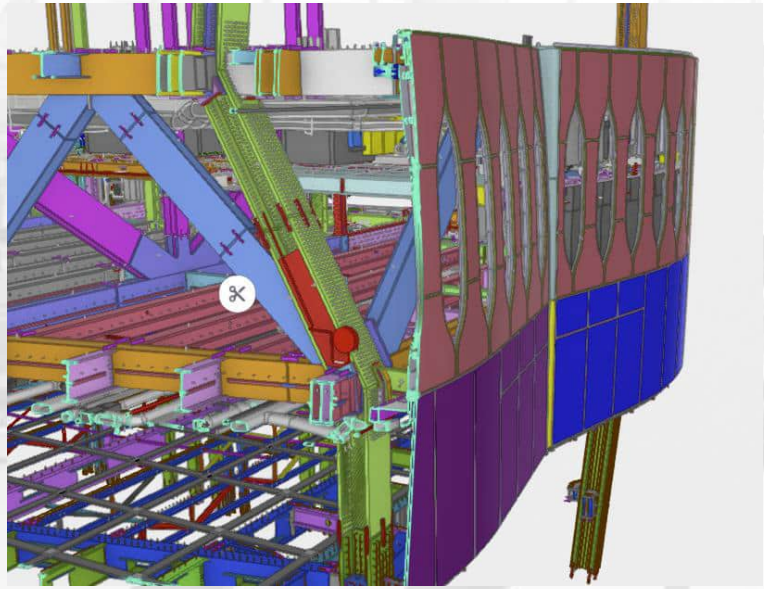
Structural Steel Construction with unusual footprint

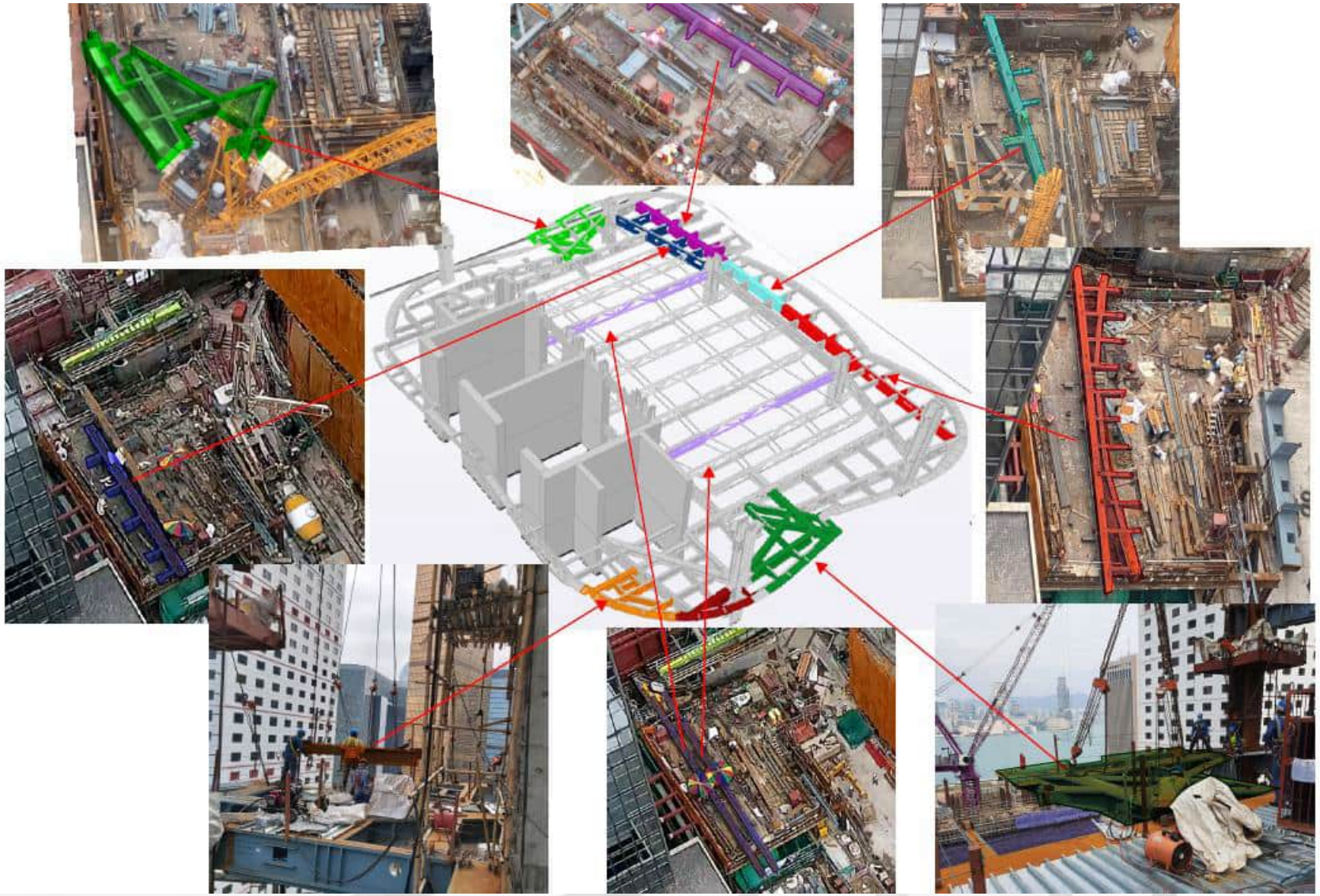


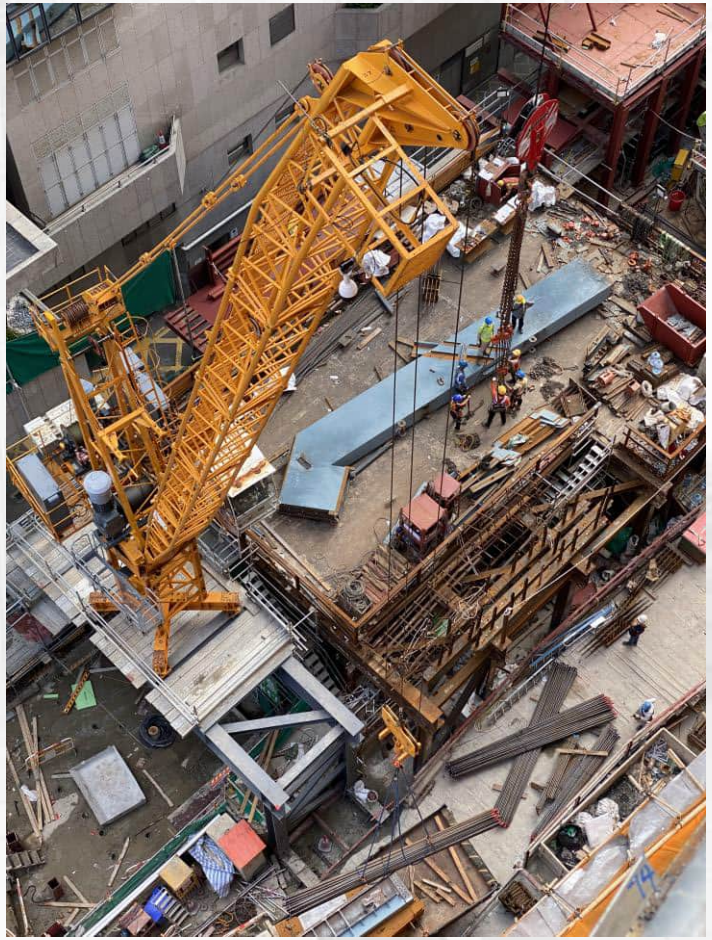




Project Challenge for Superstructure Construction

6. Limited site area to handle 22m long span truss and 8.7m x 7.5m large cantilever edge panels

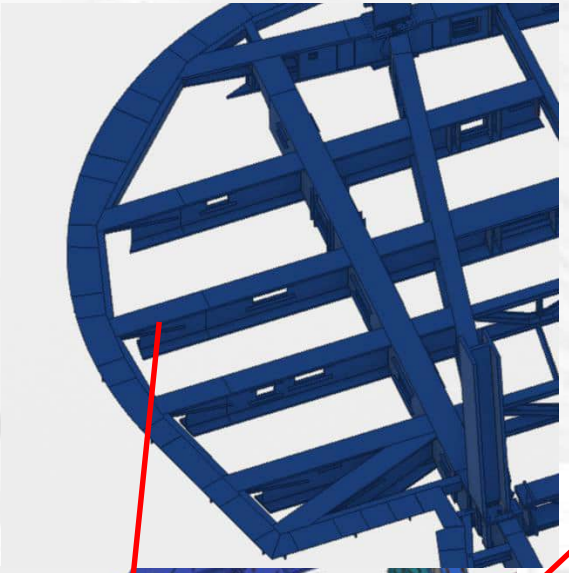


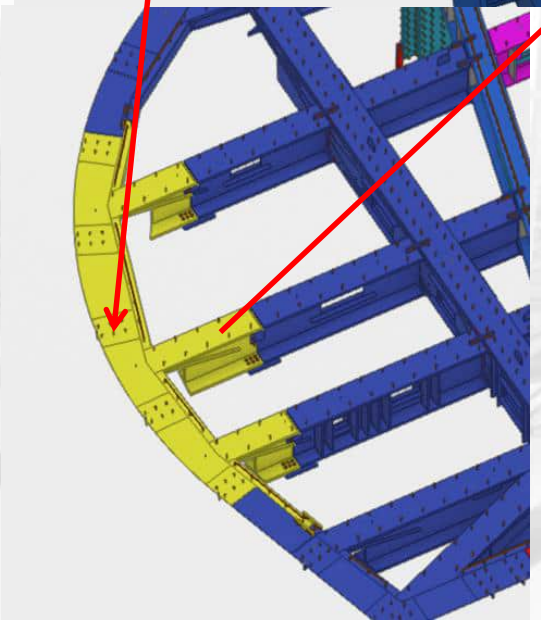


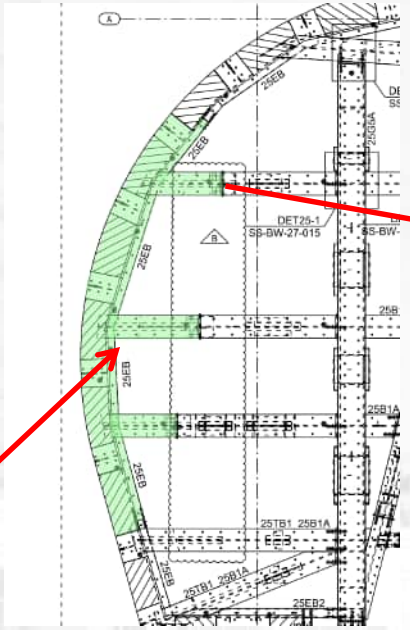
Requirement of large working platform for pre-assembly

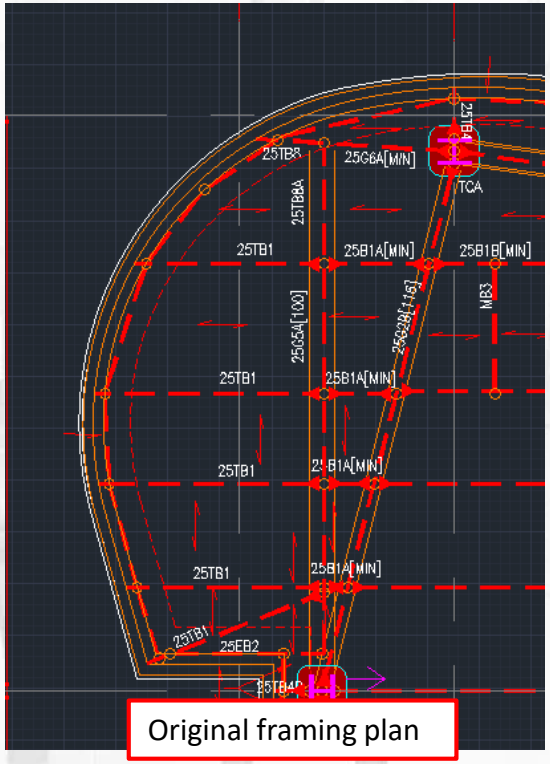
Project Challenge for Superstructure Construction

Simplify the connection detail between the cantilever edge sub-modules to improve productivity and safety.

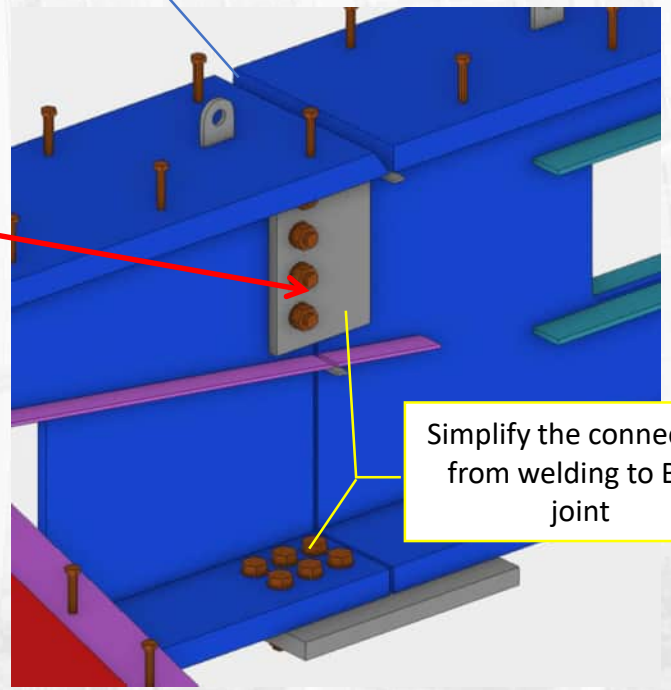








Original framing plan



FPBW at top flange

Simplify the connection from welding to Bolt joint

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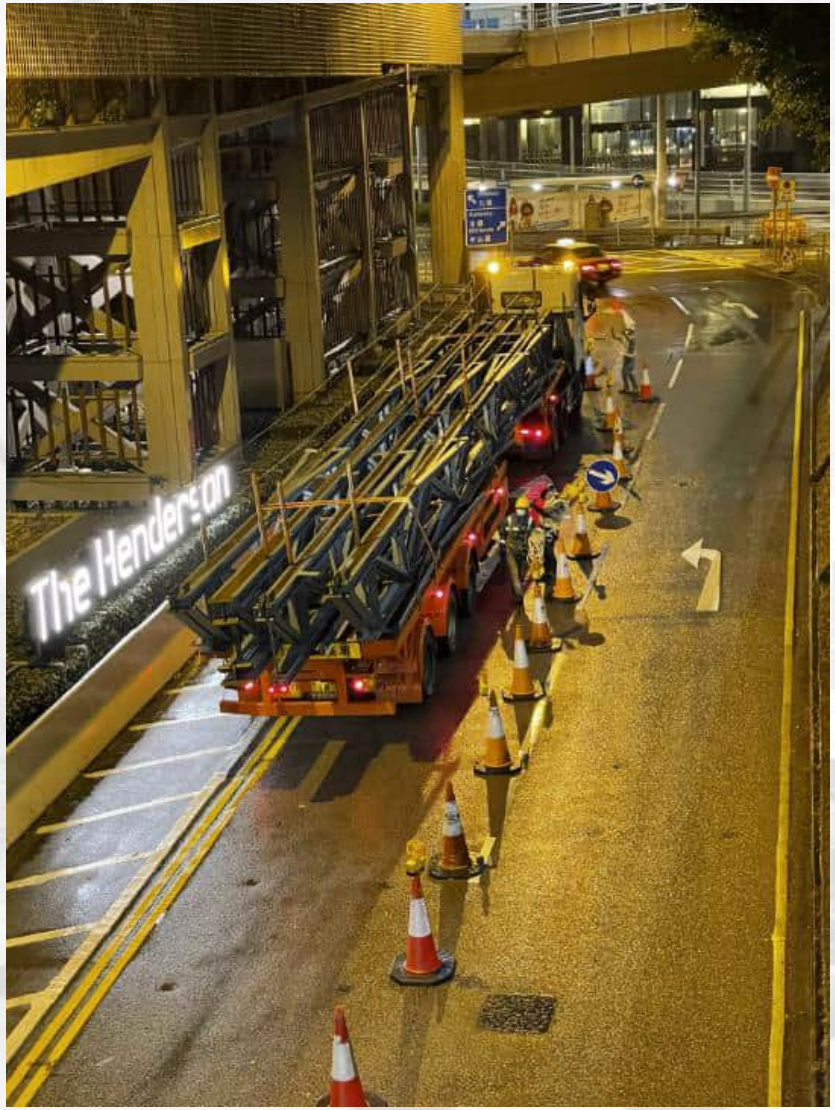
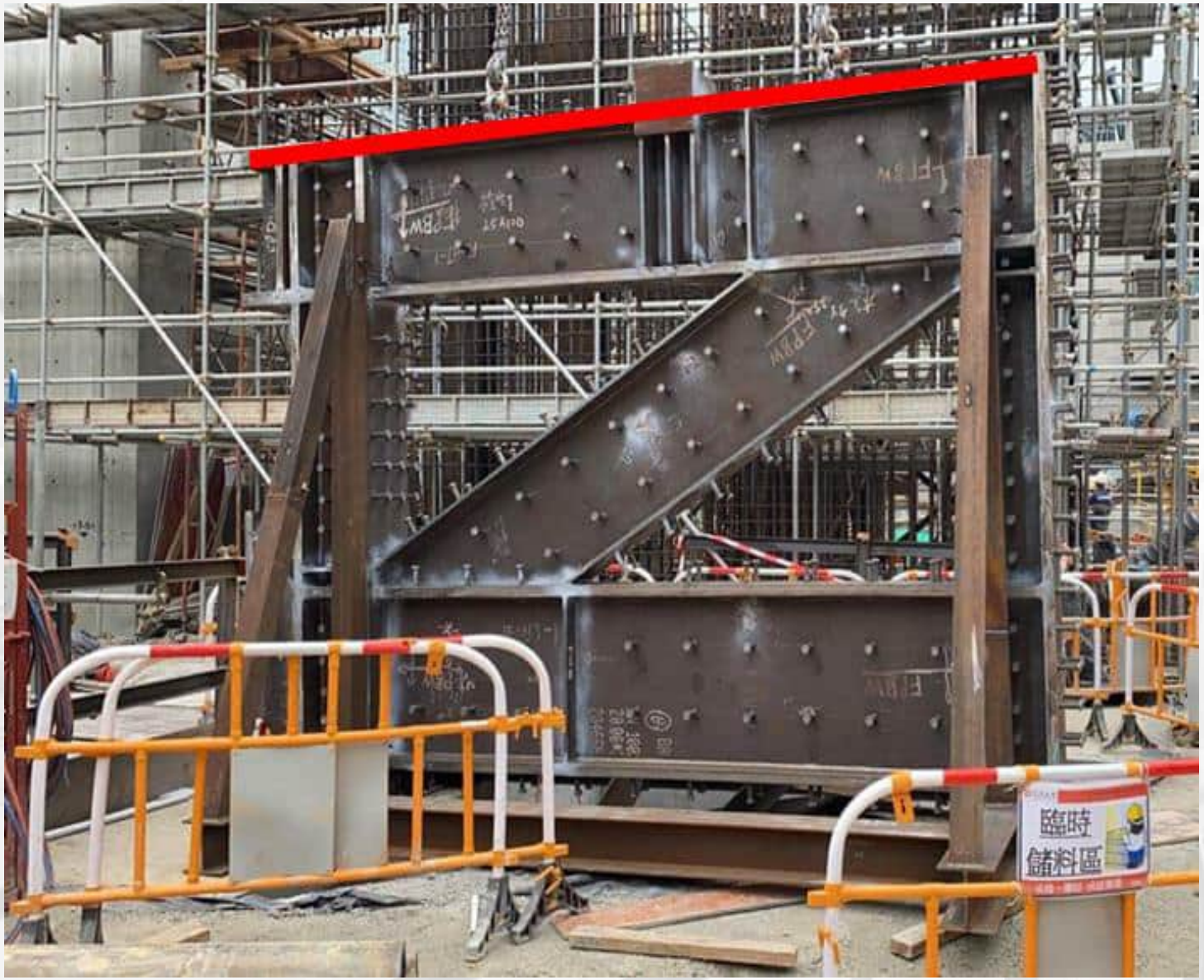
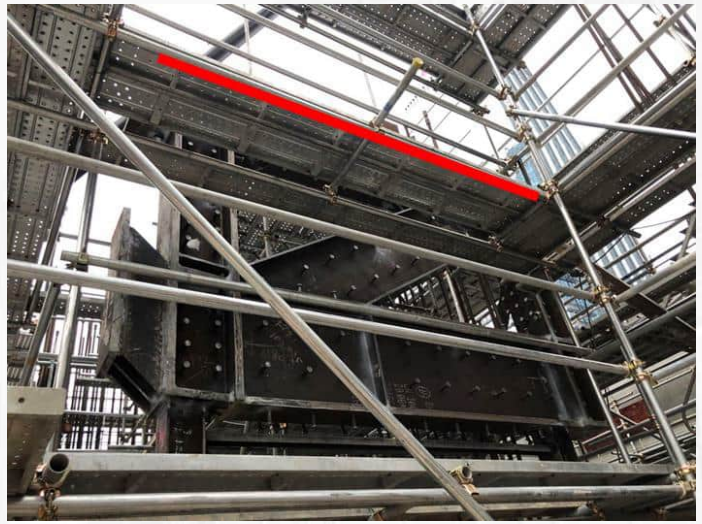
Apply Permits for Overnight delivery and unloading of Long Span Structural Steel to site + Apply CNP from EPD for road closure and overnight lifting

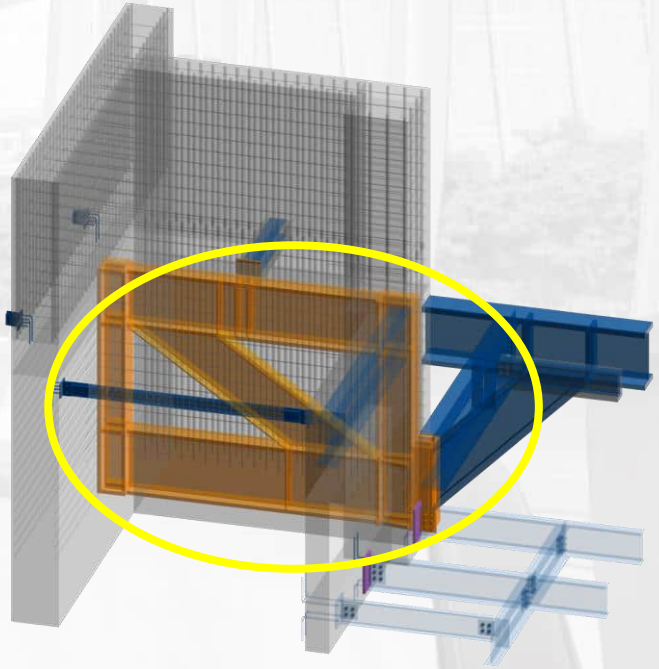


Project Challenge for Superstructure Construction

Additional Steel Frame in 1/F Core wall (PW3)

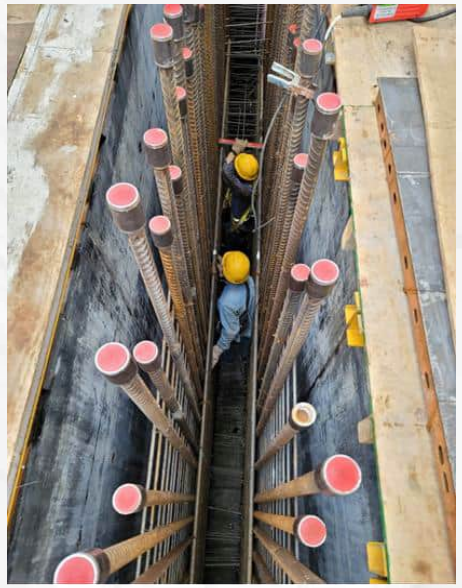


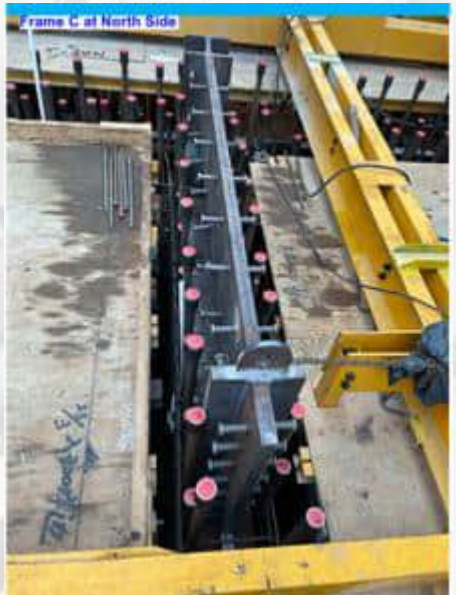


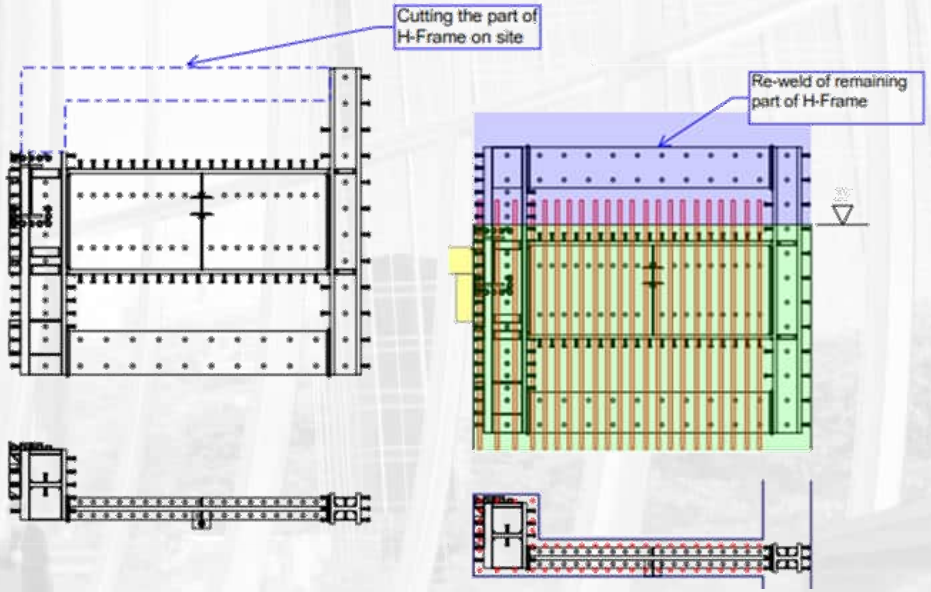


Project Challenge for Superstructure Construction

Additional Steel Frame in 3/F Core wall (PW3)







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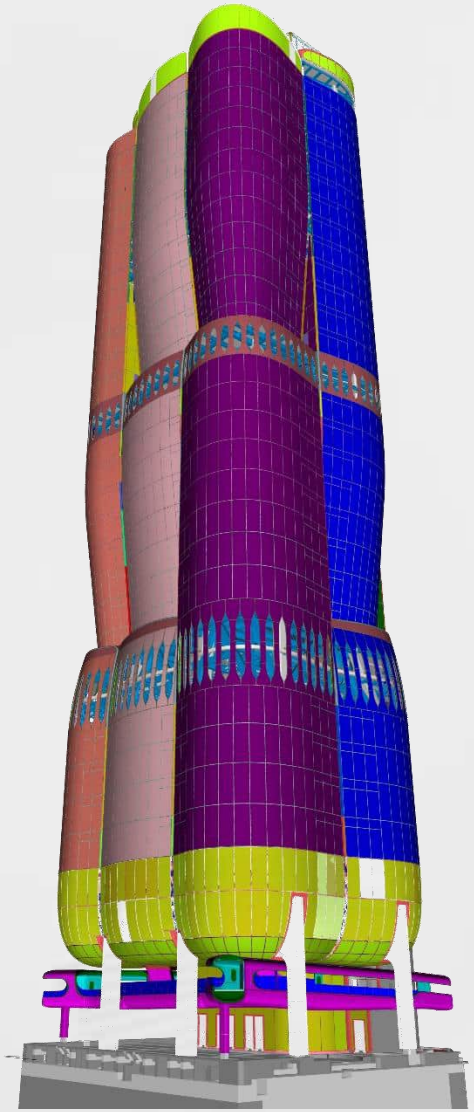
8. Double curve external façade impose tighten QA/QC on production glass panel and erection



Project Challenge for Superstructure Construction

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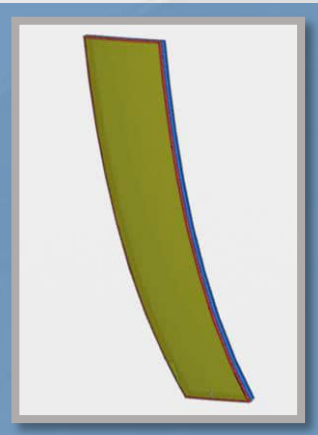
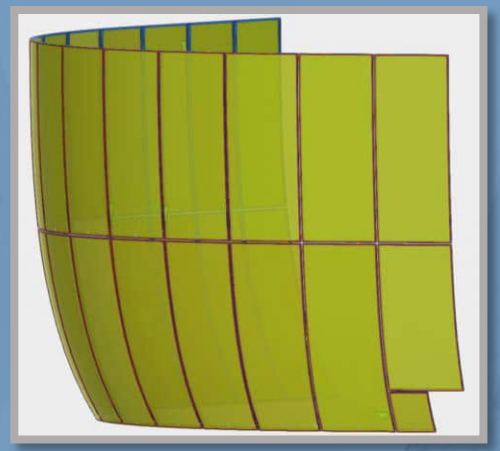
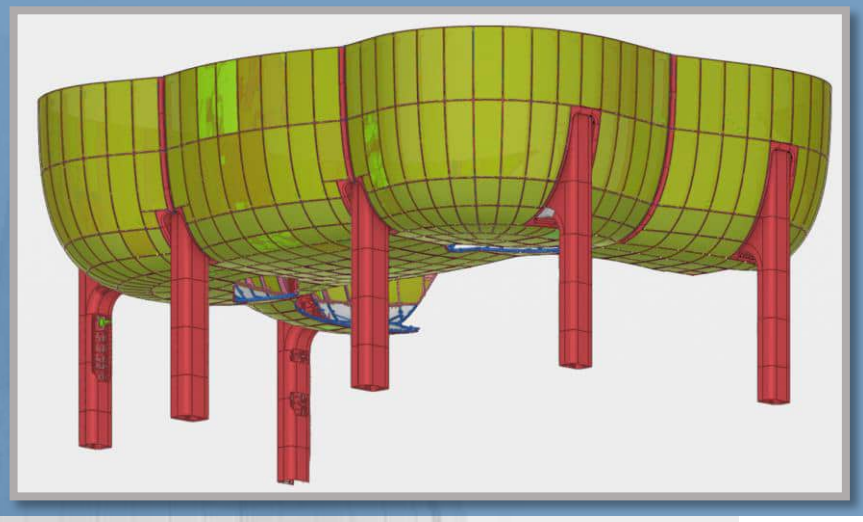
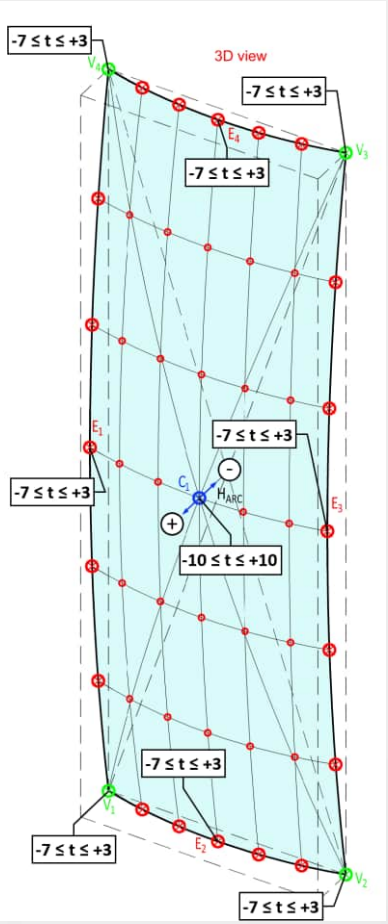
Production of façade glazing using BIM technology

We use 3D model for production of façade glazing with complex and double-curved geometry to make sure the products can perfectly match and assemble together.





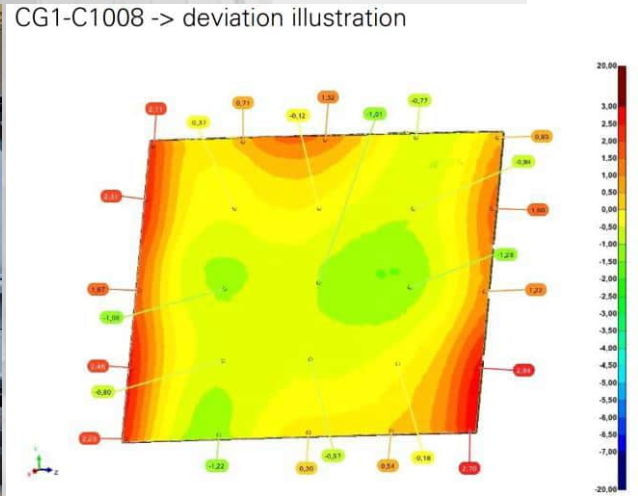




3D scanning for each piece of glass is conducted to check its dimension and deviation tolerance are within allowable range.

Light Box checking glass defect

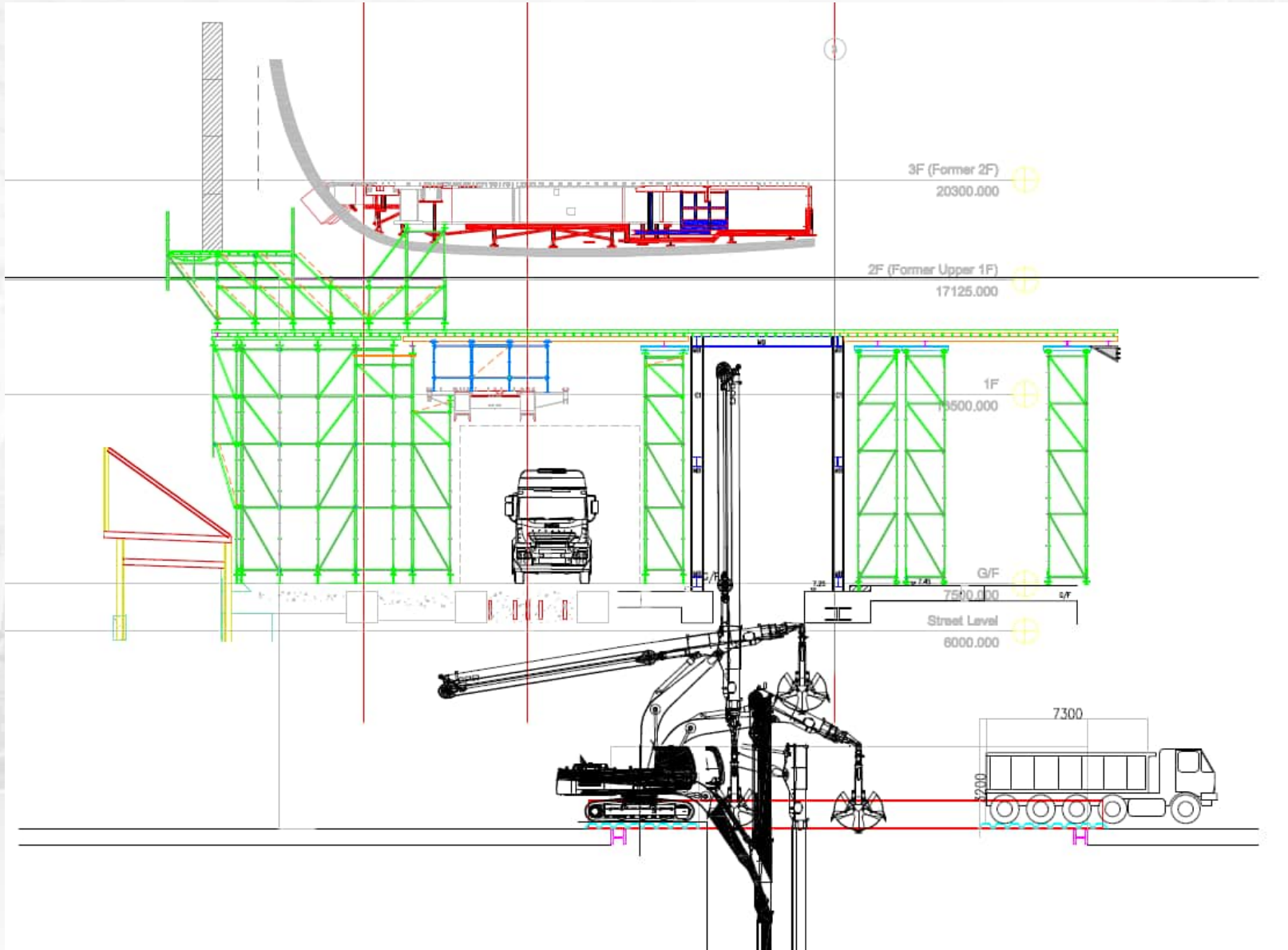
3D Full Surface Laser Scanning



Deviation Analysis Reports

Project Challenge for Superstructure Construction

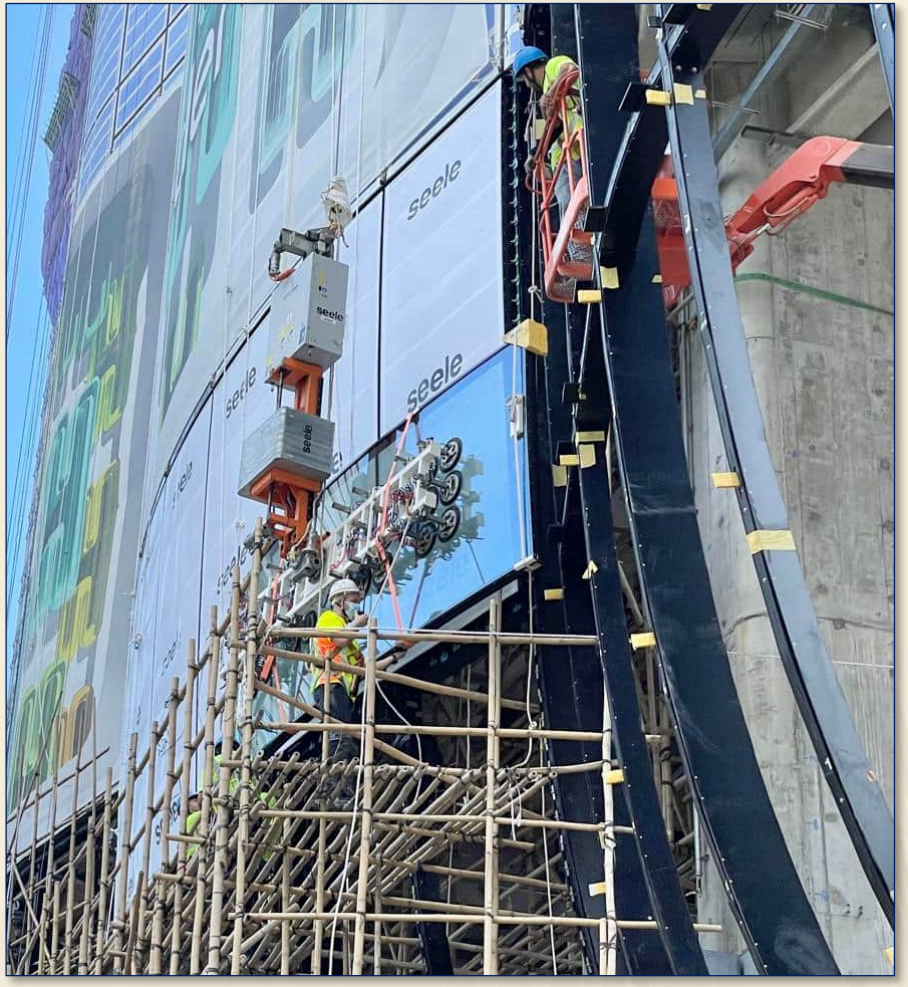
Temporary Working Platform for Underslung construction



Project Challenge for Superstructure Construction

Congested Site Condition

We erected working platform and scaffolding for curved glass installation.



Suction Cup and Cantilever Beam for lifting curved glass

Project Challenge for Superstructure Construction

2 Murray Road
(Central)
中環美利道2號

Curved Glass Lifting and Installation

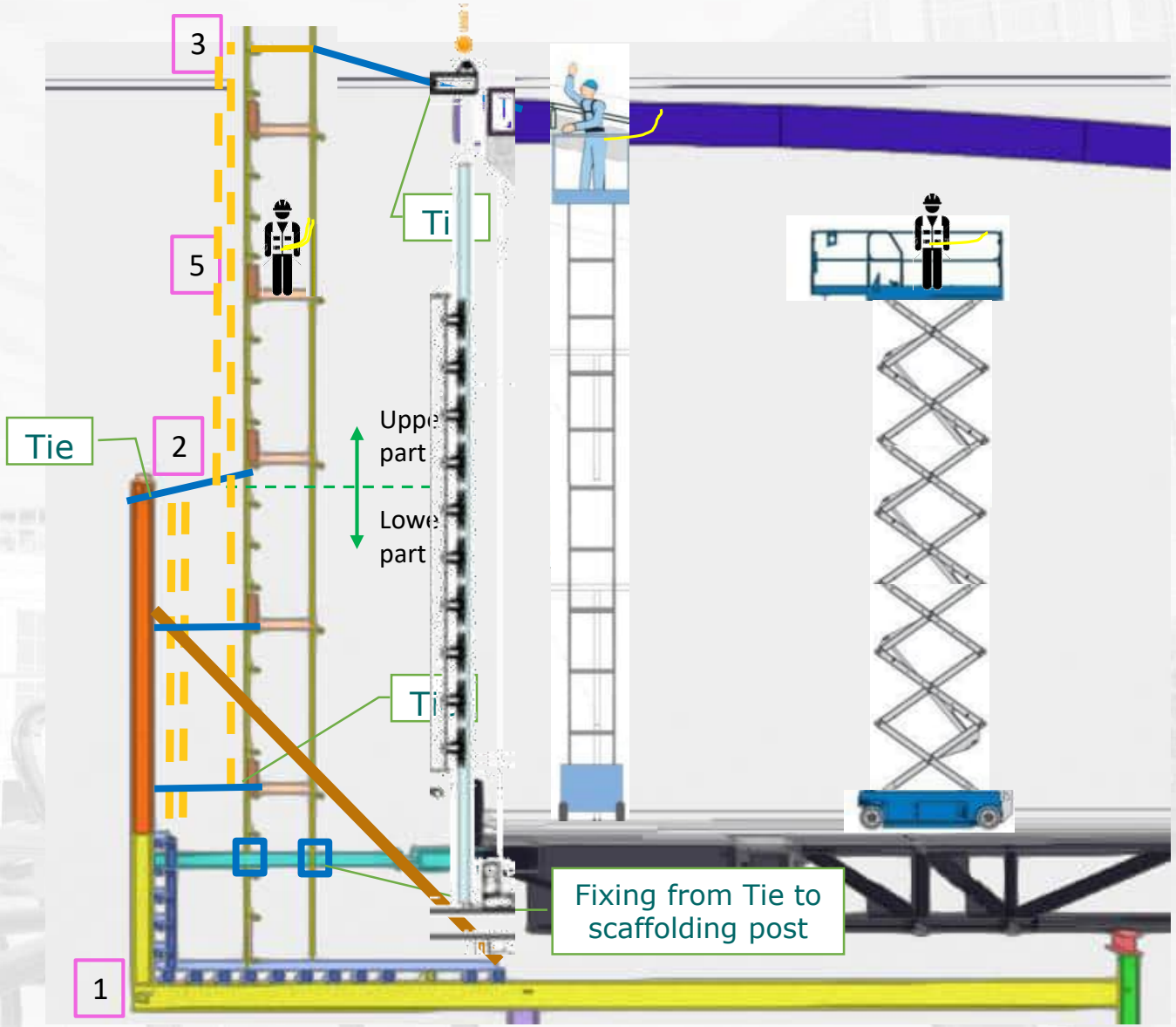
Project Challenge for Superstructure Construction

Underslung Installation

Project Challenge for Superstructure Construction

Banquet Hall glass panels Installation

1. Completion of catch fence installation.
2. Install the intermediate ties.
3. Extend the metal scaffold to final level.
4. Install the upper tie (Compensation ties at both sides should be provided when the tie be removed temporarily during seele install glass panel).
5. Erect the scaffolding safety net (double layer).



Project Challenge for Superstructure Construction

2 Murray Road
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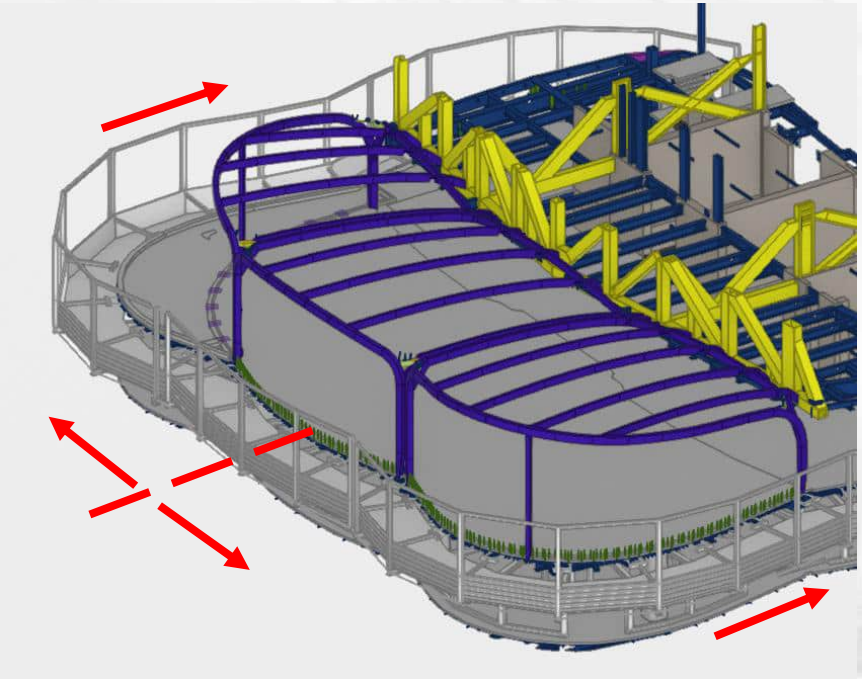
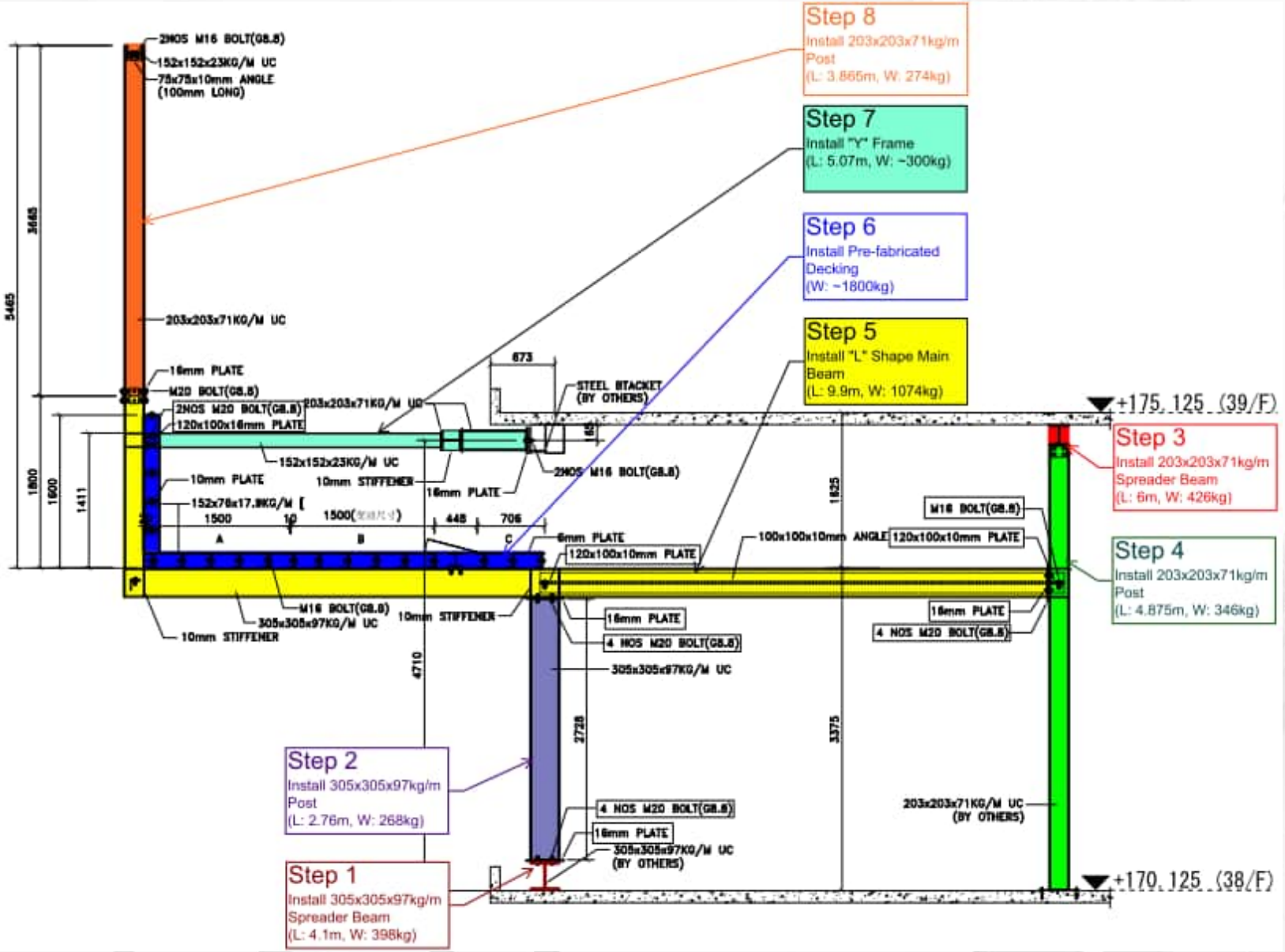
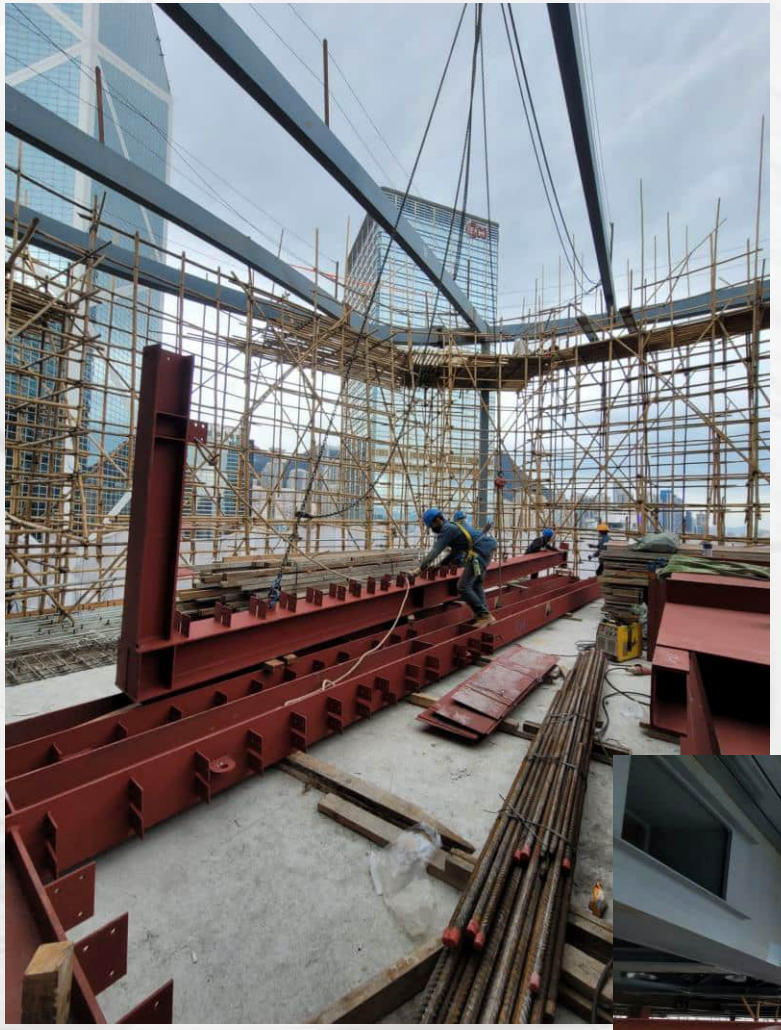
中環美利道2號

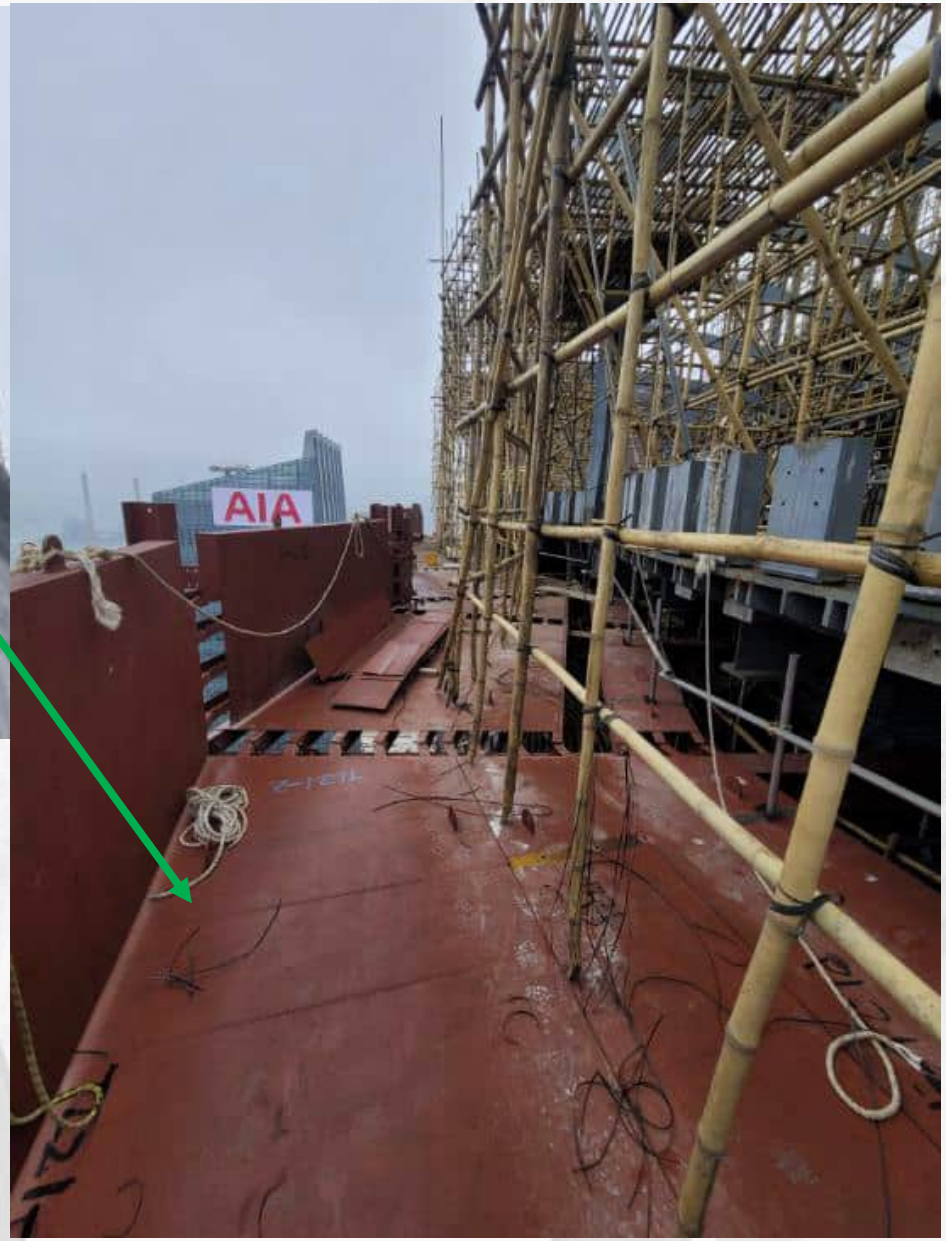
Extensive Catch Fence for Banquet Hall Installation





Project Challenge for Superstructure Construction





Project Challenge for Superstructure Construction

Banquet Hall Installation

Project Challenge for Superstructure Construction

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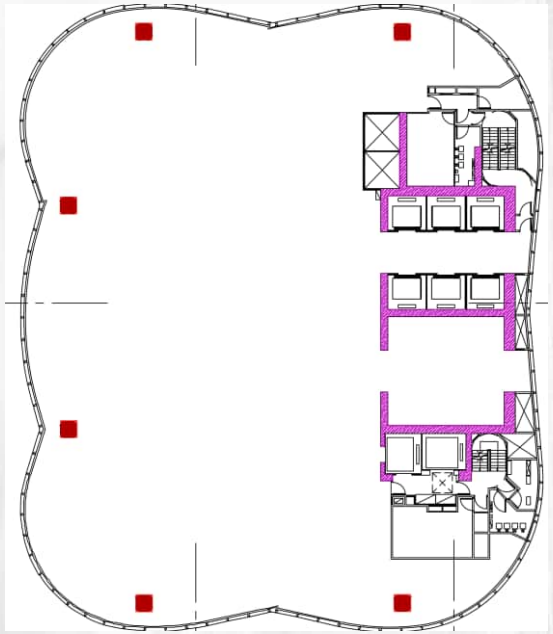
9. Overcome verticality challenge

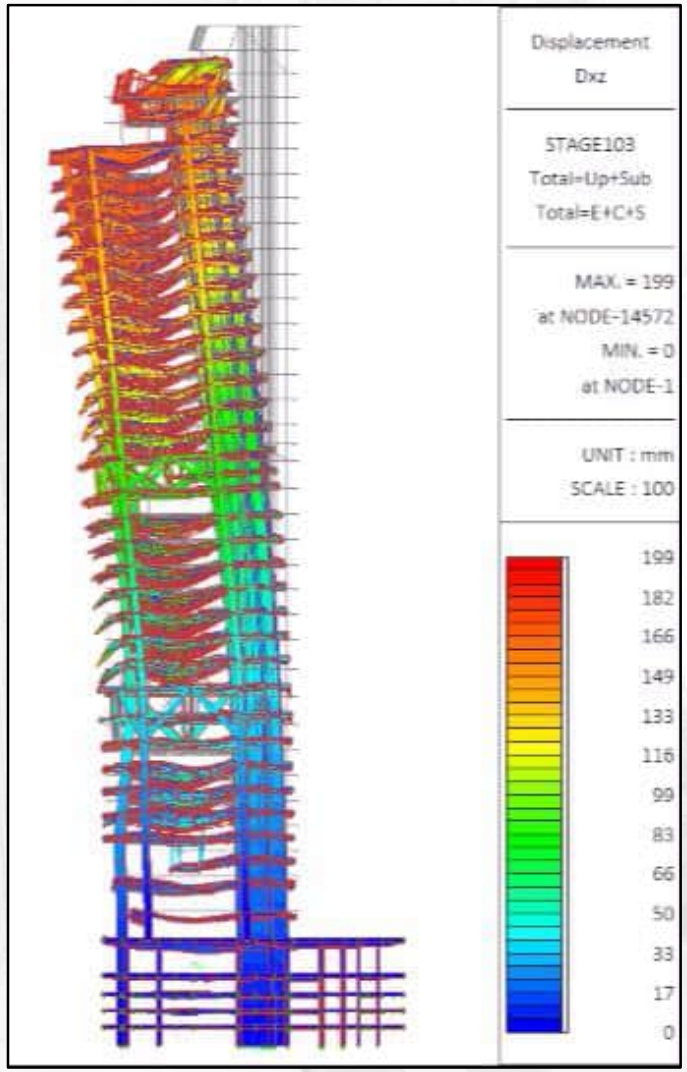
Background of Building Lean

1. Tall building move during construction
   - Vertical shortening
   - Lateral movement induced by differential shortening

2. Contributing factors
   - Time dependent properties of concrete (Creep & Shrinkage)
   - Construction sequences
   - Structural shape

3. Effects of building movements
   - Construction tolerances and serviceability
   - Elevators (Passenger comfort)
   - Curtain wall / façade (Joint allowance)





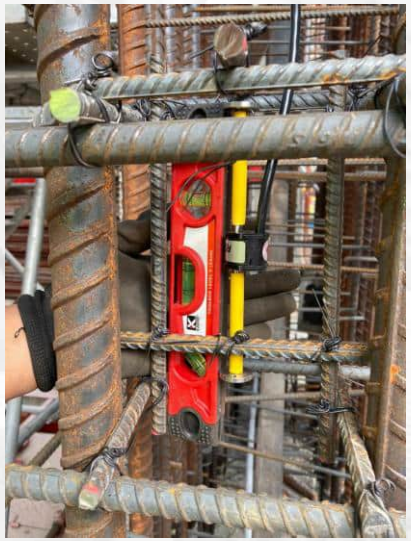
➢ How to overcome the building lean challenge?

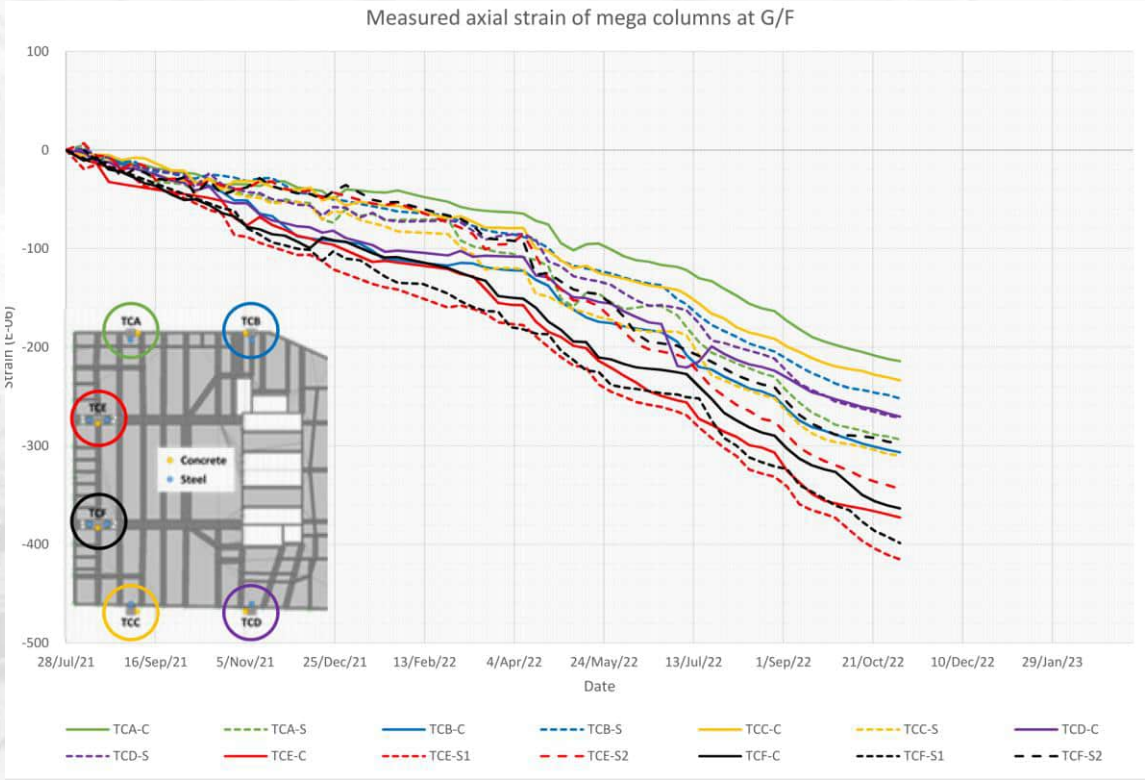
Project Challenge for Superstructure Construction

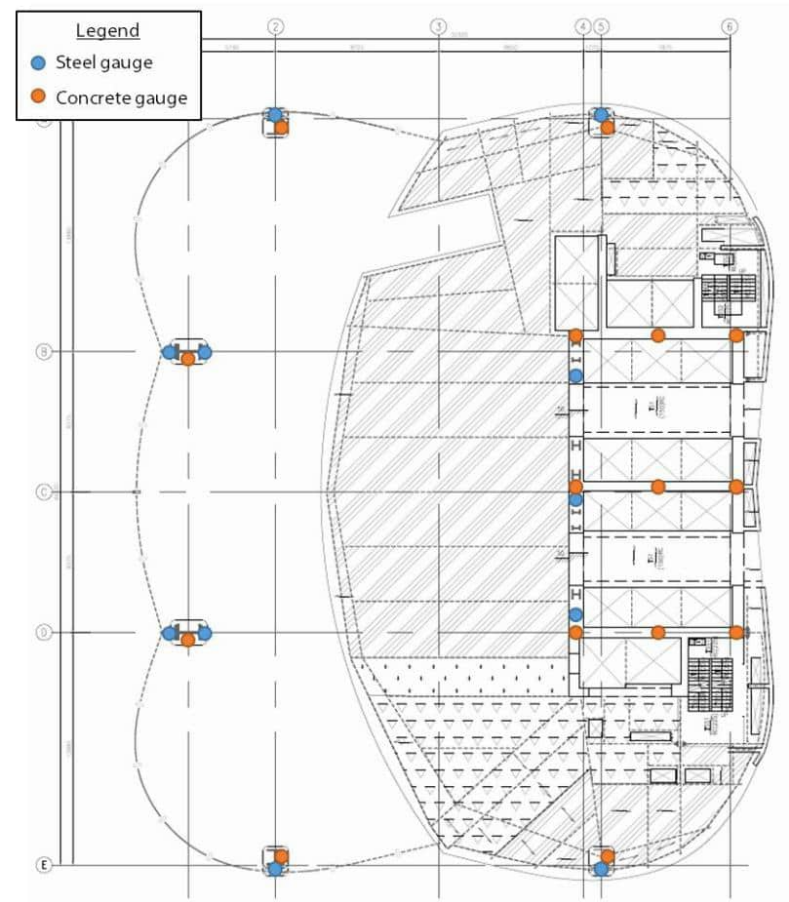
Columns and Core Walls Strain Monitoring

74 nos of strain gauges embedded in column and core wall

to monitor the change of strain during construction







Project Challenge for Superstructure Construction

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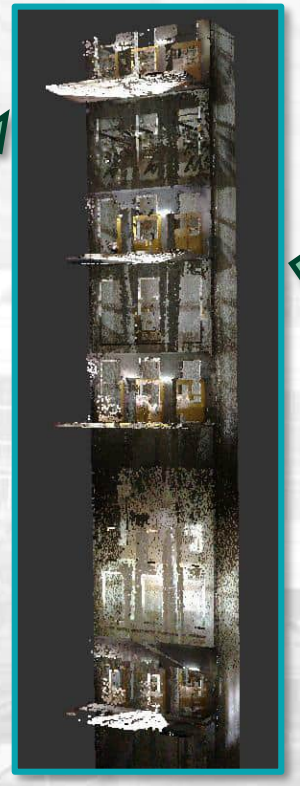
3D - Laser Scan of Elevator Shaft and Lean Verification

Step 1: Laser Scanner Data Capture

Step 2: Create reality point clouds model



Software Use:

FARO SCENE

+

Scan Data Registration & Point Cloud Processing

AUTODESK RECAP PRO

PointCab

+

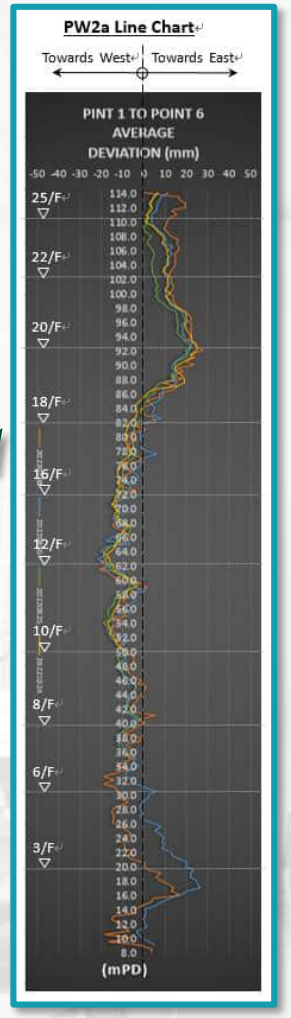
Analysis vs Laser Scan

Advanced Stage Analysis Program (A.S.A.P)
By

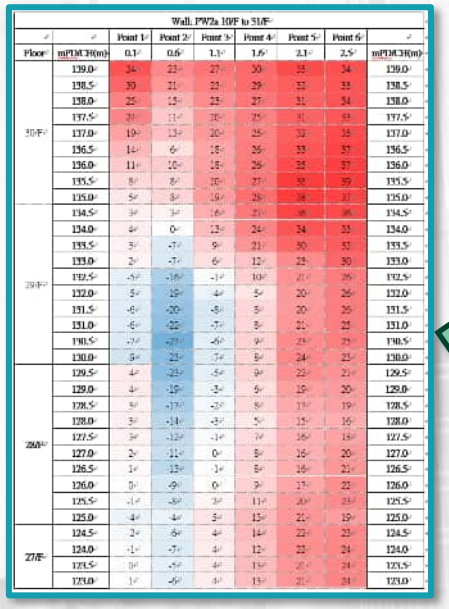
DAEWOO E&C

Data analysis and report

Monthly data import to monitor Elevator Shaft variation



Integrate point clouds model with reference points to devise all deviations



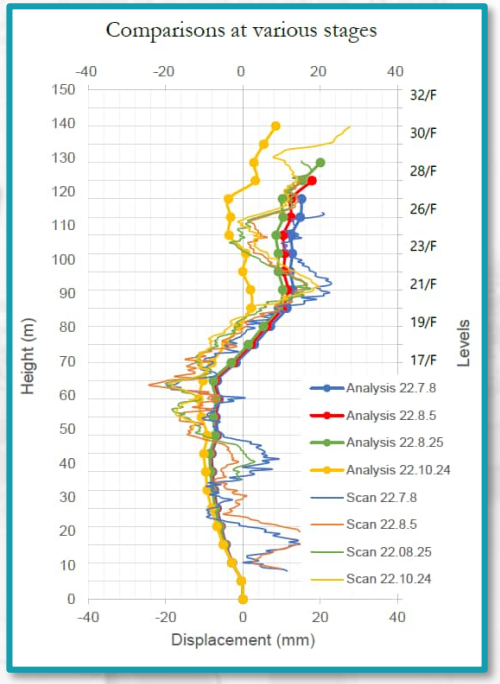
Wall, PW2a 10/F to 31/F

Floor	mPD/CH(m)	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	mPD/CH(m)
		0.1	0.6	1.1	1.6	2.1	2.5	
30/F	139.0	34	23	27	30	35	34	139.0
	138.5	30	21	25	29	32	33	138.5
	138.0	25	15	23	27	31	34	138.0
	137.5	21	11	20	25	31	33	137.5
	137.0	19	13	20	25	32	35	137.0
	136.5	14	6	18	26	33	37	136.5
	136.0	11	10	18	26	35	37	136.0
	135.5	8	8	20	27	33	39	135.5
	135.0	5	3	19	26	38	37	135.0
29/F	134.5	3	3	16	23	36	36	134.5
	134.0	4	0	13	24	34	33	134.0
	133.5	3	-7	9	21	30	33	133.5
	133.0	2	-7	6	12	23	30	133.0
	132.5	-5	-16	-1	10	21	26	132.5
	132.0	5	19	4	5	20	26	132.0
	131.5	-6	-20	-8	5	20	26	131.5
	131.0	-6	-22	-7	8	21	25	131.0
	130.5	-7	-23	-6	9	23	25	130.5
	130.0	5	23	7	8	24	23	130.0
28/F	129.5	4	23	-5	9	22	21	129.5
	129.0	4	19	-3	5	19	20	129.0
	128.5	3	17	-2	5	17	19	128.5
	128.0	3	-14	-3	5	15	16	128.0
	127.5	3	-12	-1	7	16	18	127.5
	127.0	2	-11	0	8	16	20	127.0
	126.5	1	13	1	8	16	21	126.5
	126.0	0	-9	0	9	17	22	126.0
	125.5	-1	-8	3	11	20	23	125.5
	125.0	-4	-4	5	15	21	19	125.0
27/F	124.5	2	-6	4	14	22	23	124.5
	124.0	-1	-7	4	12	23	24	124.0
	123.5	0	-5	4	13	21	24	123.5
	123.0	1	-6	4	13	21	24	123.0

Elevator Shaft Elevation Deviation

Analysis vs Laser Scan

Synchronize comparison of field survey data with time-dependent analysis results by Advanced Stage Analysis Program (ASAP)



Project Challenge for Superstructure Construction

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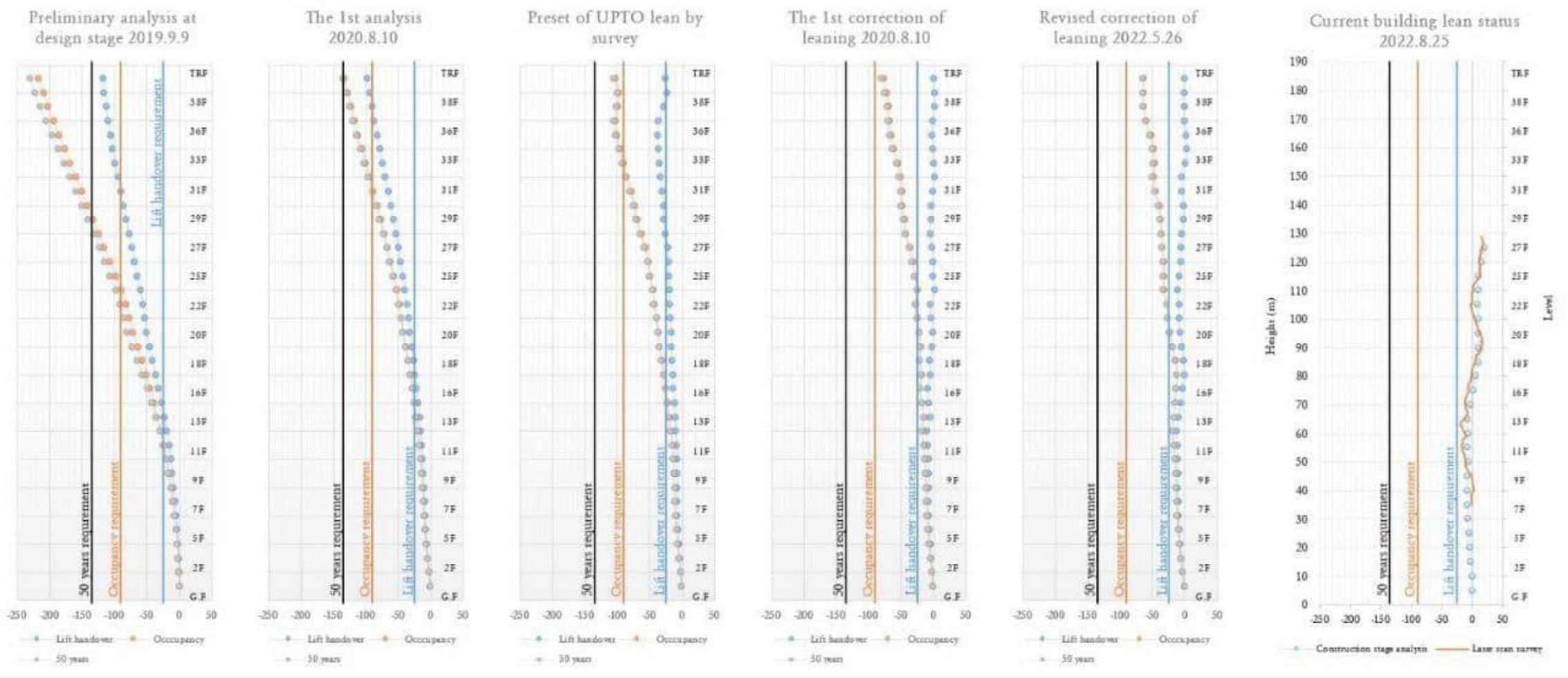
Milestones of building lean 2019~2022



Lift installation = 117mm
Occupancy = 217mm
50 Years = 230mm
(Sept 2019)

Lift installation = 21mm
Occupancy = 63mm
50 Years = 65mm
(May 2022)

3D Laser Scanning & Plumb Survey Result well match with prediction
(Aug 2022)

Adoption of Innovative Technologies

BIM in Precast Concrete Curb

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BIM in Precast Concrete Curb

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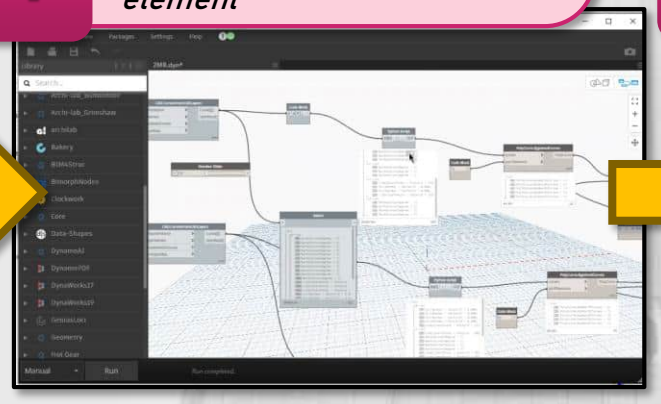
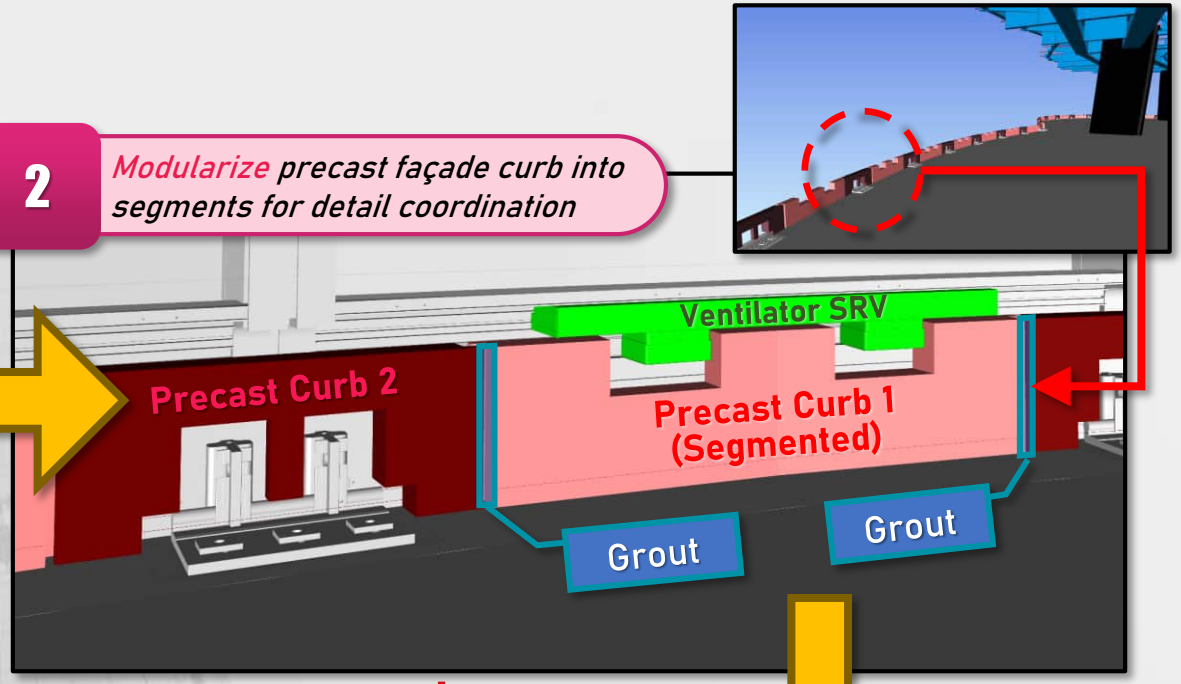
DfMA Extension – Inclined Façade Curbs

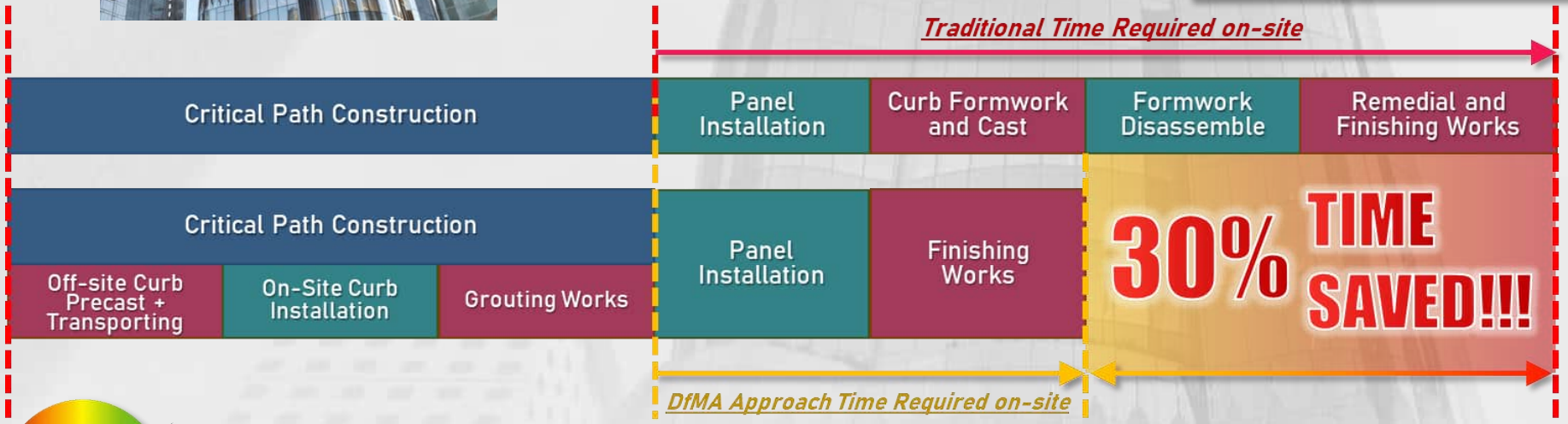
Challenge found:
Inclined Curve Curtain Wall

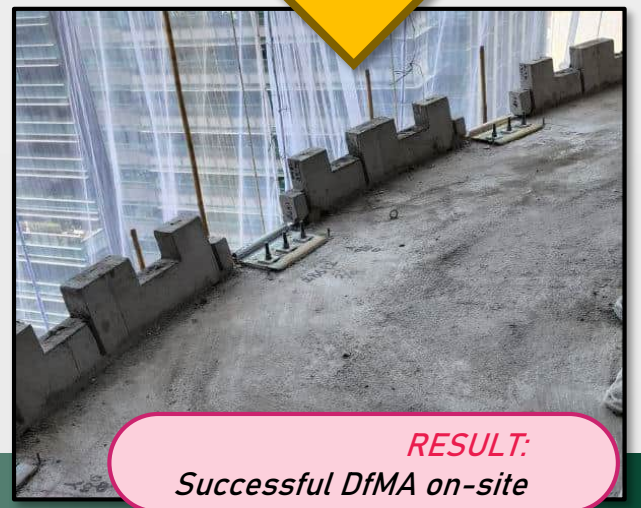
1 *Automation to optimize façade element*



2 *Modularize precast façade curb into segments for detail coordination*







RESULT:
Successful DfMA on-site

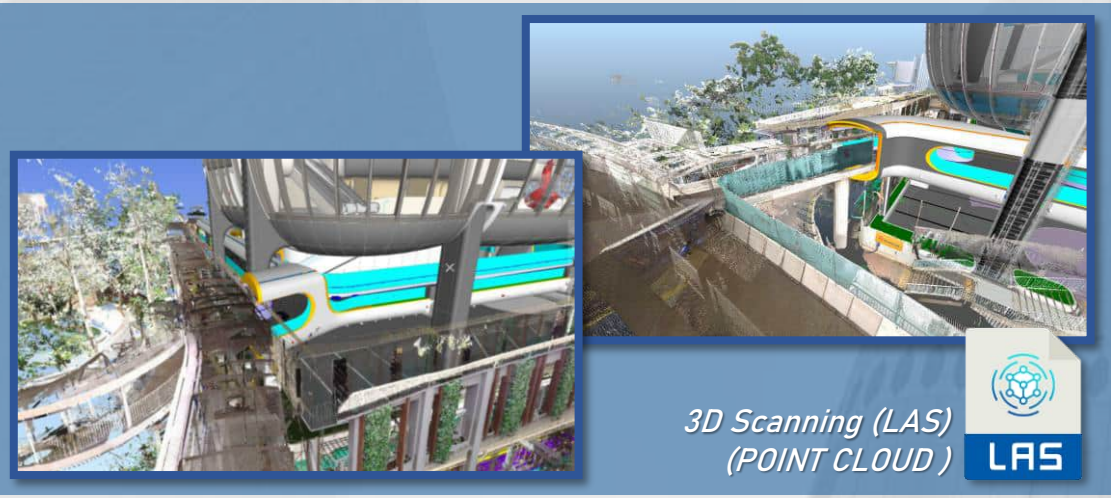
KPI

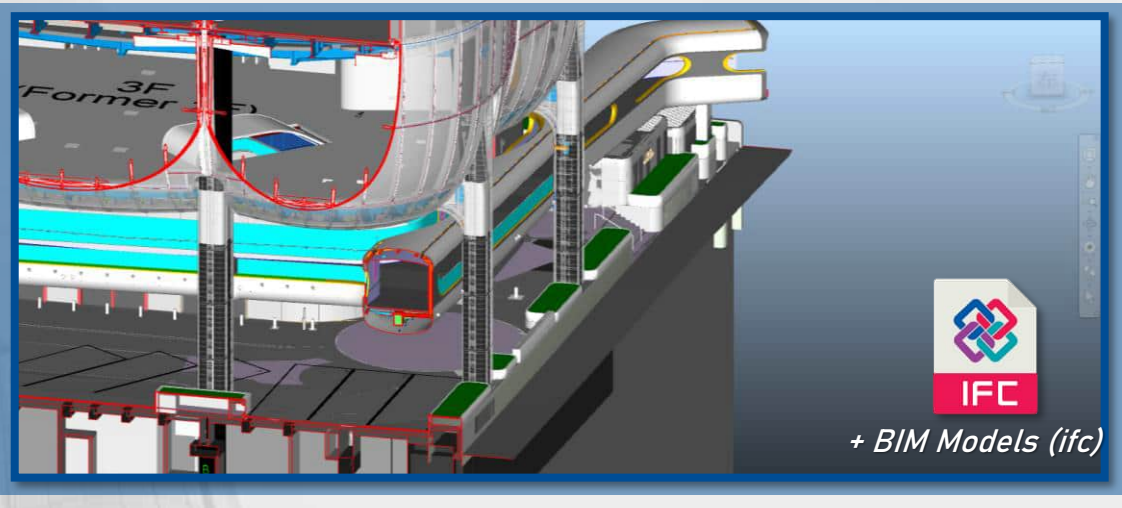
>Over 70% façade curb modularized

3D Scan Application

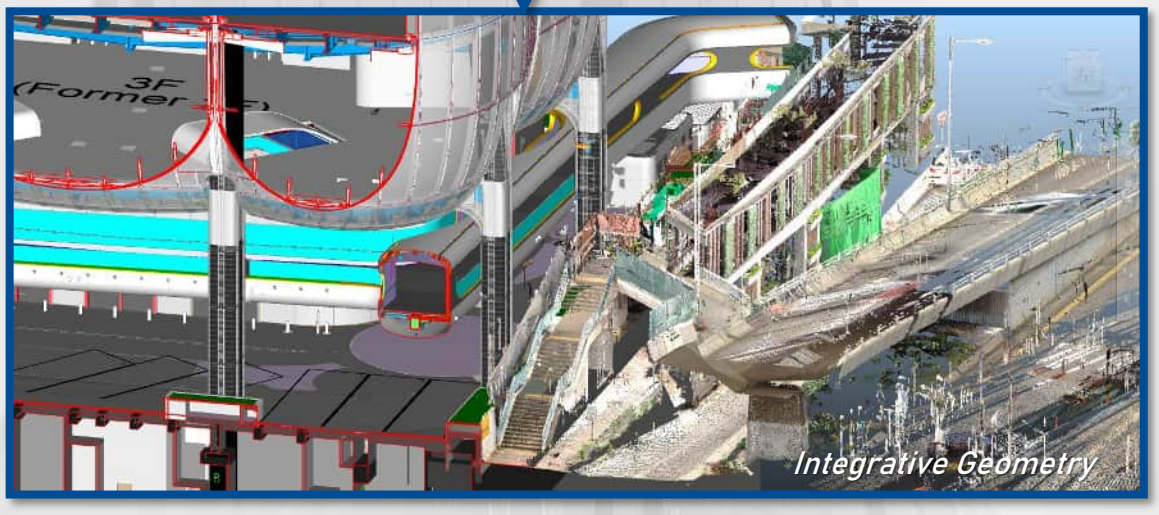
Existing Condition Coordination

We use 3D scanning/point cloud to check the relationship between the new footbridge and the existing footbrige. 3D scanning provide an as-built 3D model geometry of existing building elements, allowing construction team to visualize the full picture in current. The use of 3D scanning over traditional hand measuring methods vastly improves the accuracy of the final BIM model which also greatly benefits Visual Design and Construction (VDC).





Result



Value of 3D Scanning

- ✓ Better decision-making
- ✓ Accelerated risk assessment
- ✓ Predictive construction
- ✓ Cross-platform interoperability for coordination

3D Scan Application

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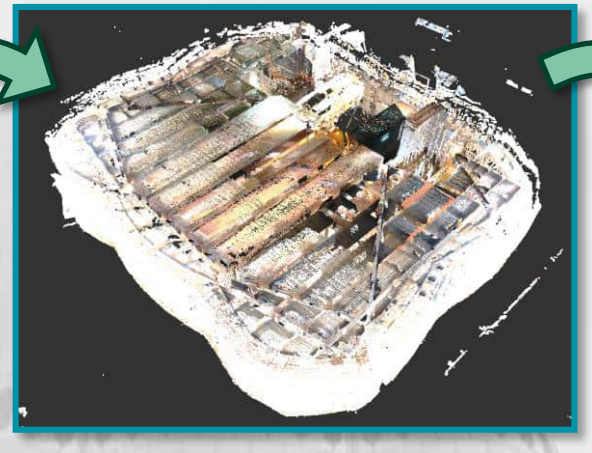
Adopt 3D Scan to Check the As-Built Skeleton

Step 1: Scan steel structure for precision verification

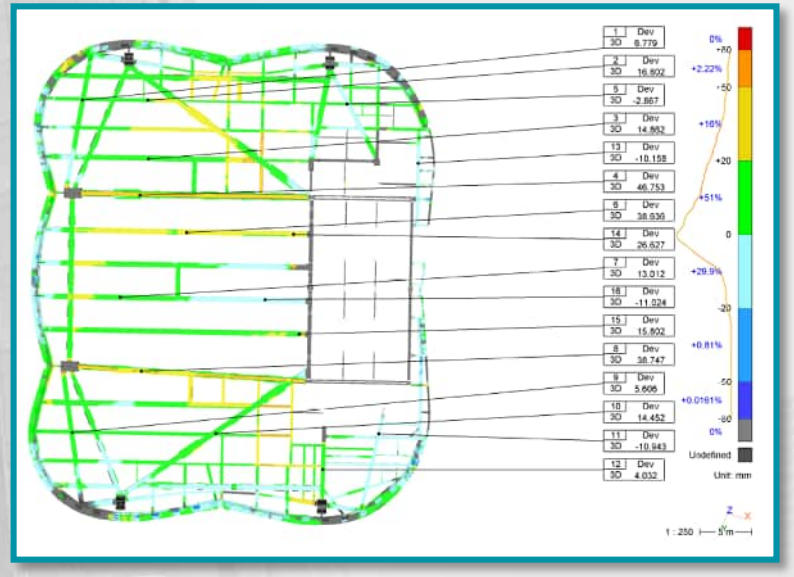
Step 2: Register reality point clouds into .las

Step 3: Integrate point clouds with IFC models to compare precision



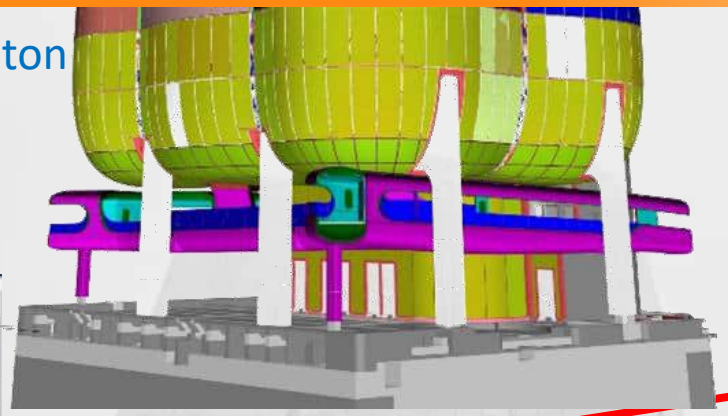
Data analysis and report generated by Point-cloud based Verification Software (Verify construction tolerance & MEP clearance!)

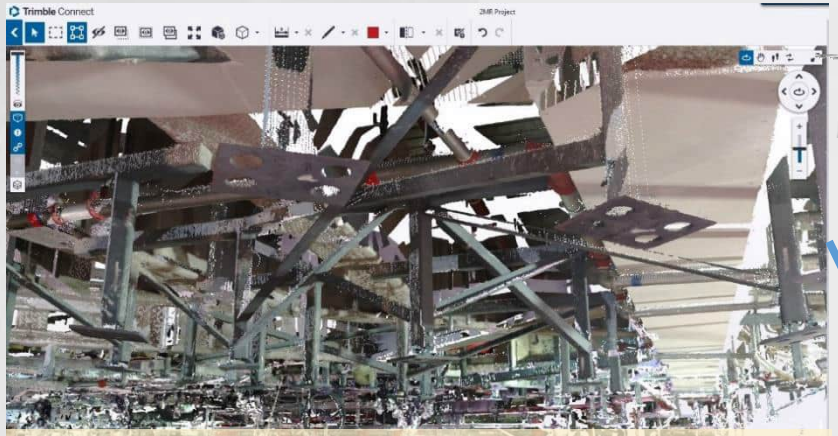
	name	Meas X (mm)	Meas Y (mm)	Meas Z (mm)	Meas 3D	Ref X (mm)	Ref Y (mm)	Ref Z (mm)	Ref 3D	Dev X (mm)	Dev Y (mm)	Dev Z (mm)	Dev 3D (mm)
1	Label #1	834729994.25825	815686084.24393	29168.22161	-	834729994.25825	815686084.24393	29175.00059	-	0	0	-6.77898	6.77898
2	Label #2	834736038.22341	815684255.68525	29158.19874	-	834736038.22341	815684255.68525	29175.00059	-	0	0	-16.80185	16.80185
3	Label #3	834737775.45559	815689637.59201	29160.13886	-	834737775.45559	815689637.59201	29175.00059	-	0	0	-14.86172	14.86172
4	Label #4	834738002.81426	815693235.95036	29168.24721	-	834738002.81426	815693235.95036	29215.00047	-	0	0	-46.75329	46.75329
5	Label #5	834754561.4151	815678956.19107	29627.86848	-	834754561.4151	815678956.19107	29625.00103	-	0	0	2.86746	-2.86746
6	Label #6	834743366.07973	815695363.13751	29136.3644	-	834743366.07973	815695363.13751	29175.00059	-	0	0	-38.63618	38.63618
7	Label #7	834739074.6509	815703203.59683	29161.98901	-	834739074.6509	815703203.59683	29175.00059	-	0	0	-13.01157	13.01157
8	Label #8	834743113.13465	815709454.75412	29176.25348	-	834743113.13465	815709454.75412	29215.00047	-	0	0	-38.74699	38.74699
9	Label #9	834738469.41994	815717075.82134	29169.39421	-	834738469.41994	815717075.82134	29175.00059	-	0	0	-5.60638	5.60638
10	Label #10	834751754.50032	815713087.5336	29160.54851	-	834751754.50032	815713087.5336	29175.00059	-	0	0	-14.45208	14.45208
11	Label #11	834766841.11398	815708504.41673	29185.94359	-	834766841.11398	815708504.41673	29175.00059	-	0	0	10.94301	-10.94301
12	Label #12	834762660.99683	815713396.82184	29520.96842	-	834762660.99683	815713396.82184	29525.00015	-	0	0	-4.03173	4.03173
13	Label #13	834762801.5878	815682408.52335	29185.15879	-	834762801.5878	815682408.52335	29175.00059	-	0	0	10.1582	-10.1582
14	Label #14	834753298.10657	815692492.2725	29148.37364	-	834753298.10657	815692492.2725	29175.00059	-	0	0	-26.62694	26.62694
15	Label #15	834756655.05521	815701544.02472	29159.19813	-	834756655.05521	815701544.02472	29175.00059	-	0	0	-15.80245	15.80245
16	Label #16	834752529.00365	815699335.37831	29186.02411	-	834752529.00365	815699335.37831	29175.00059	-	0	0	11.02352	-11.02352



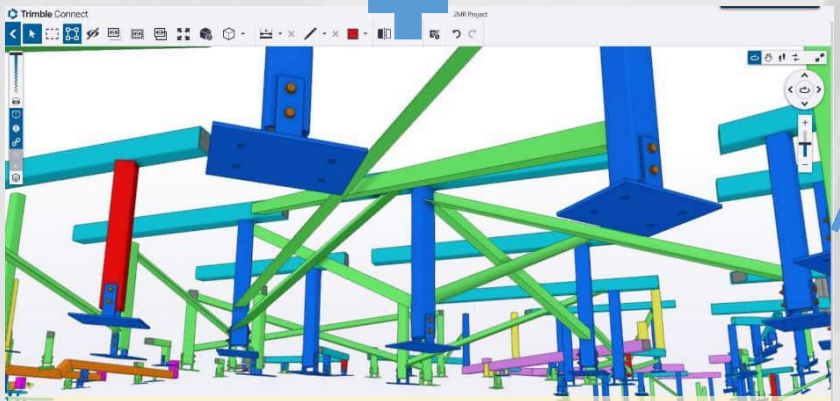
3D Scan Application

Adopt 3D Scan to Check the As-Built Skeleton

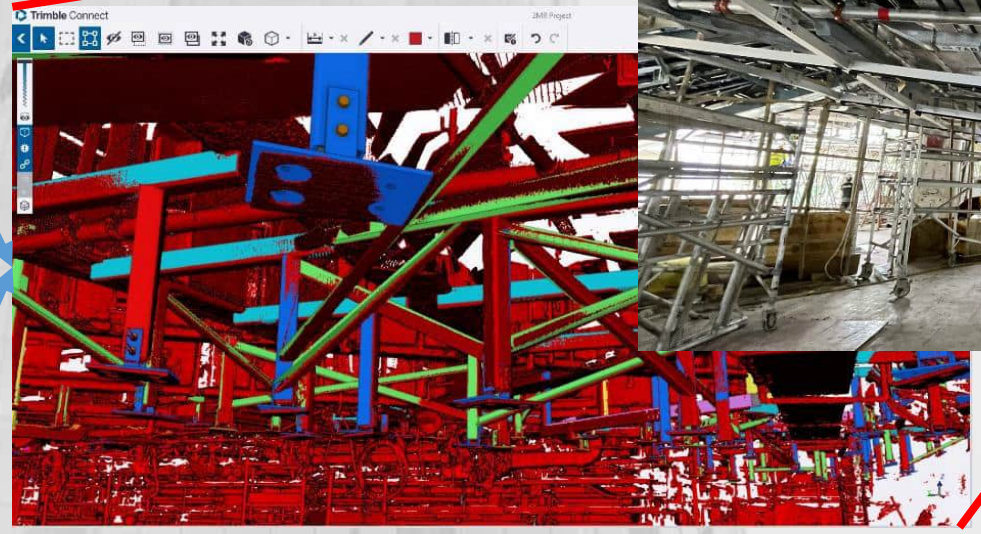


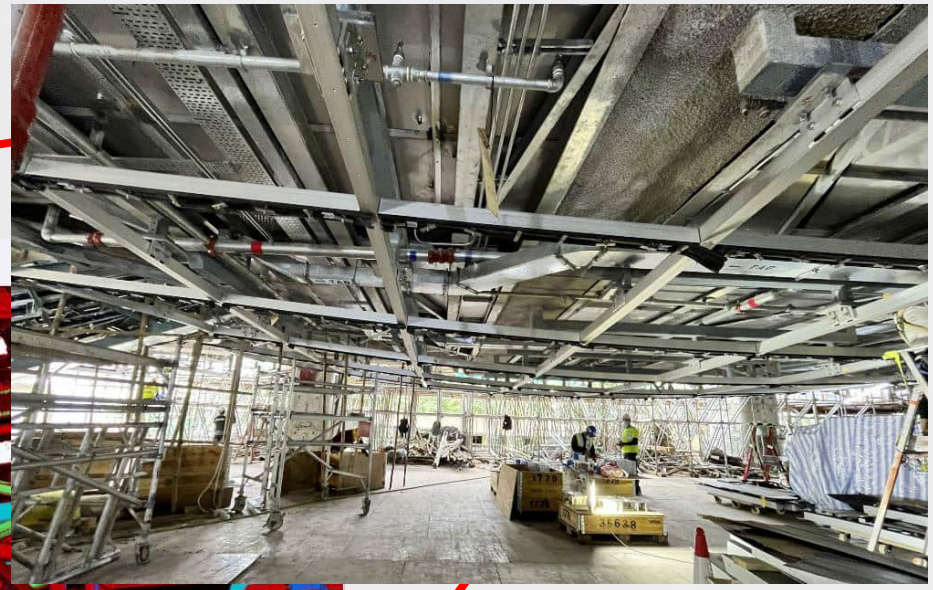


Point cloud model of as-built brackets for façade panel fixing



Construction BIM model of steel and façade brackets

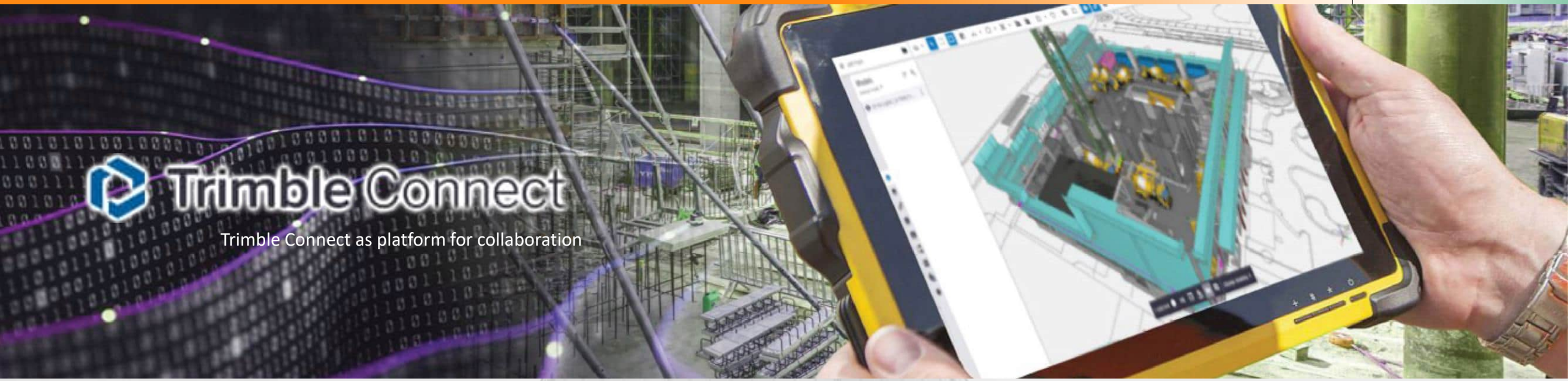




Clear overlay of as-built point cloud with BIM model, for risk identification before irremediable façade fixing problem occurs.

1. Over 95% steel effectively **scanned within 1 Day** for each floor
2. Smooth processing with IFC: **Deviation report generated in 1 Day** (after point cloud registration in .las)

Trimble Connect as CDE



During construction stage, all major appointed parties are requested to equip CDE skills to resolve clashes and develop model in at the constructible level of detail.

Online CDE facilitates real-time information exchange like design comment, project issues sharing and information model exchange without geographical limit.

1. Over **100 BIM users** are using Trimble Connect for site coordination.
2. Over **700 No. of issues** were found and recorded on Trimble Connect.

CDE navigation via different devices

Automation

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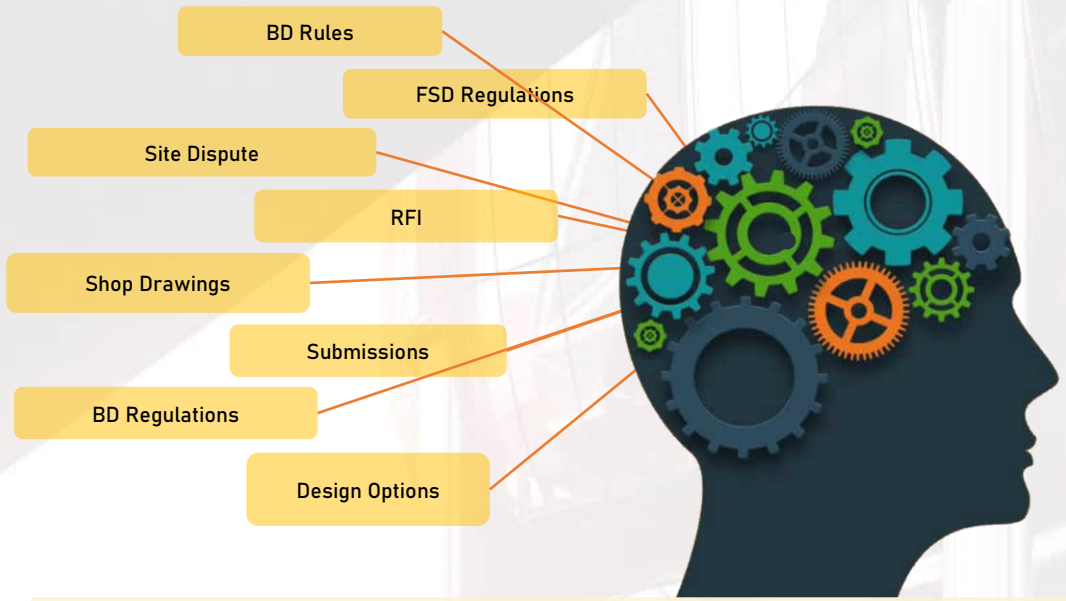
Headroom ; Stanchion; Rule-based Check



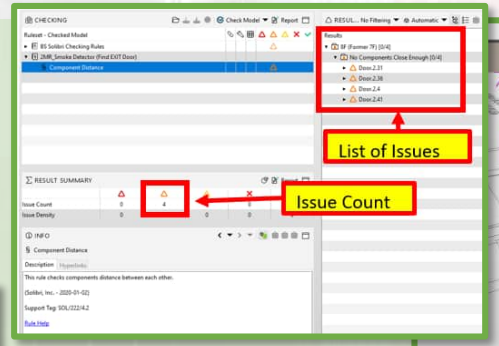
Pain-Point: Coordinators keep too much information in mind

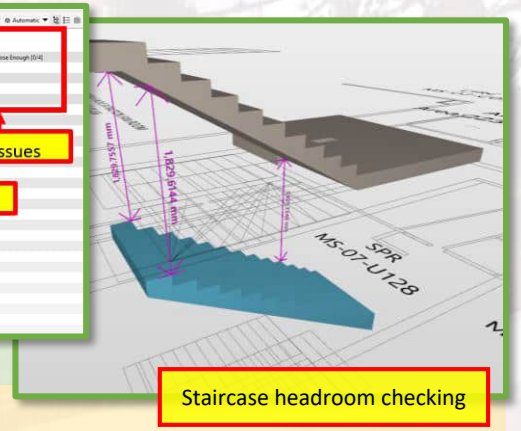
CATIA
AUTODESK REVIT
Tekla Structures
Rhinoceros 6

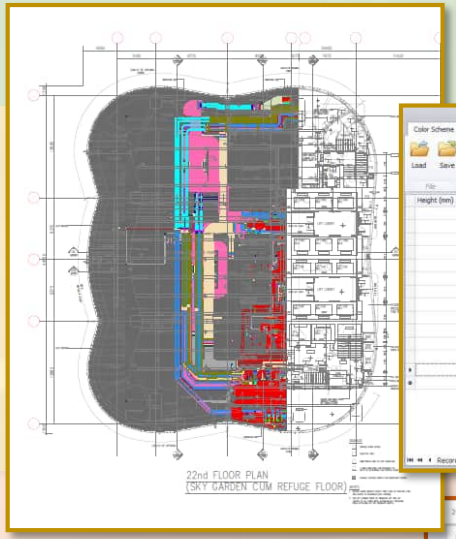
IFC → SOLIBRI (A NEMETSCHEK COMPANY) / Dynamo → BCF

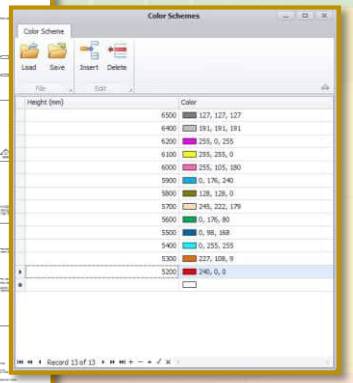
Design or modelling issues

Automation 1:
Rule-based checking against building ordinances (Solibri)



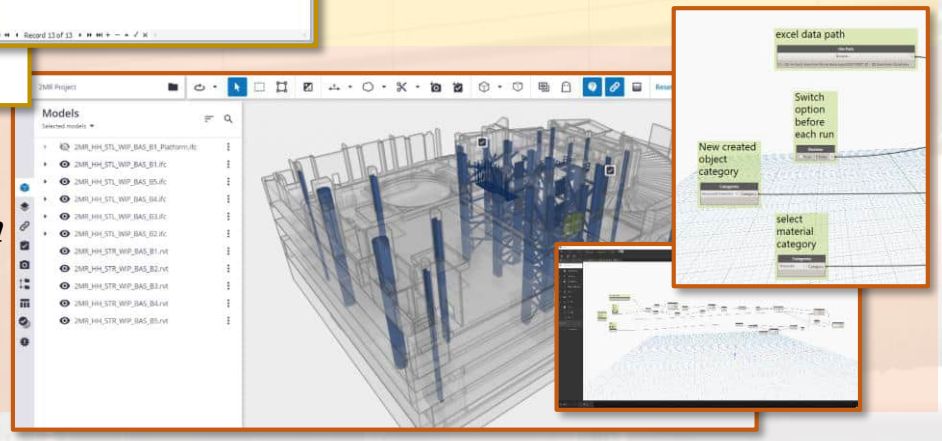




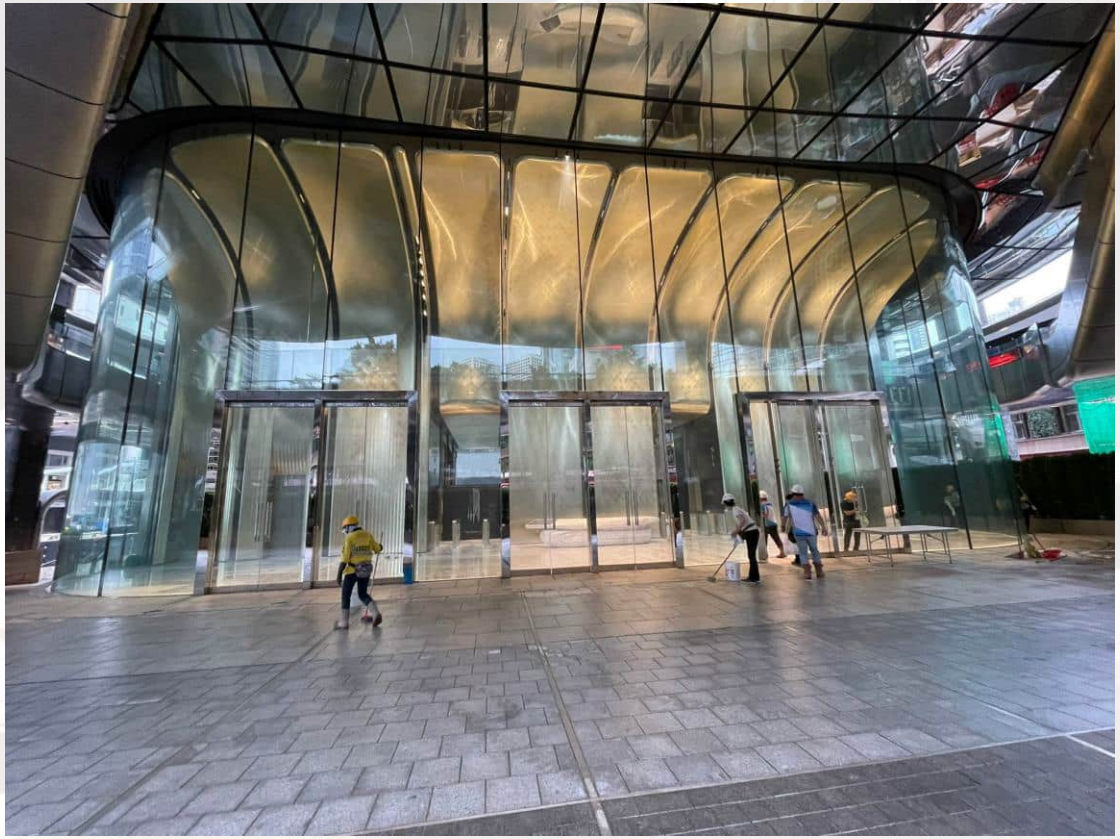


Automation 2:
MEP achievable headroom demarcation (Co-developed programme)

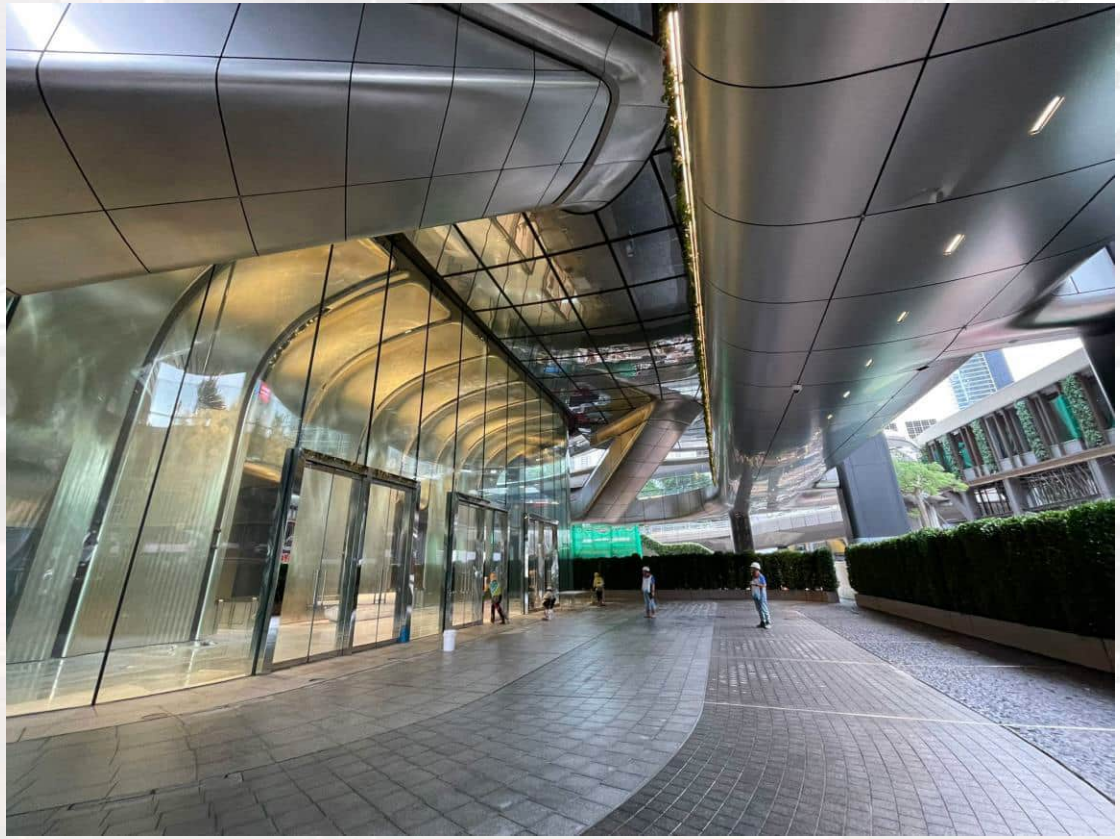
Automation 3:
MEP achievable headroom demarcation (Self-compiled Dynamo)



Architectural Works

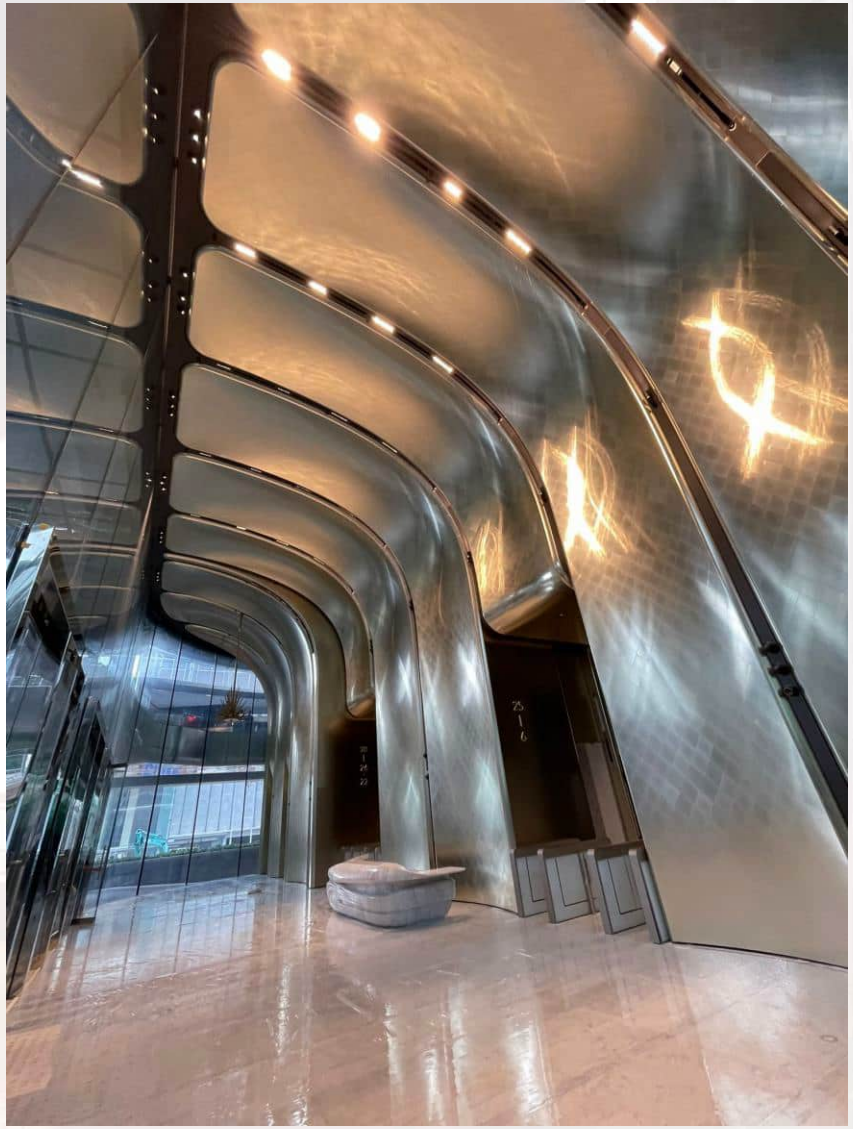


G/F Entrance Lobby



G/F Entrance Lobby

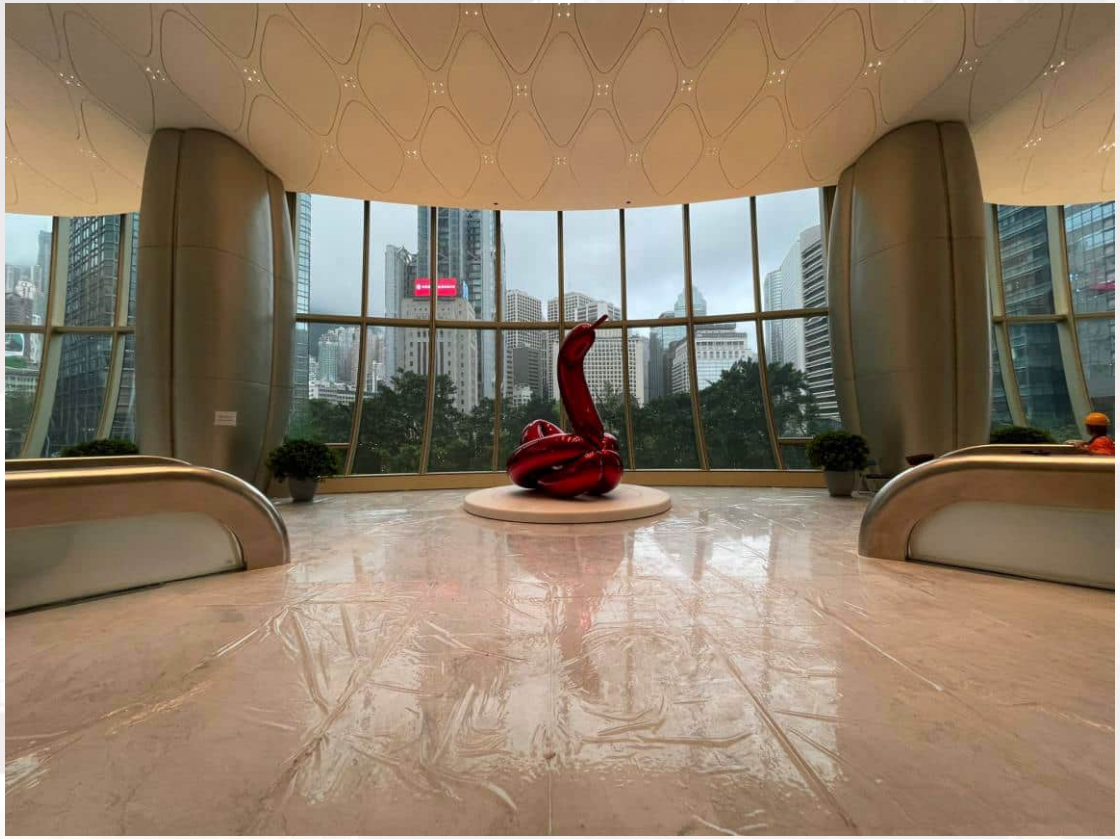
Architectural Works



G/F Lift Lobby

G/F Totem

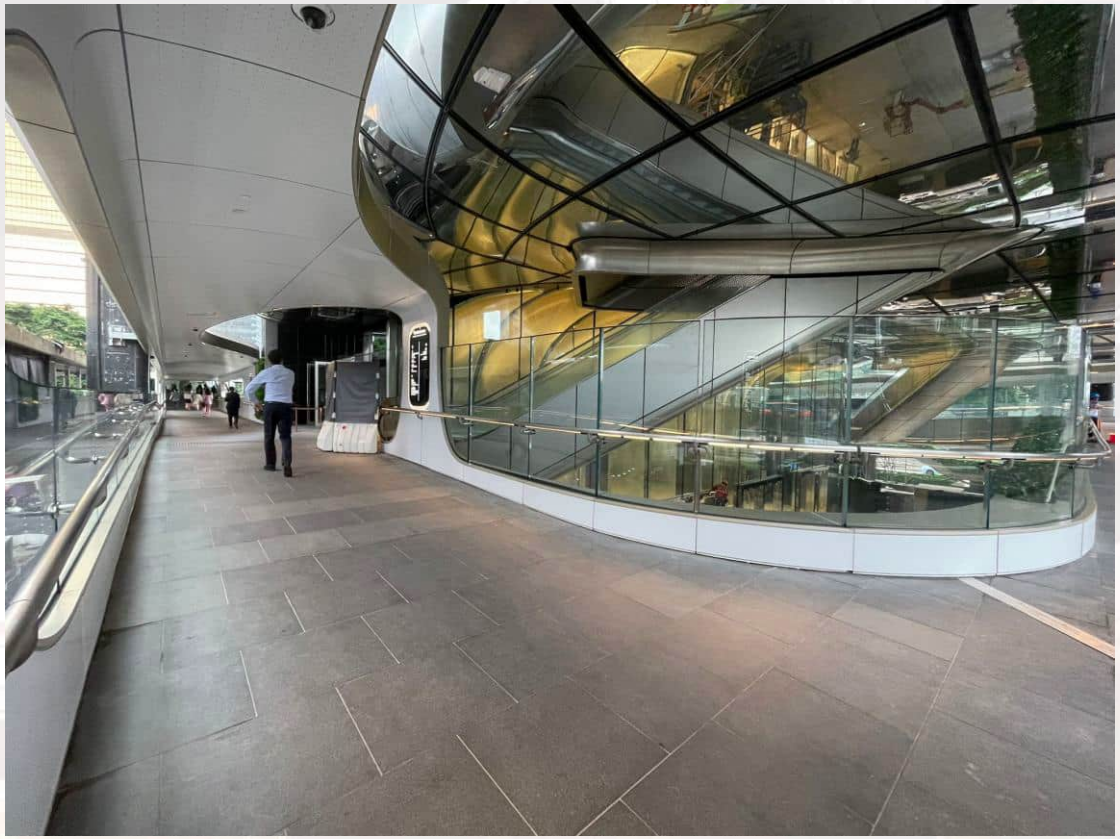
Architectural Works



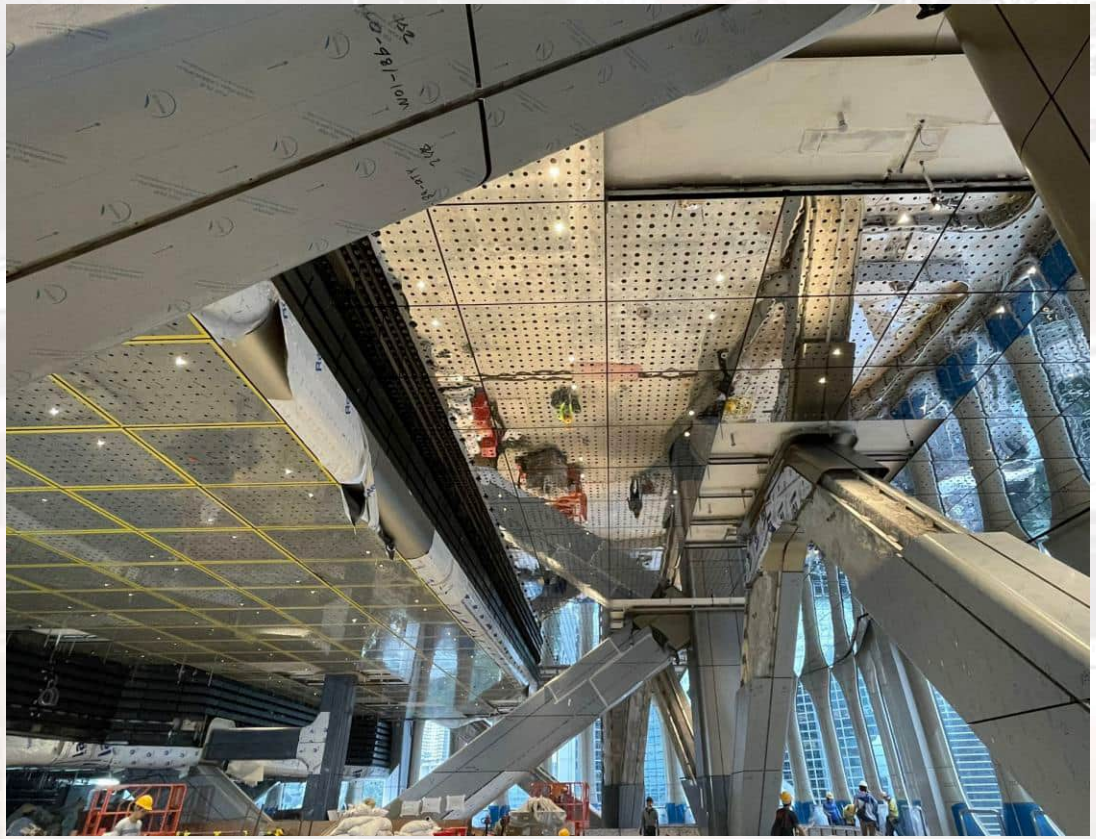
3/F Arcade

3/F Office Lift Lobby

Architectural Works



1/F Public Footbridge



22/F Sky Garden

Architectural Works

Building Elevation

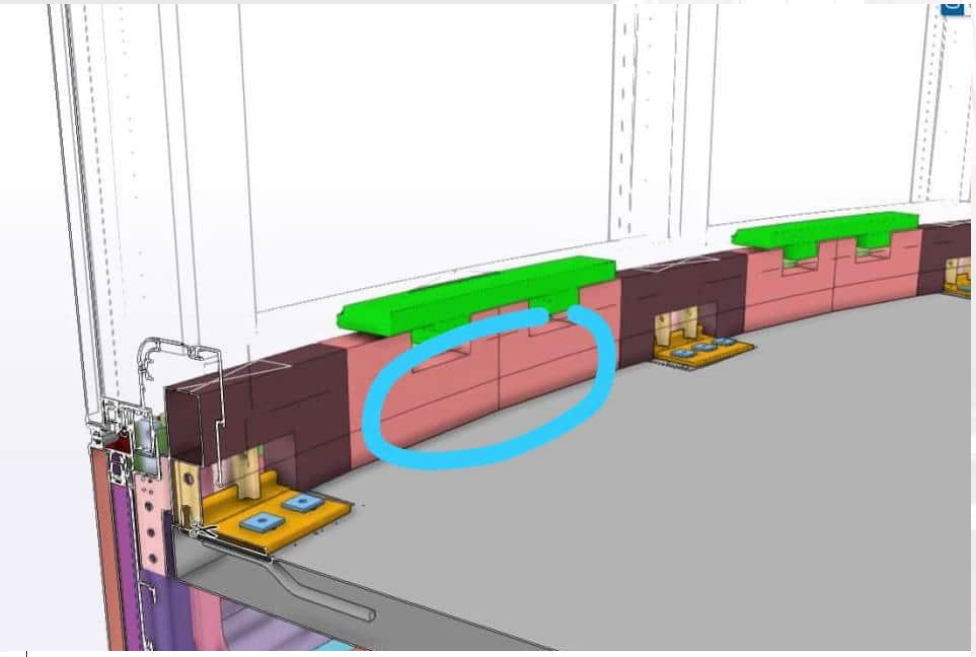
Sustainability & Smartness on Design & Construction

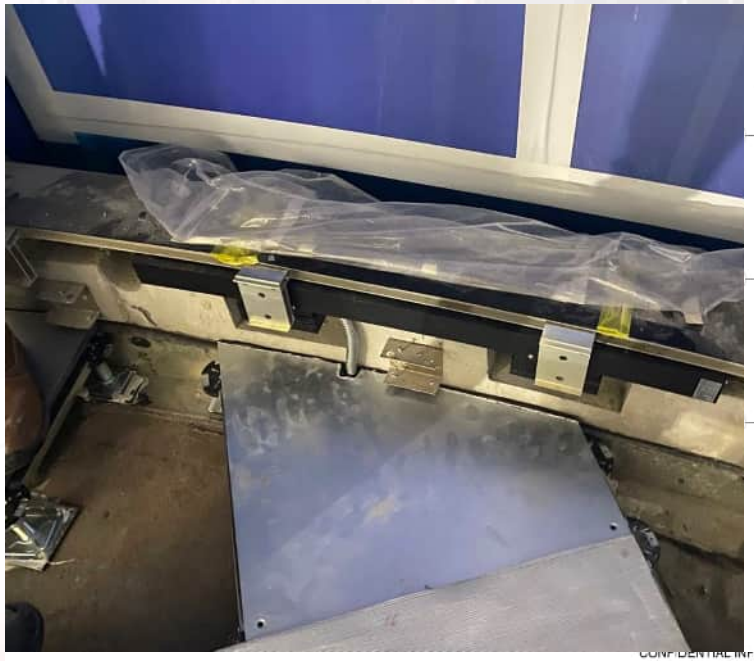
SRV to achieve thermal comfort

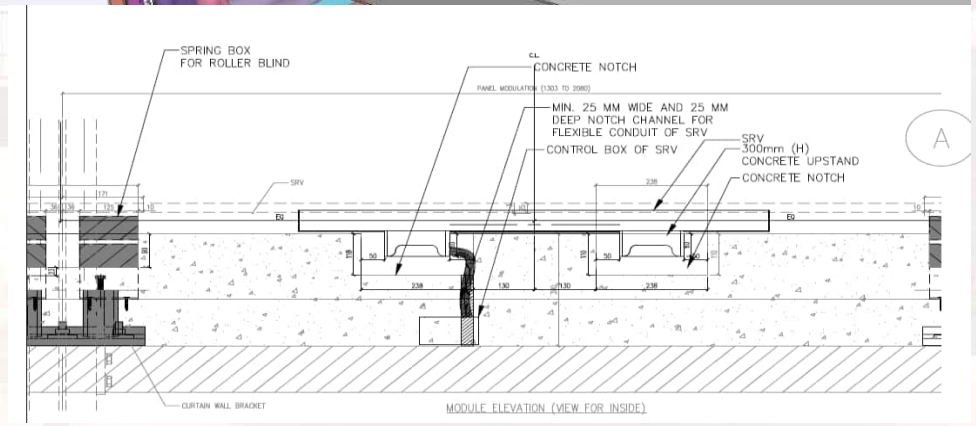
2 Murray Road
(Central)
中環美利道2號

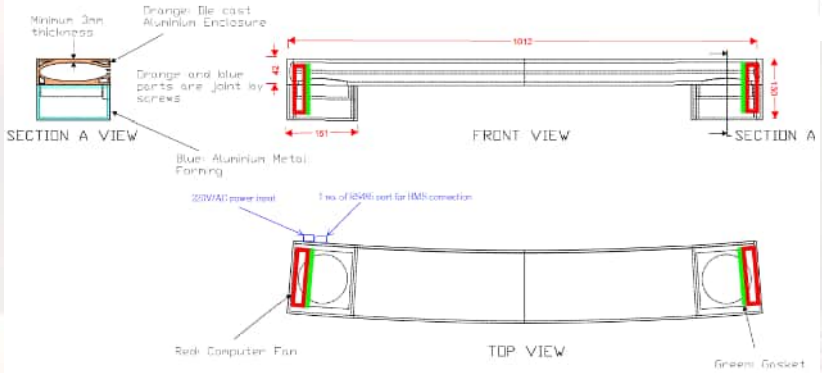
Solar Responsive Ventilator (SRV)

- Aims to enhance indoor thermal comfort along west perimeter zone
- Slow air speed ventilator with 2nos DC fans covered by metal box



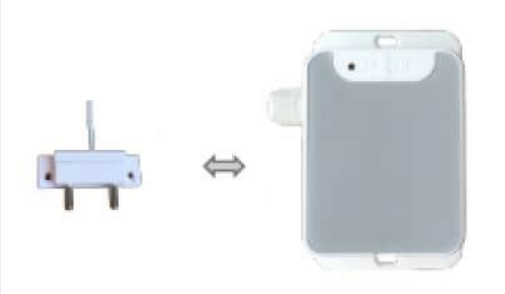






IOT Control

2 Murray Road
(Central)
中環美利道2號

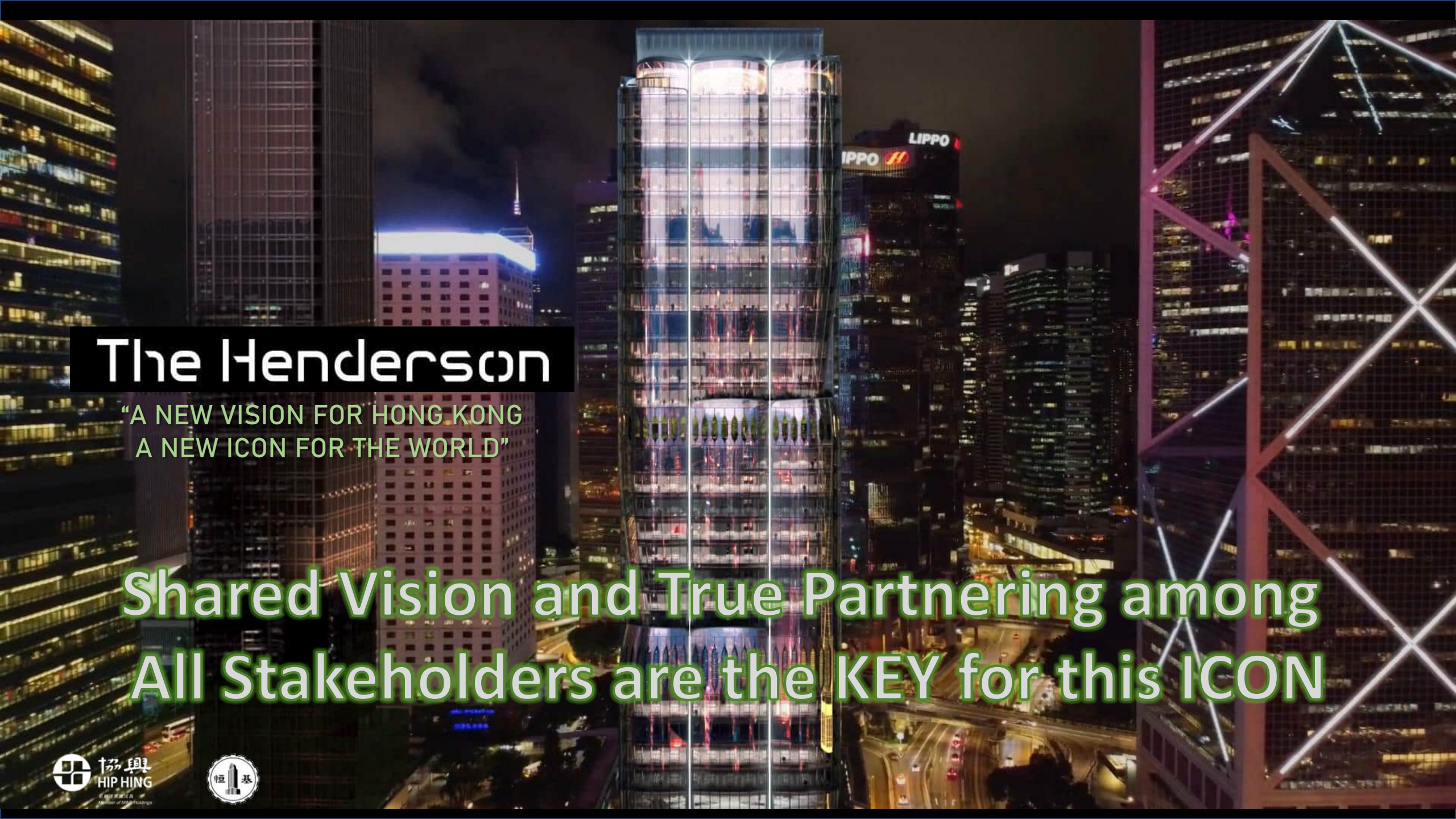
IOT Sensor Type	Photo	IOT Sensor Type	Photo
Water Leakage Sensor (sensing cable type) WLSC		Occupancy Sensor Occ	
Water Leakage Sensor (point type) WL		Soap Dispenser Sensor/ Hand Sanitizer Dispenser Sensor S HS	
Ammonia Sensor NH3		Paper Towel Dispenser Sensor/ Toilet Paper Dispenser Sensor PT TP	

IOT Control

2 Murray Road (Central)
中環美利道2號

Example of Location of using IOT Sensor: Toilet Area

IOT Sensor Type	IOT Sensor Type
Water Leakage Sensor (sensing cable type) WLSC	Occupancy Sensor Occ
Water Leakage Sensor (point type) WL	Soap Dispenser Sensor/ Hand Sanitizer Dispenser Sensor S HS
Ammonia Sensor NH3	Paper Towel Dispenser Sensor/ Toilet Paper Dispenser Sensor PT TP



The Henderson

"A NEW VISION FOR HONG KONG
A NEW ICON FOR THE WORLD"

Shared Vision and True Partnering among All Stakeholders are the KEY for this ICON

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