



# **Innovative Applications on a Mega Project in Hong Kong**

**ISSMGE Workshop 2022**

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# 1. Project Introduction



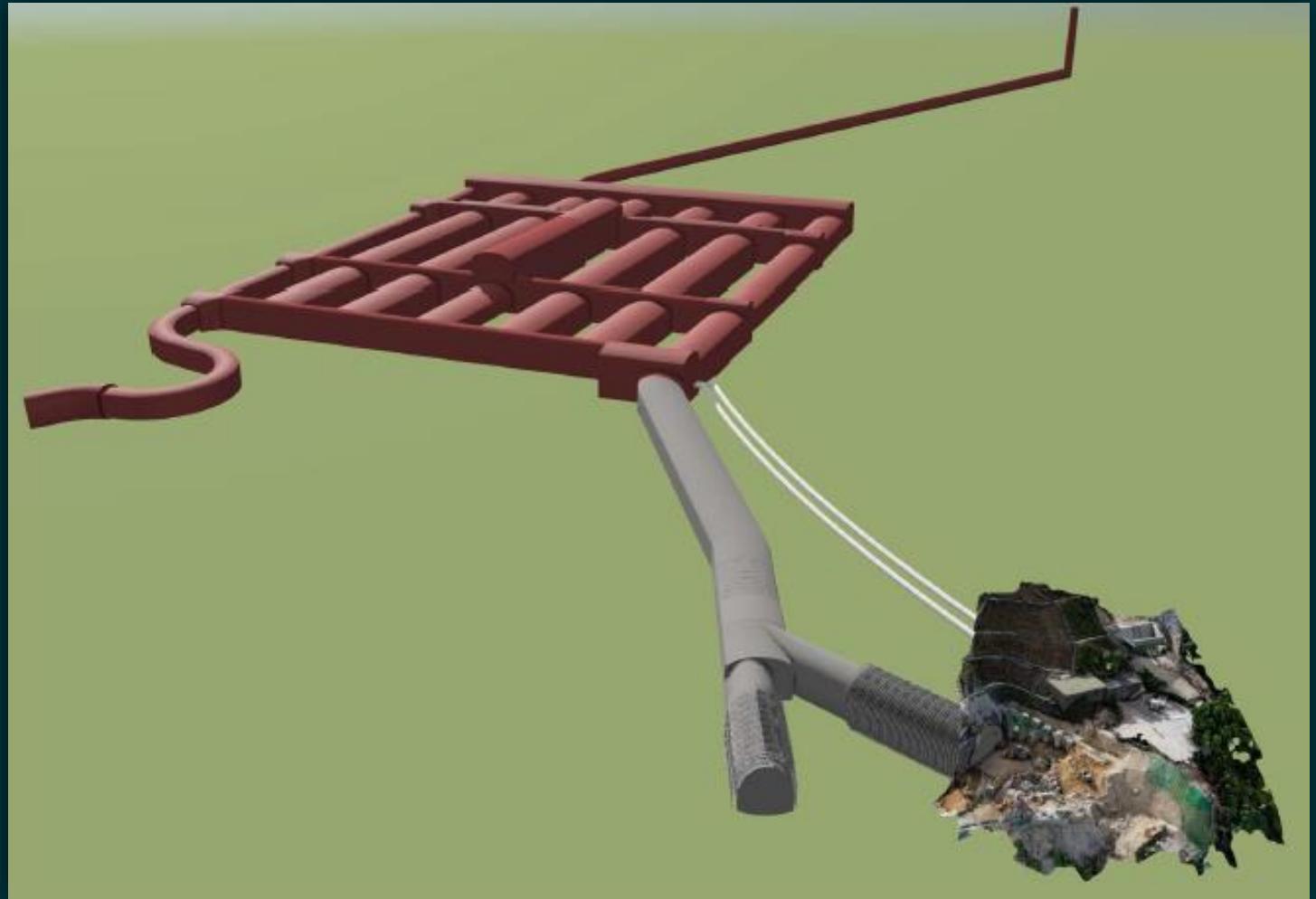
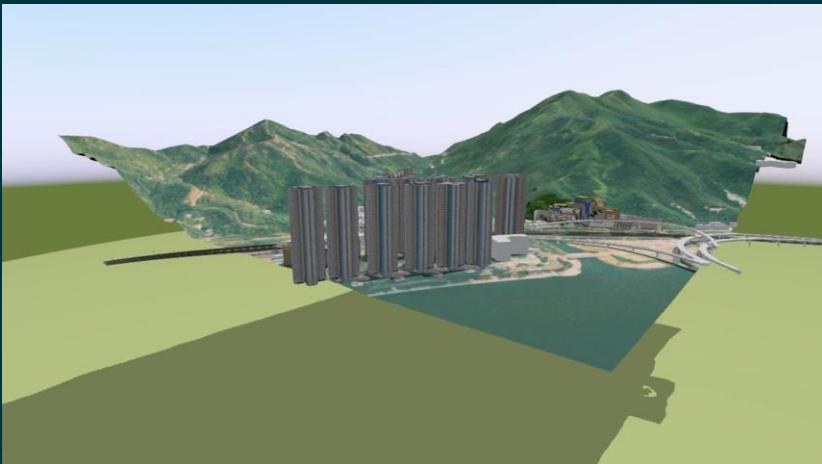
# Project Background



# Project Background

## Future Cavern Complex

- Consists of 5 parallel caverns
- Cavern hall is around 380m x 350m
- Max. span up to 32m
- Max. height up to 38m



# Drill-and-Blast Excavation

- ✓ low investment cost
- ✓ high adaptability
- ✓ large flexibility



## 2. Project Specific Challenges



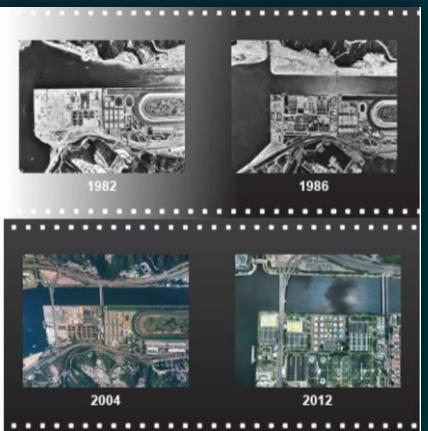
# Project – Specific Challenges



- **Large Scale :**  
The future cavern complex will be the largest of its type ever built in Hong Kong



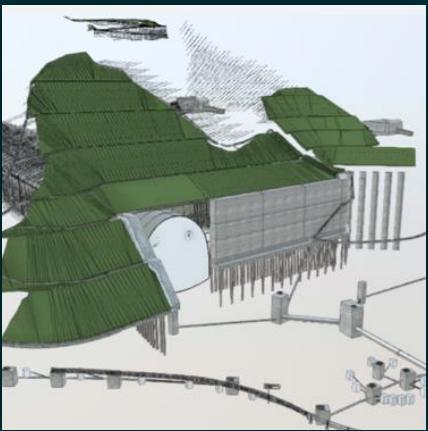
- **Sensitive Receivers :**  
The project is being carried out in the proximity of various sensitive receivers



- **Long Duration :**  
The entire project duration is expected to be 13 years



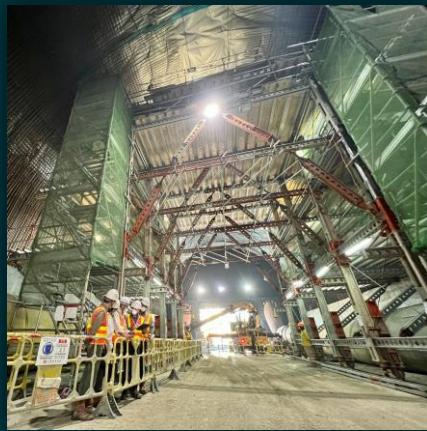
- **Multiple Blast Face :**  
Blasting on multiple blast face simultaneously



- **High Complexity :**  
Multiple disciplinary cooperation is required for this complex project



- **High Logistics Volume :**  
More than 1000 nos. of dump truck trips are required to remove the stones produced after blasting



- **Pioneering :**  
Pilot project of other future cavern developments



- **Confined Space :**  
More safety measures for working in confined space are needed

### 3. Innovation Applications to the Project



# Advanced BIM Applications

The screenshot shows the AECOM InnoShare platform interface. At the top, the AECOM logo is displayed. Below it, the project details "DC/2018/05" and "Shatin Caverns" are shown. The main area contains a horizontal bar with various inspection items, some marked as completed (blue) and others as pending (yellow). Below this is a section titled "Inspection Detail" with two sub-sections: "On-Time Submission" and "Coming Inspections". A circular progress bar indicates "No Reschedule" at 55%. On the left side, there's a sidebar with navigation links like "My Workspace", "Inspection Forms", "Safety & Environmental Inspection Checklist", "Site Diary", "Site Diary Report", "Self Audit", and "Logout".

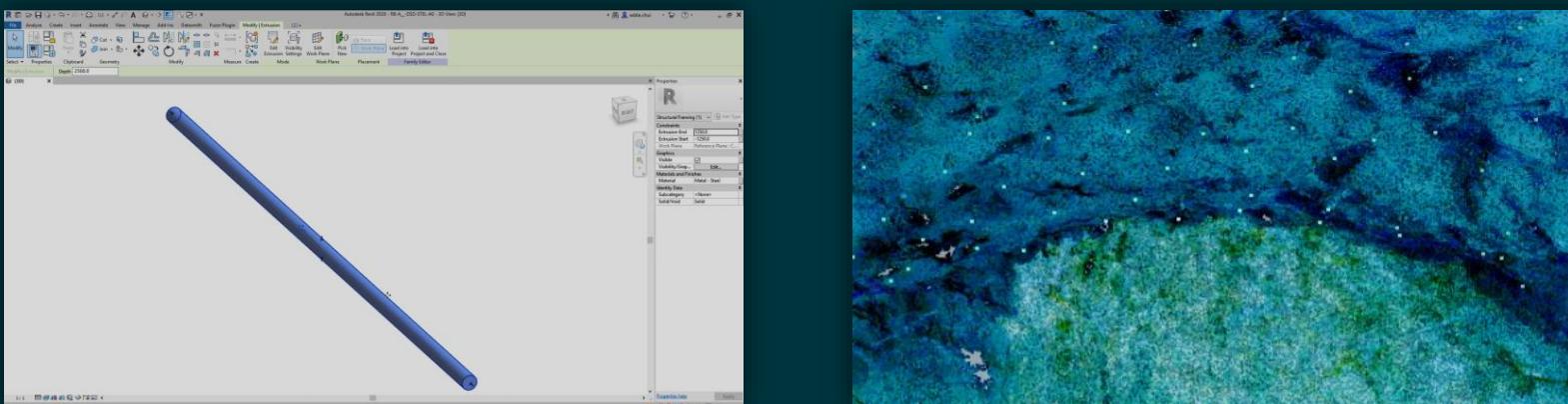
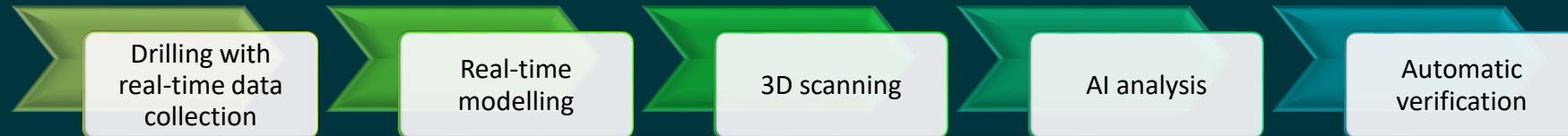
This screenshot displays a software interface for managing site inspections. It features a central table listing inspection tasks with columns for "Inspection No.", "Inspection Date", "Inspector Name", "Description", and "Inspection Date". To the right of the table is a 3D rendering of a large, curved rock formation or cavern interior, likely the Shatin Caverns mentioned in the other screenshots. A small inset window shows a detailed view of the inspection form for task number 1101.

This screenshot shows another view of the InnoShare platform. It lists several inspection and survey tasks. The "Survey" section includes "106.(Other) Survey Equipment Calibration" and "67. Record drawings". The "Inspection" section includes "73.Request for Inspection and Survey Check(RISC)" and "68.Site Diary". A "Compliance chart" is visible at the bottom, showing a timeline with various inspection points marked along a horizontal axis.

Three detailed inspection forms are shown side-by-side. From left to right: 1. "Site Survey Form" (green header), which includes sections for "Request for Inspection Form" and "Site Survey Details". 2. "Safety Inspection Form" (orange header), which includes a "Safety & Environment Inspection Checklist" and a "Daily Site Safety Inspection Checklist". 3. "Inspection Form" (blue header), which includes a "Request for Inspection Check Form" and a "Site Survey Form". Each form contains numerous checkboxes and dropdown menus for data entry. A 3D model of a rock formation is overlaid on the right side of the forms, illustrating the integration of BIM and inspection data.

DWSS with BIM Compatibility

# Advanced BIM Applications



Drill-to-BIM Integration with DWSS

# Virtual Reality (VR) Systems

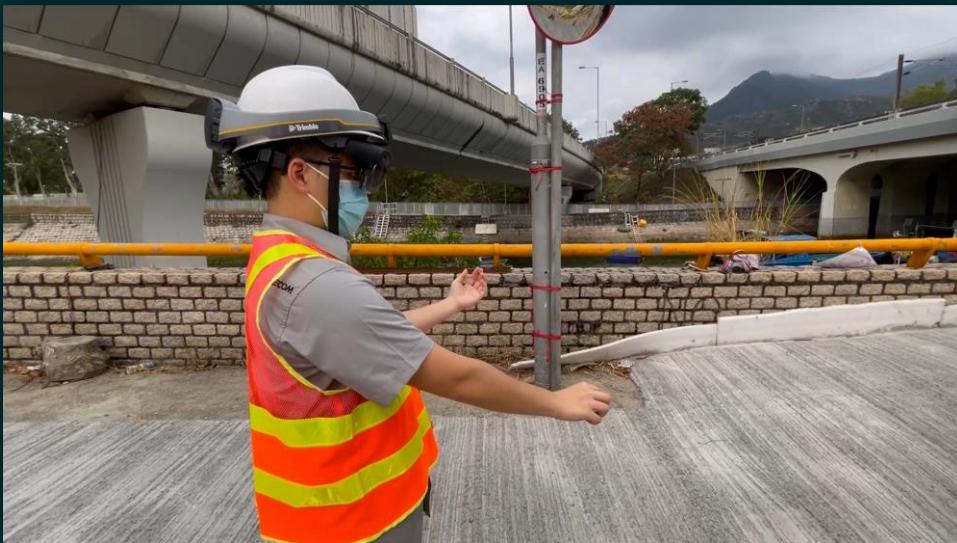
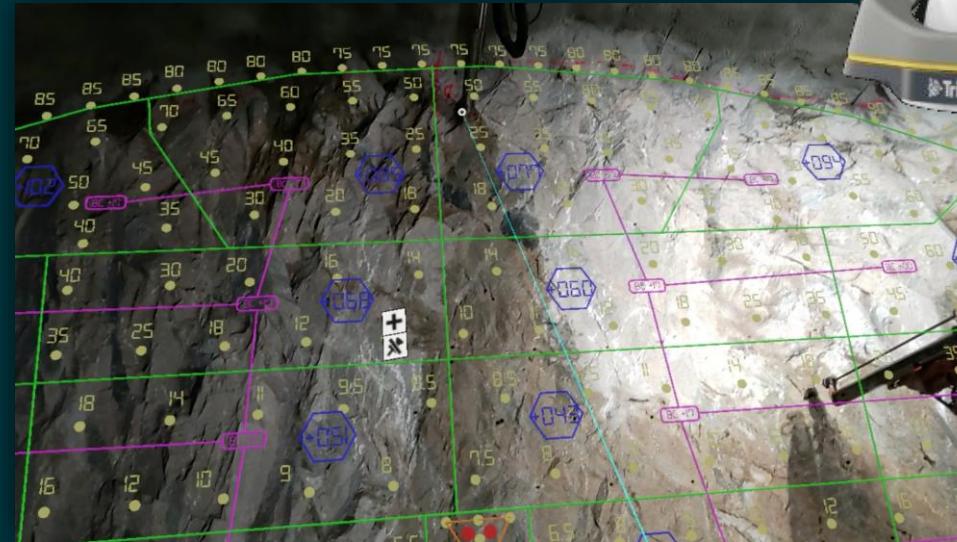


4D Immersive CAVE System



VR System – Safety Training

# Mixed Reality (MR) System – Hololens 2



Utilities Design



Blast Holes Design

# Site Specific 5G Network



Base Stations

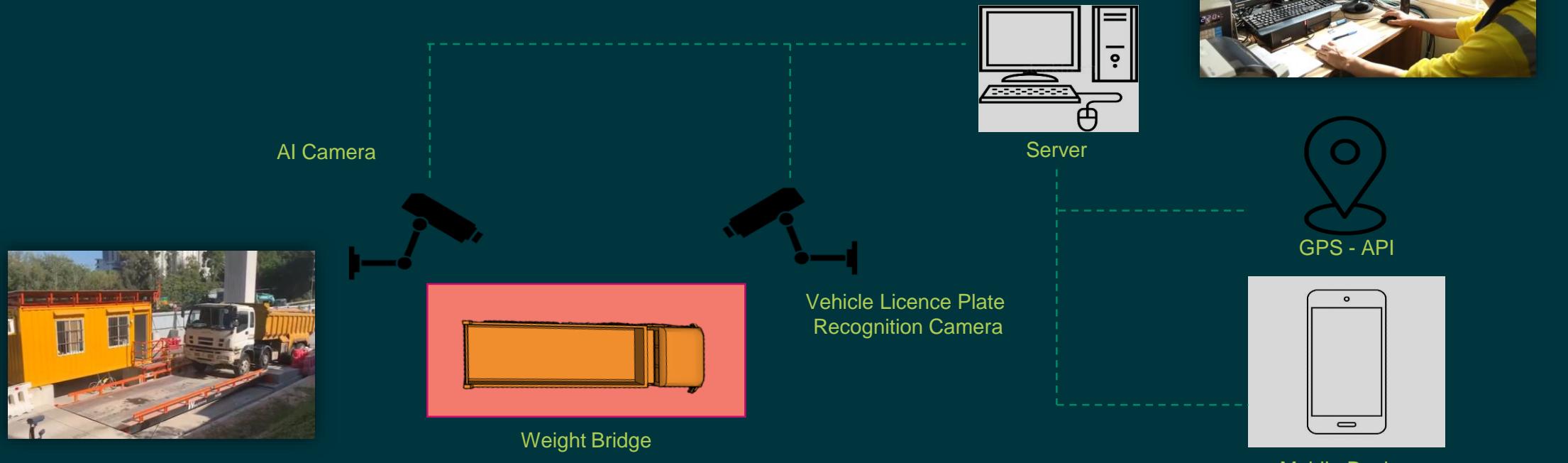


5G Network

# Asset Management System



# WeighBridge AI Monitoring System



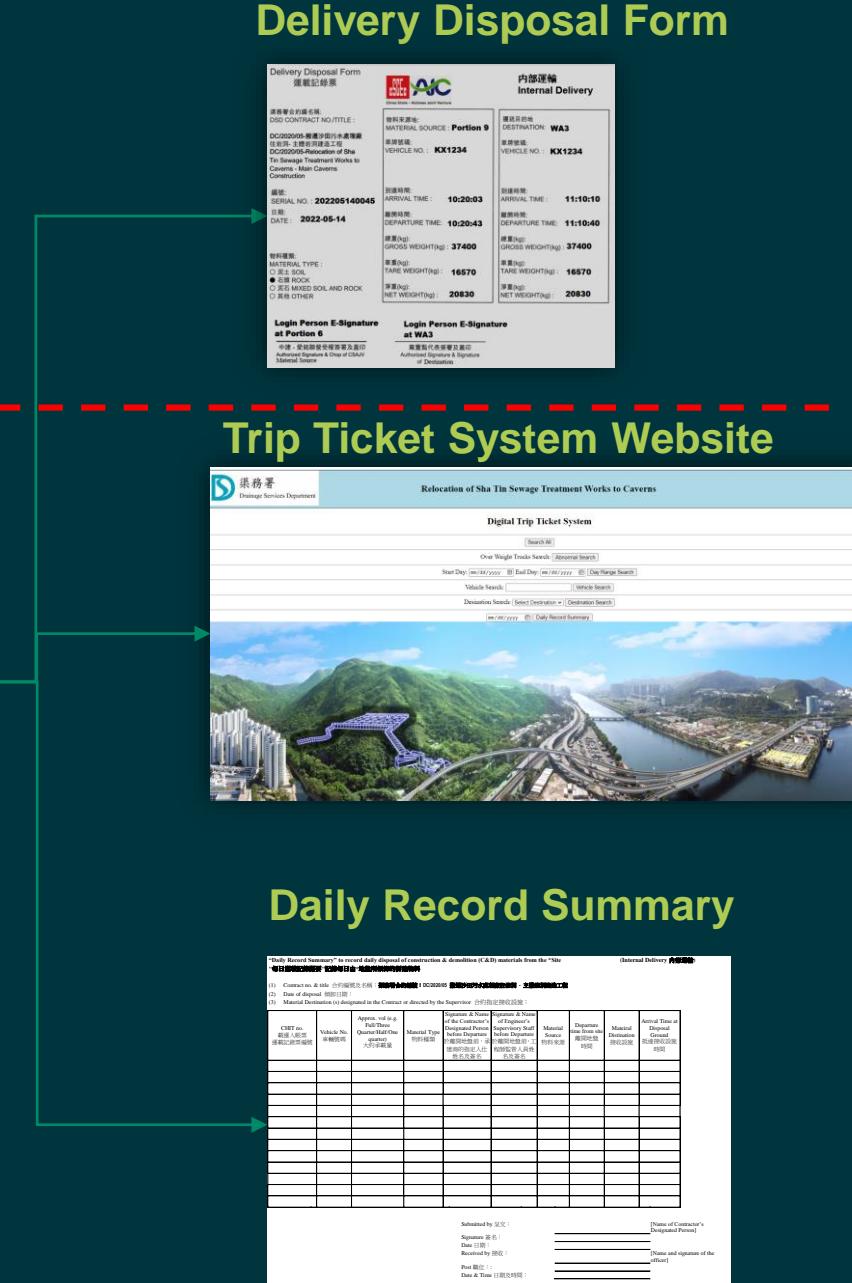
## AI Approval Logic Flow



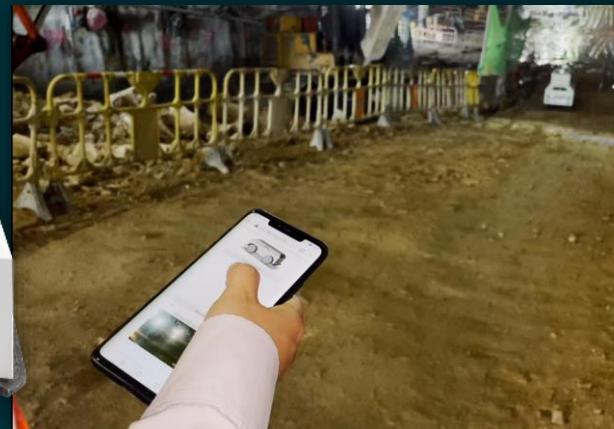
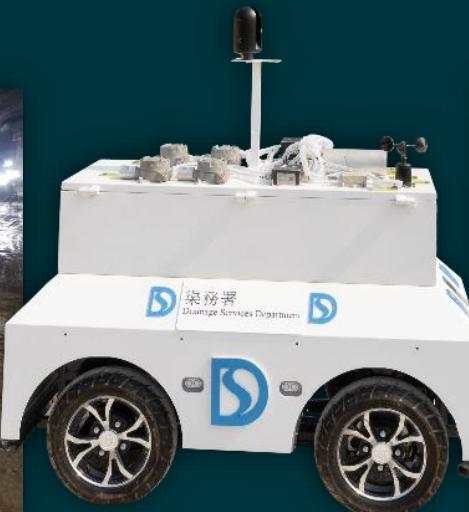
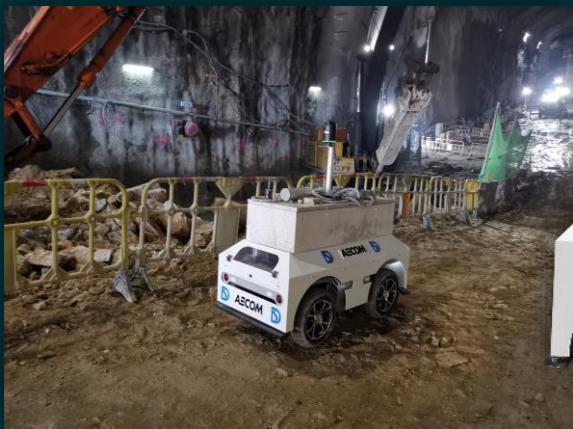
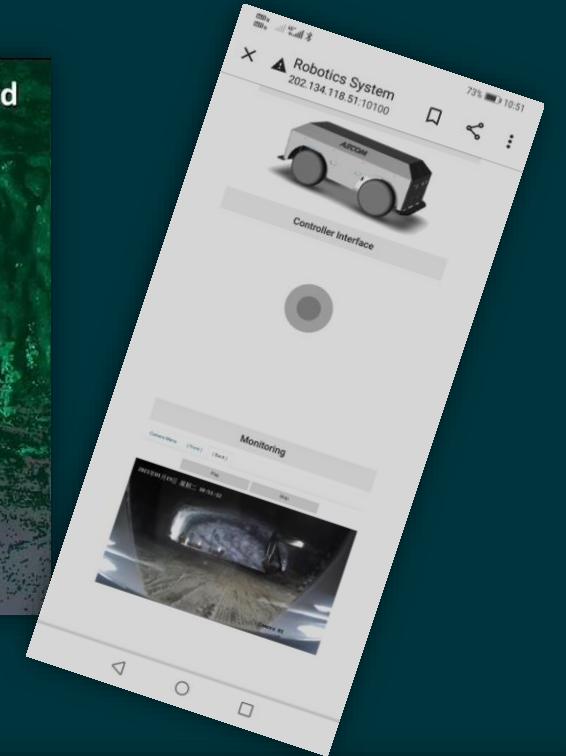
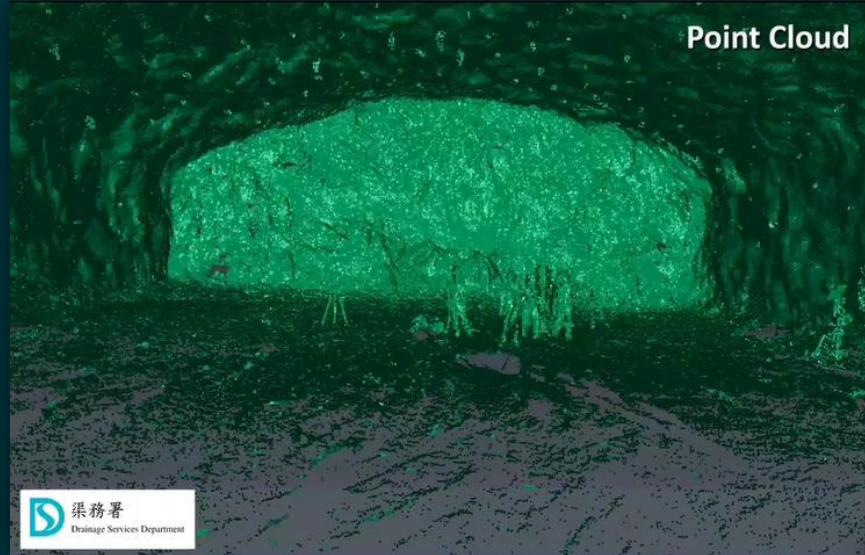
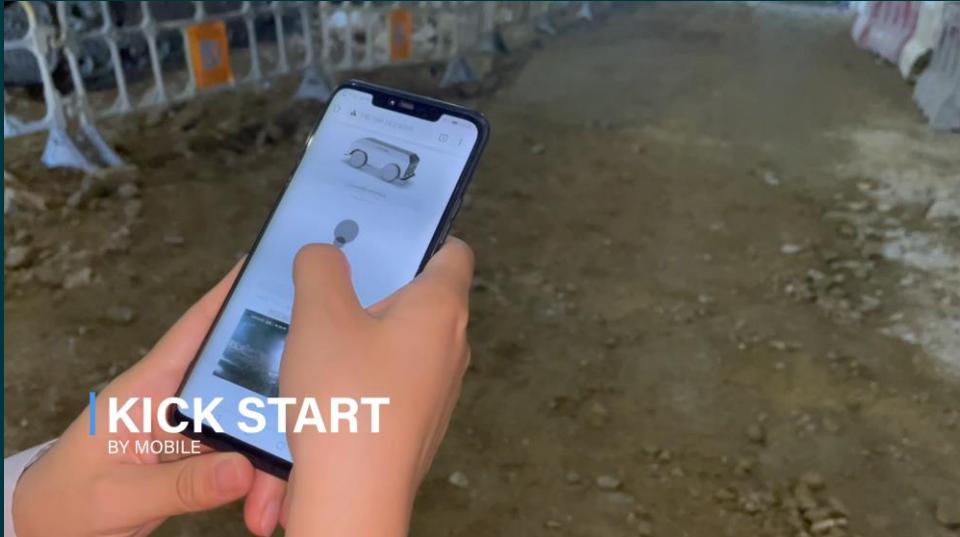
# WeighBridge AI Monitoring System



Work Sequence

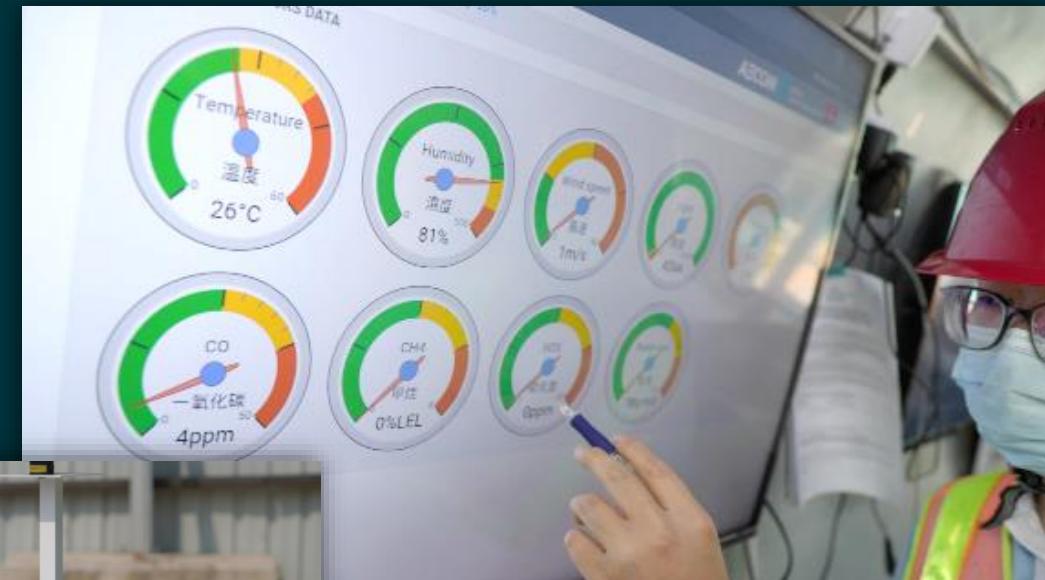


# Resident Site Robotic Supervisor (RSRS)



# Tunnel Air Quality Real-time Monitoring

- Real-time monitoring of air quality inside tunnel (9 nos. parameters).
- Real-time data observed in tally room and mobile devices.
- Alert when data exceeds the normal level.



A screenshot of a software application showing a table of alert thresholds for various parameters. The table has columns for Device, Channel, Standard Value, Below Alert Value, and Over Alert Value. The data is as follows:

	Device	Channel	Standard Value	Below Alert Value	Over Alert Value
1	HKTAD1	9	250.00 lux	20.00	500.00
1	HKTAD1	1	1.45 %	0.00	2.00
1	HKTAD1	7	0.95 %	0.00	2.00
1	HKTAD1	5	21.50 %	15.00	28.00
1	HKTAD1	4	2.00 pCi/L	0.00	4.00
1	HKTAD1	3	60.00 RH	0.00	90.00
1	HKTAD1	2	25.00 °C	0.00	50.00
1	HKTAD1	1	10.00 km/h	0.00	100.00

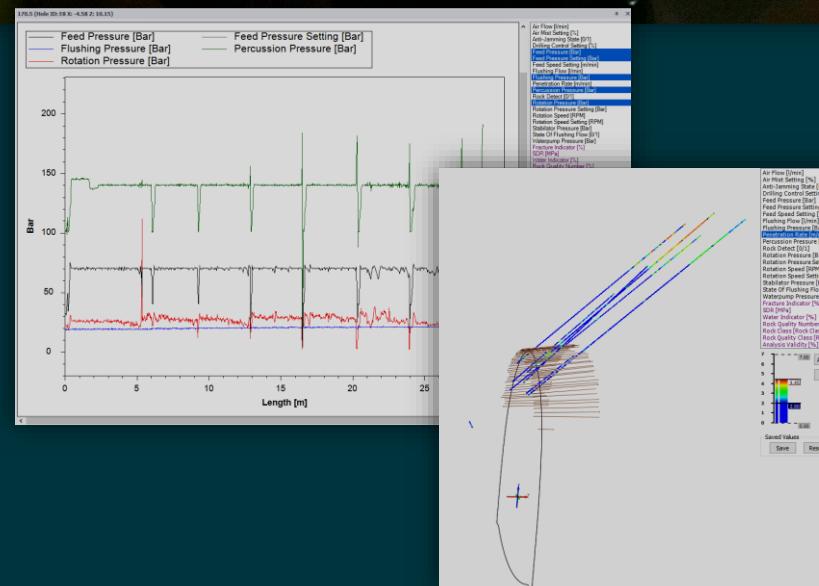
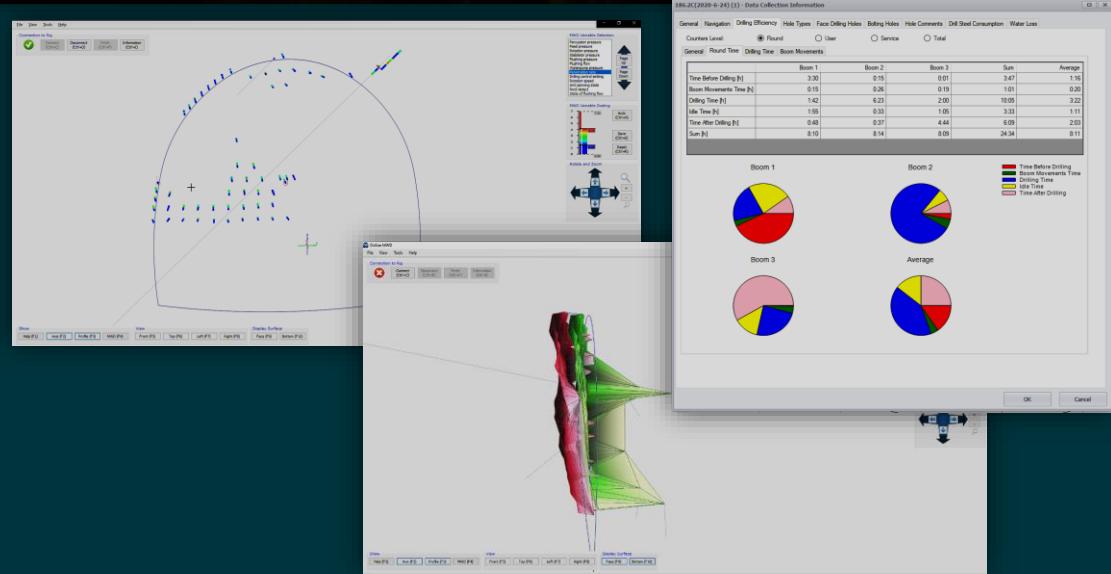
# AI for Site Safety



AI Cameras for Wheel Washing

AI Cameras for Danger Zone Detection

# Measure While Drilling

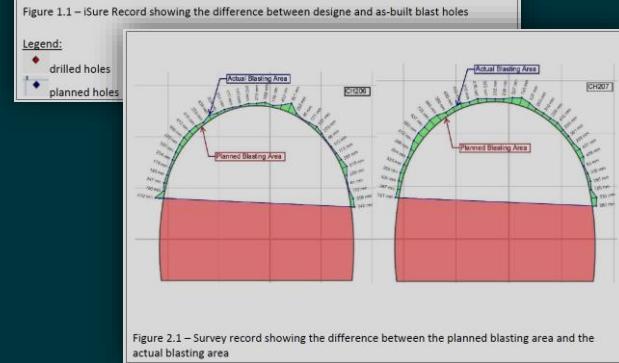
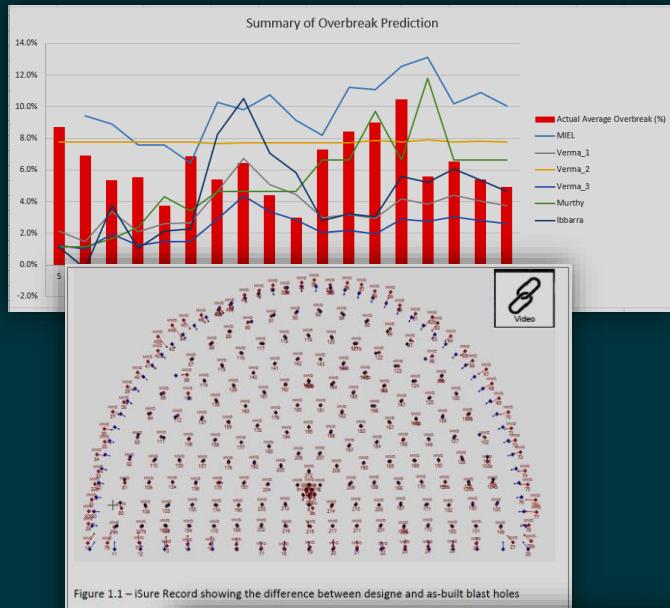


Basic parameters

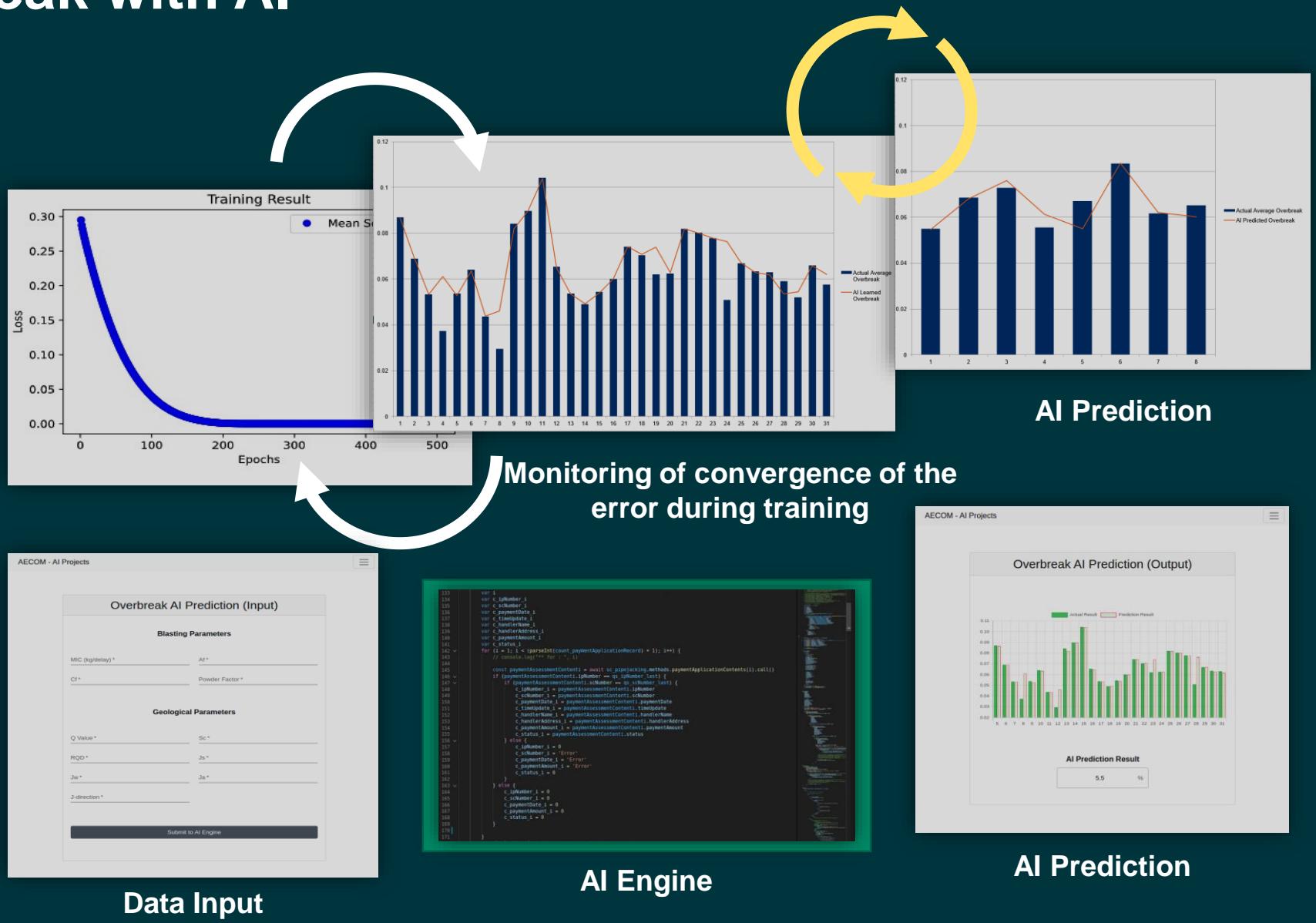
Air Flow [l/min]  
Air Mist Setting [%]  
Anti-Jamming State [0/1]  
Drilling Control Setting [%]  
Feed Pressure [Bar]  
Feed Pressure Setting [Bar]  
Feed Speed Setting [m/min]  
Flushing Flow [l/min]  
Flushing Pressure [Bar]  
Penetration Rate [m/min]  
Percussion Pressure [Bar]  
Rock Detect [0/1]  
Rotation Pressure [Bar]  
Rotation Pressure Setting [Bar]  
Rotation Speed [RPM]  
Rotation Speed Setting [RPM]  
Stabilizer Pressure [Bar]  
Waterpump Pressure [Bar]  
Fracture Indicator [%]  
SDR [MPa]  
Water Indicator [%]  
Rock Quality Number [%]  
Rock Class [Rock Class]  
Rock Quality Class [Rock Class]  
Analysis Validity [%]

Extended parameters

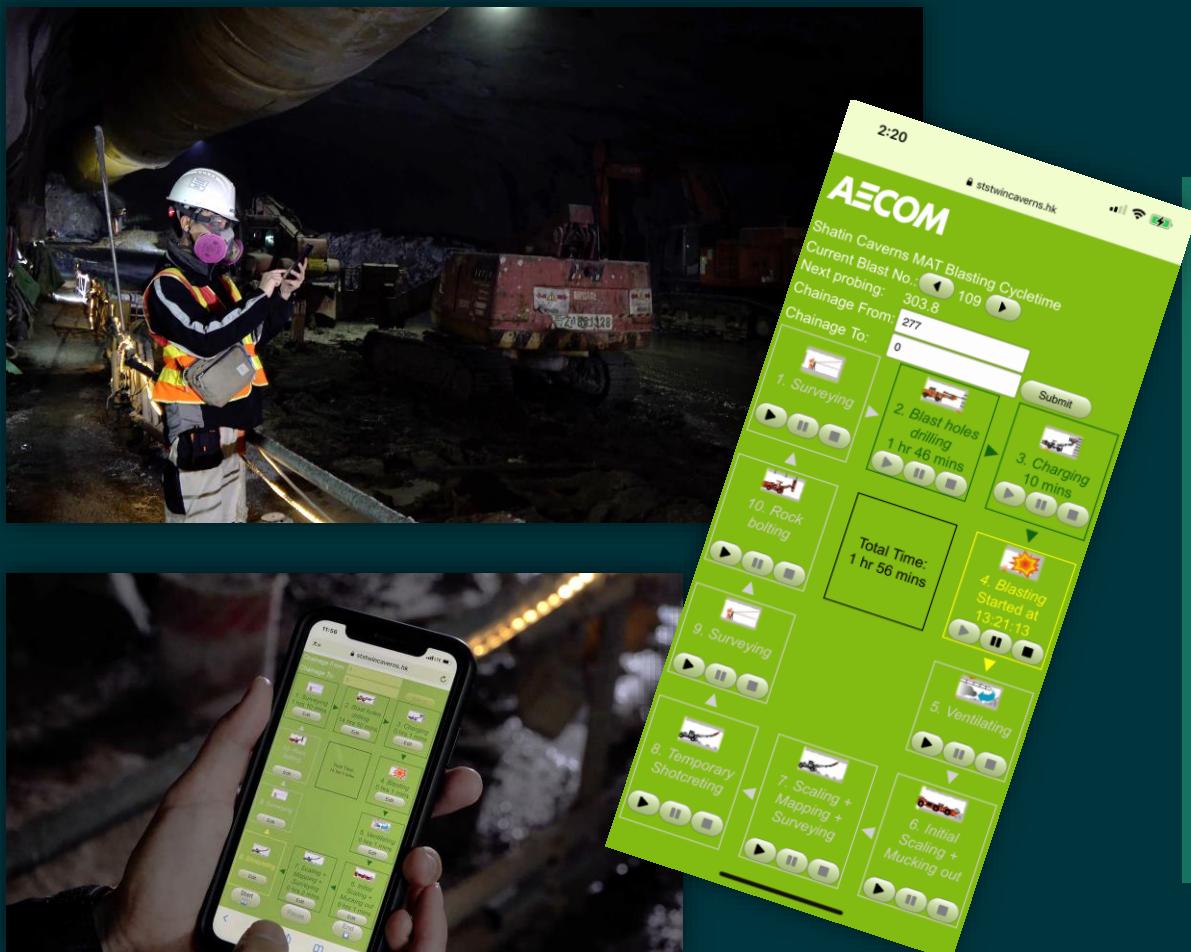
# Prediction of Overbreak with AI



Study of Geological and Blasting Data



# Tunneling Works Analysis Apps



BLASTING CYCLE TIME  
APPS

爆破應用程式

Record the  
Blasting  
Processing Time  
記錄爆破工程時間

Blasting Working Cycle Time Record

# Tunneling Works Analysis Apps

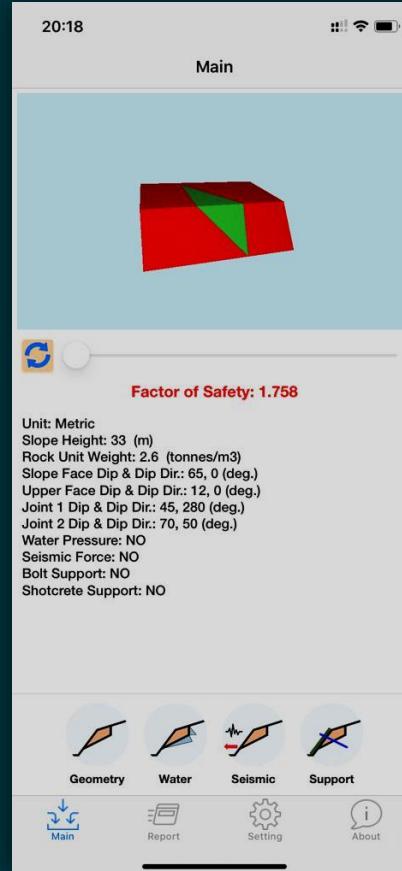
The AECOM MAT Blast Design Validation app interface includes:

- Current Blast No.:** 44
- Diagram:** Shows a circular arrangement of blast holes with labels for "Side Length of Cut Area", "Angle of Breakage", "Diameter of Blast Hole", "Nos. of relief hole", "Nos. of blast hole", and "Diameter of Relief Hole".
- Legend:** Identifies "Cut Holes" (orange circles) and "Relief Holes" (black circles).
- 1. Void Ratio Check:** Includes input fields for "Area of cut = m<sup>2</sup>" and "Total Area of relief hole = m<sup>2</sup>", and a "Void Ratio = %" field.
- 2. Sectional Area of Relief Holes Check:** Includes input fields for "Blasthole depth: m" and "Min. sectional area of relief blastholes = cm<sup>2</sup>".
- 3. Powder Factor Check:** Includes input fields for "Total weight of explosive used in cut holes: kg" and "Volume of fragmented rock = m<sup>3</sup>".

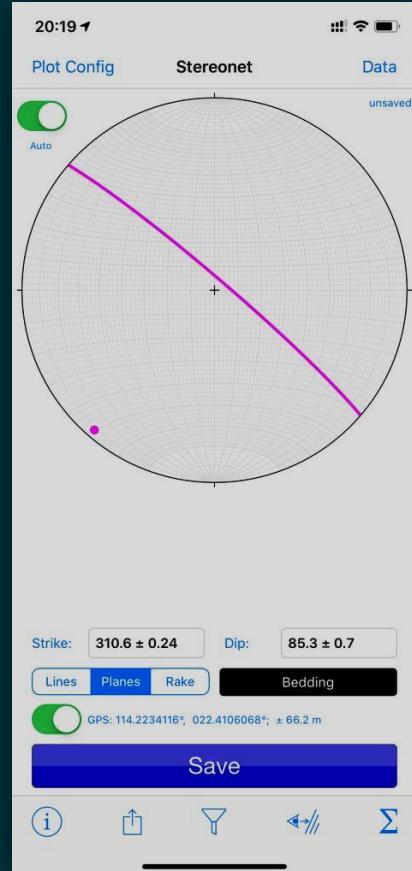
## Quick Check of Burn Cut Design

- ✓ Void Ratio Check
- ✓ Sectional Area of Relief Holes Check
- ✓ Powder Factor Check
- ✓ Breakage Angle Check
- ✓ Delay Separation Check

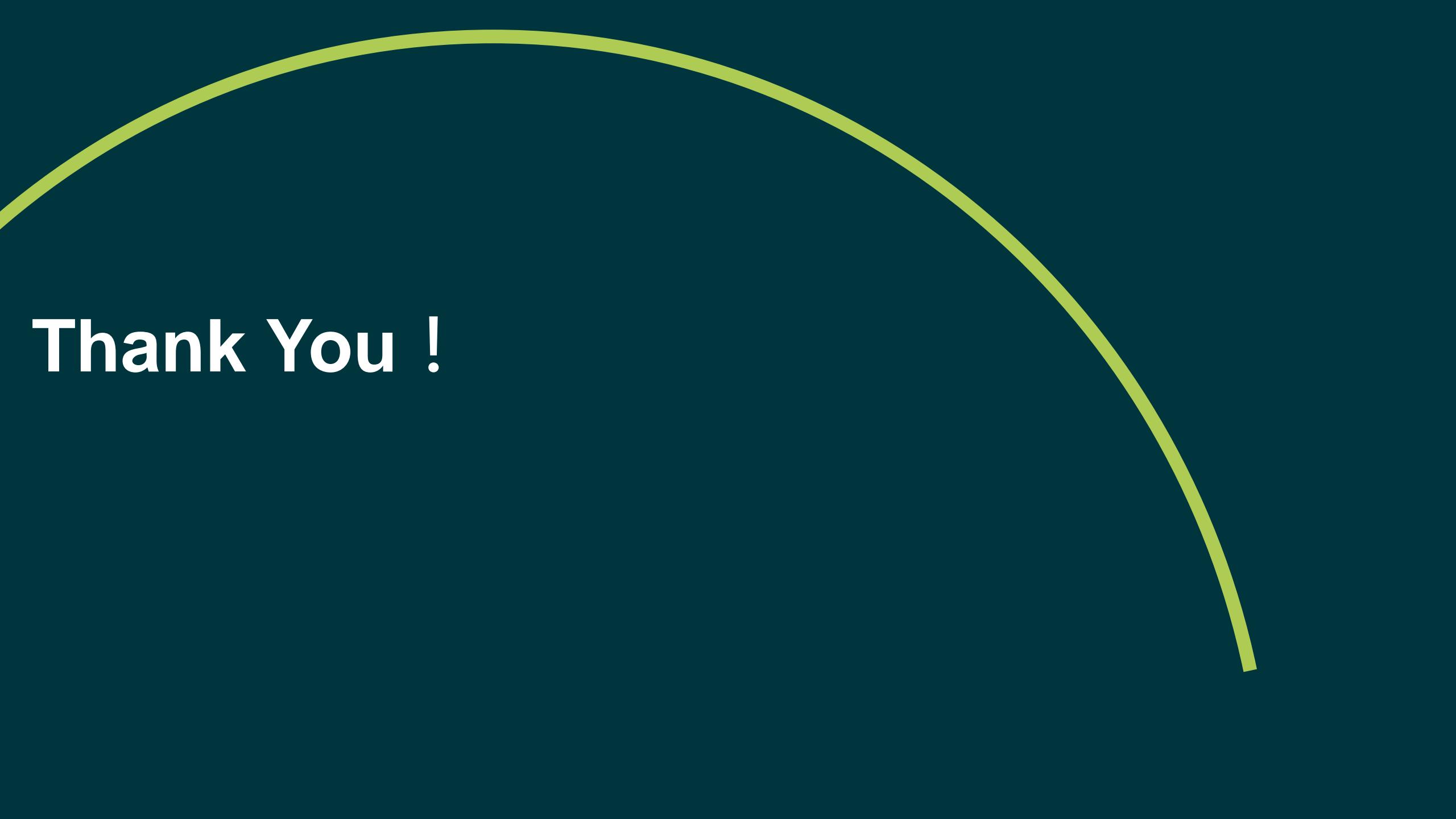
## Blast Design Validity Check



Rock Wedge Stability Analysis



Stereonet



Thank You !