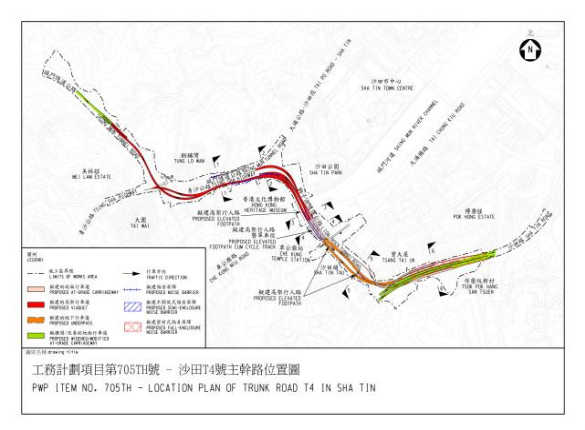
Vibration Monitoring for Heritage Application

- **CEDD Project :** Contract No. ED/2022/02 Trunk Road T4 and Associated Works
- **Consultant**
  AECOM Asia Company Limited
- **Contractor**
  CRBC – Build King Joint Venture



- **Monitoring Starting Date**
  26 August 2024
- **Location**
  Hong Kong Heritage Museum
- **Objective**
  Monitoring the vibrations in the Hong Kong Heritage Museum during construction work
- **Tools**
  - Vibration Meter
  - LORA Gateway
  - SMOS Monitoring Platform

Vibration Meter

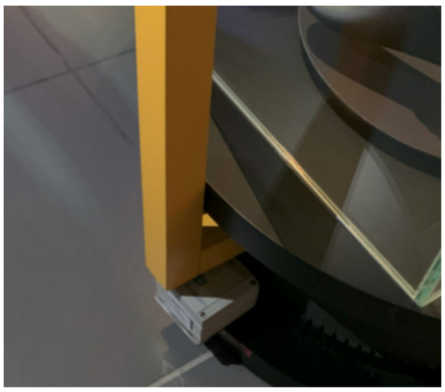
LoRa Gateway

Background

The project's principal works comprise the construction of a 2.3 km dual two-lane trunk road with connecting slip roads to Shing Mun Tunnel Road, Tsing Sha Highway, and Shatin Road. This will be accompanied by widening a 150-meter section of Sha Tin Road near Pok Hong Estate from a dual two-lane to a dual four-lane carriageway. Ancillary works include extensive civil, geotechnical, and utility efforts, along with the implementation of environmental mitigation measures and a monitoring program.

Site Work

The construction project may result in vibrations that deform the artifacts in the Hong Kong Heritage Museum. To monitor the vibrations caused by the project as a preventive measure, 36 sensors are installed in different locations within the museum. The vibration sensors are connected to network gateways that transmit and store data on cloud. These data can be accessed and analyzed with the monitoring website.



Challenge

- The Heritage Conservation Team require a fast-sampling rate (1-2 measurements/min) and uploading rate (Every 5 mins). The power consumption is high under this setting.
- A longer battery life is requested to reduce the battery replacement frequency.
- The signal between Vibration Sensors and LoRa Gateway in some warehouses are very weak. Mobile phone is difficult to get signal in this location.

Technology

Vibration Meter

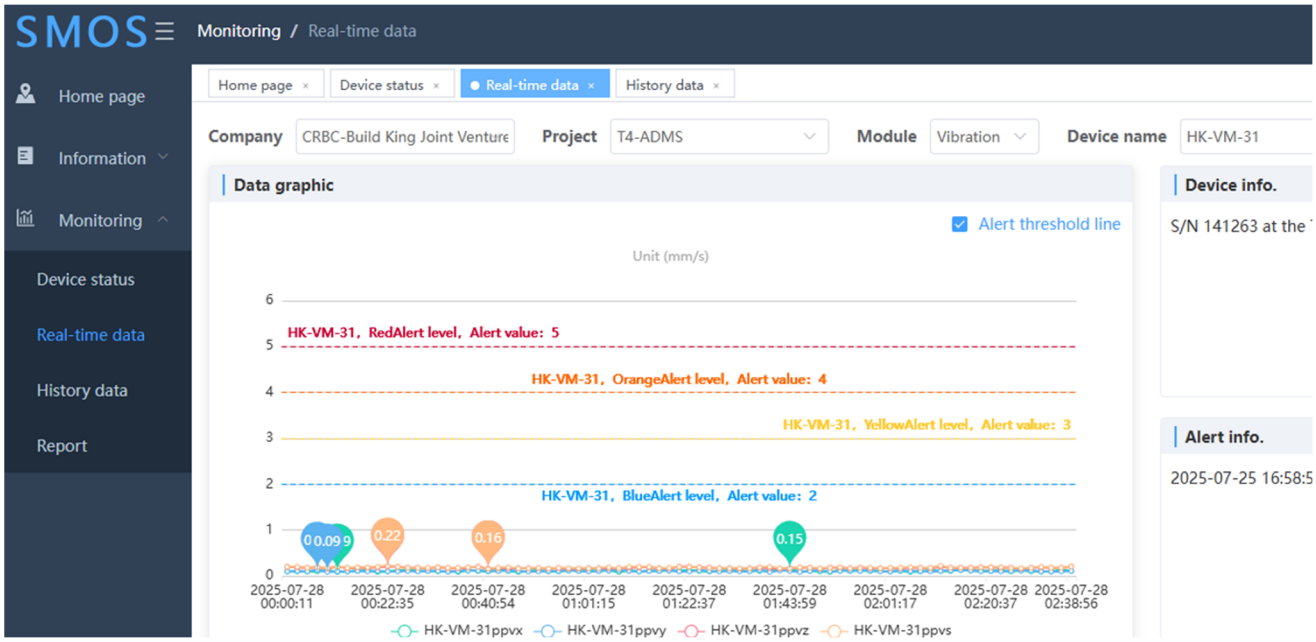
- Utilize a 3-axis MEMS accelerometer
- Measure vibration levels in LAW/PPV and frequency
- LoRa technology
- Customizable through app or CMT Cloud
- Intelligent alert threshold – Uploading frequency will be changed to every minute when vibrations exceed the alert threshold. Therefore, we can keep low uploading rate in normal condition to save power.

4G Gateway

- Collect data from each Vibration Sensors using LoRa or LoRaWan radio
- Transmit data to internet (cloud server) via 4G network

SMOS Monitoring Website

- Display the real time and historic data, locations of the sensors, project information, network status, and alert messages
- Analyze the data values and the curves formed by the data, as well as the comparison of values between sensors to identify the vibration source



Water Level Monitoring in Tuen Mun MTR Station

- **MTR Project :** Contract No. 1500
  Tuen Mun South Extension stations, viaducts and river crossing

- **Contractor**
  CRBC – Build King Joint Venture

- **Project Location**
  Tuen Mun, New Territories

- **Monitoring Starting Date**
  04/2024

- **Objective**
  Monitoring the water level of Tuen Mun River in Tuen Mun Station

- **Tools**
  - SOUTH Radar Water Level Meter
  - 4G Router
  - SMOS Monitoring Platform

Radar Water Meter

4G Router

Background

Contract 1500 encompasses several key elements, including the construction of a new station at Tuen Mun Area 16 (A16 Station) extending from Tuen Mun Station (TUM), a Tuen Mun River Bridge (TRB), and viaducts connecting the existing overrun viaduct to A16 Station and Tuen Mun South Station (TMS).

Site Work

Tuen Mun South Extension railway viaduct is being built along and over the Tuen Mun River. Several worksites are operating. Comprehensive risk assessments and contingency plans are implemented to manage impacts on the existing railway and river environment. These include the setup of the Water Level Monitoring System at Tuen Mun Station. When the water level exceeds the alert value, SMS and Email will be sent to all related parties.

Challenge

- AC power socket is not available.
- The location of Water Level Meter is inside the station. Solar panel is not effective.

Technology

Radar Water Level Meter

- Calculates distance between transmitter to water surface.
- Utilizes a special correlation technology for mm accurate.
- Measuring distances up to 70 meters.
- Works with various signal interfaces.
- Low power consumption.

SMOS Monitoring Platform

- Provide wide update frequency from every minute to every hour.
- Provide Graphical display for water level with 3A threshold line.
- Support SMS or Email alert message.
- Support Site Photo and Google map.
- Customized Report and data download.
- Dashboard support multi-sensors and multi-projects .

Typhoon 10 – Extreme Weather Case

On September 24, 2025, Typhoon Ragasa struck Hong Kong. Due to the storm and tidal effect, water level rise up from 2.5m (normal Peak of Tide) to 3.4m at 11:15am. It triggered the 1st Alert limit. The water level meter accurately detected these changes and sent alert notifications to relevant parties. SMOS displayed the trend of water level influenced by daily tidal up and fall. Based on analysis of historical and real-time data, water level could be predictable. Water level was falling after reaching the peak of tide. Risk of Flooding can be cleared.