# RESEARCH & TECHNOLOGY

## RESEARCH AND DEVELOPMENT

### Enhanced road surface depression detection tools

Prototype of the tools to be released

**in mid-2023**

### Low noise road surfacing material - PMSMA6

**100%**

of site trials completed

### Rubberized bituminous pavement material

**~20%**

of site trials completed

### Eco-paver with recycled glass cullet

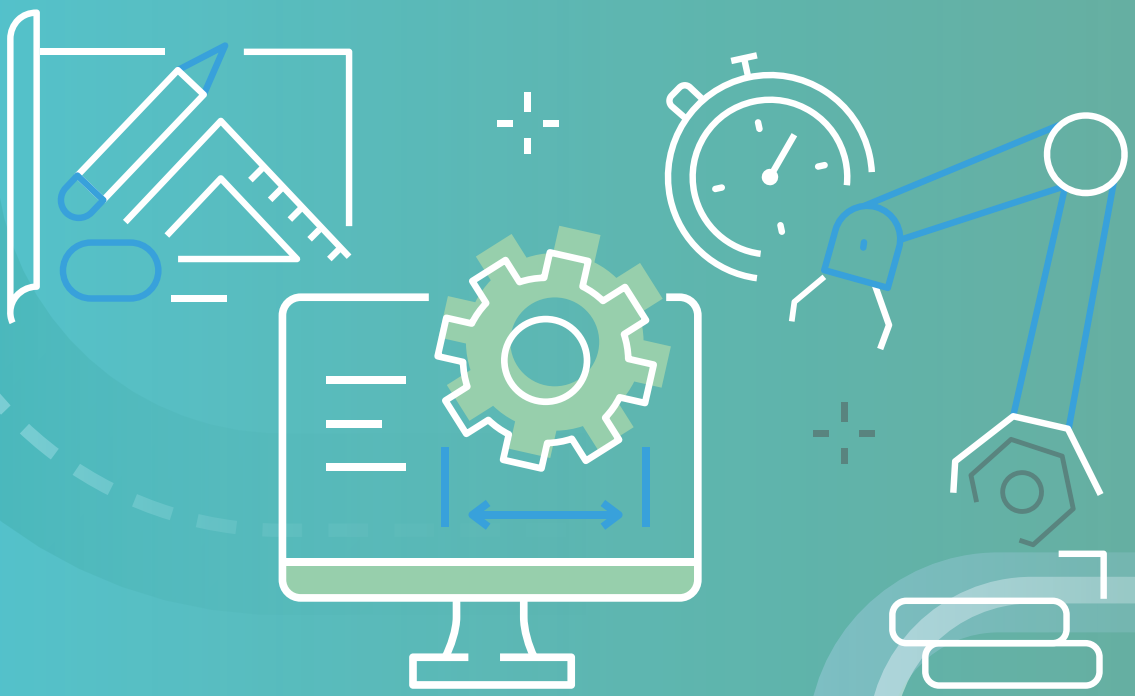
To increase the glass cullet content in eco-pavers to

**30%-35%**

### Multi-functional smart lampposts

**400**

smart lampposts to be installed in 4 districts



# RESEARCH AND DEVELOPMENT

## Applications of Innovation and Technology for Road Condition Assessment

### Mobile Laser Scanning and Imagery (MLSI) System

We have been utilizing the Mobile Laser Scanning and Imagery (MLSI) System to capture images and 3D Light Detection and Ranging (LiDAR) data of roads and surrounding environment. Benefited from the high data capturing capability of the MLSI system and mobility of Vehicle-based MLSI System (VMS), the number of field survey teams and field trips required to complete the survey is greatly reduced.

Overview of VMS

### Road Surface Depression Detection using Artificial Intelligence (A.I.) Technology

In the past decades, various 2D image-based systems and associated algorithms for pavement measurement have been developed for collecting in-situ data to identify road defects. However, traditional 2D image-based analysis for road defects detection is often constrained by the illumination conditions. In addition, subtle road depressions are difficult to be identified using 2D images due to the homogenous color of the pavement and the insufficient information of the depression depth.

In light of that, we are collaborating with the Hong Kong Polytechnic University to study the development of an A.I. algorithm for road surface depression detection based on 3D LiDAR data collected by MLSI system, which is less vulnerable to poor illumination and contains 3D information of the road surface. The algorithm can help detect the road surface depression more precisely (e.g. rutting and potholes) which in turn improves the effectiveness and efficiency of road inspections and road audits.

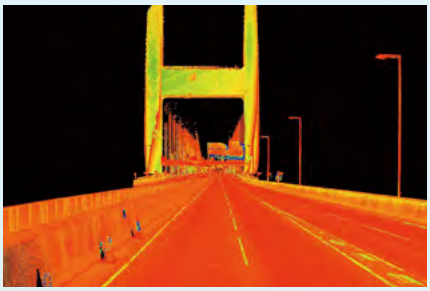
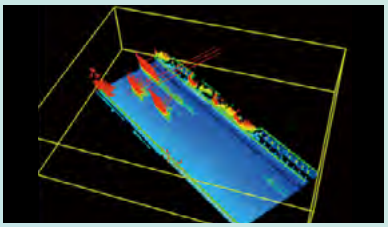


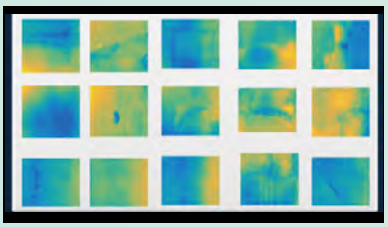
Illustration of 3D LiDAR data captured at Tsing Ma Bridge

### Result Reporting in an Environmentally Friendly Manner

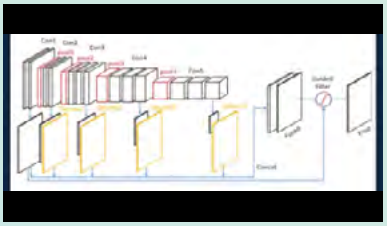
Currently, survey results are delivered to clients in the form of paper plans. Under the proposed algorithm, road defects will be reported via Geographic Information System (GIS) web platform. It could be further enhanced by importing the defect results into mobile devices to facilitate on-site inspection, which ultimately replace the conventional paper-based survey plans. In addition, it can effectively reduce the number of fieldwork teams and field trips for conducting on-site inspections, and in turn helps cut down fuel consumption, vehicle emission and road traffic.

### Methodology of the Study


3D LiDAR data acquisition

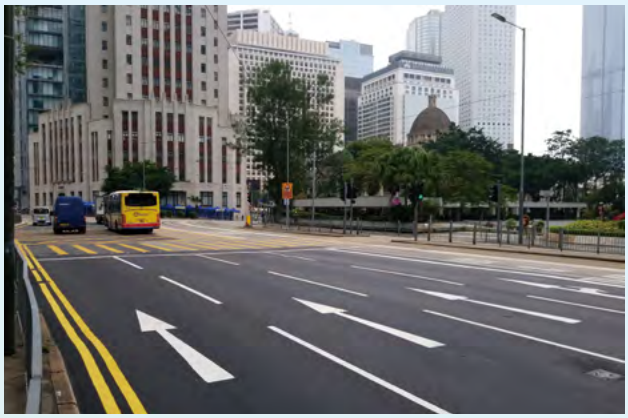

3D road surface depression library


Road surface depression detection tools


Depression detection algorithm based on deep learning

## Low Noise Road Surfacing Material - PMSMA6

- ~2.5dB(A) tyre noise reduction
- 100% of totally 53 trial road sections completed



PMSMA6 laid at Queensway

To reduce road traffic noise, we have been working closely with EPD in developing a more durable low noise road surfacing (LNRS) material for use in Hong Kong. We continued site trials of a new LNRS material - 6mm Polymer Modified Stone Mastic Asphalt (PMSMA6). Since the commencement of the site trial programme in 2019, we have completed laying PMSMA6 at 53 road sections in 2022. The laboratory and site trial results revealed that the performance of PMSMA6 in reducing tyre noise (about 2.5dB(A)) is similar to the existing LNRS material - Polymer Modified Friction Course (PMFC), while its performance on durability is better. We have summarized the road characteristics which are suitable for applying PMSMA6 in our final technical report for reference by other government departments. Also, the technical guidelines on the application of PMSMA6 on local roads in Hong Kong have already been included in the latest HyD Guidance Notes.


PMSMA6 laid at Tai Tam Road

## Rubberized Bituminous Pavement Material

- 2 feasibility studies completed
- ~20% of totally 25 trial road sections completed

Rubberized bituminous pavement material laid at Hoi Fai Road

In Hong Kong, more than 22,000 tonnes of waste vehicle tyres are generated every year, disposal of these waste tyres has been a very difficult problem for a few decades. With the vision to tackle this problem and bring in both environmental and engineering benefits, we engaged the Hong Kong Polytechnic University in 2018 to carry out 2 collaboration studies on the use of rubberized bituminous pavement materials in Hong Kong road network and the feasibility of incorporating reclaimed rubberized bituminous pavements to the new rubberized bituminous pavement materials. The studies concluded and confirmed the technical feasibility of adding crumb rubber into conventional bituminous pavement materials, including wearing course, base course and road base, and the recyclability of the rubberized bituminous pavements at the end of their service lives. In 2021, we commenced a site trial programme to test its performance in public roads. 5 trial road sections have been laid with rubberized bituminous pavement materials by Q1 2022. In the coming years, we will endeavor to expedite our site trial programme to collect sufficient data to conclude the site trial results as early as possible.

Rubberized bituminous pavement material laid at Bride's Pool Road

## Eco-pavers

- Started the use of recycled aggregates in concrete pavers in 2004
- Started the use of recycled glass cullet in concrete pavers in 2010

Site trial of eco-pavers at Tai Pak Tin Street, Kwai Chung

Developing environmentally friendly paving materials for footpath is also high on our agenda. From 2004, we have mandated the use of recycled aggregates in concrete pavers (eco-pavers), in which recycled aggregates are crushed concrete or crushed rocks generated from construction or demolition works. From 2010, we have taken further initiative to use recycled glass cullet in eco-pavers and mandated the use of glass cullet of 20% to 25% by weight of the total aggregates in road maintenance contracts.

As per the collaboration study of EPD and the Hong Kong Polytechnic University on "Enhancing the Application of Local Recycled Glass Cullet in Production of Concrete Paving Blocks", it is noted that by controlling the size of recycled glass cullet to contain the undesirable effect of alkali-silica reaction, the glass cullet content can be raised to the level of 30% to 35% by weight of the total aggregates. To facilitate further consumption of recycled glass cullet, we commenced the site trials to verify the real-life performance of eco-pavers with recycled glass cullet of 30% to 35% by weight of the total aggregates. With the satisfactory results obtained in the site trials, the use of eco-pavers with higher glass cullet will then be mandated in road maintenance contracts.

## Development of Multi-functional Smart Lampposts

- 400 smart lampposts to be installed in 4 districts
- ~120 sensors to be installed for collecting environmental and meteorological data

The 2017 Policy Address announced the launch of the Multi-functional Smart Lampposts Pilot Scheme at selected urban locations to support the building of a smart city with city-wide coverage of data and network. The smart lampposts aim to provide convenient data services and collect various real-time city data, enhance city and traffic management, and complement the digital infrastructure development for the fifth generation (5G) mobile communications services in Hong Kong.

Under the Pilot Scheme, some 400 multi-functional smart lampposts will be equipped in phases with smart devices in four selected urban locations in Central/Admiralty, Wan Chai, Yau Tsim Mong and Kwun Tong/Kai Tak Development Area to collect real-time city data.

To better monitor the air quality at district level, we have been working closely with EPD in the Pilot Scheme to install air quality sensors on the smart lampposts for real-time tracking of the concentrations of key air pollutants, fine suspended particulates and nitrogen dioxide, at roadside. Furthermore, the Hong Kong Observatory has also installed different sensors at the smart lampposts to monitor the temperature, humidity, wind speed and wind direction in the vicinity. It is planned under the Pilot Scheme to install approximately 120 number of these sensors across the districts to collect the environmental and meteorological data in real-time. With the environmental and micro-meteorological data of various regions, the regional environmental changes in Hong Kong can be assessed and monitored. This information can facilitate our understanding of the impacts of different urban activities and the impacts due to changes of the environment and cityscape.

All data collected will be released to the public as open data via the Public Sector Information portal (data.gov.hk). The data will be useful for supporting government services and development of innovative applications by the industry, such as providing citizens and tourists with information about public facilities in their vicinity.

Smart lamppost with weather stations installed at Shing Kai Road, Kai Tak