AGS Book Prize Reports
Name: Leung Amanda Ka Wing
Technical Visit to Polytechnics University for Optical Fibre Sensing Techniques
Date: 17 Sept 2023

A technical visit to Smart Geotechnology Laboratory of Polytechnics University (PolyU) on optical fibre sensing techniques was organised by the Association of Geotechnical & Geoenvironmental Specialists (Hong Kong) (AGS) on 26 August 2023.

At the first session, the PolyU researchers presented the theories and applications of several optical fiber sensing techniques. In general, optical fiber sensing techniques utilise the properties of light to measure physical parameters such as strain and temperature. There are two main types of optical fibre sensing techniques, which are quasi-distributed and fully distributed sensing. Quasi-distributed sensing uses one fiber line with multiple sensors/gratings to measure strain and temperature at designated locations. For instance, Fibre Bragg Gratting (FBG) sensor is a type of Quasi-distributed sensor which includes Bragg reflector in a short segment of optical fiber. When light is launched into the fiber, a portion of it is reflected at a particular wavelength called the Bragg wavelength (λ_B), which could be directly correlated to strain and temperature being measured. On the other hand, fully distributed fiber optic sensing (DFOS) utilises the optical fiber as the sensor itself which relies on the measurement of optical properties along the entire length of the fiber. These sensors use techniques like optical time-domain reflectometry (OTDR) or optical frequency-domain reflectometry (OFDR) to analyze the backscattered or reflected light along the fiber, to measure strain and temperature continuously with high accuracy.

The presentation also summarised that optical fibre sensors have various advantages such as immunity to electromagnetic and radio frequency interference, capability to measuring multiple points along a single optical fiber, highly sensitive and accurate etc. Hence, the presenters mentioned that optical fibre sensors are alternatives to conventional electrical sensors, i.e. strain gauge which could be interfered by other electromagnetic signals and could allow discrete data at pre-determined locations only. However, there are limitations associated with optical fibre sensing such as high cost of instruments and limited knowledge and experience in Hong Kong.

The presentation lastly highlighted a large variety of applications of fiber optic sensing in Hong Kong and mainland China, such as using FBG sensors to monitor the deflections of stonewalls and large trees in Hong Kong at remote areas in real-time using solar power and smart monitoring system; and adopting DFOS to continuously monitor circumferential forces and bending moments of a launching shaft at Hong Kong T2 trunk road project.

At the second session, PolyU researchers demonstrated to us the applications of optical fibre sensing techniques at PolyU Smart Geotechnology Laboratory. For instance, they used an continuous optical fiber to surround the diaphragm wall model filled with beads in various loops and simulated soil excavations by pouring out beads, resulting in compressive strain measurement using DFOS technique at shown in the data-logger. They also demonstrated the use of FBG sensors to measure the deflection of a metal plate.

In summary, I would like to express my sincere gratitude to AGS(HK) for organising this meaningful technical visit, which provided with participants an insightful overview of the scientific principles of various optical fibre sensing techniques and applications