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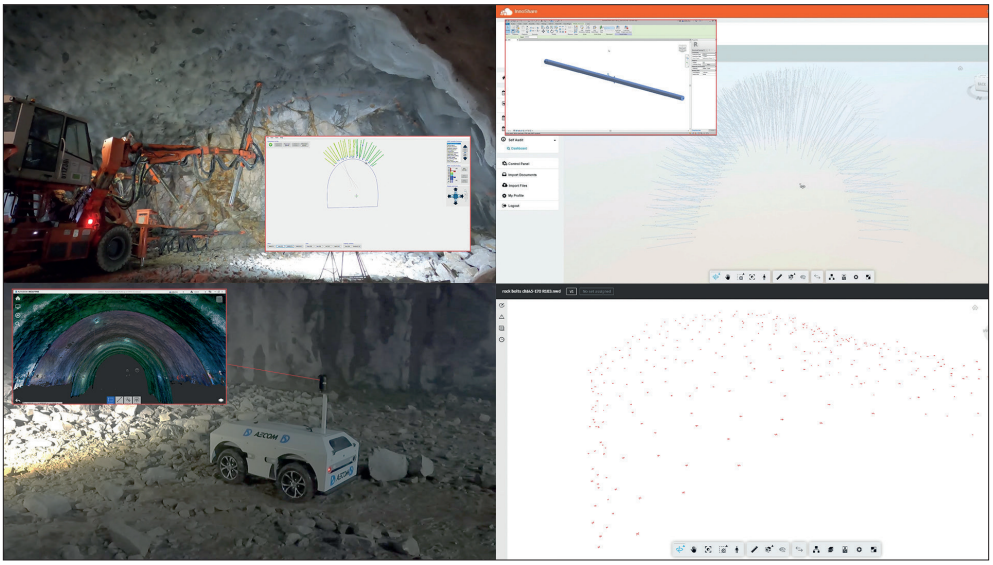
Eddie CHUI is currently the Resident Engineer of AECOM Asia Company Limited, responsible for the integration of BIM and technology, digital transformation and contract administration of the Relocation of Sha Tin Sewage Treatment Works to Caverns Project (Sha Tin Caverns Project) . Eddie is a Chartered Civil and Structural Engineer, with extensive experience in construction, engineering design, contract administration and BIM management of mega infrastructure projects. Eddie is also a part-time lecturer at the Hong Kong Institute of Vocational Education (IVE) teaching BIM for Construction.



Drilling holes for rock bolt installation; Parametric modelling using Autodesk® Revit® and Autodesk Forge®; 3D scanning with Robotic system and viewing point cloud with Autodesk® ReCap® Pro; Anchor nuts recognised by AI analysis
Image Courtesy of Drainage Services Department, HKSAR Government and AECOM Asia Company Limited

Construction Workflow Advancement with Comprehensive BIM Application and Innovative Technology of Sha Tin Caverns Project

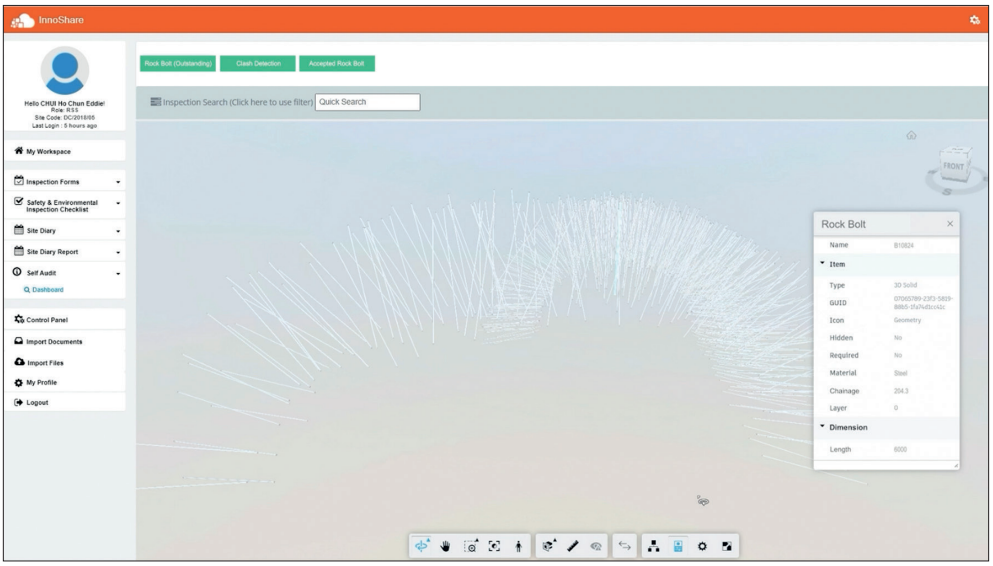
Introduction

Construction projects are dynamic and complicated in nature with many unforeseen conditions. An effective way to facilitate project delivery is to utilize Building Information Modelling (BIM) to construct geometric and informative digital models, which can facilitate design, construction, operation and maintenance of the structure from the origin. In this project, further integrating BIM with innovative technologies, enhances the workflow of asset information modelling and Design for Manufacture and Assembly (DfMA) methodology.

Drill-to-BIM Approach

Rock bolt stabilizes tunnel excavation in our cavern complex. Traditionally, only the exposed part of the rock bolt, the anchor nut, can be surveyed as the bolt shaft is fully embedded. I proposed a new workflow, Drill-to-BIM Approach, for automatic rock bolt modelling to obtain a fully completed Asset Information Model (AIM).

The workflow of Drill-to-BIM Approach is drilling, data collection, modelling, clash detection, 3D scanning and model review. The drill rig data is collected by a customized software in the drilling jumbo machine, which is then transmitted to the



Accepted AIM after automatic review using Autodesk Forge®
Image Courtesy of Drainage Services Department, HKSAR Government and AECOM Asia Company Limited

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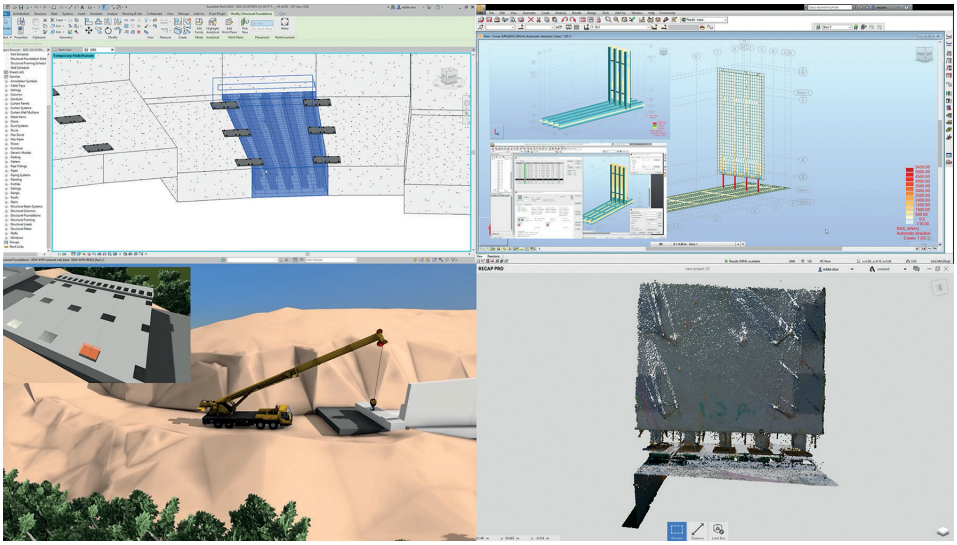


Design model of retaining wall modelled using Autodesk® Revit®; Structural Analysis of retaining wall using Autodesk® Robot Structural Analysis Professional; Construction simulation of retaining wall; Survey check and measurement using Autodesk® ReCap® Pro
Image Courtesy of Drainage Services Department, HKSAR Government and AECOM Asia Company Limited

project server instantly.

Using application programming interfaces (API) offered by Autodesk Forge, a preliminary AIM is modelled with the parametric model and drill rigs data. Real-time clash detection is then performed between the AIM and Project Information Model (PIM) automatically with Autodesk Forge.

A 3D scanner mounted on a robotic system scans the rock face for detailed inspection remotely. Artificial Intelligence (AI) analysis is used to recognize the anchor nut from the point cloud data and obtain the associated coordinates. Another script developed using Autodesk Forge checks whether the preliminary model of the rock bolt is aligned with the corresponding scanned coordinates. Parameters and conditions are carefully considered to ensure the accuracy of automatic alignments.

Construction of Retaining Wall with DfMA Methodology

The construction of Bay 1 to Bay 7 of retaining wall RMZ3 is challenging because of the limited working space and steep slopes. Cast-in-situ concreting is almost impossible. I take advantages of BIM and propose the trending DfMA methodology in retaining wall construction.

Autodesk AEC Collection, Autodesk Forge and BIM 360 are used from the design to the construction stage of that portion of retaining wall. After rounds of design scrutiny, the Revit model of the most suitable design scheme is then exported to Autodesk Robot Structural Analysis Professional for detailed design review. Shop drawings are generated with Autodesk Revit directly and reviewed by the site team.

A construction simulation showing the sequences of lifting and the assembling procedures is prepared for safety demonstration. A pre-assembling check using a 3D scanner can ensure a seamless installation on site. After assembly, the as-built structure is scanned to form the associated AIM.

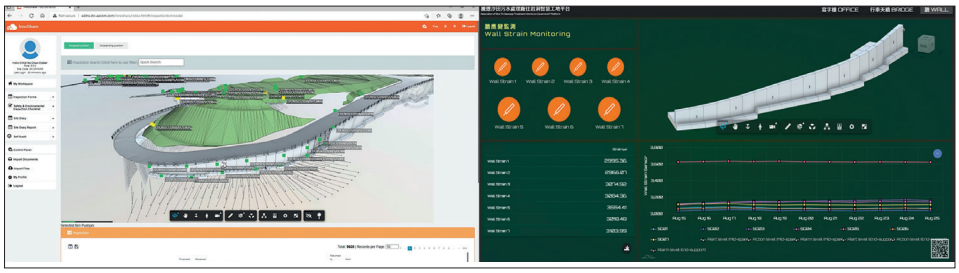
With the application of Autodesk Forge, a model viewer with a push pin function is integrated into the Digital Works Supervision System (DWSS) to ease the inspection form creation, and thereby, uplifting documentation and quality management.

During the operation stage, strain gauges are affixed to monitor the structural performance of the retaining wall at critical locations. An Internet of Things (IoT) platform is developed for easy data monitoring with the AIM.

Outcomes and sustainable development

The use of BIM and its integration with technology enhances the workflow throughout the project lifecycle, as well as reduces time and cost implications. To conclude, it is proven that BIM application helps in managing the Sha Tin Caverns Project efficiently.

Lifting and assembly of retaining wall; Overview of retaining wall
Image Courtesy of Drainage Services Department, HKSAR Government and AECOM Asia Company Limited



DWSS with BIM integration using Autodesk Forge®; IoT platform for strain monitoring using Autodesk Forge®
Image Courtesy of Drainage Services Department, HKSAR Government and AECOM Asia Company Limited

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