COMPANY
Civil Engineering and Development Department, HKSAR Government
AECOM Asia Company Limited
Leighton-China State Joint Venture

PROJECT
CEDD Contract NE/2015/01
Tseung Kwan O - Lam Tin Tunnel

LOCATION
Lam Tin - Tseung Kwan O

TYPE
Civil Works

SCHEDULED TIME OF COMPLETION
2021

BIM Benefits Abound in Major Tunnel Project

"Building Information Modelling extends the dimensions we work and provides a collaborative, metadata rich and visually dynamic platform. We are able to manage more complexity and interfaces. This allows our teams to optimise safety, innovate, and expand their delivery capabilities, resulting in greater efficiency, productivity and value sustainable projects."

—Jan Torka

Project Director,
Leighton Contractors (Asia) Limited

BIM PARTNER

Spatial Technology Limited

AUTODESK PRODUCTS USED

AutoCAD
Civil 3D
Naviswork Manage
Revit

Aerial view of Lam Tin Interchange
Image courtesy of Civil Engineering and Development Department, HKSAR Government and AECOM Asia Company Limited and Leighton-China State Joint Venture

Tseung Kwan O – Lam Tin Tunnel – Main Tunnel ("TKO-LT Tunnel") and Associated Works is a government project comprising the construction of the main tunnel, branch tunnels and portal facilities, ventilation and administration buildings, slip roads, viaducts, bridges and slopes; and the implementation of the associated building, civil, structural, marine, electrical and mechanical, landscaping and environmental protection and mitigation works.

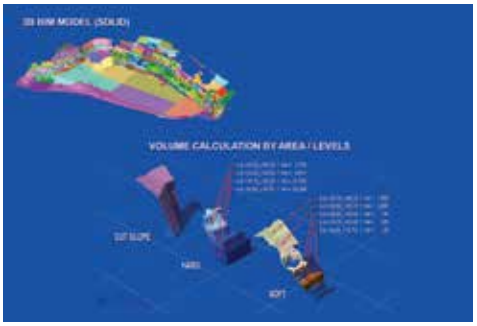
The client is the Civil Engineering and Development Department (CEDD); the consultant is AECOM Asia; and the contract was awarded to Leighton China State Joint Venture (LCSJV). Construction work commenced in July 2016, with an anticipated completion date in 2021.

BIM benefits quickly realised

Leighton Asia first implemented BIM in 2006, on the City of Dreams project in Macau. This was soon followed up on the Express Rail Link project which saw the main roof fully coordinated in a 3D environment. Now, we place significant emphasis on the implementation of BIM, and are starting to realise the multiple benefits that can be achieved through increased efficiency in both time and cost. Our processes have become more streamlined and are providing greater cost certainty.

BIM was adopted on West Kowloon Terminus as part of the contract requirements, but the value was quickly realised, and the use of the model then extended beyond the contract requirements to include quantity take-off and fabrication.

Applications of BIM in the project include: incorporating programme information in the BIM model to review constructability methods by using Construction Method Simulations (CMS), and to enhance safety



Integrate excavation progress with UAV workflow to shorten time for design and planning and reduced safety risks
Image courtesy of Civil Engineering and Development Department, HKSAR Government and AECOM Asia Company Limited and Leighton-China State Joint Venture

on site; checking critical dimensions and ensuring there are no spatial conflicts; generating TQs to give stakeholders a better understanding of the design and reduce design conflicts; sharing information to all stakeholders through cloud technologies; developing an effective Construction and Demolition (C&D) waste management system; controlling the inspection workflow using BIM360; and Cost Savings Design (CSD) reviews to provide more accurate estimations of excavation volume and construction time.

The BIM model helped with constructing major elements of the project, including seven bridges that are built with precast segments. Each viaduct was modelled in Civil 3D, according to the design setting-out information, which enabled the transfer of digital information for future fabrication via shop drawings.

The project also involves several buildings containing multiple E&M services, which can be challenging to design and install using traditional 2D designs. All elements were modelled in Revit, then checked for clashes using Navisworks, aiming to ensure all elements are fully coordinated prior to construction. The pipework and ductwork have been modelled according to shop drawings, so that we can apply Design for Manufacture and Assembly DfMA directly to site, for easier construction.

General view of Administration Building
Image courtesy of Civil Engineering and Development Department, HKSAR Government and AECOM Asia Company Limited and Leighton-China State Joint Venture

Plus, BIM helped overcome challenges arising from the site being adjacent to sensitive areas such as a school and a cemetery. Using the BIM model, the project team could plan concurrent construction activities in an attempt to eliminate potential hazards at an early stage – minimising nuisance to the public, while also avoiding abortive works.

Collaboration and positive outcomes of BIM

A further benefit of BIM arose through the model facilitating collaboration between multi-disciplinary project stakeholders – helping the team in ways such as more efficient clash analyses, planning, scheduling, quantity take-offs, de-risking, safety, and costing.

While the BIM workflow requires a high degree of commitment from the team, we have noticed the rewards far outweigh the initial investment. While the workflow differs significantly, the benefits include: improved design co-ordination, better management of project schedules, reduced errors and better control of costs.

True collaboration has been achieved for all project stakeholders, with the BIM model published and updated with a record of all technical queries and clashes. In return, resolutions have been identified and returned. More recently, we have adopted BIM360.

Although only a fraction of the overall schedule has elapsed, the project has already achieved positive outcomes in cost and time savings, risk identification and mitigation, monitoring progress, and planning.

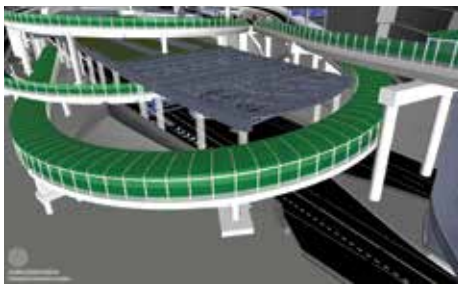
Notably, the frequency of site visits and man hours for site survey monitoring have been minimised, increasing efficiency and safety. BIM enables weekly updates on excavation volumes, for better control of the construction programme schedule. The design can be explored by manipulating the BIM model, to develop the optimum excavation volume, which has so far saved nearly three months in construction time. Plus, field conflicts with other elements are reduced or even eliminated, ensuring better quality control of the design.

Information is rapidly updated in the master BIM model and communicated across all stakeholders. With BIM 360 Field we can store project information and documentation in one place, which helps in terms of QA/QC.

Innovations

By adopting BIM and related advanced technologies, we have introduced several innovations that deliver considerable benefits compared to traditional methods. For instance, TKO-LT Tunnel is one of the biggest construction sites in Hong Kong to have applied weekly drone surveys instead of traditional survey techniques. This reduces the workload from a 4-person team for a full day, to a 1-hour operation by a 2-person team.

Also, we have adopted BIM 360 Field to



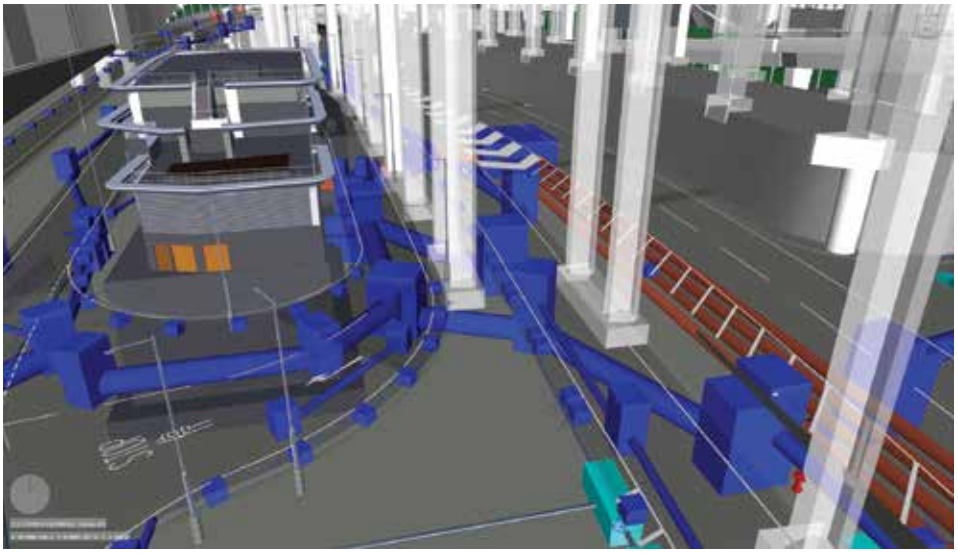
Congestion of structures in Lam Tin Interchange
Image courtesy of Civil Engineering and Development Department, HKSAR Government and AECOM Asia Company Limited and Leighton-China State Joint Venture

Falseworks for buildings to eliminate major system conflicts, control site safety and cost control
Image courtesy of Civil Engineering and Development Department, HKSAR Government and AECOM Asia Company Limited and Leighton-China State Joint Venture

digitise project forms and reduce the need for paper, providing environmental benefits.

As well as employing Unmanned Aerial Vehicle (UAV) photogrammetry surveys, we also use the model to translate method statements into Construction Methodology Simulations (CMS). These are then shared to the frontline staff prior to works beginning, so they can view the works in a virtual environment before actual implementation on site. Simulations such as these are becoming a vital tool to foresee safety risks, and to help improve the industry's overall safety performance.

Terrain model by drone to increase accuracy and reduced survey time of existing site condition
Image courtesy of Civil Engineering and Development Department, HKSAR Government and AECOM Asia Company Limited and Leighton-China State Joint Venture



Underground utilities coordination to reduce potential rework and to ensure constructability
Image courtesy of Civil Engineering and Development Department, HKSAR Government and AECOM Asia Company Limited and Leighton-China State Joint Venture

Future investment in BIM

At Leighton Asia, we have seen a huge increase in the demand for BIM implementation across our projects in Hong Kong. As a result, the number of BIM literate staff within our workforce has increased significantly, through hiring experienced people and up-skilling our existing staff.

It has been a challenge maintaining consistent BIM standards throughout the entire construction team, especially sub-contractors, given the adoption of BIM is still not common amongst our supply chain. Further training on execution planning is a key area for future improvement.

For future use of BIM, we are also looking at more extensive use of cloud platforms such as BIM360 for document management.

Aerial view of Tseung Kwan O
Image courtesy of Civil Engineering and Development Department, HKSAR Government and AECOM Asia Company Limited and Leighton-China State Joint Venture

About Civil Engineering and Development Department, HKSAR Government

With the commitment of the HKSAR Government to speed up infrastructure development for promoting economic growth, we are actively undertaking the planning and implementation of various major development projects spanning the territory. We are committed to providing high quality civil engineering services to meet Hong Kong's development needs.

CEDD's new five-year strategic plan 2015/16 - 2019/20 was promulgated in March 2015. The following five strategies were formulated to maintain the Department's momentum of continuous improvement, to tackle the challenges ahead, and to better serve the community.

· Streamline processes and reduce red tape
· Develop a caring work environment
· Strengthen staff training and development
· Strive for technical excellence
· Strengthen stakeholder engagement

About AECOM Asia Company Limited

AECOM is a global network of design, engineering, construction and management professionals partnering with clients to imagine and deliver a better world. From high-performance buildings and infrastructure, to resilient communities and environments, to stable and secure nations, our vision is to be the premier, fully integrated infrastructure firm. For the last four years, we have been named one of Fortune's World's Most Admired Companies. Additionally, we have been ranked #1 in Transportation and General Building in Engineering News Record's 2018 "Top 500 Design Firms" and recognized as Construction Dive's "Company of the Year" for the second year in a row.

About Leighton Contractors (Asia) Limited

Leighton Asia, established in 1975, is a leading international construction company. Headquartered in Hong Kong, Leighton Asia delivers high-profile infrastructure projects throughout Asia in the construction, civil and engineering and offshore oil and gas sectors. We deliver complex tunnel, rail and road networks, renewable energy infrastructure, and buildings. Leighton Asia currently operates in Hong Kong, Indonesia, India, Macau, Malaysia, Philippines, Singapore, Thailand and Iraq.

We are a member of the CIMIC Group, one of the world's leading international construction and mining groups.

CIMIC Group has businesses in construction, mining and mineral processing, operation and maintenance services, public private partnerships and engineering. Our mission is to generate sustainable shareholder returns by delivering innovative and competitive solutions for clients and safe, fulfilling careers for our people.

About China State Construction Engineering (Hong Kong) Limited

China State Construction started its construction business in Hong Kong since 1979. It is a vertically integrated construction powerhouse, engaging in building construction and civil engineering operations as well as foundation work, site investigation, mechanical and electrical engineering, highway and bridge construction, ready-mixed concrete, pre-cast production and infrastructure investment. In July 2005, China State Construction was listed on the Main Board of The Hong Kong Stock Exchange (stock code : 3311).

China State Construction is amongst the largest construction contractors in Hong Kong to deliver Buildings, Port Works, Roads and Drainage, Site Formation and Waterworks. Currently the Company is one of the biggest NW2 contractors for Hong Kong Housing Authority projects.