CONSTRUCTION INDUSTRY COUNCIL
建造業議會

Reference Materials of BIM Harmonisation for Digital Hong Kong

Disclaimer

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ABBREVIATION

Abbreviation	Definition
A&A	Alterations and Additions
AACSB	Architectural and Associated Consultants Selection Board
AAHK	Airport Authority Hong Kong
AAP	The Association of Architectural Practices
ACEHK	Association of Consulting Engineers of Hong Kong
ACQS	Association of Consultant Quantity Surveyors of Hong Kong Limited
AIIB	Asian Institute of Intelligent Buildings
AIM	Asset Information Model
API	Application Programming Interfaces
ArchSD	Architectural Services Department
AVA	Air Ventilation Assessment
BD	Buildings Department
BEP	BIM Execution Plan
BIM	Building Information Modelling
BMS	Building Management System
BO	Buildings Ordinance
BQ	Bill of Quantities
BSL	BEAM Society Limited
CCBC	CIC-Certified BIM Coordinators
CCBM	CIC-Certified BIM Managers
CDE	Common Data Environment
CEDD	Civil Engineering and Development Department
CFD	Computational Fluid Dynamics
CIAT	The Chartered Institute of Architectural Technologists
CIC	Construction Industry Council
CIC3SBDUCR	CIC Report on 3D Spatial and BIM Data Use Case Requirements of the Hong Kong Construction Industry
CICBIMNW	CIC-BIM Network
CICBIMSG	CIC BIM Standards General (Version 2.1 - 2021)

Abbreviation	Definition
CIOB	The Chartered Institute of Building
CLP	China Light and Power
Com-BIM	Committee on Building Information Modelling, CIC
CSD	Census and Statistics Department
CSDI	Common Spatial Data Infrastructure
DEVB	Development Bureau
DEVBBIMHG	DEVB BIM Harmonisation Guidelines for Works Departments
DEVB (PLB)	Development Bureau (Planning and Lands Branch)
DEVB (WB)	Development Bureau (Works Branch)
DP	Data Provider
DR	Data Requestor
DSD	Drainage Services Department
EACSB	Engineering and Associated Consultants Selection Board
EIA	Environmental Impact Assessment
EKEO	Energizing Kowloon East Office
EMSD	Electrical and Mechanical Services Department
EPD	Environmental Protection Department
ESG	Environmental, Social and Governance
FSD	Fire Services Department
GBDR	Government BIM Data Repository
GEO	Geotechnical Engineering Office
GI	Ground Investigation
GIS	Geographic Information System
HA	Hospital Authority
HKABAEIMA	Hong Kong Alliance of Built Asset and Environment Information Management Associations
HKBN	Hong Kong Broadband Network Limited
HKCA	Hong Kong Construction Association
HKCSA	Hong Kong Construction Sub-Contractors Association
HKE	Hong Kong Electric
HKFEMC	The Hong Kong Federation of Electrical and Mechanical Contractors

Abbreviation	**Definition**
HKGBCA	Hong Kong General Building Contractors Association
HKGISA	Hong Kong Geographic Information System Association
HKHA	Hong Kong Housing Authority
HKHS	Hong Kong Housing Society
HKIA	The Hong Kong Institute of Architects
HKIBIM	Hong Kong Institute of Building Information Modelling
HKICBIM	Hong Kong Institute of Civil and Building Information Management
HKIE	The Hong Kong Institution of Engineers
HKIFM	The Hong Kong Institute of Facility Management
HKILA	Hong Kong Institute of Landscape Architects
HKIP	Hong Kong Institute of Planners
HKIS	The Hong Kong Institute of Surveyors
HKIUD	Hong Kong Institute of Urban Design
HKIUS	Hong Kong Institute of Utility Specialists
HKO	Hong Kong Observatory
HKPO	Hong Kong Post Office
HKRCA	Hong Kong Registered Contractors Association
HKT	Hong Kong Telecom Limited
HyD	Highways Department
ICU	Independent Checking Unit in Housing Bureau under the Office of the Permanent Secretary for Housing
IFMA	International Facility Management Association
IoT	Internet of Things
ITIB	Innovation Technology and Industry Bureau
JUPG	Joint Utilities Policy Group
KTSP	Kai Tak Sports Park
LandsD	Lands Department
LiDAR	Light Detection and Ranging
LOD-G	Level of Graphics
LOD-I	Level of Information
LOIN	Level of Information Need

Abbreviation	Definition
LR	Land Registry
MiC	Modular Integrated Construction
MTR	The MTR Corporation
MVAC	Mechanical Ventilation and Air Conditioning
NTHS	Natural Terrain Hazard Study
OGCIO	Office of the Government Chief Information Officer
PCCW	Pacific Century CyberWorks Limited
PlanD	Planning Department
REDA	Real Estate Developers Association of Hong Kong
RFID	Radio Frequency Identification
RVD	Rating and Valuation Department
SCC	Smart City Consortium
SDO	Spatial Data Office
SPA	Swept Path Analysis
SRWR	Scottish Road Works Register
TD	Transport Department
TF-BS	CIC Task Force on BIM Standards
TF-BPD	CIC Task Force on BIM Personnel Development
TF-BSBD	CIC Task Force on BIM Submissions to the Buildings Department
TF-BT	CIC Task Force on BIM Training
TF-CD	CIC Task Force on Construction Digitalisation
TF-DBDS	CIC Task Force on Development of BIM-related Digital Solutions
TIA	Traffic Impact Assessment
Towngas	The Hong Kong and China Gas Company Limited
URA	Urban Renewal Authority
UU	Underground Utilities
Vault	Community Apparatus Data Vault System
WDs	Works Departments under Development Bureau
WKCDA	West Kowloon Cultural District Authority
WSD	Water Supplies Department

Abbreviation	**Definition**
XP	Excavation Permit
XPMS	Excavation Permit Management System

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- Asian Institute of Intelligent Buildings
- Architectural Services Department
- Buildings Department
- BEAM Society Limited
- CIC-Certified BIM Coordinators
- CIC-Certified BIM Managers
- Civil Engineering and Development Department
- The Chartered Institute of Architectural Technologists
- CIC-BIM Network
- The Chartered Institute of Building
- China Light and Power
- Committee on Building Information Modelling, CIC
- Census and Statistics Department
- Development Bureau
- Development Bureau (Planning and Lands Branch)
- Development Bureau (Works Branch)
- Drainage Services Department
- Engineering and Associated Consultants Selection Board
- Energizing Kowloon East Office
- Electrical and Mechanical Services Department
- Environmental Protection Department
- Fire Services Department
- Geotechnical Engineering Office
- Hospital Authority
- Hong Kong Alliance of Built Asset and Environment Information Management Associations
- Hong Kong Broadband Network Limited
- Hong Kong Construction Association
- Hong Kong Construction Sub-Contractors Association

- Hong Kong Electric
- The Hong Kong Federation of Electrical and Mechanical Contractors
- Hong Kong Green Building Council
- Hong Kong General Building Contractors Association
- Hong Kong Geographic Information System Association
- Hong Kong Housing Authority
- Hong Kong Housing Society
- The Hong Kong Institute of Architects
- The Hong Kong Institute of Building Information Modelling
- Hong Kong Institute of Civil and Building Information Management
- The Hong Kong Institution of Engineers
- The Hong Kong Institute of Facility Management
- Hong Kong Institute of Landscape Architects
- Hong Kong Institute of Planners
- The Hong Kong Institute of Surveyors
- Hong Kong Institute of Urban Design
- Hong Kong Institute of Utility Specialists
- Hong Kong Observatory
- Hong Kong Post Office
- Hong Kong Registered Contractors Association
- Hong Kong Telecom Limited
- Highways Department
- Independent Checking Unit in Housing Bureau under the Office of the Permanent Secretary for Housing
- International Facility Management Association
- Innovation Technology and Industry Bureau
- Joint Utilities Policy Group
- Kai Tak Sports Park
- Lands Department
- Land Registry
- The MTR Corporation
- Office of the Government Chief Information Officer
- Pacific Century CyberWorks Limited
- Planning Department
- Real Estate Developers Association of Hong Kong
- Rating and Valuation Department
- Smart City Consortium
- Spatial Data Office
- Transport Department

- CIC Task Force on BIM Personnel Development
- CIC Task Force on BIM Standards
- CIC Task Force on BIM Submissions to the Buildings Department
- CIC Task Force on BIM Training
- CIC Task Force on Construction Digitalisation
- CIC Task Force on Development of BIM-related Digital Solutions
- The Hong Kong and China Gas Company Limited
- Urban Renewal Authority
- West Kowloon Cultural District Authority
- Water Supplies Department

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Preface

The Construction Industry Council (CIC) is committed to seeking continuous improvement in all aspects of the construction industry in Hong Kong. To achieve this aim, the CIC forms Committees, Task Forces and other forums to review specific areas of work with the intention of producing Alerts, Reference Materials, Guidelines and Codes of Conduct to assist participants in the industry to strive for excellence.

The CIC appreciates that some improvements and practices can be implemented immediately whilst others may take more time for implementation. It is for this reason that four separate categories of publication have been adopted, the purposes of which are as follows:

Alerts	The Alerts are reminders in the form of brief leaflets produced quickly to draw the immediate attention of relevant stakeholders to the need to follow some good practices or to implement some preventive measures in relation to the construction industry.
Reference Materials	The Reference Materials are standards or methodologies generally adopted and regarded by the industry as good practices. The CIC recommends the adoption of the Reference Materials by industry stakeholders where appropriate.
Guidelines	The Guidelines provide information and guidance on particular topics relevant to the construction industry. The CIC expects all industry stakeholders to adopt the recommendations set out in the Guidelines where applicable.
Codes of Conduct	The Codes of Conduct set out the principles that all relevant industry participants should follow. Under the Construction Industry Council (Cap 587), the CIC is tasked to formulate codes of conduct and enforce such codes. The CIC may take necessary actions to ensure compliance with the codes.

If you have read this publication, we encourage you to share your feedback with us. Please take a moment to fill out the Feedback Form attached to this publication in order that we can further enhance it for the benefit of all concerned. With our joint efforts, we believe our construction industry will develop further and will continue to prosper for years to come.

1 INTRODUCTION

1.1 Background

1.1.1 The development of Reference Materials of the BIM Harmonisation for Digital Hong Kong for the Construction Industry Council was commissioned by the Construction Industry Council (CIC) for reference by the industry based on the BIM Harmonisation Guidelines for Works Departments by the Development Bureau (DEVB) (Technical Circular (Works) No. 8/2021), with an aim to identify appropriate additional information requirements of BIM models for reference by the industry (both public and private sectors), and in support of Government's initiative of developing Common Spatial Data Infrastructure (CSDI) and Smart City.

1.1.2 The document aims to satisfy the use cases identified in the Report on 3D Spatial and BIM Data Use Case Requirements of the Hong Kong Construction Industry published by the CIC in 2021. The development is actions in response to the items (3) CSDI, (4) BIM Standards Harmonisation – Shareable BIM, and (8) Smart City indicated in the Annex 3: Way-Forward for BIM Development of the CIC BIM Standards – General (Version 2.1 – 2021).

1.1.3 **This document provides industry-wide guidance and suggestions for non-capital works projects. Capital works projects in compliance with the DEVB TC(W) no. 8/2021 shall refer to the latest DEVB BIM Harmonisation Guideline (DEVBBIMHG) published by the Development Bureau (DEVB).**

1.1.4 **This document shall be read in conjunction with DEVBBIMHG v2.0.**

1.1.5 **For sections 2 to 5 of this document, it is developed with reference to the DEVBBIMHG v2.0. This part of the document aims to supplement or modify relevant requirements in the DEVBBIMHG v2.0.**

1.1.6 **Some clauses in the DEVBBIMHG are only applicable to Works Departments (WDs) and this documentation will not enumerate or itemise all those clauses.**

1.1.7 **Sections 6 to 18 of this documentation will elaborate on the use cases identified in the Report on 3D Spatial and BIM Data Use Case Requirements of the Hong Kong Construction Industry published by the CIC in 2021.**

1.1.8 To ensure proper preparation of BIM models, the industry should refer to sections 2 to 5, which provide essential guidelines and basic rules. These sections serve as valuable references for ensuring the quality and compatibility of BIM models in accordance with industry standards.

1.1.9 The industry should adopt a proactive mindset to prepare the BIM models with the requirements specified in sections 6 to 18 to facilitate the development of the CSDI.

1.1.10 While the Government BIM Data Repository (GBDR) is under development for the collection of BIM data from private sectors, the industry needs to keep in mind that

BIM models containing diverse data for different use cases should be translated into the CSDI. This translation is crucial for establishing a Smart City and City Information Modelling (CIM) that encompasses a wide range of data sources and supports integrated decision-making processes.

1.1.11 The purpose of this document is to facilitate the accomplishment of the objectives outlined above. Through collaborative coordination and active contributions from the industry, together with the ongoing development of the CSDI, the entire industry can benefit significantly.

1.2 The Objectives

1.2.1 The objectives of the document are: -

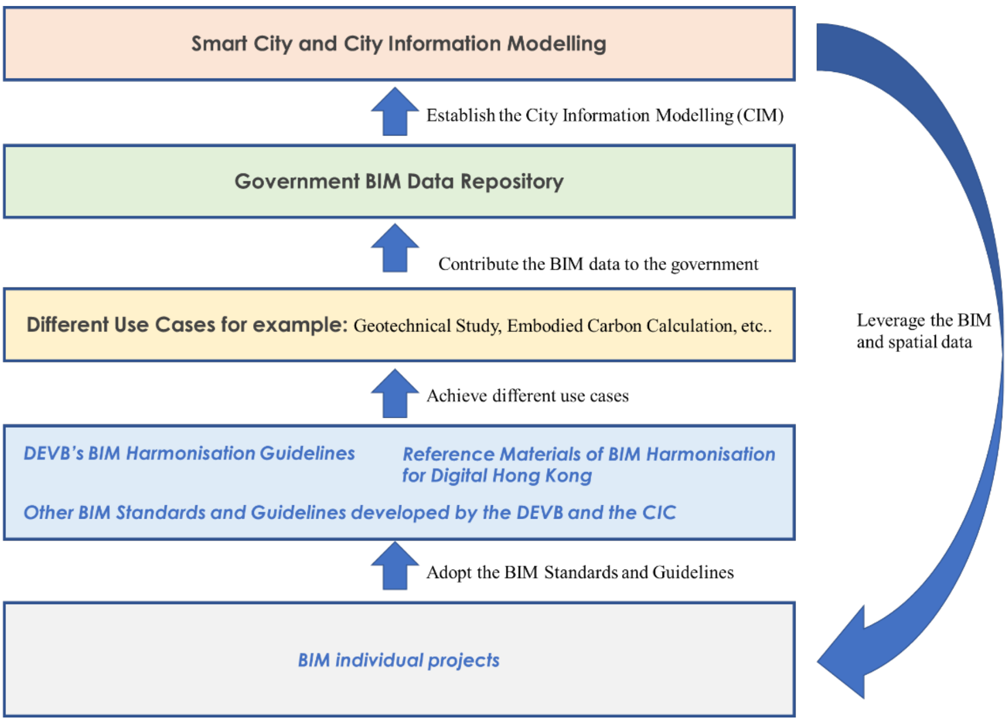
a) to identify appropriate additional information requirements of BIM models for reference by the industry (both public and private sectors), and in support of Government's initiative of developing Common Spatial Data Infrastructure (CSDI) and Smart City;

b) to enable sharing, dissemination and maintenance of BIM models and BIM attributes across the industry for projects other than capital works projects;

c) to support the sharing of BIM objects with the CIC for reference by the industry; and

d) to provide a set of aligned BIM standards to achieve Smart City across the industry for projects other than capital works projects.

The following graphic provides a comprehensive overview and outlines the necessary steps to achieve City Information Modelling (CIM), illustrating the holistic perspective and the path forward towards its realisation.



1.2.2 This document makes reference to the following BIM documents:

a) BD Guidelines for Using Building Information Modelling in General Building Plans Submission 2019

b) BD Guidelines for using Building Information Modelling in Statutory Plan Submissions (other than General Building Plan) 2023

c) CIC BIM Standards – General (Version 2.1 – 2021) (CICBIMSG)

d) CIC BIM Standards for Underground Utilities (August 2019) and (Version 2 – 2021)

e) CIC Production of BIM Object Guide – General Requirements (August 2019 and Version 2 – 2021)

f) CIC Reference Material on Use of Digital Technologies for QA/QC of MiC Modules in MiC Factories (June 2022) in particular Appendix B – A Suggested Naming Convention for MiC/Offsite Modules and Components

g) CIC Report on 3D Spatial and BIM Data Use Case Requirements of the Hong Kong Construction Industry (CIC3SBDUCR)

h) DEVB BIM Harmonisation Guidelines for Works Departments version 2.0 (DEVBBIMHG)

i) EMSD Building Information Modelling for Asset Management (BIM-AM) Standards and Guidelines

j) HKIS BIM Measurement Information Requirements

k) Housing Authority Building Information Modelling Standards and Guidelines

l) Reference Guide to Preparation of Plans for Submission using Building Information Modelling (BIM) Technology

1.2.3 This document also makes reference to the following non-BIM documents:

a) Code of Practice for Foundations 2017

b) Code of Practice on Wind Effects in Hong Kong 2019

c) Practice Notes for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers (PNAP)

d) Joint Practice Notes on protection and improvement of the built and natural environment by Buildings Department, Lands Department and Planning Department (JPN)

e) iBEAM Unison User Guide

1.3 The Adoption of ISO 19650

1.3.1 BIM development in Hong Kong has aligned with the approach of Information Management since the publication of ISO 19650-1:2018 – Organisation and digitisation of information about buildings and civil engineering works, including building information modelling (BIM) – Information management using building information modelling. The CIC BIM Standards General (CICBIMSG) was developed with the alignment to ISO 19650. "Local Annex" of ISO 19650-2:2018 for Hong Kong was also developed and included in Annex 1 of CICBIMSG.

1.3.2 After these four years of adopting ISO 19650, the construction industry has gained more experience in information management while challenges also emerge. Users in BIM found it difficult to apply it to projects since there are items to develop. For example, Exchange Information Requirements (EIR) should be provided in the tender, while it should be developed from Organisation Information Requirements (OIR), Asset Information Requirements (AIR) and Project Information Requirements (PIR).

1.3.3 ISO 19650 sets the principles and frameworks of Information Management, providing details, especially the management processes to follow.

1.3.4 This document is developed to define the process. However, these requirements will only be imposed in the case of Information Exchange, i.e. when information is provided from one organisation to another such that both the provider and receiver refer to the same common references for the meaning of the codes.

1.4 Summary of the Use Case

Table 1-1 Summary of Use Cases

Use Case	Title
1	Underground Utilities Study and Space Management
2	Visualisation of Construction Project Lifecycle
3	Geotechnical Study
4	Traffic Impact Assessment and Swept Path Analysis
5	Foundation Design
6	Excavation Permit (XP) Application
7	Environmental Impact Assessment
8	Building Energy Monitoring and Facility Management
9	Air Ventilation Assessment
10	Premium Assessment and Property Valuation
11	Preliminary Design for Building (including A&A works) and Civil Engineering Projects
12	Embodied Carbon Calculation
13	3D Pedestrian walkability and navigation

2 INFORMATION REQUIREMENTS AND EXCHANGE

Add the following clauses after DEVBBIMHG (v2.0) Clause 2.1.6 as follows:

2.1 Information Ownership

2.1.7 Information ownership shall belong to the Originator as defined in the project parameter and the filename. However, the Originator shall be changed when the information is delivered, accepted, and adopted to be used beyond the delivery team. The information ownership is taken over by the party which adopted the information.

2.1.8 Information under development by the delivery team shall be owned by the delivery team authoring the BIM model until the information is delivered, accepted and adopted to be used beyond the delivery team.

2.1.9 In the Delivery Phase[1], the Appointing Party shall develop information requirements, including OIR, AIR, PIR and EIR. EIR shall be included in the tender documents for the appointment of the Lead Appointed Party, which delivers information. The Lead Appointed Party shall develop EIR for each of their Appointed Parties, which produce and deliver information to the Lead Appointed Party.

2.1.10 BIM Execution Plan shall be prepared by the Lead Appointed Party to address the information requirements stipulated in the EIR developed by the Appointing Party and included in the tender for the appointment.

2.1.11 At the end of the Delivery Phase, information will be handed over to the asset owner managing the asset in the Operational Phase[2].

Enhancement of DEVBBIMHG (v2.0) Clause 2.3.1 as follows:

2.3 BIM File size

2.3.1 With the advancement of technology, no file size limit for each BIM model is specified in this document. However, the BIM model for large projects should be divided based on the considerations under the federation strategy. Organisations may impose information requirements for a limit on the file size. The limit should be specified by the Appointing Party in the EIR for projects. However, the Appointing Party is recommended to observe relevant requirements from various Government bureaux / departments. Lead Appointed Party may impose information requirements for a limit of the file size if it is not specified in the EIR. The Lead Appointed Party may specify the limit in their BEP and the EIR(s) for the Appointed Parties.

[1] "Delivery Phase" denotes part of the life cycle (ISO 19650-1:2018, 3.2.10), during which an asset (ISO 19650-1:2018, 3.2.8) is designed, constructed and commissioned
[2] "Operational Phase" denotes part of the life cycle (ISO 19650-1:2018, 3.2.10), during which an asset (ISO 19650-1:2018, 3.2.8) is used, operated and maintained

Add the following clause after DEVBBIMHG (v2.0) Clause 2.4.5 as follows:

2.4 Information Exchange Formats and Mechanisms

2.4.6 An example of the Method to export parameters to IFC format

Information included in BIM models or connected to BIM objects as parameters can be exported to IFC format for the Information Exchange by BIM authoring software. For example, when a BIM model is developed in Autodesk Revit, parameter values from a Revit model can be exported to the IFC format following the steps below:

a) Open the Revit model and ensure that the required parameter values are assigned to the elements prepared to export.

b) Go to the "File" menu and select the "Export" option.

c) In the "Export" dialog box, choose "IFC" as the file format.

d) Specify the desired file name and location for the exported .ifc file.

e) Click on the "Modify setup …" button to access the export settings.

f) In the "Modify Setup" dialog box, find various tabs with different settings.

g) In the "General" tab, you can specify options such as the IFC version and coordination view to use.

h) Switch to the "Property Sets" tab. Map the Revit parameters to IFC property sets.

i) Check “Export Revit property sets” to export the parameters included in the Revit model.

j) Finally, click "Export" in the "Export" dialog box to export the Revit model to the .ifc format. The parameter values will be included in the exported file.

3 BIM OBJECT

Add the following clause after DEVBBIMHG (v2.0) Clause 3.1.5 as follows:

3.1 Principles

3.1.6 Sharable BIM objects shall have the Originator code of the owner organisation in the naming to identify the owner. Sharable BIM objects shall be checked by the BIM Manager or Project Manager in the owner organisation and uploaded to the CIC BIM Portal for industry use.

4 FEDERATION AND BIM MODEL NAMING

No modifications.

5 LOIN IMPLEMENTATION

Add the following clauses after DEVBBIMHG (v2.0) Clause 5.4.6 as follows:

5.4 LOD-G

5.4.7 LOD-G requirements should refer to CICBIMSG.

5.4.8 In the development of BIM models, the following good practices should be followed.

a) Overlapping elements should be avoided and minimised. When overlapping elements cannot be eliminated, the reason and associated parameters for filtering should be documented in the BEP.

b) Model elements spanning more than one level (e.g., walls spanning over one storey high) or across buildings (e.g., floor plates spanning between buildings through connection bridges) could be a common design practice, especially in the early stage of the design. The model element should be developed into separate elements to achieve the object information clarity for other specific BIM Uses, such as object grouping on QTO, BQ preparation, online review and object filtering by floors or portions on CDE platforms, etc.

c) Model elements in building works should be defined at the floor level where the element is presented in a floor plan unless it spans more than one level.

d) Complex geometry should be developed with logic to enable information exchange or further development for other BIM Uses. For constructability, the logic should avoid the use of two-way curves and non-uniform rational basis spline surfaces. The developed logic could be documented to facilitate digital fabrication or other 3D interpretation of information for manufacturing, fabrication, installation, and construction without geometry deviation. However, the BIM model with complex geometry should not cause excessive file size for information exchange.

e) Spatial objects should be modelled as much as practicable, such as the public circulation area of buildings, to facilitate spatial identification and drawing generation (e.g., the display of room tags). However, model elements to suit computational interference checks may be created to reflect the geometric boundaries of the spatial objects for verifying compliance of dimensional requirements between physical elements such as clear width and clear headroom.

f) For building services and mechanical types of BIM elements, the operation and maintenance spaces are the concerned information for the asset owners. Therefore, it is suggested to model the operation and maintenance space for these kinds of BIM elements, such as control panel/switch box with panel door, vent relief valve unit with control valve set, etc. However, shared operation and maintenance space, e.g., the clearance between pipes and ducts, or locally congested areas, e.g., narrower width at pipe flanges, should be carefully interpreted to avoid the inefficient use of space.

6 USE CASE 1 – UNDERGROUND UTILITIES STUDY AND SPACE MANAGEMENT

6.1 General

6.1.1 Underground Utilities (UU) are underground public service infrastructures, including water supply pipelines, drainage and sewer pipelines, electric cables, telecommunication and data cables, and gas pipelines.

6.1.2 In Hong Kong, the space under urban roads is frequently intricate with various types of utilities. Reliable records of UU for the type, position and configuration of such UU may not be available for use outside the UU owner. Works around the UU may not be well planned to manage the impact on the UUs before the works are carried out. The industry practice is to conduct a UU survey at the works area early in a project. The process involves the collection of UU records from various UU owners, exposing the UU to locate the UUs if necessary and then using the survey results for the planning works. Results of these surveys conducted by various projects in the vicinity of the same area are not centralised for sharing, causing repetitive survey works, including digging trial pits to expose the UUs.

6.1.3 The 2021 Policy Address Supplement directed that an accurate 3D digital underground utilities database be developed. The database facilitates the construction industry to plan and conduct the underground works efficiently and reduce road closure time resulting from the excavation works, thereby benefiting the community as a whole.

6.1.4 An Underground Utilities Study is crucial to develop the database, which forms the foundation of the centralised Space Management System to manage UU. The Space Management System is a web-based GIS platform, based on a digital map, providing 3D spatial and geometrical information about the UUs. 3D objects on the digital map are used to represent the UUs such that UU information can be obtained by selecting the objects.

6.1.5 **Underground Utilities Information System (UUIS)**

6.1.6 "Underground Utilities Study and Space Management" is the topic of Use Case 1. The study of the topic reveals that LandsD is developing an "Underground Utilities Information System" (UUIS). It was developed to embrace the direction of providing a digitalised UU Information Database for the Government Sector and Private Sector in Hong Kong. UUIS facilitates the consolidation of 3D UU data through a cloud platform to share among stakeholders.

6.1.7 The initial 3D UU dataset was enriched by field survey/point cloud data acquired through survey contracts engaged by LandsD. It is planned that the site contractor of road excavation works will provide as-built UU data in future to gradually develop an updated and comprehensive 3D digital UU information database for Hong Kong.

6.1.8 **BIM as the source of information for UUIS**

6.1.9 The as-built BIM information developed by the works contractors will be one of the sources of the as-built UU data. BIM UU objects with geo-reference developed in the project design and construction stages, then updated and verified for the as-built records, can be converted to 3D objects in GIS. With the required information stipulated for the information delivery by the works contractor, the as-built BIM information will meet the requirements of the as-built UU dataset for UUIS. The illustration in this document elaborates on the technical aspects of the information exchange process from BIM to UUIS.

6.2 The Process

6.2.1 **The BIM Part**

6.2.2 Individual and line-based BIM objects are developed in BIM models for the UUs. Individual BIM objects (e.g., manhole, junction box, …) will be converted to points as the nodes (either 2D or 3D) to connect the line-based BIM objects. The control line (usually the centreline) of line-based BIM objects (e.g., water pipes, power cables, …) will be converted to 3D lines or 3D polylines. Points and polylines (or lines) will be imported to GIS as the objects to use.

6.2.3 Attributes (both geometrical and non-geometrical information) in the BIM objects are exported to a dataset format with the OBJECTID to connect with the GIS objects (i.e., polygon, polyline, and point).

6.2.4 **The GIS Part**

6.2.5 For the purposes of the illustration in this document, UUIS is used for the GIS part.

6.2.6 UUIS is a web GIS platform serving as the centralised storage of the territory-wide 3D digital UU database of Hong Kong. Works Departments and participating private utilities stakeholders can contribute, share UU data and enjoy the platform’s features, such as conducting 2D & 3D measurements, slice, clash analysis, and collecting the attributes of existing UU.

6.2.7 **Workflow for Provision of the UU Data to the UUIS**

6.2.8 The workflow for providing the required data to the UUIS by UU stakeholders is currently under development since the UUIS project is still in the system design stage. The workflow generally involves two main processes – Data Transfer and Data Conversion.
To facilitate this process, the following proposed data collection options are provided for UU stakeholders’ reference:

I. <u>Via CSDI Portal</u>
This option maybe suitable for datasets that are already available in the CSDI portal, as it allows specific UU stakeholders to conveniently upload the UU data to CSDI and UUIS would directly download and convert data into the UUIS Database. UU stakeholders will need to have an account on the CSDI portal and have the necessary permissions to upload data.

II. Via Web API provided by UUIS
Department or organisation will call the Web API provided by UUIS to upload the data. This option requires UU stakeholders to have the technical capability to integrate their data with the UUIS web API, which may be a barrier for some stakeholders.

III. Via Manual Upload using UUIS user interface
This option may not be suitable for UU stakeholders who have large or complex datasets, as it may be time-consuming or impractical to upload the data manually.

6.2.9 After the data transfer process, the collected data will undergo data conversion processes by data conversion engine(s) before being imported into the database. This ensures that the format and structure of the data are consistent with the requirements of the UUIS database.

6.2.10 The data conversion engine(s) may perform various tasks, such as data validation, data normalisation, data cleaning, and data transformation. These processes help to improve the accuracy, completeness, and consistency of the data, which are important for the effective management and analysis of underground utilities information.

6.2.11 Once the data has undergone the data conversion process, it can be imported into the UUIS database, where it can be accessed, analysed, and utilised for various purposes by relevant stakeholders.

6.2.12 **The Essential Elements of UU Data**

6.2.13 Data owners / providers shall prepare and provide the GIS data to UUIS in compliance with the Data Specifications of UUIS. According to the data specification of UUIS – feasibility and technical study and independent project management on developing an underground utilities management system for the LandsD, three types of geometries will be used to represent the UU objects from various data providers. These geometries include polygons, polylines, and points. This approach helps to facilitate the integration of UU data from different sources and formats.

Table 6-1 Use Case 1 The essential elements of UU data

Geometry	UU Object
Polygon	Box Culvert/Tunnel for Sewage & Stormwater Pipes (Area)
	Chamber
	Drop Shaft
	Manhole with Special Shape
	Tunnel Protection Zone
	Gas Capping Plate, Gas Offtake Frame
	Structure Boundary/Duct Boundary

Geometry	UU Object
Polyline	Box Culvert/Tunnel for Sewage & Stormwater Pipes (Path)
	Channel, Dry Weather Flow Channel, U channel
	Pipe, Rising Mains
	Map Network Line of Medium Voltage Conductor, Low Voltage Conductor
	Cable Duct
	Carrier Drain, Connection Pipe, Cross Road Drain
	Highmast Cable
	Gas Kiosk Frame
	Gas Pipe
	Fresh Water Main, Raw Water Main, Salt Water Main, Reclaimed Water Main and Grey Water Main
	Inlet, Interface Valve Chamber, Oil / Petrol Interceptor, Outfall, Outlet, Sand Trap, Sewage Tapping Point
Point	Map Network Junction of Medium Voltage Cable Joint / Low Voltage Cable Joint / Medium Voltage Survey Point / Low Voltage Survey Point, Structure Junction of Survey point
	Catchpit, Gully Sump
	Grating Gully
	Inlet, Interface Valve Chamber, Oil / Petrol Interceptor, Outfall, Outlet, Sand Trap, Sewage Tapping Point
	Manhole
	Connector
	Control Cubicle
	Drawpit
	Highmast
	Highmast Connector
	Highmast Pillar
	Lamppost
	Gas CP, Gas Fitting, Gas Governor, Gas Riser, Gas Syphon Gas Valve Chamber, Gas Valve Pit

Geometry	UU Object
	Gas Pipe Depth
	Fresh Water Valve, Raw Water Valve, Salt Water Valve, Appurtenance, Fitting

Note: The list may not be exhaustive as UUIS will include more UU data and update its data specifications in suitable juncture.

6.3 The Relation to BIM And GIS

6.3.1 The use of BIM is crucial in obtaining and developing the UU model for the UUIS. The UU model can be obtained from the point cloud by performing a Laser Scanning Survey, downloading the existing UU model from the CSDI portal, or building the existing UU BIM model.

6.3.2 Additionally, polygon, polyline and point can be developed in BIM and exported to GIS format for use in UUIS. When BIM is developed in projects with UU included in the as-built BIM model, the UU objects in BIM with geo-reference settings are formatted to polygon/polyline/point. Then, together with the information/attributes connected to the UU objects, they are exported to an information exchange format, e.g., IFC, for input to GIS.

6.4 Additional Information Requirements of BIM Models

6.4.1 The UU BIM object shall incorporate the attributes listed in Appendix I below. This includes information such as the location, type, size, and depth of underground utilities such as water, gas, electricity, and telecommunications.

6.4.2 The requirement of UU geometry information should be clearly defined to facilitate the data exchange (e.g., The naming of IFC entities)

6.4.3 The UU object data should be validated to ensure it is accurate and conforms to utility mapping standards such as PAS 128.

6.5 Information Available

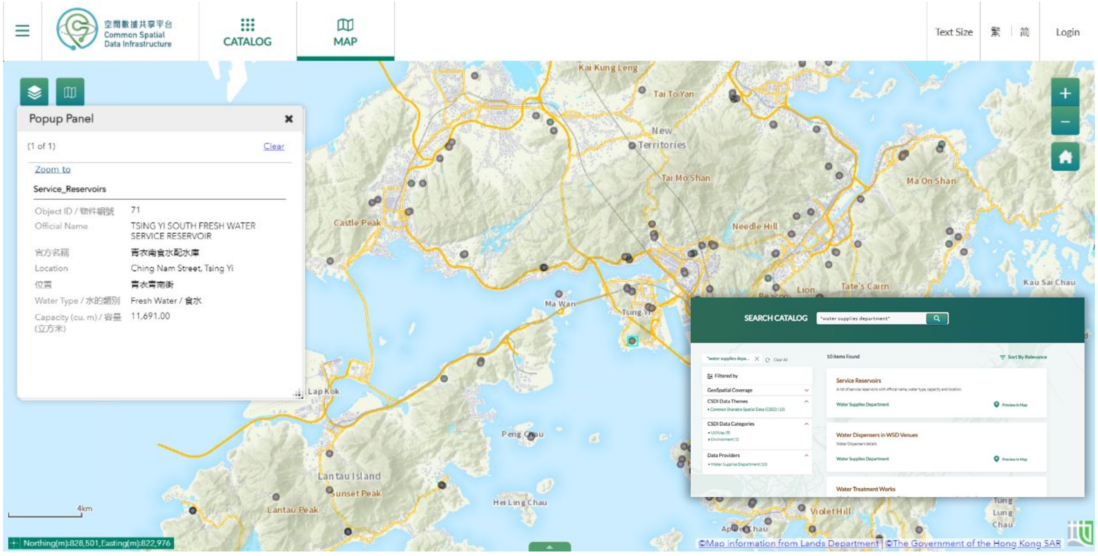
6.5.1 Common Spatial Data Infrastructure (CSDI), developed by the Development Bureau and the LandsD, aims to provide a platform to link and integrate geospatial data across various government departments. It facilitates easy sharing and use of high-quality spatial data by government departments, public and private organisations, academia, and the general public. The portal makes it easier for users to find and use the data they need for various purposes, such as research, policy-making, planning and developing various Smart City applications. The CSDI portal typically includes tools for data discovery, visualisation, and analysis, as well as data download and sharing features.

6.5.2 Some UU information is already published in the CSDI portal. For example, stormwater manholes and stormwater drainage pipes provided by the Drainage Services Department (DSD) are selected as shown below. Attributes of a selected manhole are shown in the popup panel.

Figure 6-1 Use Case 1 Information of stormwater manhole from CSDI

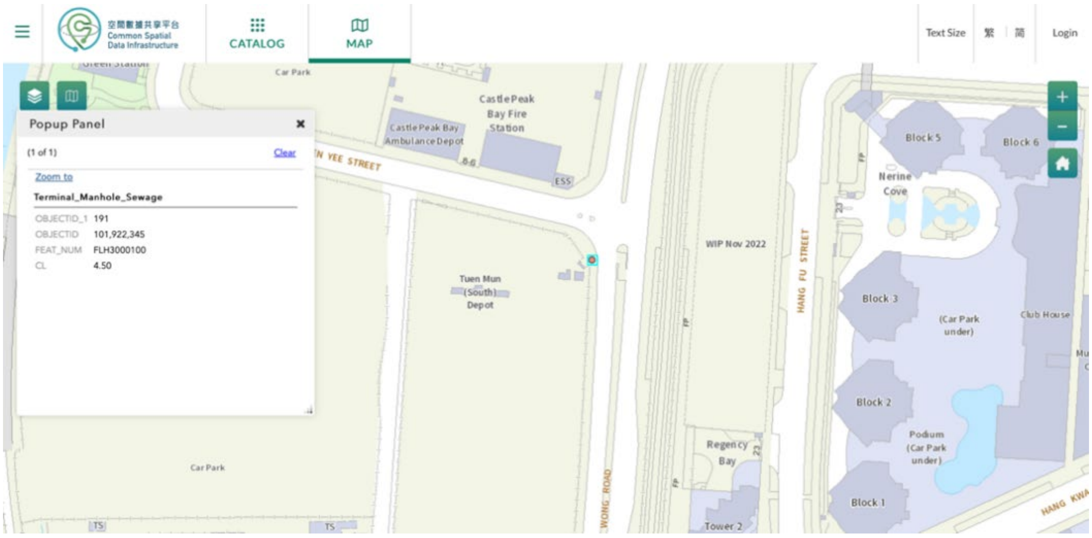
6.5.3 Not all UUs are published in CSDI. For example, data shared by WSD contains only the location point with attributes connected. UU from utility companies is not provided.

Figure 6-2 Use Case 1 Information shared by WSD in CSDI



6.5.4 Some UU Objects in GIS format have already been launched in CSDI with attributes. For example, the Terminal Manhole (Sewage) in CSDI such as object ID – A computer-generated unique identifier for the UU object, and Feature Number defined by the Drainage Services Department (DSD) to identify the Sewage Terminal Manhole and Cover Level of manhole provided by DSD.

Figure 6-3 Use Case 1 Information of Terminal Manhole (Sewage) shared in CSDI



Users can download various formats such as FGDB, Geopackage, Geojson, GML, SHP, KML, CSV, etc. in CSDI to obtain the attributes and location of UU. Hong Kong 1980 Grid System (EPSG:2326) is the reference coordinate system used by the Lands Department. This information can be used by various stakeholders for research, policy-making, planning, and developing various Smart City applications, among other purposes.

Figure 6-4 Use Case 1 Information of Terminal Manhole (Sewage) downloaded in CSV format

Terminal_Manhole_Sewage

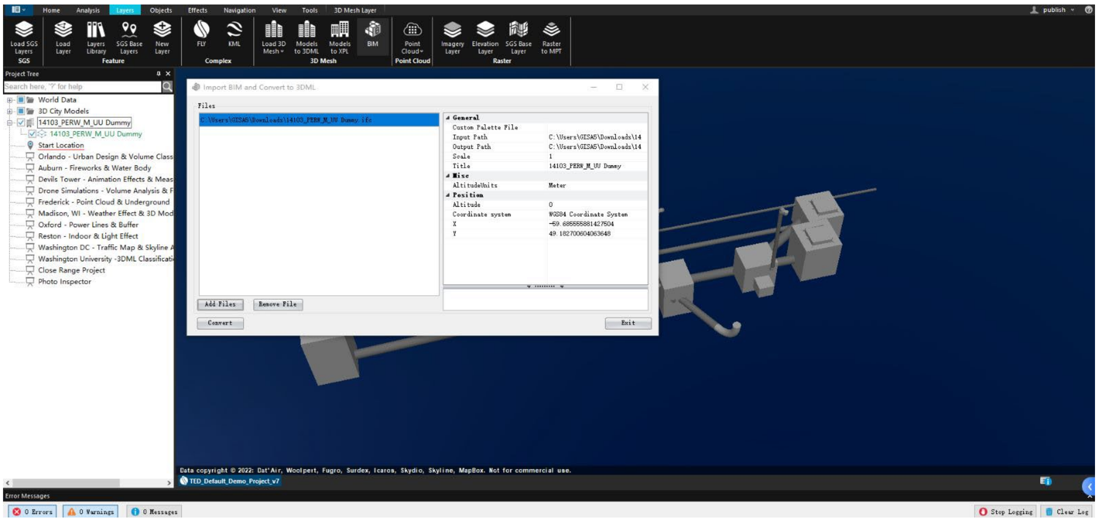
OBJECTID_1	OBJECTID	FEAT_NUM	CL	GeometryEasting	GeometryNorthing
1	61261358	FLH4007783	5	835389.5186000000	819964.2011999990
2	61261350	FLH4007782	5.15	835408.0697000000	819868.9542000000
3	61354280	FLH4019140	64.48	832552.8449000000	825478.4686999990
4	61354283	FLH4019141	65.59	832572.7749000000	825463.0924999990
5	61354284	FLH4019142	71.8	832613.7061000000	825435.8123000000
6	100437035	FLH4026140	4.3100000000000000	840332.0739000000	819376.1636000000
7	61332128	FLH4016140	59.89	840234.9358000000	821193.5136999990
8	61268739	FLH4010180	12.52	835696.7016000000	818290.1078999990
9	61315075	FLH4015740	7.05	831577.9843000000	824810.2108999990
10	100574152	FLH7026660		832663.7647000000	816528.6423000000

6.6 Method of Information Exchange

6.6.1 The use of interoperability standards such as Industry Foundation Classes (IFC) can facilitate data exchange between BIM and GIS. These standards define a common language and data structure for representing building and infrastructure models.

6.6.2 Export an IFC model from BIM software and import it into GIS software. After importing the IFC model into GIS, extract the relevant geometry information to create a schedule. Common file formats for schedules include CSV, Excel, and PDF.

Figure 6-5 Import IFC model and convert to 3DML



6.7 Conclusion

BIM can serve as a reliable source of information for UUIS. The as-built BIM information can be utilised as a source of as-built UU data, which can be converted to 3D objects in GIS. Attributes contained in the BIM can be mapped to 3D GIS after the conversion process. By meeting the required information delivery by works contractors, the as-built UU dataset for UUIS can be updated by the as-built BIM information.

7 USE CASE 2 – VISUALISATION OF CONSTRUCTION PROJECT LIFTCYCLE

7.1 General

7.1.1 BIM has transformed the construction industry by providing a digital representation of building projects that can be used for design, construction, and maintenance. One important aspect of BIM is the ability to create 4D visualisations of a construction project's lifecycle, which allows project stakeholders to understand the timeline of activities better, identify potential issues or conflicts, and optimise project planning and management.

7.1.2 4D visualization presents the 3D model in an animated format. It can be viewed by users as an animation or published on a webpage with a timeline slider that allows users to select specific points in time and view the model accordingly.

7.1.3 This document focuses on the exchange of information between a BIM model and 4D visualization software. The process involves importing scheduling information from the project's master program and mapping this data with the geometry of the BIM model elements in the 4D animation software.

7.1.4 The processes outlined in this document are generic and independent of any specific software. While a particular 4D animation software is used for illustration purposes, the underlying logic can be applied to other 4D animation software as well.

7.1.5 For detailed instructions on operating the software, users should refer to the respective software's user manual.

7.2 The Process

7.2.1 The Concept

7.2.2 The concept of producing 4D animation follows the principles below:

3D geometrical model is developed in BIM;

a) BIM objects are provided with a label (e.g., ObjectID) or other attributes (e.g., ActivityID) to enable the mapping of time elements;
b) Time elements (i.e., the start time and end time) developed in the programme Gantt chart are exported to a database (or schedule) format with a label (e.g., ActivityID) for the mapping to BIM objects;
c) Two ways to handle the time elements:

7.2.3 Time elements are imported to BIM objects in the BIM models with the mapping of ActivityID, and the BIM model is exported out with the time elements for import to the 4D animation software;

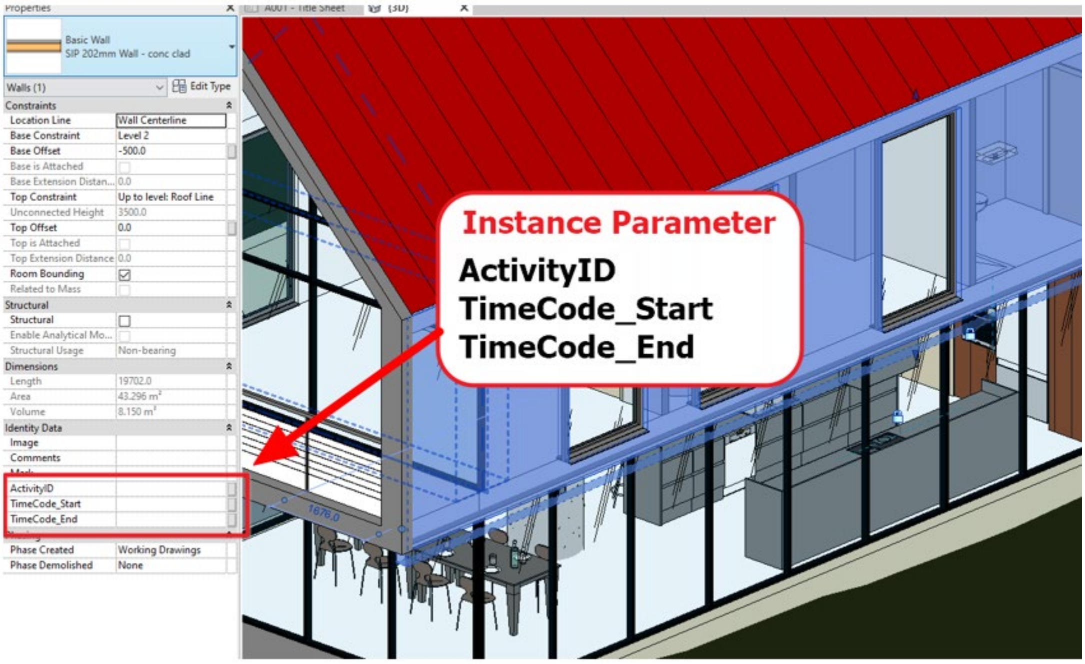
7.2.4 BIM objects and time schedules are imported to 4D animation software for the mapping and connection of the time elements to the 3D objects; and

7.2.5 4D animation is exported in the desired formation, e.g., video.

7.2.6 **Detailed Illustration**

7.2.7 To begin, extract the scheduling information from the programme, such as a master programme or construction schedule, and export it to a suitable format, such as .csv, .xls, or .pdf. This information should include the ActivityID, StartDate, EndDate, and whether the activity involves construction or demolition. The ActivityID is then inputted into the BIM model, which enables the object geometry with the corresponding ActivityID to be exported to the .ifc format. This format can then be imported into the 4D Animation software.

Figure 7-1 Use Case 2 Add instance parameters in BIM authoring software



7.2.8 Once the scheduling information has been successfully integrated and mapped with the object geometry, BIM 4D animation software can generate the 4D animation in .mp4/.wav video format. This animation provides a visual representation of how the project will progress over time, allowing project stakeholders to better understand the timeline and the potential effects of various project tasks. The animation can be viewed from different angles and can be adjusted to show different levels of detail, ensuring that all viewers can appreciate the intricacies of the project.

7.3 The Relation to BIM And GIS

7.3.1 To import the scheduling information into the 4D Animation model, the ActivityID is used to map the data with the geometry of the BIM model elements. This process ensures that the scheduling information is accurately integrated with the project's visual representation

7.3.2 It is worth noting that some BIM authoring software such as Fuzor, Synchro and Autodesk Navisworks, etc. include the capability to produce a 4D animation. In this case, all scheduling information can be imported into the BIM model with the ActivityID assigned before the import takes place.

7.3.3 In the context of BIM, software applications like Revit provide the ability to add instance parameters such as ActivityID, start dates, and end dates. These parameters allow scheduling information to be stored and managed within the BIM model itself. By incorporating scheduling information directly into the model, project teams can effectively track progress, manage timelines, and ensure that the project stays on schedule and within budget.

7.3.4 When it comes to the integration of Geographic Information System (GIS) technology with Common Data Environment (CDE) platforms, there are key functions that need to be considered. One important aspect is ensuring easy accessibility for all stakeholders involved in the design and construction process. Additionally, the CDE platform should be capable of handling a wide range of digital data generated throughout the engineering lifecycle. In comparison to BIM, GIS technology has a well-established history of web-based 3D data dissemination capabilities due to its server-based development. 4D visualization involves rendering various spatial data from sources such as digital photogrammetry, CAD, BIM, LiDAR, IoT, and GIS in a web-based platform. Web-based 3D GIS has developed APIs and technology architecture that effectively serve large volumes of digital data for online viewing.

7.3.5 Traditionally, the 3D GIS engine used in many CDE systems is the open-source Cesium solution. However, this solution has limitations in performance when dealing with the increasing size of 3D spatial data. The emergence of WebAssembly (Wasm)-based 3D GIS technology is becoming the preferred choice for the next generation of 3D GIS platforms. For example, the new web-based Google Earth system utilises this technology. In the coming years, competent CDE systems may need to incorporate WebAssembly technology to overcome the limitations of thick clients (hardware requirements) and to provide native support for local coordinate systems. This technology offers improved performance and enhances the overall user experience in handling large-scale 3D spatial data. (https://webassembly.org)

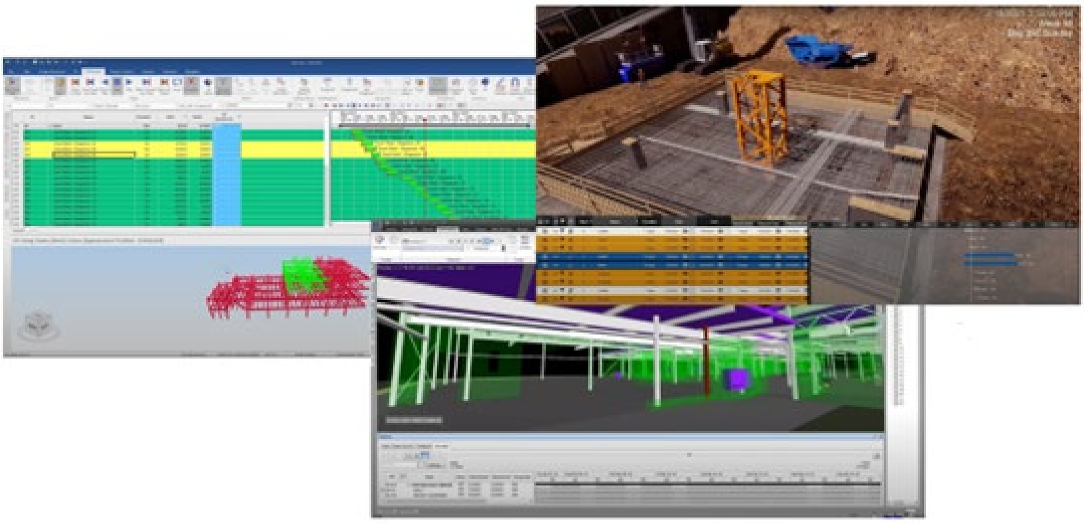
7.4 Additional Information Requirements of BIM Models

7.4.1 To ensure accurate inputting of scheduling information, it is recommended that BIM models be divided into appropriate parts based on level, zoning and category of geometry elements. The division of models should align with the zoning plan and activity items in the master programme. This approach will facilitate efficient scheduling of work and allow for better management of the project timeline.

7.4.2 BIM objects for cast-in-situ permanent works (especially structural beam and column) should not be divided at the construction joint to produce 4D animation. The presentation of forming the construction joints for these BIM objects should be manually defined in the 4D animation production. There are practices in which BIM objects for the construction zones are built to allow automation to streamline manual work.

7.4.3 BIM objects for other permanent works, such as structural slabs and walls, may be divided at the construction joint. However, it is not recommended if structural considerations of the elements are taken into account.

Figure 7-2 Use Case 2 Examples of project timeline that BIM models are divided into appropriate parts



7.4.4 Moreover, the BIM elements should be suitably configured to contain the ActivityID, and it is advisable to export them to the .ifc format for smooth importing into the 4D Animation software. This format ensures that the information is accurately represented and that the scheduling information is seamlessly integrated into the animation model, providing a comprehensive visual representation of the project's progress over time.

7.4.5 To serve the purpose of smart city development while not over-providing excessive information, the following model objects/elements are recommended to be modelled with the link to the ActivityID of the Construction Master Programme.

a) Hoarding Works

b) Piling Works

c) ELS Works

d) Superstructure

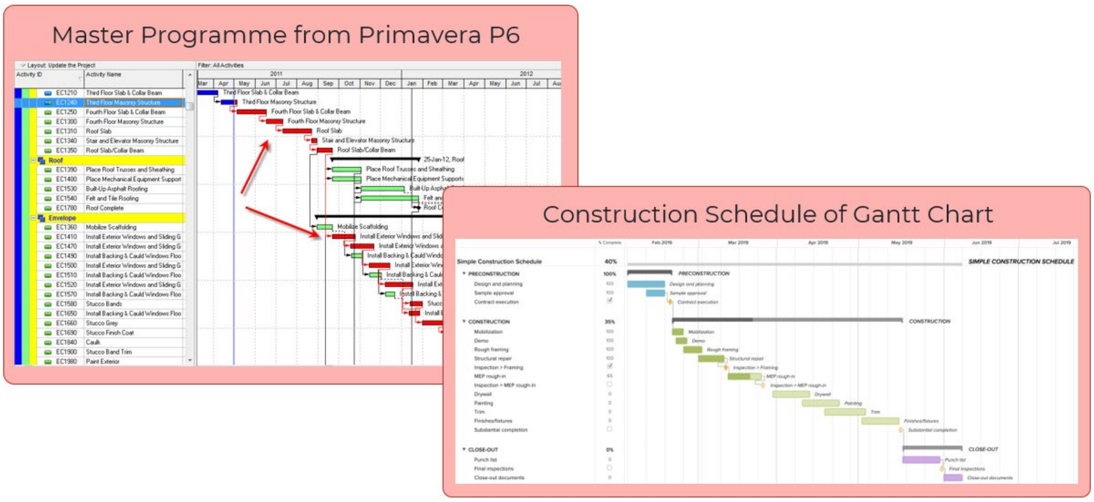
e) Façade Works

7.5 Information Available

7.5.1 The Project Master Programme (PMP) or Phasing Plan is a critical document in the construction process, as it provides detailed information about the project's schedule, sequencing of activities, milestones, and dependencies between tasks. This information plays a crucial role in creating 4D visualisations in BIM, as it allows for accurate mapping of the construction timeline with the BIM model elements. By leveraging the information available from the Project Master Programme or Phasing

Plan, BIM 4D visualisation can provide a comprehensive and accurate representation of the project's timeline, dependencies, and progress.

Figure 7-3 Use Case 2 Examples of Project Master Programme in different software



7.6 Method of Information Exchange

7.6.1 After the ActivityID is inputted into the BIM model. This allows the BIM model elements' geometry to be linked with the corresponding ActivityID. By doing this, the object geometry with the ActivityID can be exported to the .ifc format, a neutral file format used to exchange BIM data between different software applications and GIS in CDE.

Figure 7-4 Use Case 2 Incorporate the data into the BIM model from construction programme

STOREY	ELEMENT	DAYS	START TIME	END TIME
STOREY 1	COL.WALL	7	1/1/2023	1/8/2023
STOREY 1	BEAM/SLAB	7	1/9/2023	1/16/2023
STOREY 2	COL.WALL	7	1/17/2023	1/24/2023
STOREY 2	BEAM/SLAB	7	1/25/2023	2/1/2023
STOREY 3	COL.WALL	7	2/2/2023	2/9/2023
STOREY 3	BEAM/SLAB	7	2/10/2023	2/17/2023
STOREY 4	COL.WALL	7	2/18/2023	2/25/2023
STOREY 4	BEAM/SLAB	7	2/26/2023	3/5/2023
STOREY 5	COL.WALL	7	3/6/2023	3/13/2023
STOREY 5	BEAM/SLAB	7	3/14/2023	3/21/2023
STOREY 6	COL.WALL	7	3/22/2023	3/29/2023
STOREY 6	BEAM/SLAB	7	3/30/2023	4/6/2023
STOREY 7	COL.WALL	7	4/7/2023	4/14/2023
STOREY 7	BEAM/SLAB	7	4/15/2023	4/22/2023
STOREY 8	COL.WALL	7	4/23/2023	4/30/2023
STOREY 8	BEAM/SLAB	7	5/1/2023	5/8/2023
STOREY 9	COL.WALL	7	5/9/2023	5/16/2023
STOREY 9	BEAM/SLAB	7	5/17/2023	5/24/2023
STOREY 10	COL.WALL	7	5/25/2023	6/1/2023
STOREY 10	BEAM/SLAB	7	6/2/2023	6/9/2023
STOREY 11	COL.WALL	7	6/10/2023	6/17/2023
STOREY 11	BEAM/SLAB	7	6/18/2023	6/25/2023
STOREY 12	COL.WALL	7	6/26/2023	7/3/2023
STOREY 12	BEAM/SLAB	7	7/4/2023	7/11/2023
STOREY 13	COL.WALL	7	7/12/2023	7/19/2023
STOREY 13	BEAM/SLAB	7	7/20/2023	7/27/2023

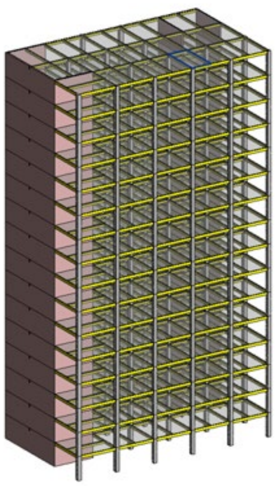
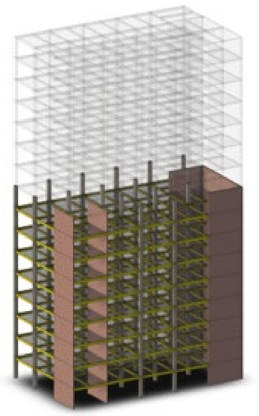


Figure 7-5 Use Case 2 Import the schedules with ObjectID and time data to 4D simulation program

TYPE	ID	SEC	STOREY	START TIME	END TIME
BEAM	1008740	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008741	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008742	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008743	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008744	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008745	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008746	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008747	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008748	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008749	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008750	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008751	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008752	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008753	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008754	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008755	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008756	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008757	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008758	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008759	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008760	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008761	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008762	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008763	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008764	B250x400	STOREY 1	1/9/2023	1/16/2023
BEAM	1008765	B250x400	STOREY 1	1/9/2023	1/16/2023



選擇檔案 construction sequence.csv

2023/4/24

Id	Start Date	Complete Date
1008740	2023-01-08	2023-12-07
1008743	2023-01-08	2023-12-07
1008746	2023-01-08	2023-12-07
1008749	2023-01-08	2023-12-07
1008752	2023-01-08	2023-12-07
1008755	2023-01-08	2023-12-07
1008758	2023-01-08	2023-12-07
1008761	2023-01-08	2023-12-07
1008764	2023-01-08	2023-12-07
1008767	2023-01-08	2023-12-07
1008770	2023-01-08	2023-12-07
1008773	2023-01-08	2023-12-07
1008776	2023-01-08	2023-12-07
1008779	2023-01-08	2023-12-07
1008782	2023-01-08	2023-12-07
1008785	2023-01-08	2023-12-07
1008788	2023-01-08	2023-12-07
1008791	2023-01-08	2023-12-07
1008794	2023-01-08	2023-12-07
1008797	2023-01-08	2023-12-07
1008800	2023-01-08	2023-12-07

7.7 Conclusion

7.7.1 The use of BIM 4D animation software is a valuable tool for creating a visual representation of a construction project's timeline and potential impact. The process involves exporting scheduling information from the project master program or construction schedule and integrating it with the BIM model's object geometry. BIM authoring software can also be used to produce a 4D animation. The BIM model should be divided into appropriate parts based on the zoning plan and activity items in the master program, and BIM elements should be suitably configured to contain the ActivityID. The .ifc format is recommended for smooth importing into the 4D Animation software. Overall, the use of BIM 4D animation software can facilitate efficient scheduling of works and enable better management of the project timeline.

8 USE CASE 3 – GEOTECHNICAL STUDY

8.1 General

8.1.1 Geotechnical studies are essential investigations carried out to analyse and evaluate the soil, rock, groundwater, and geological conditions at a particular site. The objective is to determine the suitability of the ground for various construction, mining, infrastructure development, and slope stability activities. The primary purpose of geotechnical studies is to identify any potential risks or hazards associated with the ground conditions and provide recommendations to ensure the design and construction of safe and stable structures.

8.1.2 Geotechnical studies involve a range of activities to gather and analyse data related to the ground conditions. Site investigation is conducted to assess the physical characteristics of the site, including soil and rock formations, groundwater levels, and geological features. Laboratory testing is performed on collected soil and rock samples to determine their composition, strength, permeability, and other relevant properties. The data obtained from these investigations and tests is then analysed to develop geotechnical models, which help in understanding the behavior of the ground under various loads and conditions.

Figure 8-1 Use Case 3 GI Inspection and sample collection

8.1.3 In geotechnical studies, the ground surface, geological stratum profiles, and bedrock strata are commonly used elements. When BIM is employed in geotechnical studies, these elements are modelled in 3D to consolidate information, facilitate spatial coordination, and enable information exchange for engineering analysis. The BIM model can also be utilised for various other BIM applications, such as drawing production and design review.

8.1.4 The use of 3D computer models and analyses in geotechnical studies is not uncommon. For instance, certain 3D geological modeling software tools assist geoscientists and mining engineers in creating accurate and dynamic models of subsurface geology, facilitating informed decisions regarding resource management and infrastructure development. Users can import different types of geological data, including drillhole data, geological maps, and geophysical data, to construct a 3D model of the subsurface geology. The software also provides visualisation options, such as 3D block models, cross-sections, and contour maps, along with tools for interpreting and analysing the data.

8.1.5 The adoption of BIM for geotechnical studies in Hong Kong is influenced by several factors. One major challenge is the complexity of geotechnical data and its integration with BIM models. Geotechnical data often requires specialized software tools and expertise for management and interpretation. Moreover, integrating geotechnical data with BIM models can be challenging due to differences in data formats and software compatibility issues.

8.1.6 Another factor is the limited number of geotechnical professionals trained in BIM. While BIM is extensively taught in universities and professional training programs, there is a lack of specialised BIM training for geotechnical engineers and other professionals working with geotechnical data. This document focuses on how BIM technology can assist engineers in designing pile foundations, with a specific emphasis on generating 3D soil profiles as the foundation for further geotechnical analysis.

8.2 The Process

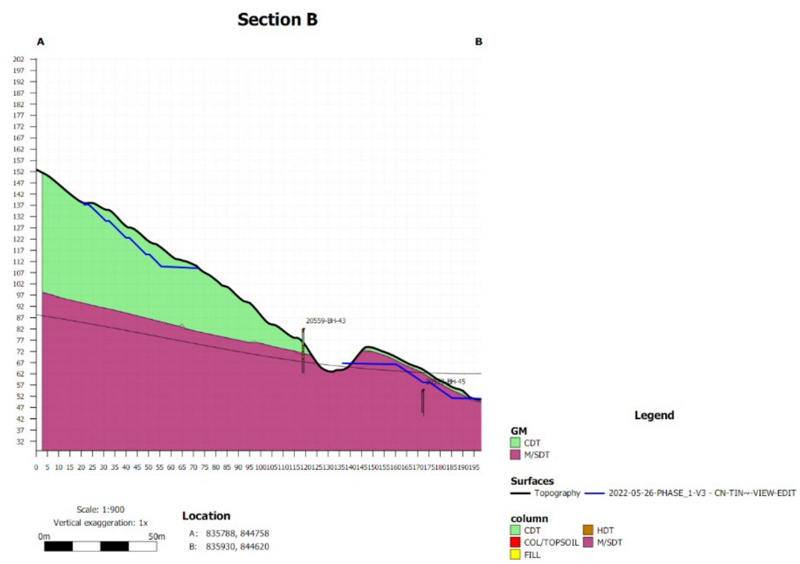
8.2.1 **Geotechnical Study**

8.2.2 The current engineering practice for geotechnical study involves a combination of field investigations, laboratory testing and numerical modelling. Field investigations may include drilling boreholes, conducting in-situ tests, and collecting soil and rock samples for laboratory testing. The samples will then be analysed to determine their physical and mechanical properties. The geotechnical engineers will then carry out the numerical modelling such as finite element analysis or slope stability analysis to check the soil behaviour under various conditions. The results of these studies will then inform both structural and civil engineers and be used for the design of bridges, buildings, foundations and retaining structures etc to ensure their safety and stability.

8.2.3 There are several software (Geostudio Slope/W or Plaxis2D) available that are specifically designed for slope analysis. These tools can help engineers model complex slope-structure interactions and analyse the behaviour of the slope under various loads and soil conditions.

8.2.4 In addition to the use of the above software for visualise and analyse geological data in 3D, the application of remote sensing tools such as LiDAR and drone-based photogrammetry can provide high-resolution data that can be used to create accurate and detailed 3D models of the slope and surrounding terrain. These data can be integrated with BIM software to provide a more comprehensive analysis of slope stability.

Figure 8-2 Use Case 3 Soil profile example captured from example software Leapfrog



8.2.5 The software Suffer, or Leapfrog Geo can import the borehole data from both Excel or CSV files. Once the data is imported, the engineers create geological domains based on the interpreted data, which can be used to create a 3D mesh, i.e., to create and modify the geological surfaces and volumes, as well as adding faults and other geological structures. At last, the engineers can analyse the model to gain insights into the subsurface geology, calculate rock mass ratings and perform slope stability analyses.

8.3 The Relation to BIM And GIS

8.3.1 **The BIM Part**

8.3.2 BIM can enhance the geotechnical study by providing a digital representation of the structure and its surrounding environment. BIM can then be used to manage and store these geotechnical data, such as soil and rock test results. This allows for easy access and data sharing among the project team, which can improve communication and collaboration. In addition, BIM can be used to visualise the geotechnical data and results, aiding in decision-making and design optimisation.

8.3.3 One example of BIM application in slope analysis in Hong Kong is to create a virtual representation of the slope and surrounding terrain. This allows the design team to visualise the slope in 3D, identify potential hazards or areas of instability and make design modifications before construction begins. However, a 3D soil profile should be first determined before processing the above analysis.

8.3.4 **The GIS Part**

8.3.5 GIS technology has been the main digital approach for geotechnical applications in Hong Kong and over the world, which includes underground geological 3D modelling, geomorphology mapping, natural landslide mapping, landslip numerical simulation, landslide quantitative risk assessment (QRA) and especially man-made slope digital inventory in Hong Kong. The well-developed history of local geotechnical professions in the integrated use of LiDAR for digital terrain modelling (DTM) and slope analysis in GIS, has created an ideal digital environment/pre-condition for integration with BIM.

8.3.6 In recent years, the adoption of new-generation oblique photogrammetry techniques in photorealistic 3D modelling of natural landslides, man-made slopes and site formation status has become common. Such 3D modelled results are normally being imported into the 3D GIS platform for visualisation and spatial analysis; they also, serve as the base 3D model in the CDE system for familiarisation of existing site conditions. Digital photogrammetry technology is also being used in digital stereoscopic viewing of archived aerial photos from GEO; there is a large-scale digitisation process to transform traditional/manual Aerial Photo Interpretation work about site formation history into a fully automatic approach; site feature extraction will be directly recorded in GIS then seamlessly transfer to CAD or BIM applications; which furnished the digital transformation of the engineering industry.

8.4 Additional Information Requirements of BIM Models

8.4.1 In relation to the geotechnical study related to BIM, several additional pieces of information may need to be input into BIM models beyond what is available in CSDI. Some of these may include:

a. **Soil properties**

The geotechnical study may provide information on the properties of the soil, such as soil type, density, and shear strength. This information can be used to create more accurate foundation and soil-structure interaction models.

b. Site conditions

The geotechnical study may provide information on site conditions, such as groundwater levels, soil moisture content, and slope stability. This information can be used to create more accurate foundation models and ensure that it is designed to withstand the specific site conditions. The data in the BIM model can include information such as the GI report ID and project name, making it convenient for future projects to locate corresponding PDF documents or AGS data to access the aforementioned information.

c. Details from private sector

Geotechnical information on private projects is often defined as confidential documents that are only available to the project team members. It is not open to the CSDI platform.

d. Only 2D geotechnical data is available on CSDI

Three-dimensional rock surfaces or related data documents are not provided.

8.4.2 By inputting these additional pieces of information into the BIM model, engineers can create more accurate and efficient designs of the foundation, reduce errors, and rework, and improve collaboration and communication with other members of the design and construction team.

8.5 Information Available

8.5.1 The geotechnical information available from the below-listed authorities in Hong Kong has already been launched in Common Spatial Data Infrastructure (CSDI). It is a government-led initiative in Hong Kong that aims to provide a centralised platform for managing and sharing geospatial data across different government departments and agencies. In terms of geotechnical information, the CSDI includes a range of data related to land use, geology, slope stability, and other geotechnical information, including site investigation reports, laboratory test results and other types of geotechnical data.

a. Geotechnical Engineering Office (GEO)

The GEO is a government department responsible for providing geotechnical information and services related to the development of Hong Kong. The GEO maintains a database of geotechnical information, including soil and rock investigation reports, laboratory test results, and geotechnical monitoring data.

b. Civil Engineering and Development Department (CEDD)

The CEDD is responsible for the planning, design, and construction of major infrastructure projects in Hong Kong. The department provides a range of geotechnical information and services related to infrastructure development, including slope safety reports, geotechnical monitoring data, and other types of geotechnical information.

c. Lands Department

The Lands Department is responsible for managing land and property in Hong Kong. They maintain a land and property information database including geotechnical data such as Slope Maintenance Responsibility Boundary Data and Digital Land Boundary Map (i.e., iC1000).

The geotechnical data in CSDI can be found in a variety of formats, including:

a. Shapefile format

Shapefiles are a common format for storing geospatial data, and they can be used with a wide range of software applications for mapping and analysis.

b. GeoJSON format

GeoJSON is a format for encoding geospatial data in JavaScript Object Notation (JSON), which is a lightweight data-interchange format.

c. KML format

KML (Keyhole Markup Language) is a format for storing geospatial data used by Google Earth and other mapping applications.

d. CSV format

CSV (Comma-Separated Values) is a simple format for storing tabular data, including geospatial data.

e. Other formats (AGS, PDF)

The CSDI also provides data in other formats, including AGS (Association of Geotechnical and Geoenvironmental Specialists) format, which is a standard format used for geotechnical data exchange in the UK. Some projects only have PDF documents without corresponding AGS files for their soil and rock data.

8.5.2 **Private projects**

8.5.3 Other source of geotechnical information available in Hong Kong also includes Private Consultants. Several private geotechnical engineering firms are operating in Hong Kong that provide a range of geotechnical services, including site investigation, laboratory testing, and geotechnical analysis. These firms may also maintain their databases of geotechnical information related to specific projects or locations. However, some projects only have PDF documents without corresponding AGS files for their soil and rock data. CSDI also provides a JSON file corresponding to the distribution of borehole positions in the AGS files, making it easier to search for data. These are confidential documents and only available for the project team members. Thus, these cannot be found in CSDI.

8.6 Method of Information Exchange

8.6.1 Method of Exchange

8.6.2 The method of exchange is co-related between Use Case 3 Geotechnical Study and Use Case 5 Foundation design. It may generate a 3D soil profile using geotechnical data from CSDI. The AGS files provided by CSDI are in text file format and generated according to the AGS standard, which can be used to provide geotechnical data for determining the rock stratum surface and the soil profile. For example, drilling data, model surfaces and sections can be exported in some IFC formats on an object-by-object basis.

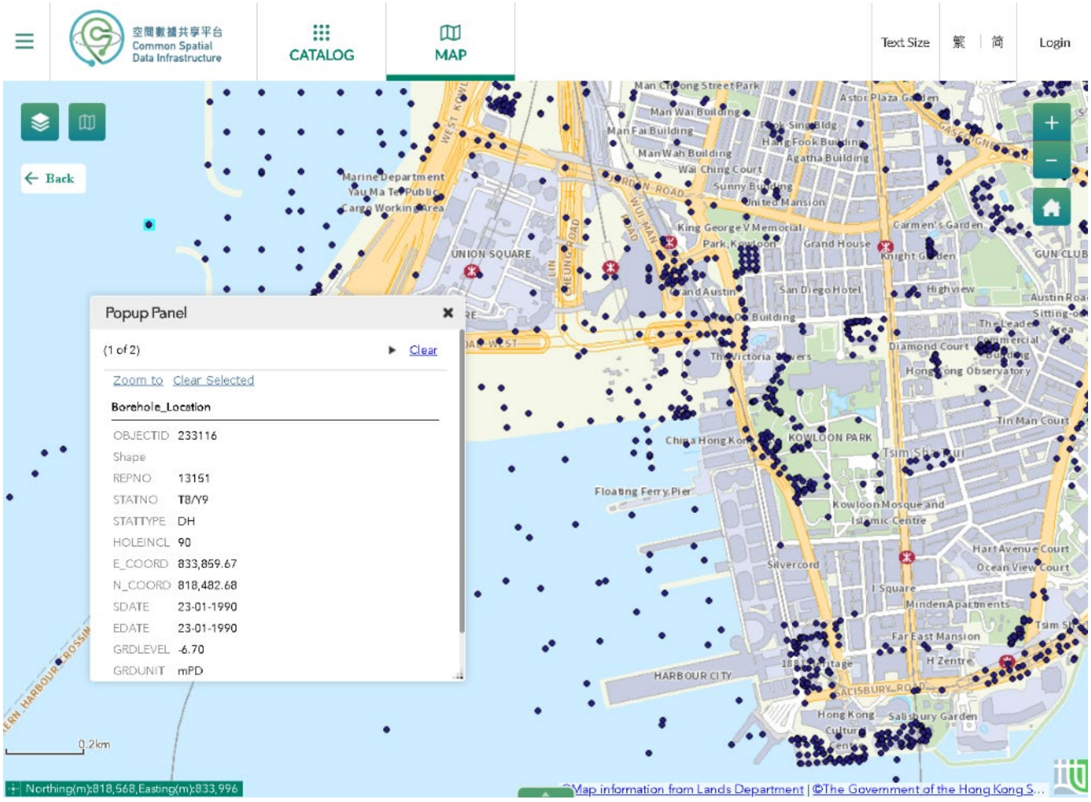
8.6.3 The specific data conversion process is shown below.

Figure 8-3 Use Case 3 Data conversion process

a. Obtain the relevant geotechnical electronic data file (AGS File)

The CSDI system provides AGS files collected by government agencies, which can be downloaded from the CSDI website. The AGS file contains information such as the coordinates of the borehole, depth, and distribution of different soil layers along the depth, which can help engineers generate the surface of the rock layer. However, the CSDI system does not collect geotechnical data from other private projects. Geotechnical data from private projects can only be obtained by drilling on-site to obtain AGS files.

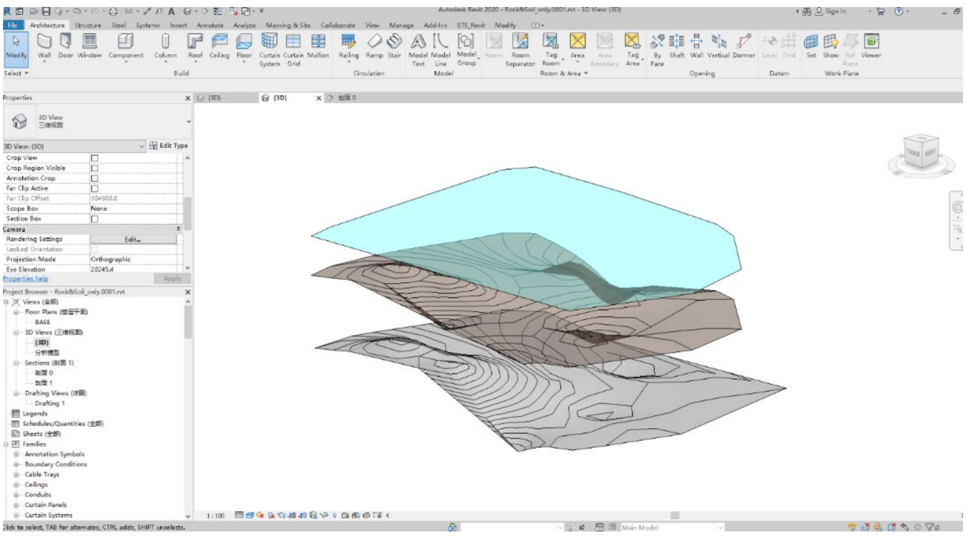
Figure 8-4 Use Case 3 Geotechnical information from CSDI



b. Generate a three-dimensional surface model of the rock layer

After obtaining the AGS file, the depth of the rock layer at each borehole location can be obtained through data conversion, and the predicted depth of the rock layer at all locations in the site can be obtained through mathematical interpolation algorithms. This calculation process is completed through commercial software or BIM automation technology. Finally, a three-dimensional surface model of the rock layer is obtained.

Figure 8-5 Use Case 3 Soil / rock layers in BIM authoring software



The data from CSDI can be stored in BIM by way of parameters, schedules, tags, and external references. Some examples of the types of data that can be stored in BIM are listed below:

a. Site Parameters

Create parameters in BIM to store information about the project site, such as the location, area, and elevation.

b. Material Parameters

Create parameters in BIM to store information about the materials used in the project, such as the soil type, compressive strength, and other properties.

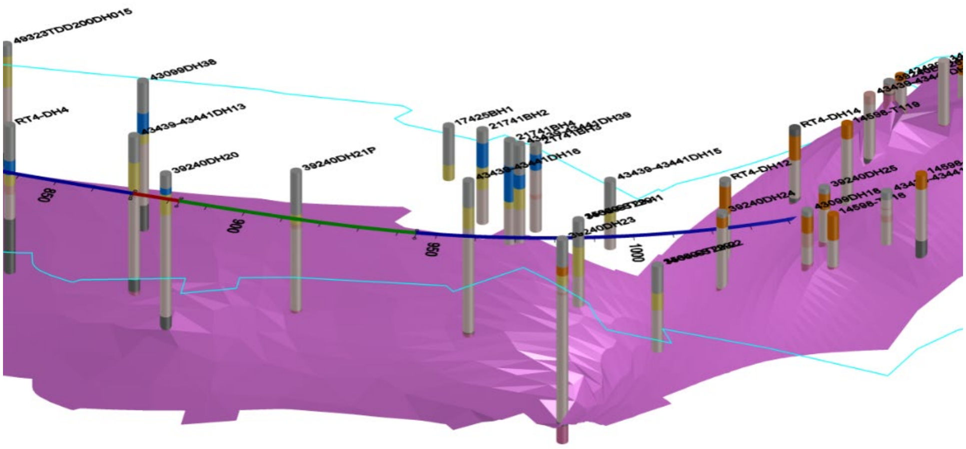
c. Schedules

Create schedules in BIM to display information about the geotechnical data from the CSDI, such as the soil investigation reports, geotechnical monitoring data, and geological maps.

e. Tags

Create tags in BIM to display information about specific elements of the project, such as the soil layers or geotechnical features.

Figure 8-6 Use Case 3 BIM models showing the relationship between bore holes and soil layers



f. External References

Link external references in BIM to the geotechnical data from the CSDI, such as the soil investigation reports and geological maps. Access and reference the data directly within the BIM project.

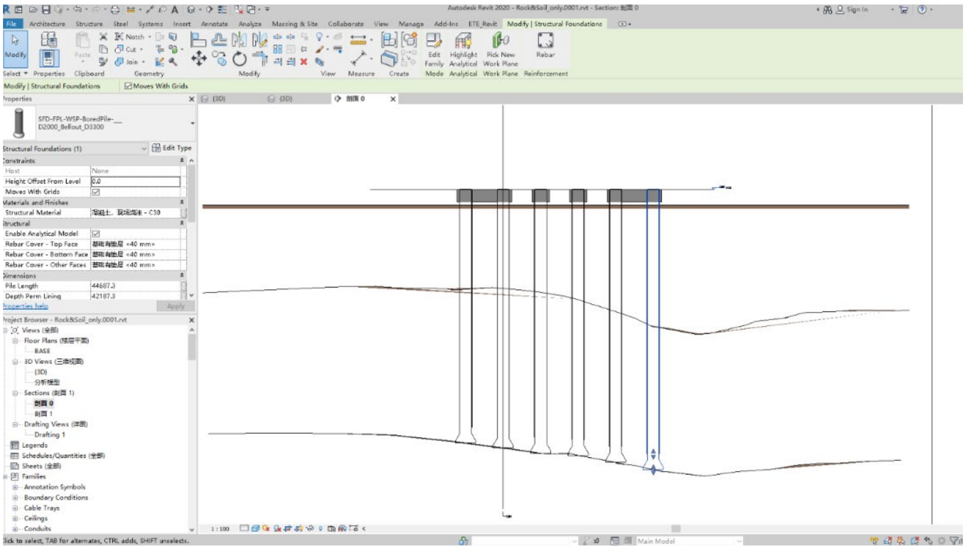
8.7 Conclusion

8.7.1 In conclusion, the CSDI portal has provided a large amount of AGS data files for government projects, which can be used to generate geotechnical-related information but require numerical processing.

8.7.2 More information, such as MTR tunnels and the boundaries of the Scheduled Areas, should be collected and shared in CSDI for the comprehensive information set to enable the geotechnical design.

8.7.3 It is suggested that the GI engineering firms provide the data not only in pdf but also in AGS data format to facilitate the engineer's design. Importing the geotechnical data available from CSDI to different BIM authoring software such as Revit or Civil 3D can offer many benefits, such as improved accuracy, efficiency, collaboration, and visualisation. This exchange can be done by importing the data into the software applications or creating an API to exchange data programmatically.

Figure 8-7 Use Case 3 Visualisation of borehole data for the entire project



8.7.4 However, there may be potential statutory conflicts or risks associated with the exchange of geotechnical data, such as data security, accuracy, legal and regulatory risks, and organisational risks. To mitigate these risks, it is important to ensure that the exchange of data is done in compliance with applicable laws and regulations, and that appropriate data security measures are implemented.

9 USE CASE 4 – TRAFFIC IMPACT ASSESSMENT AND SWEPT PATH ANALYSIS

9.1 General

9.1.1 Swept path analysis (SPA) is a process used to assess the spatial requirements of a moving object, typically a vehicle, as it travels a specific path or route. The analysis involves examining the available space along the path to ensure that the vehicle can safely maneuver past obstacles and constraints, such as buildings, curbs, or other vehicles.

9.1.2 SPA is commonly used to design and plan transportation infrastructure, such as roads, highways, and parking lots. It is also used to design buildings and other structures to ensure sufficient space for vehicles to access and navigate around the site.

9.1.3 SPA is particularly important in Modular Integrated Construction (MiC) projects. MiC involves the assembly of pre-fabricated building components off-site and their transportation to the construction site for installation. SPA is used to evaluate the feasibility and practicality of the logistics and travel routes for delivering MiC units. Since the size of MiC units can push the limits defined in design guidelines, SPA helps identify any potential obstacles or constraints that may arise during transportation, enabling adjustments to be made to ensure a smooth and safe delivery process.

9.1.4 The analysis traditionally involves the use of computer-aided design (CAD) software. The software simulates the movement of the vehicle or object along the specified path, considering factors such as the vehicle's dimensions, turning radius. By visualizing the movement in a virtual environment, designers and planners can identify any conflicts or limitations and make necessary modifications to the design. This ensures that the path is safe and functional for the intended use, optimising the overall performance and operation of the infrastructure or site.

9.1.5 **3D Swept Path Analysis**

9.1.6 A 3D approach to swept path analysis involves constructing a three-dimensional model of the vehicle or object and simulating its movement within a virtual environment that accurately represents the real-world conditions of the path or route. This approach provides a more comprehensive analysis of the spatial requirements by considering not only the horizontal movement but also the vertical movement and clearance requirements. By utilising a 3D model, designers can accurately represent the size, shape, and turning radius of the vehicle or object being analysed. This allows for a more precise assessment of its interaction with the surrounding environment, including obstacles, such as buildings, bridges, street furniture, and signs.

9.1.7 In a 3D swept path analysis, the vehicle or object is typically modelled using specialised software that allows for precise measurements of its size, shape, and turning radius. The software then simulates the vehicle's movement along the path or route, considering any obstacles or constraints that may be present.

9.1.8 The 3D SPA requires 3D information on the road features causing the restraint to the vehicle movement. The road features include bridges/flyovers, street furniture, and signs that could limit the vehicle path's height and width.

9.1.9 **BIM SPA**

9.1.10 The 3D SPA could be advanced using BIM/GIS to source modelling objects. For example, suppose road surfaces and curb lines, as well as street furniture, can be obtained from GIS provided by the government. In that case, engineers/designers can quickly develop the analysis background with the latest update.

9.1.11 This document will explore BIM/GIS information availability for road features. In addition, it will discuss the method of conducting the SPA in 3D and the possibility of information exchange from BIM/GIS to the analysis.

9.2 The Process

9.2.1 As a result of consolidating the opinions by the interviews with stakeholders, relevant HK BIM guidelines and vast desktop studies, the following brief is a common practice to produce a SPA with BIM integration in the industry.

9.2.2 Method of obtaining 3D spatial data and 2D data

3D Spatial Data

Digital data of 3D models featuring geometry models, texture maps and texture attributes to represent the geometrical shape, appearance, and position of three types of ground objects i.e., Building, Infrastructure and Terrain, can be obtained from the CSDI portal.

Suggest applying 3D laser scanning to collect point cloud data for those elements that could not be collected from government databases.

2D Data

Vehicle size could be obtained by requesting the Transport Planning & Design Manual (TPDM).

9.2.3 Obtaining Swept path analysis

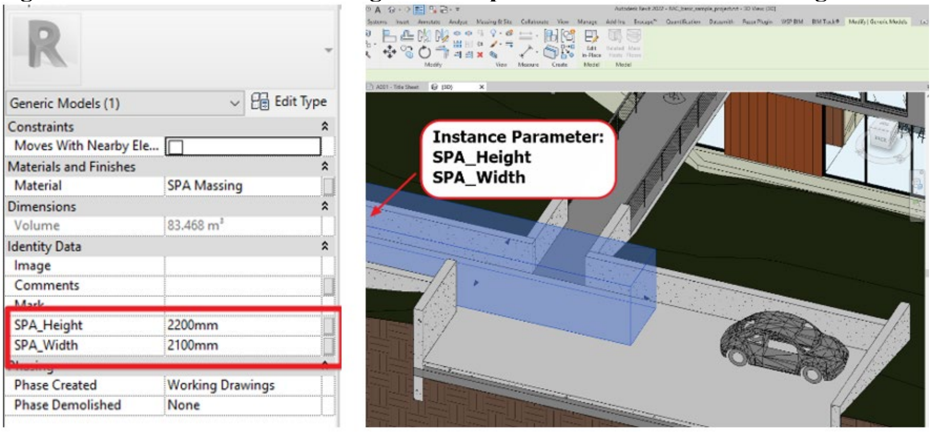
In common practice, a proposed Swept path alignment will be generated from authoring software such as AutoTurn, Vehicle tracking in AutoCAD that also contains the vehicle's size and minimum requirement.

The data in this 2D or 3D simulation could be exported and imported to BIM software e.g., Revit. Then produce a precise routing with massing for manoeuvring the vehicle pass through by making up the attributes with Application Programme Interface.

9.2.4 Added common 3D data in the SPA parameter.

The BIM element, swept path massing, could contain helpful information (z value – Height, road Width, appropriate vehicle types, sizes, etc.) by adding instance parameters. Combined with the 3D spatial data, the feasibility of SPA study in BIM and 4D simulation could be visualised.

Figure 9-1 Use Case 4 Adding instance parameters in BIM authoring software



9.3 The Relation to BIM And GIS

9.3.1 The relationship between swept path analysis and BIM is closely intertwined, as swept path analysis is a key component of BIM-based construction projects. By incorporating swept path analysis into BIM models, designers and engineers can ensure that their designs are optimised for safety and efficiency and that potential conflicts are identified and addressed before construction begins. This leads to a more accurate and efficient construction process and can help reduce costs, save time, and ensure that projects are completed on schedule and within budget.

9.3.2 A virtual SPA envelope is necessary to contain the road information to facilitate a safe roadwork system that assists professional plans.

9.3.3 Given this, BIM involvement is indispensable to detail and accurate representation and streamlines the SPA of the proposed development or project. An ideal concept is the data should take account of its instantaneity and interactivity, etc.

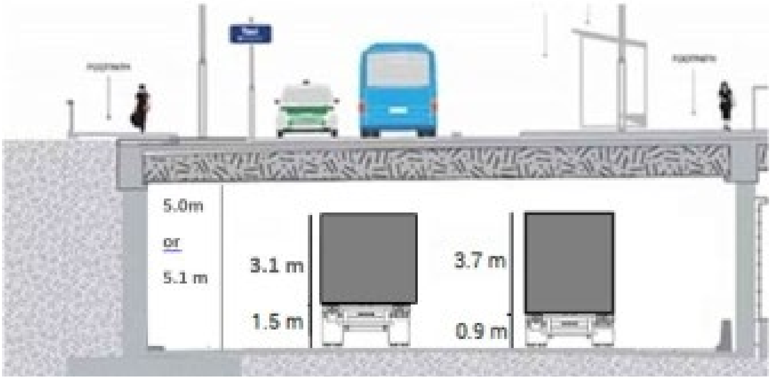
9.3.4 The SPA BIM components shall contain parameters that could be readily gathered and exported to serve different stakeholders needed, to avoid repetitive modelling work in the future.

9.4 Additional Information Requirements of BIM Models

9.4.1 Reflects conflict subjected to the design if added instance parameters are contained to show the traffic reference as below:

- The Z values of the footbridge or viaduct underneath,
- The utmost width of the turning part of the swept path,
- Added parameters for calculating the result based on the radius, spacing data, etc.

Figure 9-2 Use Case 4 Example of instance parameters for TIA



9.5 Information Available

9.5.1 The below tables show the data required for traditional TIA and SPA models usually depend on obtaining 3DSD data, FBX VRML.

Table 9-1 Use Case 4 Information available for TIA

Date	File Format	Source
Road size and Alignment/ Interpreted from LandsD iB1000 or TD Road Network	SHP/GDB; FGDB/KML/GML	Purchase from LandsD; Download from PSI (DATA.GOV.HK)
Traffic aids and traffic signs	GDB/KML GML/CSV	TD – download from PSI (DATA.GOV.HK)
Base District Traffic Model (BDTM)	DAT	Purchase from TD
Annual traffic census	GDB/GML/KML	TD – download from PSI (DATA.GOV.HK)
Outline Zoning Plan (OZP)	SHP/GeoJSON/GML	PlanD's Digital Planning Data website
Census Data	CSV/GML/XLS	Download from CSD or Geodata Store
Traffic count survey	Table	Custom made by traffic consultant
Aerial Photo	TIFF	Purchase from LandsD; Custom made by traffic consultant
LiDAR Data	LAS	Custom made by traffic consultant
3D Spatial Data (3DSD)	3Ds/FBX/VRML	Purchase from LandsD
iB1000 (Topographic Map)	CAD/GDB	Download from CSDI
MiC module design	CAD/RVT/etc.	Custom made by contractor

9.6 Method of Information Exchange

9.6.1 As the core concepts of BIM technology are cooperation and collaboration, effective integration of shareable BIM and GIS data would facilitate the application across department projects or discipline stakeholders.

9.6.2 Data can be standardised in specific object identity, properties, abstract concepts, space, planning and information provider etc. The concept of data exchange is as below:

Figure 9-3 Use Case 4 Concept of data exchange

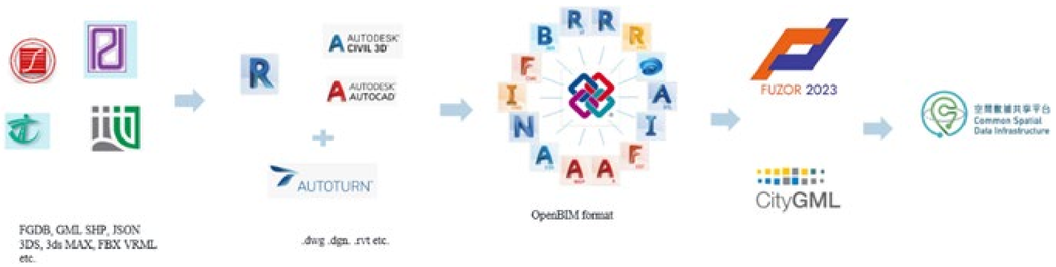


Table 9-2 Use Case 4 Generate swept path

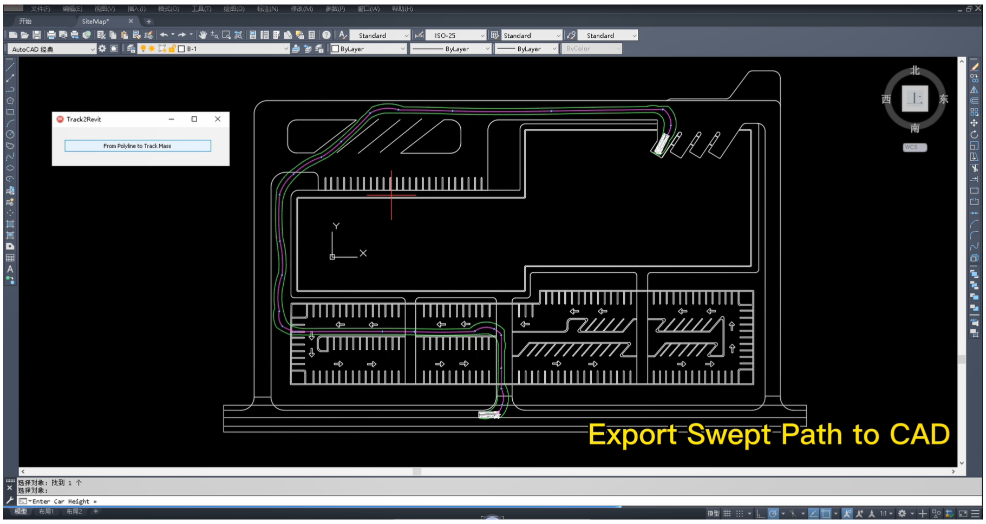
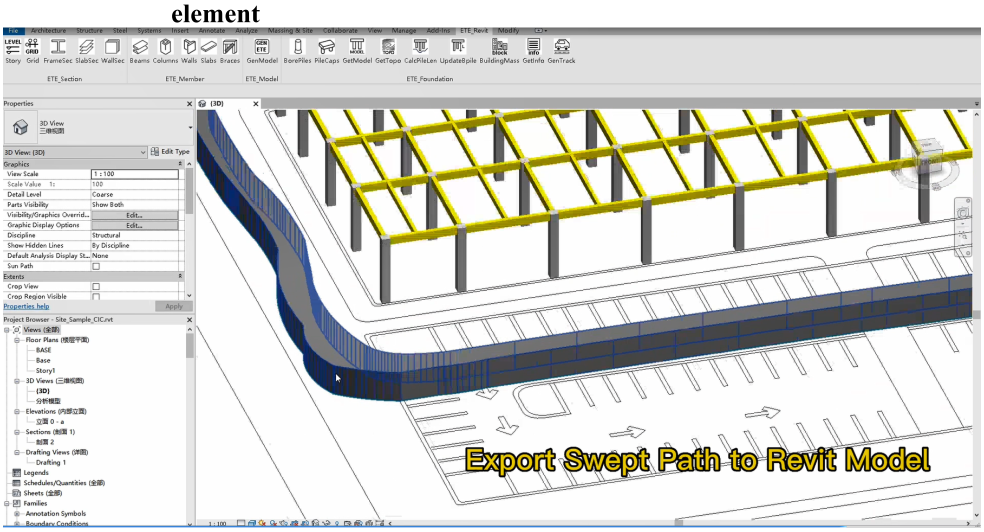


Figure 9-4 Use Case 4 Incorporate the swept path into BIM model and generate a missing element



9.7 Conclusion

The solutions of data exchange for creating SPA-related components are a crucial issue. Therefore, standardizing and centralizing the key BIM components of SPA creation should be conducted more frequently in the long term.

A more accurate attribute (BIM / 3D data) in the BIM technology should be the appropriate approach for enriching the Government BIM Data Repository (GBDR) development of BIM/GIS integration. It would be valuable to the public and could be shared via CSDI.

10 USE CASE 5 – FOUNDATION DESIGN

10.1 General

10.1.1 BIM in Foundation Design focuses on modelling pile foundations in complex geotechnical conditions. The analysis of induced pile loading takes into account the pile length, which is influenced by the pile's position due to variations in the bedrock profile. As a result, the pile load analysis becomes an iterative process involving adjustments to the pile number, pile position, and pile length, as well as updates to the bedrock profile based on additional ground investigation information.

10.1.2 BIM streamlines the iterative process of pile foundation design, making it more efficient. The first step is to model the bedrock profile as a 3D surface object with the correct geo-reference setting. Next, the piles are modelled in 3D, with their locations geo-referenced to ensure accurate placement with respect to the bedrock surface. Finally, the pile length can be determined by referencing the bedrock profile at the specific pile location. This means that whenever there are updates to the bedrock profile, changes in pile locations, or the addition of new piles, the pile length can be quickly obtained through manual or automatic methods.

10.1.3 This document mainly discusses how the bedrock surface is modelled and how the pile length is obtained.

10.2 The Process

10.2.1 Foundation Design

10.2.2 In Hong Kong, the conventional approach to foundation design typically involves the application of geotechnical engineering principles, specifically soil mechanics and rock mechanics. The process begins with a thorough site investigation to assess the soil and rock conditions at the location, which can be supplemented by referencing previous geotechnical investigation (GI) records available through the CSDI. Utilizing the results of geotechnical tests, engineers analyse the anticipated loads that the foundation system must bear. With this information, structural engineers can then determine the optimal length for each pile, taking into consideration the three-dimensional surface of the underlying rock layer, and subsequently optimise the layout of the piles for the best overall performance.

10.3 The Relation to BIM And GIS

10.3.1 **BIM**

10.3.2 Upon defining the 3D surface of the soil profile, a 3D model of the structure and its foundation can be first created to assess the impact of the soil and rock conditions on the design of the foundation. The model can also be used to simulate the behaviour of the foundation and the surrounding soil under different loading conditions. For example, it can help engineers better understand the impact of soil and rock conditions on the design of the foundation and adjust the design as necessary. This digital model can be used to simulate different design scenarios and evaluate the structural integrity of the foundation in the below different ways:

a. Visualisation

BIM allows engineers to visualise the relationship between the foundation and the superstructure and as well as the underground conditions.

b. Analysis

BIM can assist in understanding the structural behaviour of a building's foundation under different loads and conditions, helping engineers to identify potential issues early on in the design process.

c. Construction

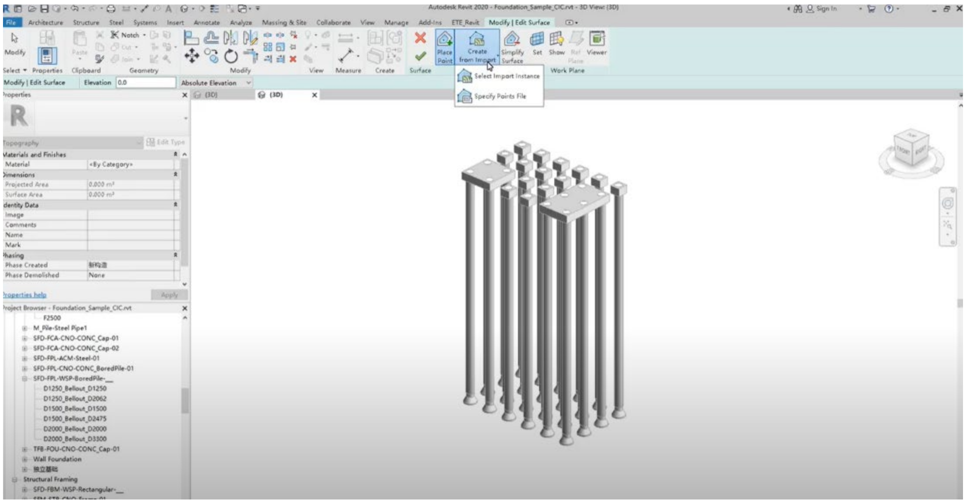
BIM can be used to generate construction drawings and models that can be used to guide the construction of the foundation, ensuring that it is built according to the design specifications.

d. Collaboration

BIM facilitates collaboration between architects, engineers, and contractors, allowing them to work together more effectively to design and construct a building's foundation.

The entire design process of the pile foundation can be aided by BIM technology to improve work efficiency and accuracy, and the whole process is closely related to BIM. The data for the depth of the rock layer can be obtained through the AGS file, and a BIM model of the three-dimensional surface of the rock layer can be drawn through mathematical interpolation. Combined with the planned location of the pile foundation, the pile length can be calculated automatically. In addition, the CSDI system has provided a large amount of AGS data, which can be used in the early stage of the project to design the foundation through the AGS data provided by CSDI near the project.

Figure 10-1 Use Case 5 Piles and pile caps in the BIM model



10.3.3 **GIS**

10.3.4 It is the global industry standard practice for using GIS to process, delineate, illustrate and visualise the ground investigation (GI) findings including the rockhead level of the underground geological model. It is so common that the industry's most popular GI record storage software - gINT, has developed its GIS plugin for direct plotting of its GI information into GIS, including ArcGIS Desktop, etc.

10.3.5 For current common practice in the industry is to use GIS to delineate the Rockhead contour by inputting the borehole's rock level as a spot in the desktop GIS, then through the GIS inbuilt interpolation algorithms to generate the Rockhead continuous surface for foundation design. Expert level of 3D geological model system with direct support and plugin application to couple with GIS for high level complicated underground geological 3D modelling application.

https://www.ctech.com/products/mvsevs-product-suite-new/mvs/

10.4 Additional Information Requirements of BIM Models

10.4.1 In relation to the foundation design related to BIM, several additional pieces of information may need to be input into BIM models beyond what is available in CSDI. Some of these may include:

a. **Soil properties**

The foundation design requires information on the properties of the soil to deduce the type of foundation and load capacity. This information is essential to the foundation and the soil-structure interaction.

b. Site conditions

Environmental factors such as earthquake or flood zones, frost depth, and soil erosion potential need to be considered in foundation design. If the construction site is located in a region prone to earthquakes, for example, the foundation must be designed to withstand seismic forces. This information can be demonstrated in 3D models that allow the engineer to have an overview of the site condition and ensure that it is designed to withstand specific site conditions.

c. Construction details

The BIM model may also need to include additional information on the construction details of the foundation, such as reinforcement details, formwork, and concrete mix design.

d. Details from private sector

Geotechnical information on private projects is often defined as confidential documents only available to the project team members. It is not open to the CSDI platform.

e. Only 2D geotechnical data is available on CSDI

Three-dimensional rock surfaces or related data documents are not provided. By inputting these additional pieces of information into the BIM model, engineers can create more accurate and efficient designs of the foundation, reduce errors and rework, and improve collaboration and communication with other members of the design and construction team.

10.5 Information Available

10.5.1 The geotechnical information available from the below-listed authorities in Hong Kong has already been launched in Common Spatial Data Infrastructure (CSDI). It is a government-led initiative in Hong Kong that aims to provide a centralised platform for managing and sharing geospatial data across different government departments and agencies. In terms of geotechnical information, the CSDI includes a range of data related to land use, geology, slope stability, and other geotechnical information, including site investigation reports, laboratory test results and other types of geotechnical data.

a. Geotechnical Engineering Office (GEO)

The GEO is a government department responsible for providing geotechnical information and services related to the development of Hong Kong. The GEO maintains a database of geotechnical information, including soil and rock investigation reports, laboratory test results, and geotechnical monitoring data.

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c. Lands Department

The Lands Department is responsible for managing land and property in Hong Kong. They maintain a database of land and property information including geotechnical data such as slope safety reports and land use zoning maps.

The geotechnical data in CSDI can be found in a variety of formats, including:

a. Shapefile format

Shapefiles are a common format for storing geospatial data, and they can be used with a wide range of software applications for mapping and analysis.

b. GeoJSON format

GeoJSON is a format for encoding geospatial data in JavaScript Object Notation (JSON), which is a lightweight data interchange format.

c. KML format

KML (Keyhole Markup Language) is a format for storing geospatial data used by Google Earth and other mapping applications.

d. CSV format

CSV (Comma-Separated Values) is a simple format for storing tabular data, including geospatial data.

e. Other formats (AGS, PDF)

The CSDI also provides data in other formats, including the AGS (Association of Geotechnical and Geoenvironmental Specialists) format, a standard format used for geotechnical data exchange in the UK. Some projects only have PDF documents without corresponding AGS files for their soil and rock data.

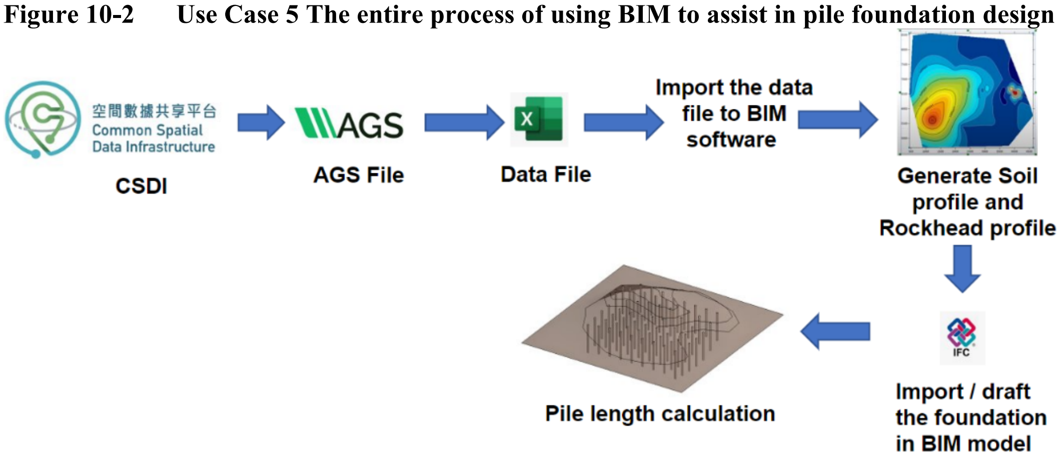
10.6 Method of Information Exchange

10.6.1 **Method of Exchange**

10.6.2 The method of exchange is co-related between Use Case 3 Geotechnical Study and Use case 5 Foundation design. Upon processing the soil profile as listed in use case 3, This geotechnical data can be used to determine the rock stratum surface and as well as the soil profile. With the pile foundation plan and rock stratum surface in place, pile length can be determined using BIM automation.

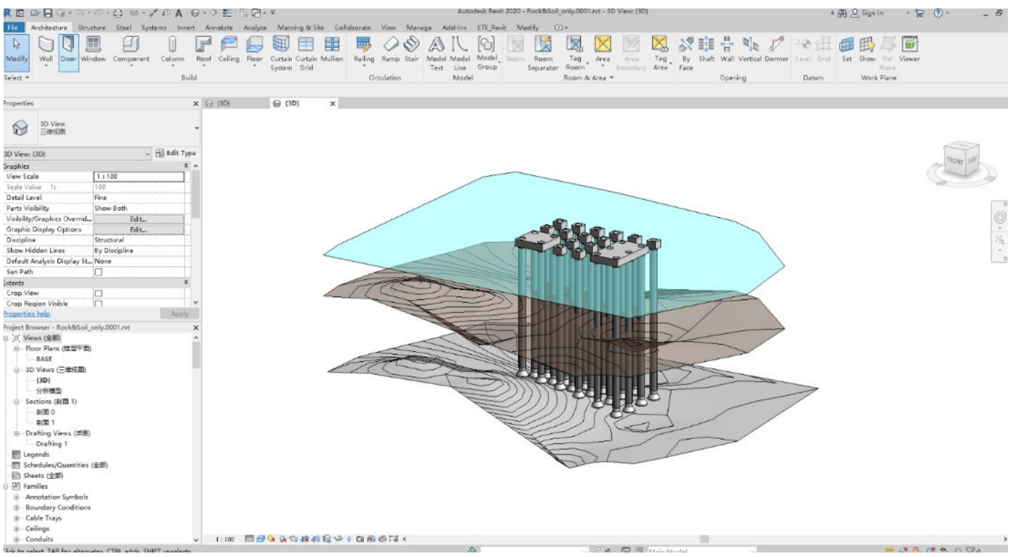
10.6.3 The specific data conversion process is shown below.

Figure 10-2 Use Case 5 The entire process of using BIM to assist in pile foundation design



10.6.4 By combining with the pile layout 3D model and the rock layer surface, the length of each pile is calculated.

Figure 10-3 Use Case 5 BIM model displaying the relationship between pile foundation, ground surface, soil / rock layers



10.7 Conclusion

10.7.1 In summary, the integration of datasets obtained from the CSDI portal with offers engineers and contractors enhanced accessibility and utilization of spatial data in the foundation design process. The portal offers a substantial collection of AGS data files sourced from Government departments or statutory organisations, which require numerical processing to generate geotechnical-related information. However, it is important to note that the absence of geospatial information prepared by private sectors, at their own expense, is unavoidable. Consequently, this may result in a lack of drilling data from private projects, limiting the applicability of the data provided by the CSDI portal to early-stage foundation design in specific areas.

11 USE CASE 6 – EXCAVATION PERMIT (XP) APPLICATION

11.1 General

11.1.1 XPMS is a web-based system used by HyD utilized for electronic administration and control of road excavation works. However, all pertinent information, such as excavation layout, start and end dates, and more, currently requires manual input into the system.

11.1.2 The Audit Report conducted by HyD highlights the absence of a documented standard for verifying the detailed alignment and disposition of the system within the existing control mechanism. Consequently, XP applicants are not obligated to ensure and confirm whether the proposed installations' alignment and disposition might conflict with other existing or planned installations.

11.1.3 The government would benefit from sharing road excavation location data with industry stakeholders through a unified data platform. This would enhance the accessibility and convenience of monitoring the progress of road excavation works, while also facilitating coordination between government works departments and other utility companies for improved management of the underground space.

11.1.4 This use case aims to integrate XPMS, the UU data platform, BIM, CSDI to minimise manual input for enhanced accuracy and efficiency. The required information can be sourced from BIM, and the proposed underground utilities can be overlaid onto the 3D underground utility data available on the centralised data platform. This will help clarify the space occupation beneath the surface. Ideally, a clash analysis can be performed between the proposed or necessary updates to utilities and the existing utilities within the excavated area. This analysis can serve as a reference to facilitate XP approval.

11.2 The Process

11.2.1 To obtain an excavation permit, a detailed application must be submitted to the relevant government department, such as the Highways Department (HyD). This application should include a layout plan, a program of works, and other supporting documents. To simplify the process, applicants may utilize the Excavation Permit Management System (XPMS), an online platform that has been developed and is managed by the HyD.

11.2.2 XPMS offers a user-friendly interface that allows applicants to search for their proposed work location, draw the construction area, and input trench dimensions such as length, width, and depth.

Figure 11-1 Use Case 6 Search for proposed work location in XPMS

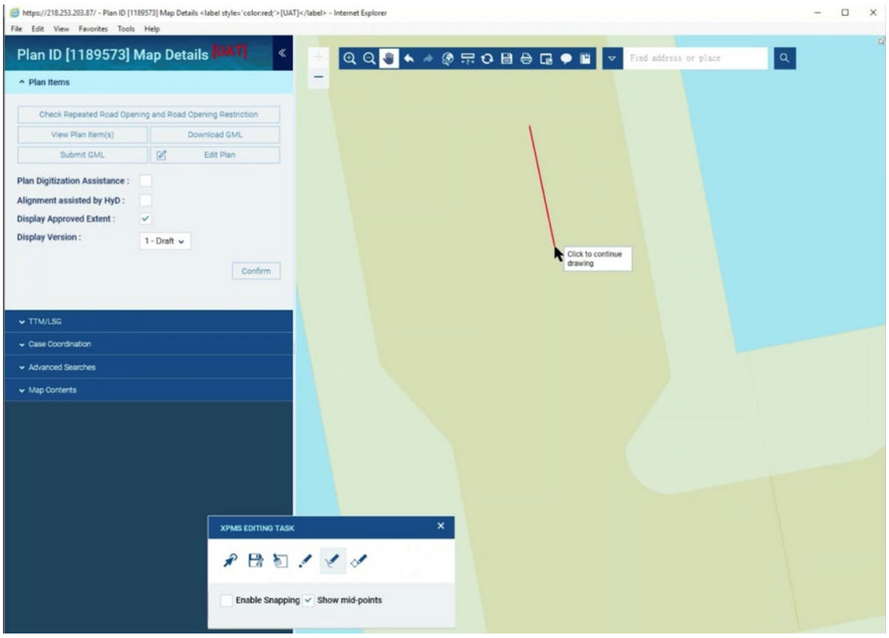
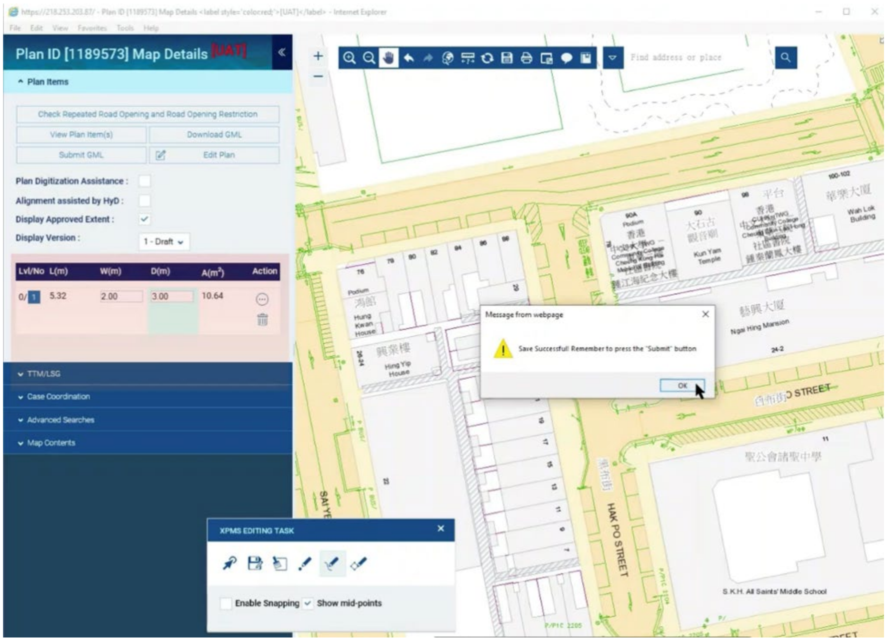
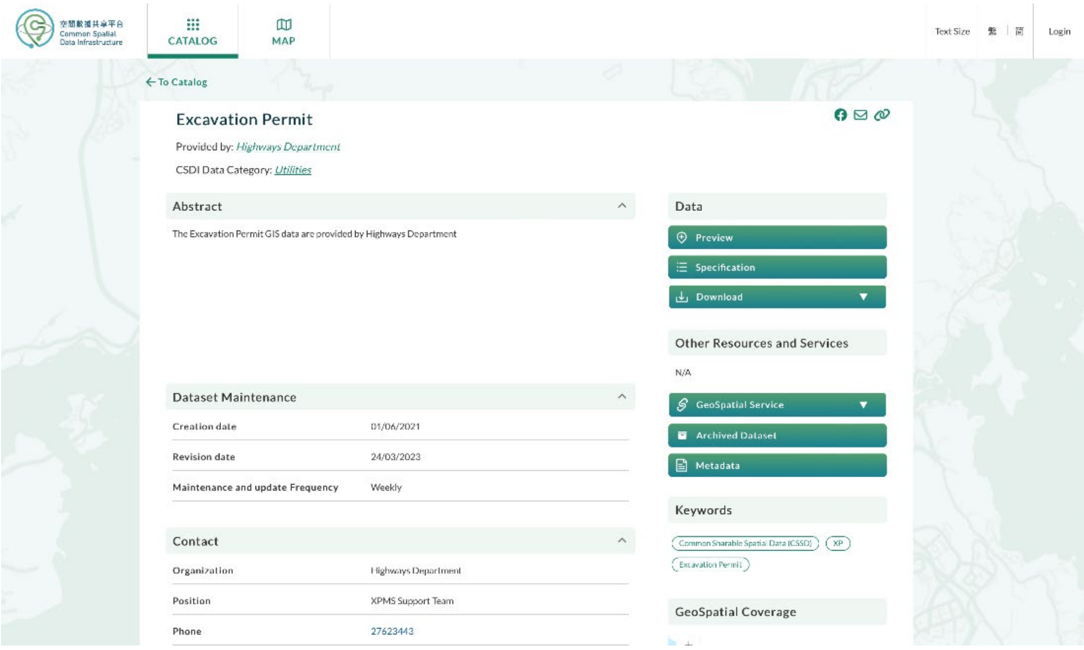


Figure 11-2 Use Case 6 Information input in XPMS



11.2.3 The HyD has released road excavation location data in GIS format, which has been made available by the CSDI. This data includes line, polygon, and point features. The line features represent narrow trench excavations (less than 2m wide). The polygon features represent non-narrow trench excavations (2m wide or more). The point features represent excavations with an area of less than four square meters.

Figure 11-3 Use Case 6 Road excavation location data in CSDI



11.2.4 The line, polygon and point are associated with the attributes including starting date of the permit, ending date of the permit, the purpose of the excavation, type of excavation permit, approved extent, level of highway polygon, trench area, length, depth and width.

11.3 The Relation to BIM And GIS

11.3.1 BIM can export the excavation area in a geo-referenced surface format or as longitude/latitude data of the vertices.

11.3.2 The coordinated layout plan can be exported from BIM to provide a detailed map of the proposed excavation site for the application of an excavation permit, along with other utility undertakings. BIM software can be used to identify potential clashes with existing infrastructure or utilities. This information can be incorporated into the coordinated layout plan in XPMS, improving the accuracy of the proposed excavation plan and reducing the potential for delays or cost overruns.

11.4 Additional Information Requirements of BIM Models

11.4.1 In the current practice, the excavation area was not required to be indicated in a BIM model. For the excavation area, massing model is good enough to provide geometry and record the excavation information in BIM.

11.4.2 The data attributes in BIM models should be mapped to the corresponding fields listed in Appendix I below to ensure that the data is accurately represented in the system. This can be done through the import process or by manually mapping the attributes in XPMS.

11.5 Information Available

11.5.1 To minimise manual input and improve efficiency, it is recommended that XPMS develop a data import feature as an alternative to manual input. This process typically involves selecting the source file or data set, mapping the data fields to the corresponding fields in the target system, and initiating the import process. The system may also provide options for data validation and error handling to ensure that the imported data is accurate and complete. By providing a data import feature, XPMS can streamline the process of importing data into the system and reduce the risk of errors or inconsistencies that can arise from manual data input. This can help support more efficient and effective excavation planning and permit management.

11.6 Method of Information Exchange

11.6.1 An Industry Foundation Classes (IFC) model can be developed for road and building mass, including a schedule of related attributes from BIM data. This model can then be imported into GIS software to support better decision-making and planning for excavation projects. By integrating the IFC model with GIS software, stakeholders can gain a more comprehensive understanding of the excavation site, including the location, size, and shape of the excavation area.

11.6.2 To export the excavation area as longitude/latitude data of the vertices, the user can extract the necessary data points from the BIM model and save them in a format that is compatible with GIS software, such as CSV or Excel. The longitude/latitude data can then be imported into a GIS software to create a geo-referenced surface of the excavation area.

11.7 Conclusion

11.7.1 The integration of XPMS, UUIS, and BIM presents a promising solution to enhance the accuracy and efficiency of road excavation works management. However, the current manual input of excavation data into the XPMS system is acknowledged as a weakness within the existing control mechanism. Furthermore, the absence of a documented standard for verifying system alignment and disposition poses a potential risk of conflicts with other existing or proposed installations.

11.7.2 By integrating the XPMS system with a common UU data platform, while leveraging the capabilities of BIM and CSDI technologies, road excavation location data can be readily accessible and conveniently monitored. Overlaying the proposed underground utilities onto the 3D underground utility data will provide clarity regarding the space occupation below the surface. Additionally, conducting a clash analysis can facilitate XP approval and improve the overall management of the underground space. We recommend further exploration and implementation of this solution to enhance the current control mechanism for road excavation works management.

12 USE CASE 7 – ENVIRONMENTAL IMPACT ASSESSMENT

12.1 General

12.1.1 The Environmental Impact Assessment (EIA) process was established under the Environmental Impact Assessment Ordinance (EIAO) with the objective of identifying and assessing potential impacts of projects during the early planning stages, while also considering alternatives and mitigation measures. The EIAO mandates the conduct of EIAs for designated projects in both the private and public sectors. This process is designed to foster sustainable development, safeguard the environment, and encourage public engagement and participation.

12.2 The Process

12.2.1 **EIA Study**

12.2.2 An EIA study is a systematic process that examines and evaluates the potential environmental impacts of a proposed development project or program. Its purpose is to identify, predict, and assess the likely effects of the project on various environmental components such as air, water, soil, and human health. The study helps to determine whether the project's potential benefits outweigh its adverse environmental impacts and provides valuable information for decision-making and project planning.

12.2.3 During the EIA study, relevant data and information are collected through various methods, including surveys, data analysis, field studies, modelling, and stakeholder consultation. The study considers the project’s potential impacts at various stages, such as construction, operation, and decommissioning. It assesses the proposed project's direct impacts (e.g., pollution, habitat loss) and indirect impacts (e.g., socioeconomic effects, cultural heritage).

12.2.4 The EIA study involves identifying potential environmental risks, the analysis of alternatives, and the development of mitigation measures to minimise or mitigate adverse impacts, which are the combined effects of multiple projects or activities on the environment.

12.2.5 Traditional EIA practices have a well-established professional framework, with specialized environmental consultants and expert modeling systems for various studies, including air quality, water quality, noise, land impact, and cultural heritage. However, the comprehensive usage of GIS and BIM technologies to facilitate the workflow of EIA studies is still limited.

12.2.6 **EIA Report**

12.2.7 The EIA study culminates in the preparation of an EIA report. The report presents the study's findings, including the identified potential impacts, the effectiveness of proposed mitigation measures, and the comparison of alternative options.

12.2.8 The EIA report serves as a key document for decision-makers, stakeholders, and the public to understand the potential environmental consequences of the proposed project. It helps in evaluating the project’s feasibility, identifying necessary permits, and ensuring that the development is environmentally responsible.

12.2.9 EIA reports are usually delivered in a 2D paper-based format, which is voluminous and makes it difficult to identify the key findings. 3D data for the visualisation of EIA aspects can be utilised to present quantitative data, which is suggested in the CIC3SBDUCR.

12.2.10 3D EIA has been promoted by the Environmental Protection Department (EPD) since 2004 to offer suggestions, innovative solutions, alternative options, and mitigation measures in the EIA study process to encourage good understanding of the professional study report by layman or the publicity.

12.2.11 GIS was the key technology being used to generate the landscape model and integration of environmentally sensitive receiver attributes into such model, which was then exported for online publishing to serve public access. Although some recent 3D EIA publishments have adopted improved GIS online technology to enhance user experience, emphasis has been on demonstration or concept rather than on exploring the Virtual Reality capabilities of GIS/BIM technologies.

12.3 Relation to BIM And GIS

12.3.1 BIM can be utilised in EIA studies to facilitate the analysis of potential environmental impacts of a proposed project. BIM models allow for visualisation, simulation, and analysis of a project's impacts in a comprehensive and interactive manner, improve the accuracy of predictions and provide a better understanding of the potential effects of the project. Following are some examples:

12.3.2 Visualisation of Environmental Impact Analysis

BIM can be used to simulate and visualise the environmental impact of a proposed project. By incorporating acoustic-related data in the BIM model, simulations can be run to predict the air/noise level at various points in and around the project site.

Figure 12-1 Use Case 7 Examples from EPD of Electronic Visualisations of the Major Findings and Elements of the EIA Report

(Source: https://www.epd.gov.hk/eia/3dv/eia300/app/index.html)

12.3.3 Visualisation of Sightline Analysis

BIM can be used to simulate and visualise sightlines from proposed developments. Sightline analysis allows the identification of visual effects of developments, such as the impact of a building on views from important landmarks or vistas and the visual impact of developments on the surrounding environments.

Figure 12-2 Use Case 7 Examples of visualising sightlines from proposed developments with BIM and GIS model

12.3.4 Integrate EIA Data into BIM/GIS

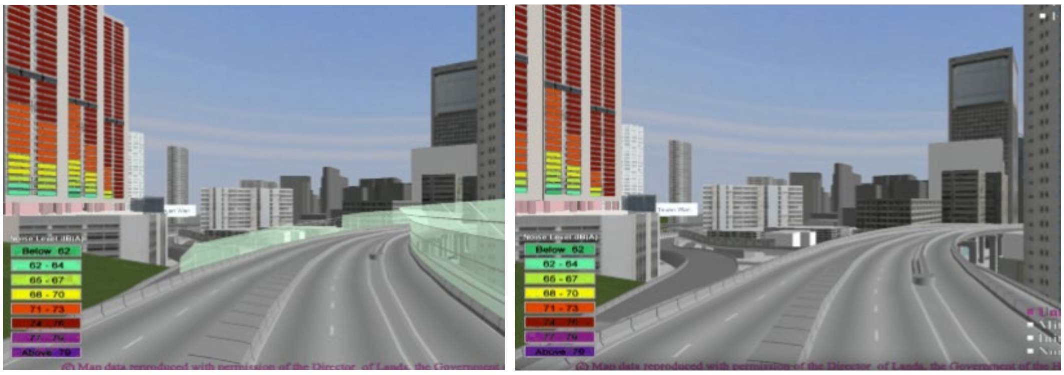
Importing EIA assessment reports, environmental data, and analysis results to BIM/GIS allows for centralising all relevant information. It helps to streamline data management and reduce the risk of information loss or duplication. Create a traceable record of environmental impact assessments, which is accountability and transparency, as all decisions and actions related to environmental considerations can be tracked and documented.

12.4 Additional Information Requirements of BIM Models

12.4.1 Visualisation of Environmental Impact Analysis

12.4.2 Input acoustic-related data to BIM model for visualisation. E.g., noise/air impact in different scenarios.

Figure 12-3 Use Case 7 Examples of acoustic data in different scenarios

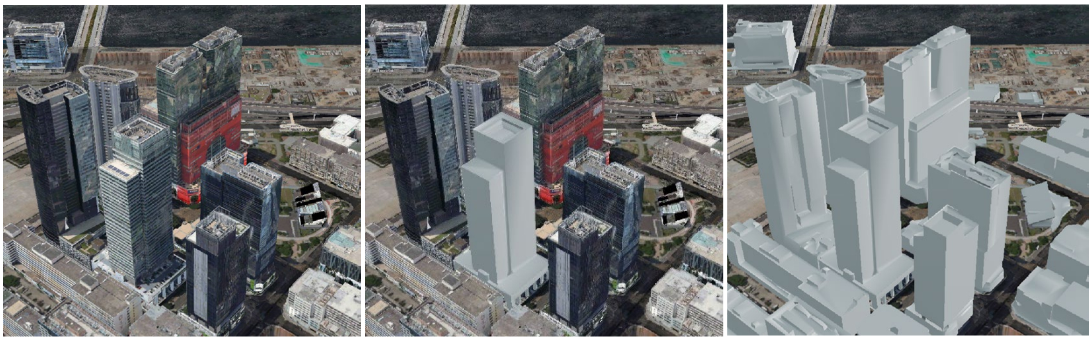


(Source: https://www.epd.gov.hk/eia/3d/index.html)

12.4.3 Visualisation of 3D Map Building Texture

12.4.4 Massing objects for buildings and infrastructures with textured data is sufficient for visualisation. However, textured data can often be overwhelming to look at. Simplifying the view by turning off or hiding irrelevant layers or textures may help. Visible Parameters for textured data or grouping for filters are suggested for identifying and highlighting areas of interest.

Figure 12-4 Use Case 7 Turning off irrelevant layers or textures for identifying area of interest



12.4.5 Design Options

12.4.6 Multiple versions of BIM models shall be created, each representing a different design alternative, by creating separate design option sets within BIM software. Distinct designs for each option set shall easily switch between options and compare side by side.

Figure 12-5 Use Case 7 BIM models of a different design or alternative

(Source: https://experience.arcgis.com/experience/5325c4d429b745629537b27495f72174/page/Noise/)

12.5 Information Available

12.5.1 Geospatial data, including location information, ground terrain profile, and sea level, can be provided from GIS/BIM in a topographic map with elevation contours.

12.5.2 Building-specific data, including building geometry, and infrastructure such as roads and highways, can be provided from BIM in massing objects.

12.5.3 Environmental data ranging from air quality, noise and land contamination to ecology, landscape and cultural heritage are available on EPD's platform. The methods for gathering environmental data include conducting field surveys, reviewing, and auditing existing data, collecting routine monitoring data, etc.

12.5.4 Summary table of information available:

Table 12-1 Use Case 7 Information available for EIA

Information Available	Supporting Organisation	Platform	Source
Geo-spatial data to support smart city applications	Lands Department	Common Spatial Data Infrastructure (CSDI) (Former Hong Kong Geodata Store)	https://portal.csdi.gov.hk/csdi-webpage/
3D Photo-realistic model based on aerial photos captured in March 2017 and 2018	Planning Department	3D Photo Realistic Model	https://www.pland.gov.hk/pland_en/info_serv/3D_models/download.htm
Light Detection and Ranging (LiDAR); Digital Map; Unmanned Aerial Vehicle (UAV) Products	Civil Engineering and Development Department (CEDD)	Spatial Data Portal	https://sdportal.cedd.gov.hk/
Various baseline data related to environment and ecology in the EIA reports (air quality, water quality, hydrology, traffic noise, etc)	The Environmental Protection Department (EPD)	Centralised Environmental Database (CED)	https://eiaced.epd.gov.hk

12.6 Method of Information Exchange

12.6.1 Convert the data into a common format that can be used by both BIM and GIS software. This may involve exporting BIM models as IFC (Industry Foundation Classes) or CityGML files and converting GIS data to compatible formats like shapefiles or GeoJSON, LandXML, and Collada.

12.6.2 Additionally, data interoperability can be facilitated by open Application Programming Interfaces (APIs) and web services to facilitate seamless data transfer between BIM and GIS software platforms.

12.7 Conclusion

12.7.1 The way forward for 3D EIA in Hong Kong would involve continued collaboration between government agencies, industry professionals, and academic institutions to develop more advanced techniques for integrating BIM and GIS data into the EIA process. This may include the development of new standards and guidelines for data sharing and management, as well as increased investment in research and development of cutting-edge technologies such as LiDAR scanning and drone mapping. Additionally, stakeholder engagement will be crucial to ensuring that these technologies are used effectively in a transparent and inclusive manner.

13 USE CASE 8 – BUILDING ENERGY MONITORING AND FACILITY MANAGEMENT

13.1 General

13.1.1 The adoption of Internet of Things (IoT) technology is becoming increasingly important in the construction industry. Asset owners are recognizing the benefits of utilizing IoT devices to collect environmental data such as temperature, humidity, electricity usage, and water consumption. This data can assist in facility management and operations and maintenance (O&M) activities. By gathering this information, asset owners can formulate preventive maintenance plans and optimise the performance of their properties.

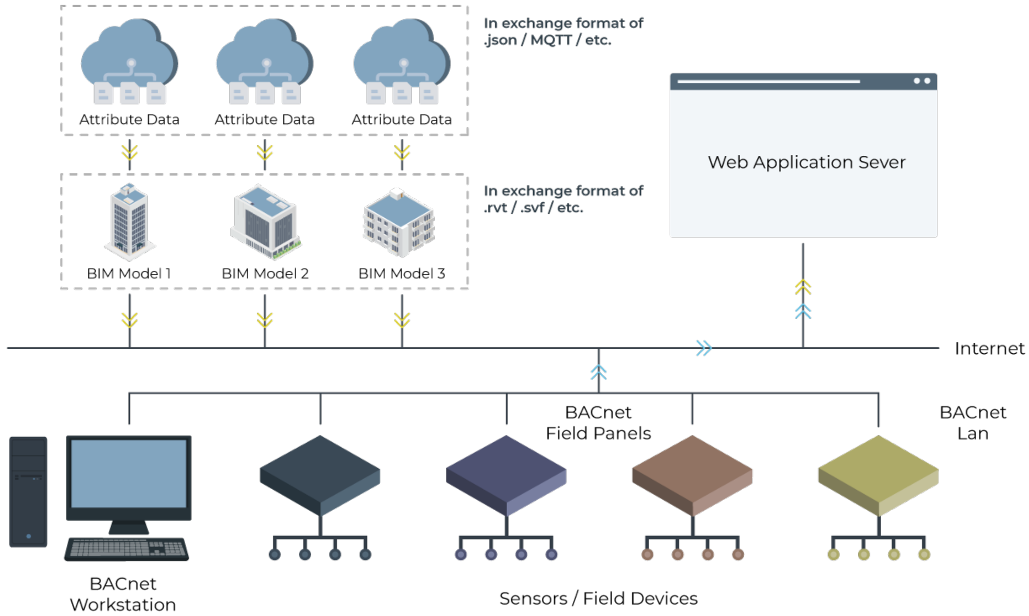
13.1.2 However, currently, the project data collected through IoT devices is often used for internal purposes and not shared among project stakeholders. To fully leverage the potential of IoT technology, there is a need to develop a centralized data platform that integrates with BIM technology. This integration would enable the sharing and exchange of information among stakeholders and foster the development of digital platforms. For example, by sharing occupancy data from public car parks and making it available online, applications could be developed to monitor and track public transport data for the government or provide real-time information on available parking spots for road users.

13.1.3 To facilitate the development of the centralized data platform and enable the gathering of IoT information from various projects and different owners, it is crucial to establish standards for data sharing and the integration of BIM models with IoT data.

13.2 The Process

13.2.1 The following is an overview of the interfacing between IoT devices and BIM models.

Figure 13-1 Use Case 8 An overview of the interfacing between IoT devices and BIM models



13.2.2 To allow interfacing between BIM models and IoT sensors, the sensors shall be built into the BIM models with the following information, including but not limited to geometry, appearance, location, and Feature ID.

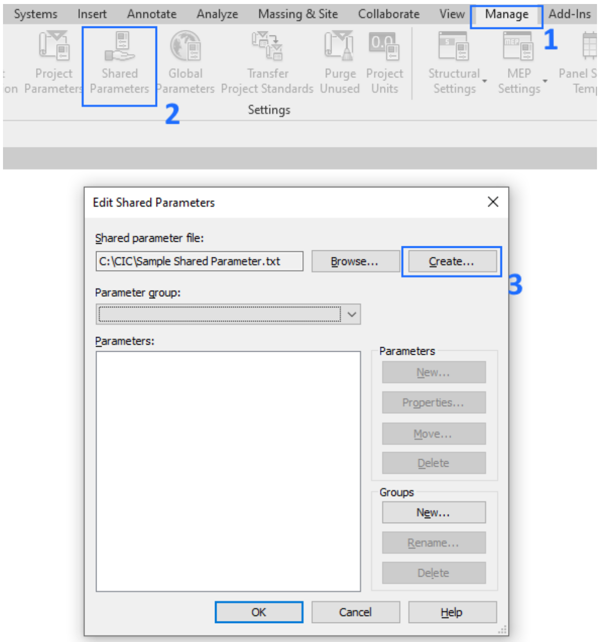
13.2.3 The sensors may contain and transmit multiple data; for example, an IAQ sensor can transmit temperature, humidity, and concentration of PM2.5 at the same time. Those different datasets should be named and defined in convention to the BMS system as practical as possible.

An example of the naming convention of the data point can be found in the Appendix H of BIM-AM Standards and Guidelines version 3.0 by EMSD.

13.2.4 The method to embed custom attributes into BIM objects may varies by the authoring software. The following is an example of adding custom attributes in Revit:

1. Create a shared parameter file by accessing **Manage** > **Shared Parameters**.

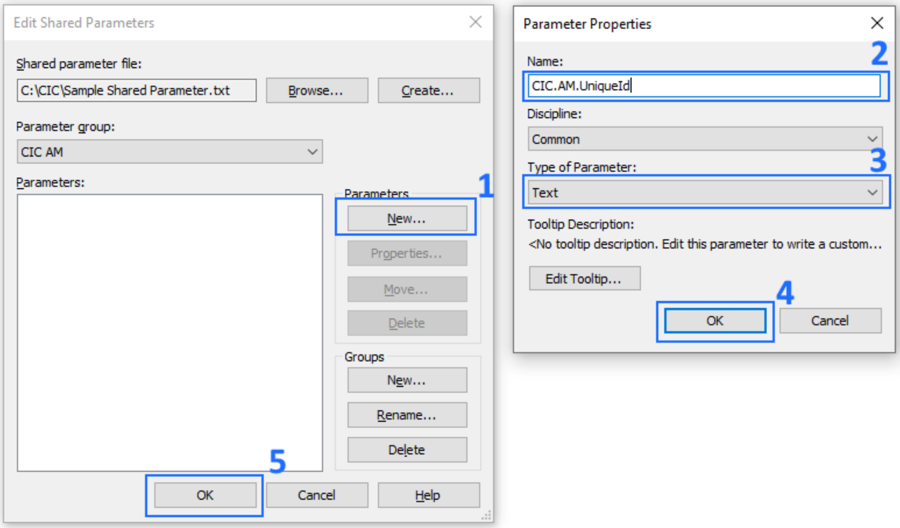
Figure 13-2 Use Case 8 Create a shared parameter file



2. Create new group by clicking **New** button in the **Groups** section. In this example, "CIC AM" is used as the group name.

3. Create new parameters by clicking **New** button in the **Parameters** section. In the popup dialog, input "**CIC.AM.UniqueId**" as the name of the parameter. Select "**Text**" as the parameter type and click OK.

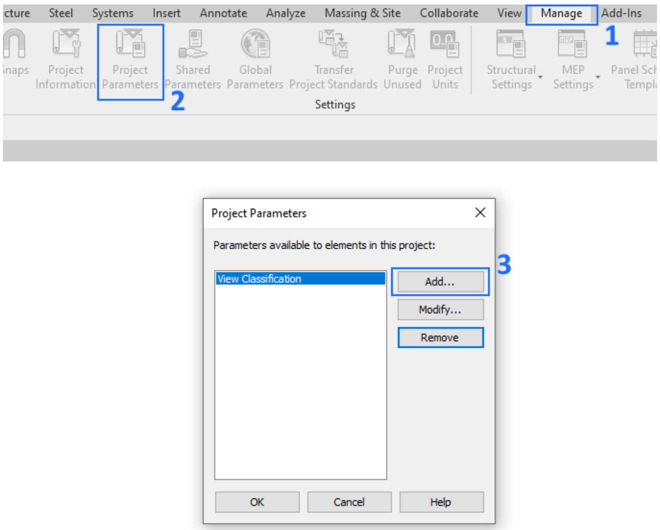
Figure 13-3 Use Case 8 Create new parameters



4. A shared parameter file with parameter definition is created and is ready to be used in the project.

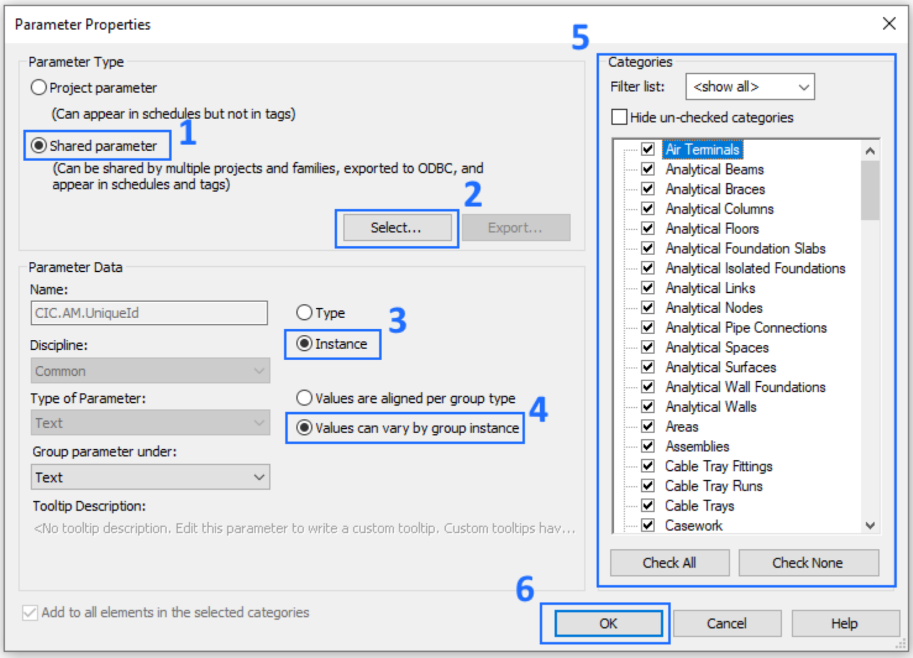
5. Proceed to **Manage** > **Project Parameters** > **Add** to add custom parameters in the project file.

Figure 13-4 Use Case 8 Add custom parameters in project file



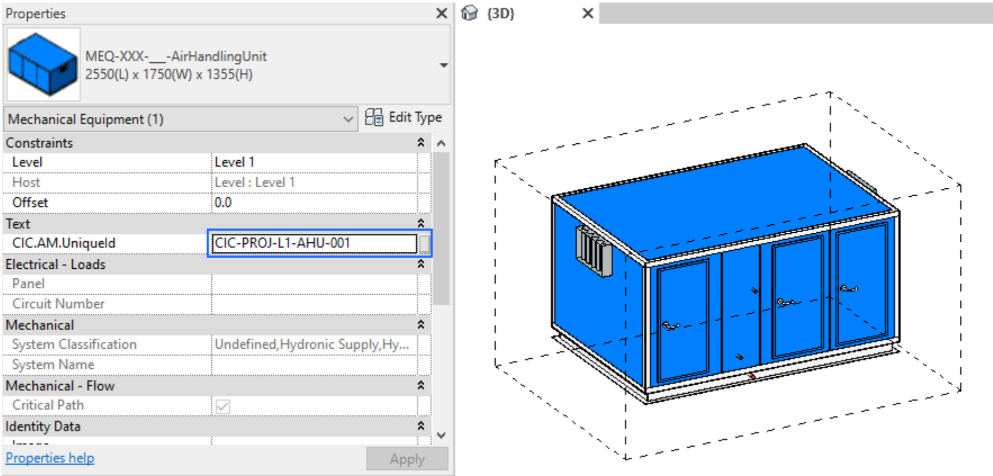
6. Select "Shared Parameter" in the popup window and click "**Select…**". Another dialog will pop up, and pick "CIC.AM.FeatureId" as the parameter to be added. Select "**Instance**" and "**Values can vary by group instance**" in the parameter data section. Pick appropriate categories on the right-hand side and finally click OK to proceed.

Figure 13-5 Use Case 8 Selection of Shared Parameter



1. "CIC.AM.FeatureId" now appears as a writable attribute of BIM objects.

Figure 13-6 Use Case 8 BIM object with Shared Parameter in project file



13.2.5 The Feature ID is used to build a link between the IoT sensors and BIM models. The data provided by IoT sensors shall contain a Feature ID, which allows the system to create mapping and linkage to visualise the data for the specific sensors.

Table 13-1 Use Case 8 Example of Unique ID

Organisation Name	-	Project Name	-	Location	-	Equipment Type	-	Sequence No.
CIC	-	PROJ1	-	L1	-	AHU	-	001

A single asset may have a relationship with multiple data points. The IoT platform can handle and visualise the data accordingly if the data point is paired with the asset identifier.

13.2.6 To allow interfacing between BIM models and asset / equipment data (permanent data), the assess / equipment shall be built into the BIM models and contains, but is not limited to, geometry appearance, location and required attributes and values.

13.2.7 After the preparation work, the BIM models are exported into compatible formats such as .ifc and its data is ready to be extracted by / used with other systems / platforms.

13.3 The Relation to BIM And GIS

13.3.1 The BIM object is an information container that stores different data depending on the user's requirement. The data may include unique identifier ID, geometric location, appearance, materials, manufacturer information, installation date, serial number, relationship, hierarchy of its connected objects, etc. The data can be extracted from the BIM models for further uses, such as visualisation and IoT sensor information overlay, to provide a more instinctive user experience.

13.4 Additional Information Requirements of BIM Models

13.4.1 To co-link the BIM models with IoT data, several additional pieces of information may need to be input into the BIM models.

a. FeatureID

The object's unique identifier must be attached to the BIM object to build a linkage between the BIM model and FM / IoT data.

b. Geometric Location

13.4.2 The geometric location of the objects must be available so that the information can be processed and visualised by any platform. FM information that is essential for maintenance should be attached to the BIM objects accordingly based on the LOD-I and DOC requirement derived by the final uses of the BIM models provided by the appointing parties.

13.4.3 FM Attributes:

The following is an example of attribute data embedded in a BIM object. The attribute list is extracted from the EMSD-BIM-AM Standards and Guidelines version 3 – Appendix B Asset Data Templates. The attribute data list may vary depending on the organisation and the nature of the equipment.

Figure 13-7 Use Case 8 Example of attribute data embedded in BIM Object

FM Attributes:

EMSD.Electrical Distribution Type:	Radial
EMSD.Electrical.Date of Last PITC:	10-三月-2023
EMSD.Electrical.Dimensions:	600 x 1160 x 200
EMSD.Electrical.Distribution Type:	Radial
EMSD.Electrical.Equipment Type:	MCCB
EMSD.Electrical.Insulation Type:	MCCB
EMSD.Electrical.Location:	STORY 16
EMSD.Electrical.Make:	N/A
EMSD.Electrical.Material:	Galvanized 1.2mm Steel Sheet
EMSD.Electrical.Model:	B17104R
EMSD.Electrical.Nos. of Phase:	3
EMSD.Electrical.Nos. of Poles or cores:	1
EMSD.Electrical.Nos. of ways:	14
EMSD.Electrical.Outgoing Circuit:	CCT-001
EMSD.Electrical.Switchgear No.:	1
EMSD.Electrical.Upstream LVSB CCS No.:	LVSB101

13.5 Information Available

13.5.1 The information would be further categorised into persistent type and transient type. Persistent type is data that persists and remains unchanged for a long period of time, such as manufacturer name, serial number, and installation date of the equipment. The persistent data is available once the equipment information is finalised and input into the BIM objects.

13.5.2 The transient type is data that changes continuously, and an example includes the temperature and humidity reading from IAQ sensors. The data is available once the IoT infrastructure and sensors are installed and committed. The update triggers, for example, the time interval to update the data or when the data has a noticeable change, should be mentioned and included in the exchange data format to facilitate smooth interfacing between developers.

13.5.3 The following are examples of attributes organisations may consider endorsing in the facility management process.

Table 13-2 Use Case 8 Examples of attributes

System	Equipment	Attribute	Data Type
Air-Conditioning	AHUs	Rate Power Input	Permanent
Air-Conditioning	AHUs	Cooling Capacity	Permanent
Air-Conditioning	AHUs	Instantaneous Power	Permanent
Air-Conditioning	IAQ sensors	Temperature & Humidity reading	Transient
Air-Conditioning	IAQ sensors	CO2 concentration reading	Transient
Electrical	Light Fittings	Manufacturer	Permanent
Electrical	Light Fittings	Luminaire Power	Permanent
Electrical	Light Fittings	Light Status (On / Off)	Transient
Electrical	Lux Sensors	Lux reading	Transient
Electrical	Power Meters	Accumulated energy consumption	Transient
Plumbing	Water Pumps	Motor Power	Permanent
Plumbing	Water Pumps	Water pressure	Transient

System	Equipment	Attribute	Data Type
Security	CCTVs	Camera IP address	Permanent
Security	CCTVs	Web streaming data	Transient

13.6 Method of Information Exchange

13.6.1 As mentioned earlier, data can be further classified into different categories, and the methods of exchanging data vary depending on the nature of the data.

13.6.2 For persistent data, the most common method of obtaining it is through the transfer of BIM model files. This can be done using traditional approaches such as peer-to-peer file servers, email attachments, or copying files from a computer to a portable storage device. Once the transfer is completed, the persistent data can be accessed using appropriate authoring or model viewing software. In addition to traditional methods, some CDEs offer the option to convert BIM models into lightweight models, allowing users to access the persistent data through a web browser.

13.6.3 The methods used to obtain transient data depend on the IoT infrastructure and its data transmission protocol. Examples of data transmission protocols include MQTT, which is often used in resource-constrained networks with limited bandwidth, and OpenAPI, which is widely used in web services. Once the IoT infrastructure and services are set up, the transient data can be accessed using the respective protocol.

13.7 Conclusion

13.7.1 To conclude, there are numerous different ways of integrating IoT data into BIM models. For the ease of the development of centralised platform, standards and guidelines shall be established regarding the format and protocol of the shared data. This will minimize the cost and time required for the development of a system.

13.7.2 The following is a screenshot of a web platform integrating IoT data with BIM models. Sensor readings, maintenance data and certificates of equipment are incorporated in the platform.

Figure 13-8 Use Case 8 Web platform integrating IoT data with BIM models - Lift

Figure 13-9 Use Case 8 Web platform integrating IoT data with BIM models - Distribution boards

TYPE	ID	SEC	STOREY	VOL	STOREY + TYPE	DATE	CONC	YEAR	MONTH	YEAR-MONTH
BEAM	1008740	B250x400	STOREY1	0.48	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008741	B250x400	STOREY1	0.46	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008742	B250x400	STOREY1	0.4	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008743	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008744	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008745	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008746	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
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BEAM	1008748	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008749	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008750	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008751	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
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BEAM	1008761	B250x400	STOREY1	0.47	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
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BEAM	1008764	B250x400	STOREY1	0.46	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008765	B250x400	STOREY1	0.46	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1

14 USE CASE 9 – AIR VENTILATION ASSESSMENT

14.1 General

14.1.1 An Air Ventilation Assessment involves evaluating the impact of urban planning and building development on external air movement and temperature, particularly at the pedestrian level. It aims to understand how the design of buildings and their surroundings influence airflow patterns and thermal comfort in outdoor spaces.

14.1.2 In the industry, the application of Computational Fluid Dynamics (CFD) simulations is often preferred over traditional wind tunnel tests for conducting Air Ventilation Assessments. CFD simulations allow for a more detailed analysis of airflow patterns and temperature distribution, considering factors such as building geometry, wind conditions, and surrounding structures. However, the preparation work for CFD simulations can be time-consuming, involving tasks such as model creation, mesh generation, and setting up simulation parameters.

14.1.3 This section focuses on studying and streamlining the process of incorporating BIM technology into the CFD simulation task. BIM technology provides a 3D digital representation of the building and its surroundings, including detailed geometric information. By leveraging BIM, the workflow of CFD simulations can be improved and made more efficient.

14.2 The Process

14.2.1 Performing CFD simulations requires obtaining relevant data from various sources and manipulating it to be compatible with the CFD software. The procedure for data preparation is outlined as follows:

14.2.2 Firstly, the topology map is downloaded from LandsD and converted into a compatible 3D format in the CFD software. The topology map provides information about the terrain and elevation of the study area. This map needs to be converted into a compatible 3D format that can be recognised by the CFD software. The coverage area of the topographic map should typically extend 10 times the height of the building being analysed to account for the surrounding environment.

14.2.3 Secondly, the mass of surrounding buildings is built from the building polygon layer and the height can be acquired from the attribute table of the building polygon layer. The building masses are then converted into a compatible format within the CFD software, allowing them to be recognized and incorporated into the simulation.

Figure 14-1 Use Case 9 Collect building boundary and the height from CSDI

14.2.4 Thirdly, the BIM model of the project is simplified and transformed into a compatible format and imported into the CFD software.

Figure 14-2 Use Case 9 Massing model of surrounded buildings

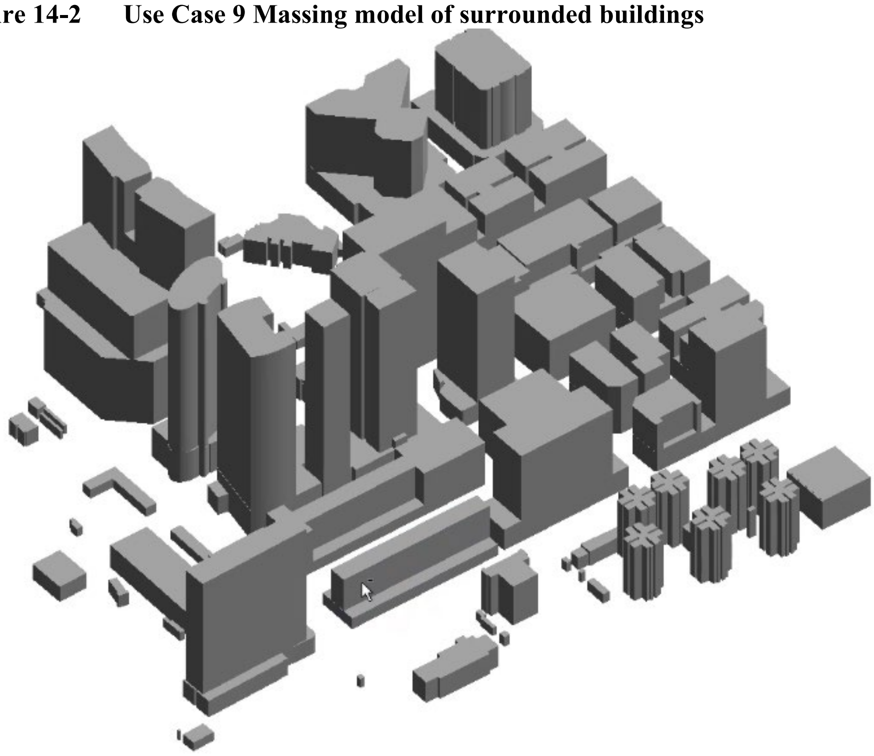
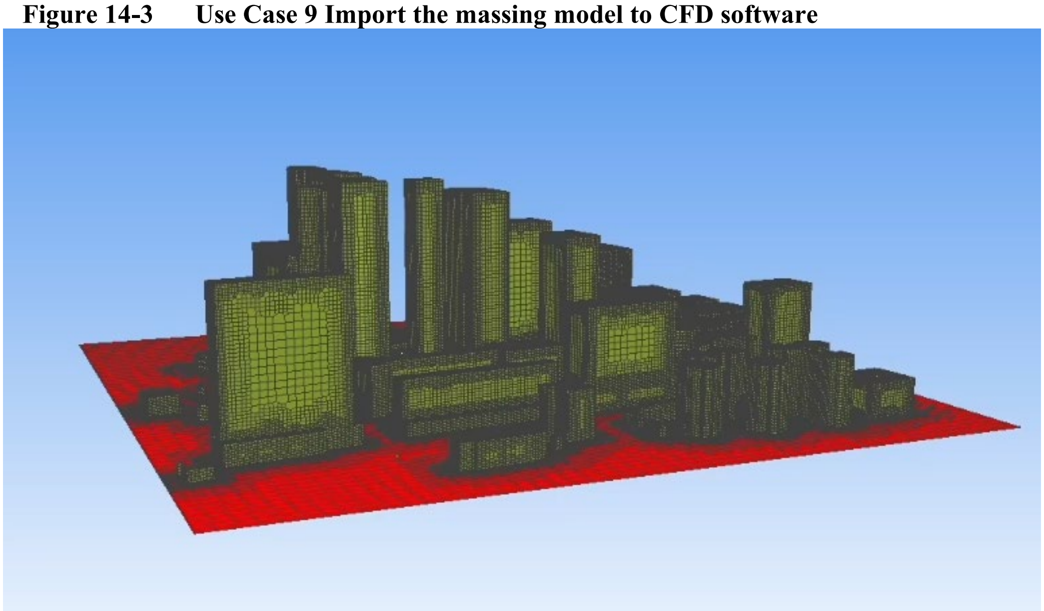
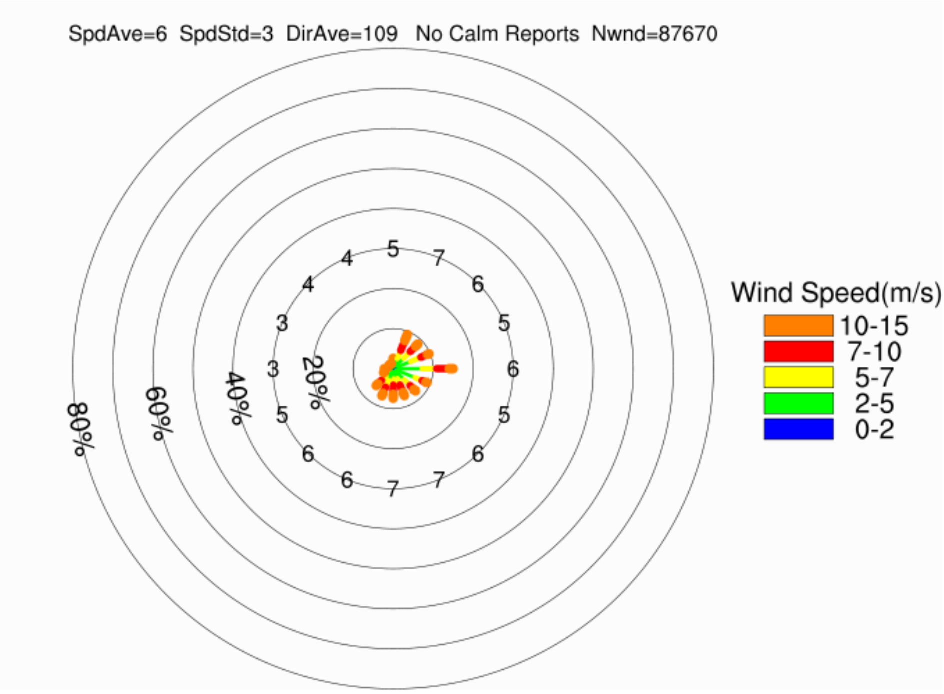


Figure 14-3 Use Case 9 Import the massing model to CFD software



14.2.5 Fourthly, wind data is downloaded from the website of PlanD. The data is in .jpg format which will need further steps to convert into numeric data, for example, manual conversion to excel format.

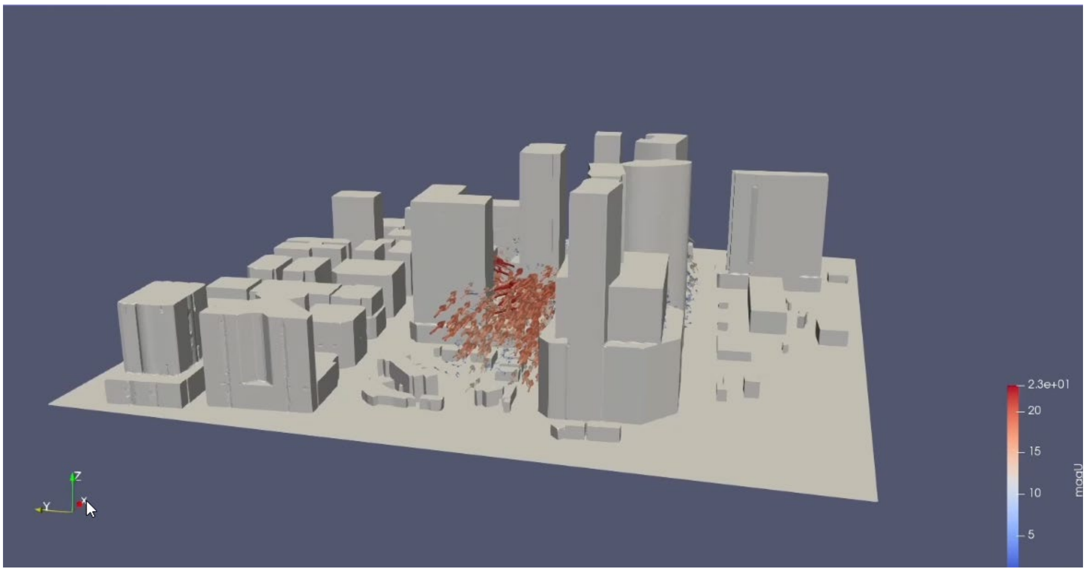
Figure 14-4 Use Case 9 Wind data download from LandsD



14.2.6 The wind data is finally imported into the CFD software as boundary conditions and is ready to proceed to simulation.

14.2.7 CFD may also be applied for indoor air ventilation analysis, for example, air flow simulation in the data hall of the data centre. Multiple boundary conditions can be input to specify and study the air flow of the simulation.

Figure 14-5 Use Case 9 Example of the result of sir ventilation analysis



14.3 The Relation to BIM And GIS

14.3.1 As discussed previously, the 3D geometry of the building is directly exported from the BIM model and is further simplified to be compatible to be used with the CFD software.

14.4 The Additional Information Requirements of BIM Models

14.4.1 The BIM model should be built as a solid and not a surface nor meshes in order to support the software to perform simulation.

14.5 Information Available

14.5.1 The required data and its source to perform AVA are listed below:

14.5.2 Topographic Map

The topographic map is available in CAD and GDB format on LandsD's website. The CAD or GDB file is used to convert the topography of the simulation.

14.5.3 Surrounding Building Mass

The boundary profile and height of the project's surrounding buildings are available on LandsD's website. The data is available in various formats, for example, CityXML, JSON, etc, and is consumed by software and generates building masses.

14.5.4 Building Mass

The building mass is exported from the native file format of the BIM model.

14.5.5 Site Wind Availability

The site wind availability data is available on PlanD's website in JPG format. The data is usually further processed to interpolate the required boundary conditions and input into the simulation software.

14.5.6 AVA Project's Location & Report

The data is available as a PDF on PlanD's website, and boundary conditions are extracted and input into the simulation software.

14.6 Method of Information Exchange

14.6.1 The surrounding building mass data required for the AVA is available on the LandsD and PlanD websites, and the datasets are published regularly in multiple formats, e.g., CityXML and JSON.

14.6.2 The building mass of the building is available once the BIM model with the building geometry is ready. The model is further simplified to be CFD-friendly.

14.6.3 Common used CFD software in the Hong Kong industry is listed as follows:

a. Ansys Fluent

b. Autodeks CFD

c. OpenFoam

d. PHENOICS

e. Solidworks

14.7 Conclusion

14.7.1 In conclusion, the process of gathering and preparing data for CFD simulations can be time-consuming, involving communication with various parties, consolidation of data, and converting it into the appropriate format. This process is prone to errors, which can lead to inaccurate simulation results.

14.7.2 Thus, a centralised data-sharing platform is recommended to expedite data acquisition and data pre-treatment procedures. Such a platform could streamline the data gathering process by providing functions to download topographic maps and surrounding building masses within a specified range. This would eliminate the need for manual communication and data conversion, expediting the data acquisition process.

15 USE CASE 10 – PREMIUM ASSESSMENT AND PROPERTY VALUATION

15.1 General

15.1.1 "Land Premium" valuation and "Property Valuation" are two different topics using Land and property units' information. The information is expected to be accessed through a digital map with the building block (or flat unit for the "Property Valuation") as the selection "tag" to connect the information.

15.1.2 The building blocks of existing buildings can be obtained from the Geospatial Datastore of the Hong Kong Lands Department (CSDI). In the future, the building blocks of new buildings can be derived from the as-built information of construction projects. Additionally, the plug-in being jointly developed by BD and LandsD, which utilizes predefined parameters like PremiseID and PremiseLocation, can be used to develop the flat unit blocks for the Property Valuation.

15.1.3 Although the required information is available, it is currently not centrally organised for easy access. To address this, it is recommended to develop a web-based information portal that connects to various sources to obtain or purchase the available information. This portal would provide a centralized platform for accessing land and property unit data, streamlining the process for valuations and related purposes.

15.2 The Process

15.2.1 The Use Case of Premium Assessment and Property Valuation details are described in CIC3SBDUCR. In addition, CIC3SBDUCR suggested ways to develop a "3D GIS Web Property Information Platform" and "3D Cadastral System".

15.2.2 The "3D GIS Web Property Information Platform" and "3D Cadastral System" are web-based platforms or systems embedded with GIS having building blocks and flat unit objects included as the information link connectors.

15.2.3 In this document, the technical source and method of providing BIM's building blocks and flat units are elaborated.

15.3 The Relation to BIM And GIS

15.3.1 The building blocks and flat units in GIS can be provided from BIM using the massing objects. The definition of the massing object for the building block shall follow the Area calculations based on the LocationID. The building block's height shall reach the block's roof level.

15.3.2 The definition of the massing object for the flat units shall follow the Area Calculation with the identification of Premise ID, Premise Location, and Level, assuming that unit height follows the floor-to-floor height between Levels.

15.4 Additional Information Requirements of BIM Models

15.4.1 The massing model is not mandatory in most of the building projects in Hong Kong. It is only built at the early stage (e.g., Master Layout Plan) of a project when BIM is used. The primary purpose of these massing models is to show the form or scale of the building. Therefore, there are no specific requirements on the definition of the massing model, even if it is built.

15.4.2 To provide building objects for the building block or flat units for the "3D GIS Web Property Information Platform" and "3D Cadastral System", the massing model is good enough to provide the information about the form and scale. With the definition ties in with the Area calculations, it is an essential and straightforward item that projects can build and provide.

15.5 Information Available

15.5.1 Although the massing model is not mandatory, Area definition is commonly included in BIM for building projects. The Area definition is an essential item in building control in terms of its allowed scale meeting the statutory requirements and the allocation of usage meeting the schedule of accommodation requirements provided by the client. The development of the massing model based on the Area definition is just a small additional step after the Area calculations are developed.

15.6 Method of Information Exchange

15.6.1 The massing model in BIM shall be exported to openBIM (.ifc) format for import to GIS. In addition, the GIS model shall be embedded in the web-based platform or system to develop the “3D GIS Web Property Information Platform” and “3D Cadastral System”.

15.7 Conclusion

15.7.1 Building blocks and the flat units in the "3D GIS Web Property Information Platform" and "3D Cadastral System" can be provided from BIM when the BIM model is properly setup with layout and building information included in line with other BIM uses, e.g., statutory submission in the future. The proposed additional information in BIM is aligned with the settings (e.g., Parameter Name) developed by the BD. Once statutory plan submission is in place, there will be information available for the 3D GIS platform.

16 USE CASE 11 – PRELIMINARY DESIGN FOR BUILDING (INCLUDING A&A WORKS) AND CIVIL ENGINEERING PROJECTS

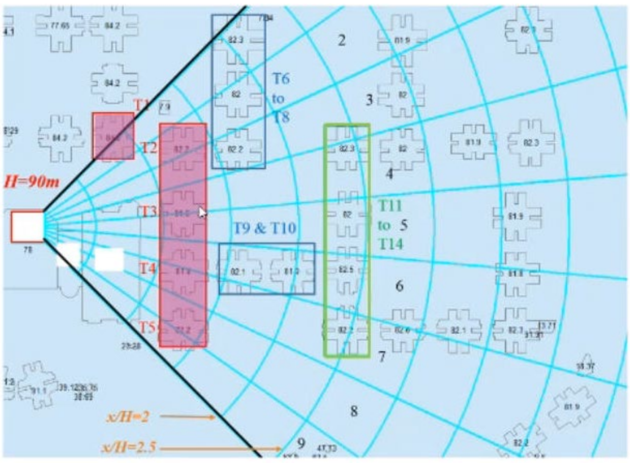
16.1 General

16.1.1 This use case encompasses a wider range of aspects. The below-presented wind analysis serves as an illustrative example highlighting a specific aspect within the broader theme of the use case. The intention behind including this analysis was to demonstrate a practical application and showcase the practicality.

16.1.2 In the preliminary structural design phase, conducting wind analysis and calculating wind loads are critical tasks. The new wind load design code, the Code of Practice on Wind Effects in Hong Kong 2019, emphasizes the consideration of the wind sheltering effect around buildings, which can lead to a reduction in the design wind load. Taking the sheltering effect into account requires obtaining models of the surrounding buildings, and the calculation process can be relatively complex.

16.1.3 This document will discuss the integration of information from the Hong Kong urban building models provided by CSDI. By leveraging data processing techniques, wind load calculations can be made easier, and models of the surrounding buildings can be obtained. This integration can be achieved through the use of BIM automation technology or by directly importing the data into other wind analysis software for wind load calculation.

Figure 16-1 Use Case 11 Code of practice on wind effects in Hong Kong 2019 &Wind shelter effect calculation



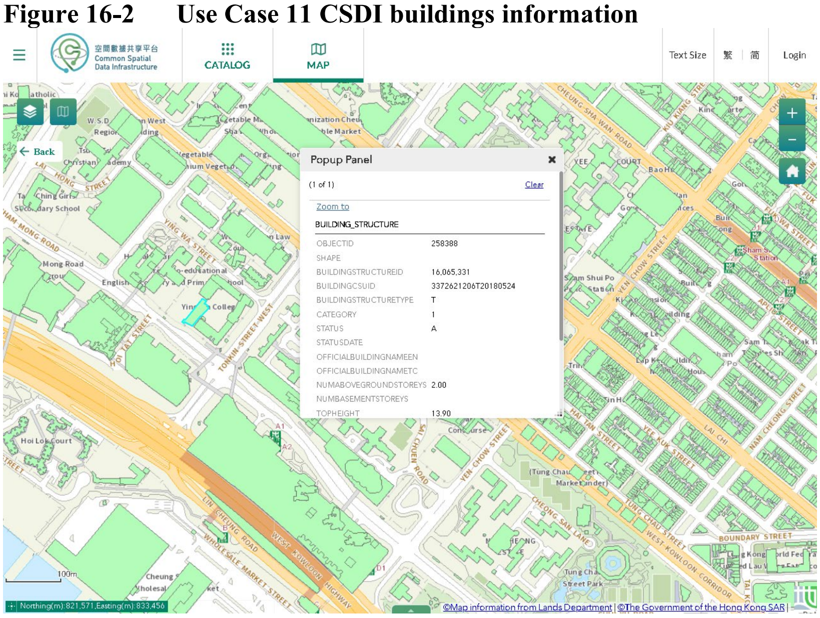
16.2 The Process

16.2.1 As a result of consolidating the opinions by the interviews with stakeholders, relevant HK BIM related documents, and a vast number of desktop studies, the following brief is a common practice for wind load calculation.

16.2.2 Method of obtaining 3D models of the surrounding buildings of the project

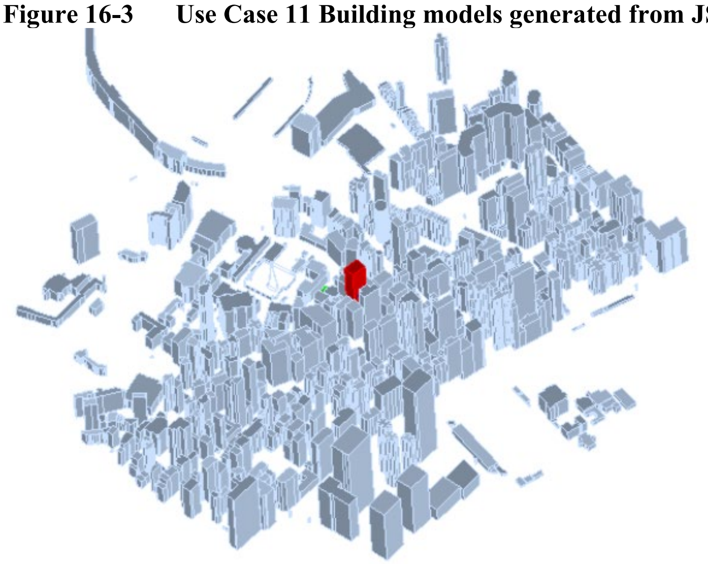
a) Users can download 3D model information of Hong Kong buildings on the CSDI system, including simplified polyline models and building heights (but not ground elevations), which have met the requirements for wind load calculations. The use of simplified building models is sufficient for the purpose.

Figure 16-2 Use Case 11 CSDI buildings information



b) Build 3D models for wind analysis: The CSDI system provides building polylines and building heights in JSON format. Users first select the surrounding buildings of the project through coordinates, and the scope is determined according to the requirements of wind load specifications. Users can use BIM Automation to convert JSON data into 3D models of the project's surrounding buildings.

Figure 16-3 Use Case 11 Building models generated from JSON file



c) Import the wind analysis software for wind load analysis

Users import the generated 3D models of the surrounding buildings of the project into commercial software (for example, NIDA wind) for wind load calculation and obtain the wind load for the preliminary design of the structure. Alternatively, users can directly use BIM Automation technology to calculate the wind load.

Figure 16-4 Use Case 11 Calculating wind load directly using NIDA wind

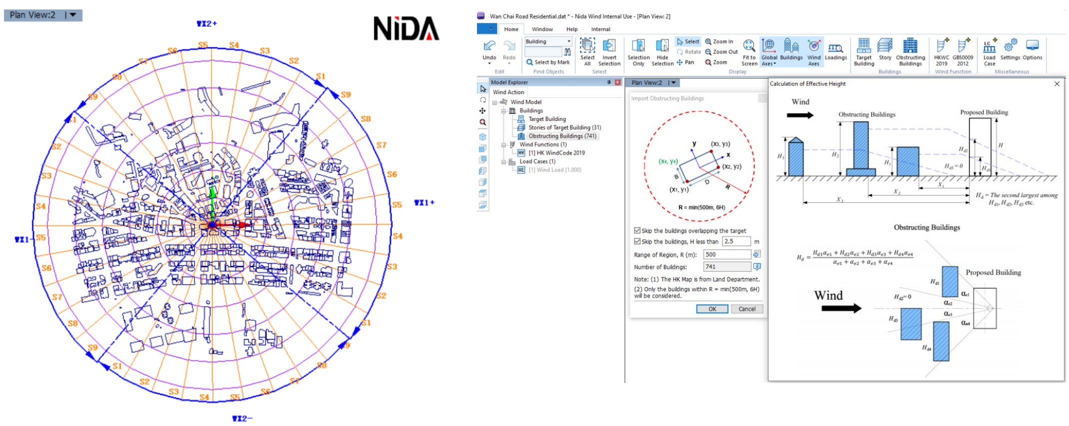
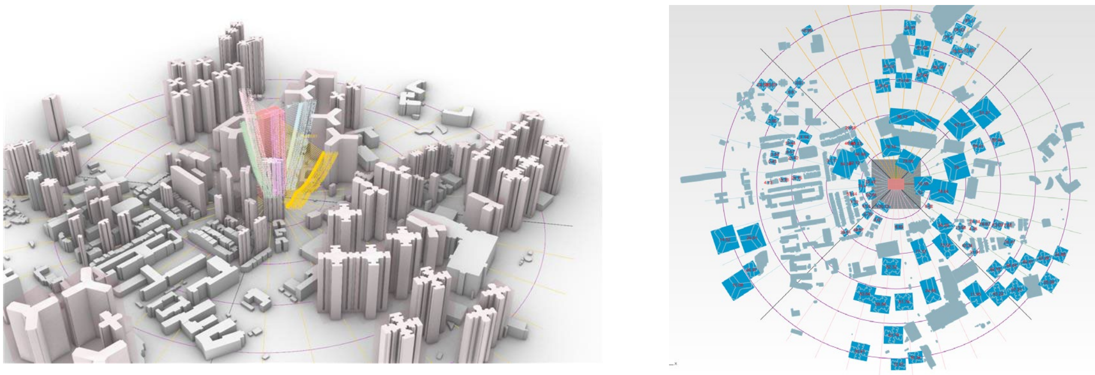


Figure 16-5 Use Case 11 Calculating wind load directly using BIM automation



16.3 The Relation to BIM And GIS

16.3.1 The new wind load specifications require the calculation of wind shielding efficiency, which requires understanding the spatial relationship between the project and surrounding buildings. Therefore, the relationship between wind load analysis and BIM is closely intertwined.

16.3.2 The CSDI system provides building data suitable for wind load analysis, which can be directly converted into a 3D BIM model through BIM Automation technology and then used for wind load analysis. This process avoids time-consuming data collection and 3D modelling for engineers, thereby improving work efficiency.

16.4 Additional Information Requirements of BIM Models

16.4.1 Currently, the CSDI system provides building footprint polylines and building height information but lacks the ground elevation information of buildings.

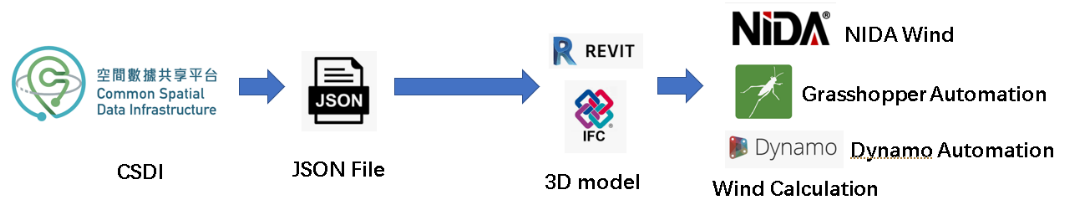
16.5 Information Available

16.5.1 LandsD provides digitalised map data in the form of JSON files. The data includes simplified floor plans and information on building heights and stories for most urban Hong Kong buildings.

16.6 Method of Information Exchange

16.6.1 The current data format provided by the CSDI system is JSON, which includes information such as building names, polylines, and building heights. Converting the JSON data format into the OpenBIM format may be considered, including Building Mass and other object properties.

Figure 16-6 Use Case 11 Process of converting JSON data to OpenBIM format



16.7 Conclusion

16.7.1 The CSDI system provides model data for wind load analysis, which can be converted into a 3D BIM model through BIM technology and imported into the program for wind load analysis. This work process reduces the time for engineers to collect information and draw models, improving work efficiency. Additionally, suggestions are made for the format of future shared model data and the shortcomings of the data.

17 USE CASE 12 – EMBODIED CARBON CALCULATION

17.1 General

17.1.1 The calculation of embodied carbon is a crucial aspect of sustainable construction, as it helps to reduce the environmental impact of building projects. BIM has emerged as a valuable tool for accurately estimating the embodied carbon of a construction project. By providing detailed information about the materials and components used in construction, BIM enables a more precise assessment of the carbon emissions associated with a building.

17.1.2 BIM models can be utilised to gather data on material quantities, types, and sources, which are necessary for calculating the embodied carbon. This information can be extracted from the BIM models and used in conjunction with environmental databases to determine the carbon footprint of the construction project. The accuracy of embodied carbon calculations is crucial for ensuring that building projects are sustainable and comply with relevant environmental regulations.

17.1.3 This document will explore t the process of utilizing BIM models for embodied carbon calculation. It will explore the requirements for accurate quantity take-off from BIM, including the need for comprehensive and detailed models that include all relevant materials and components. Furthermore, the article will discuss the benefits of incorporating embodied carbon calculation within the BIM workflow for sustainable construction.

17.2 The Process

17.2.1 Traditionally, quantity data has been collected from a Quantity Surveyor. However, the use of BIM models for material quantity take-off has emerged as an additional data source. The process of utilising the BIM model for material quantity take-off involves extracting the necessary data from the model to estimate the required materials for the project accurately. Once this data has been collected, it can be submitted to online platforms such as the CIC Carbon Assessment Tool and iBEAM Unison for embodied carbon calculation.

Figure 17-1 Use Case 12 Data input of material

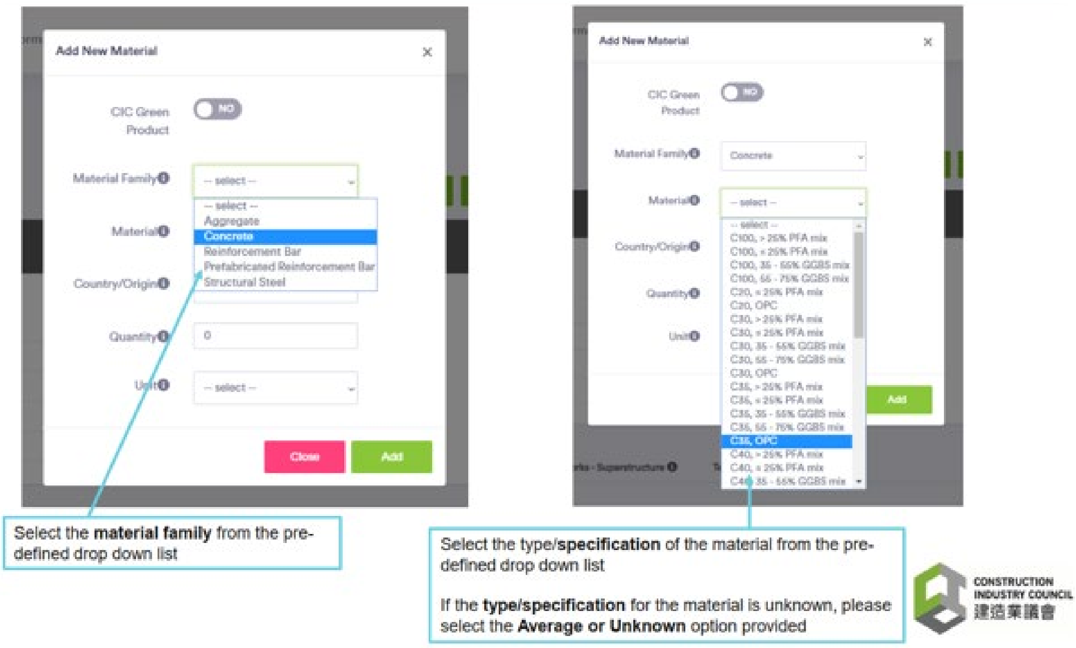
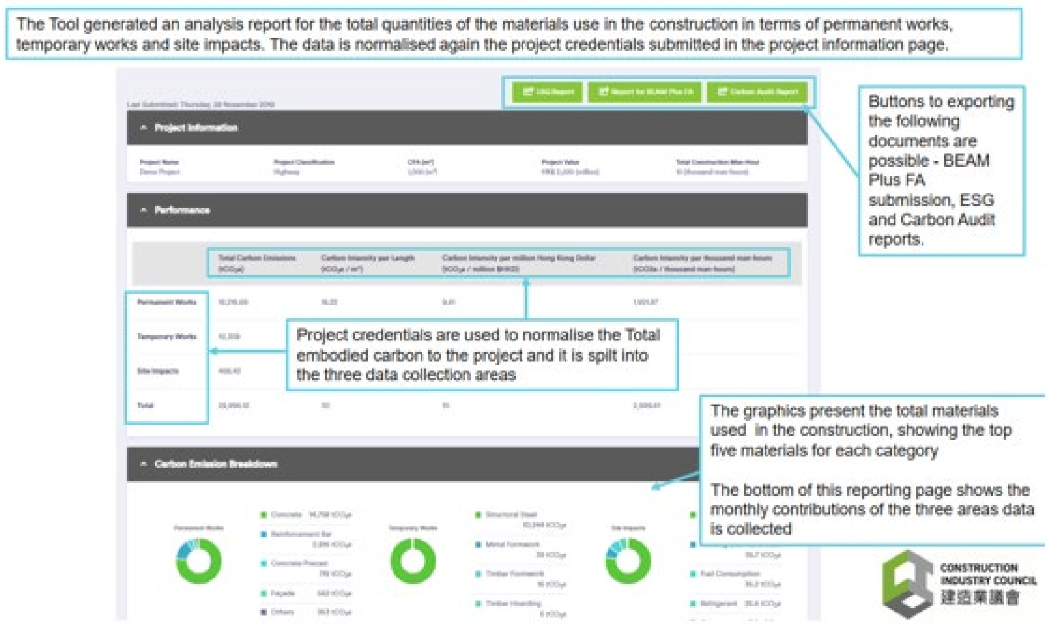


Figure 17-2 Use Case 12 Report analysis



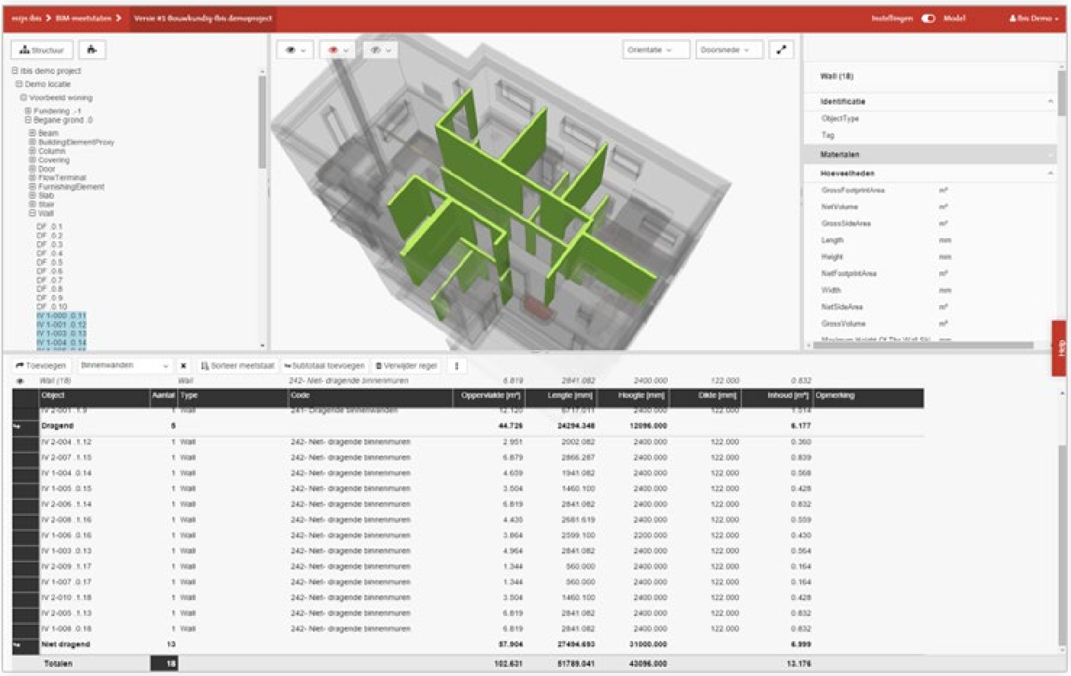
17.2.2 These platforms utilise the collected data to calculate the project's embodied carbon, allowing stakeholders to understand the project's carbon footprint better. This information is vital in ensuring that the project is environmentally sustainable and that measures can be taken to minimise its carbon impact. By incorporating BIM models into the process of material quantity take-off and carbon footprint calculation, stakeholders can gain valuable insights into the environmental impact of a construction project. BIM models provide detailed information about the materials and components used, allowing for more accurate calculations of embodied carbon. This data-driven approach enables stakeholders to make informed decisions and take proactive measures to reduce carbon emissions and enhance sustainability throughout the project lifecycle.

17.3 The Relation to BIM And GIS

17.3.1 A detailed BIM model is essential for accurate quantity take-off and carbon footprint calculation. This model should comprise comprehensive building components and material data. Furthermore, each BIM object should be assigned appropriate properties, such as dimensions, weight, volume, area, and material type.

By incorporating these specific details, the BIM software can precisely calculate the quantities and measurements of each building component. As a result, this approach provides stakeholders with an accurate understanding of the project's material requirements and environmental impact.

Figure 17-3 A detailed BIM model should include the building components and material data



17.3.2 Related to GIS, sustainable energy supply is one of the global trends that are aiming to achieve a zero-carbon emission strategy. Solar energy generation in metropolitan city buildings effectively remedies green power development. For this reason, it can utilise the rooftop surface of high-rise buildings to achieve maximum energy generation efficiency.

Using a new generation of 3D GIS together with the photorealistic digital surface model of oblique photogrammetry, it can accurately simulate the sunlight illumination extent of the city in each season and quantitatively calculate the solar energy index for the entire building façade and rooftop surface. Such index and the BIM data for new developments can provide the blueprint for a large-scale local solar energy plan, directly contributing to the government's zero carbon strategy.

17.4 Additional Information Requirements of BIM Models

17.4.1 BIM authoring software, such as Revit, ArchiCAD, Tekla, etc, offer advanced features for accurate quantity take-off. One such feature is the ability to create schedules and filters, which extract precise quantity data for each building component. This includes essential materials like Concrete, Structural Steel, and Reinforcement bars.

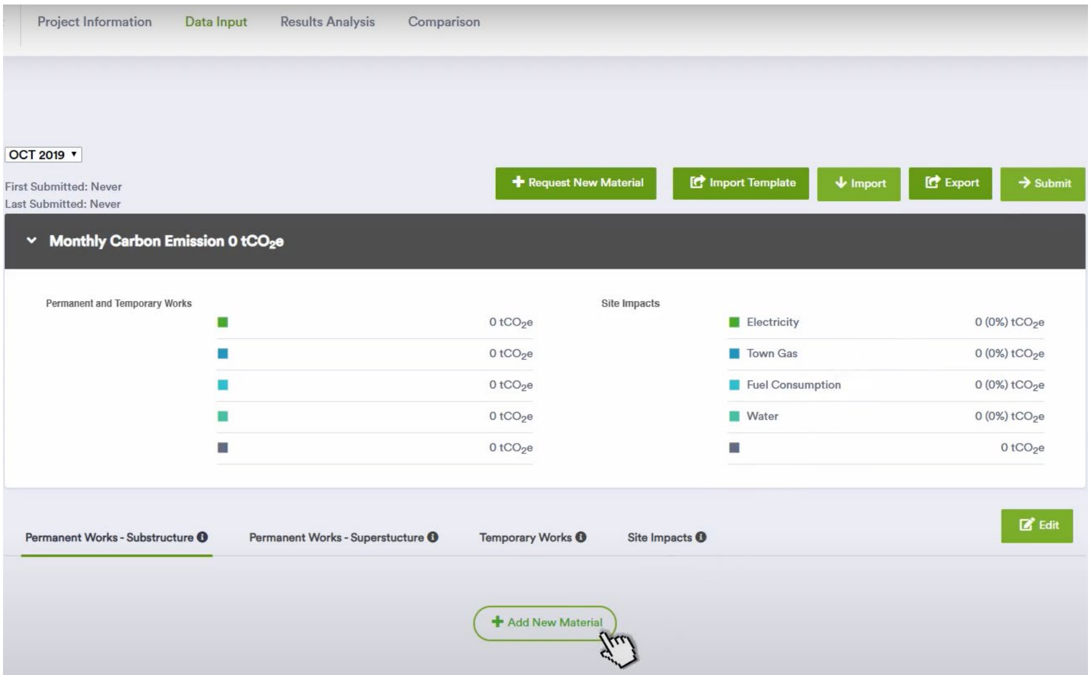
Figure 17-4 Use Case 12 Example of material take-off schedule

<Multi-Category Material Takeoff>

A	B	C	D
Family and Type	Material: Name	Material: Area	Material: Volume
Basic Wall: Generic - 200m	Concrete, Precast	22 m²	4.38 m³
Basic Wall: Generic - 200m	Concrete, Precast	10 m²	1.92 m³
Basic Wall: Generic - 200m	Concrete, Precast	17 m²	3.33 m³
Basic Wall: Generic - 200m	Concrete, Precast	15 m²	2.99 m³
Basic Wall: Generic - 200m	Concrete, Precast	19 m²	3.81 m³
Basic Wall: Generic - 200m	Concrete, Precast	38 m²	7.68 m³
Basic Wall: Generic - 200m	Concrete, Precast	30 m²	6.00 m³
Basic Wall: Generic - 200m	Concrete, Precast	11 m²	2.16 m³
Basic Wall: Generic - 200m	Concrete, Precast	38 m²	7.69 m³
Basic Wall: Generic - 200m	Concrete, Precast	27 m²	5.40 m³
Basic Wall: Generic - 200m	Concrete, Precast	17 m²	3.48 m³

17.4.2 The CIC Carbon Assessment Tool is a common platform developed by the CIC for evaluating the carbon performance of buildings and infrastructure in Hong Kong. This tool assesses the carbon impact of a project from the extraction of raw materials to the completion of construction. To utilise this platform, it is necessary to provide specific data within the BIM model, such as the names of materials and their country of origin. The tool's user guide provides guidance on the data requirements and the process of importing this data, mainly through the Excel files into the platform.

Figure 17-5 Use Case 12 Data input on CIC Carbon Assessment Tool



17.4.3 iBEAM Unison is a data platform designed by BEAM Society Limited specifically for calculating embodied carbon. To use this tool, it is necessary to set up the required data for performing a carbon assessment by uploading the IFC model. Setting up this data involves configuring specific BIM model parameters and relevant properties within the BIM Model. This can be done by following the instructions provided in the tool's user guide.

Figure 17-6 Use Case 12 iBEAM Unison User Guide

17.5 Information Available

17.5.1 The material schedule and quantity information are important components of construction projects. They provide a detailed breakdown of the materials needed for the project, the quantities required, and the estimated cost of each item. This information is critical for budgeting, procurement, and work schedules and is typically prepared by contractors and quantity surveyors.

17.6 Method of Information Exchange

17.6.1 BIM can be used to generate a material schedule of quantity take-off, which provides a detailed breakdown of the materials needed for the project and their quantities. The BIM model elements with geometry and material information for quantity take-off can be exported from BIM software in IFC format and imported into other applications. Also, the schedule of quantity take-off can be exported in spreadsheet format, such as Excel. The spreadsheet can be used for further analysis.

Figure 17-7 Use Case 12 Extract the material schedule from BIM model for the quantity summary

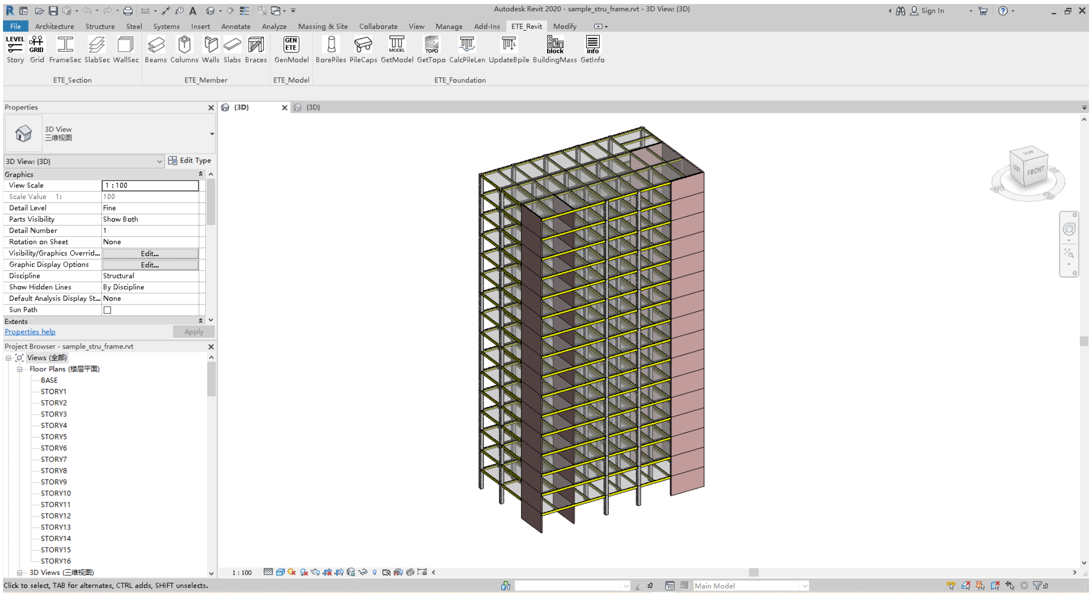


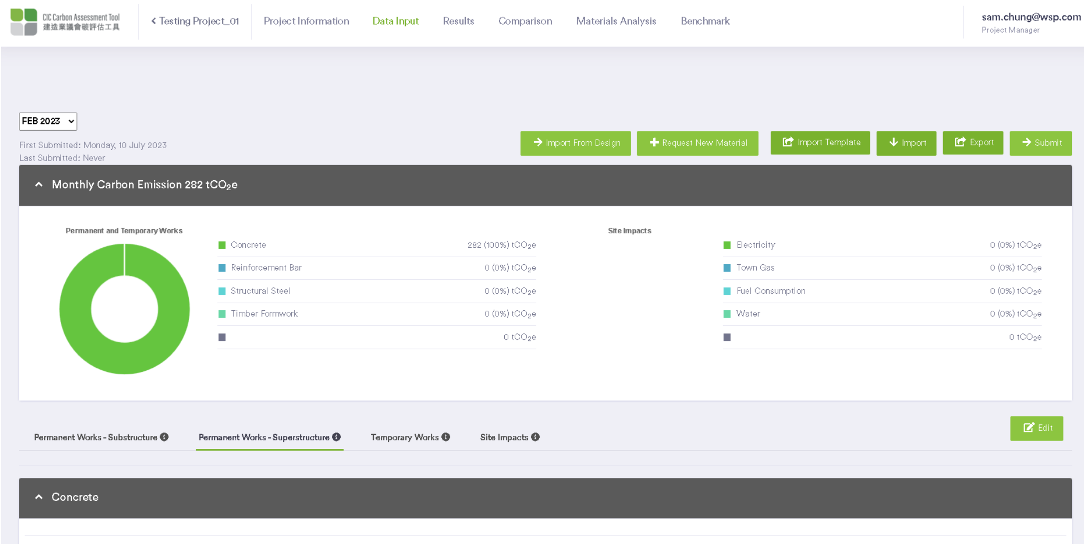
Figure 17-8 Use Case 12 Schedule including the element type, material, and volume

TYPE	ID	SEC	STOREY	VOL	STOREY + TYPE	DATE	CONC	YEAR	MONTH	YEAR-MONTH
BEAM	1008740	B250x400	STOREY1	0.48	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008741	B250x400	STOREY1	0.46	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008742	B250x400	STOREY1	0.4	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008743	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008744	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008745	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008746	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008747	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008748	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008749	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008750	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008751	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008752	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008753	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008754	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008755	B250x400	STOREY1	0.4	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008756	B250x400	STOREY1	0.4	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008757	B250x400	STOREY1	0.39	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008758	B250x400	STOREY1	0.51	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008759	B250x400	STOREY1	0.48	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008760	B250x400	STOREY1	0.46	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008761	B250x400	STOREY1	0.47	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008762	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008763	B250x400	STOREY1	0.38	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008764	B250x400	STOREY1	0.46	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1
BEAM	1008765	B250x400	STOREY1	0.46	STOREY1BEAM	1/9/2023	C45	2023	1	2023-1

Figure 17-9 Use Case 12 Matching the summary table with CIC Carbon Assessment Tool Template

Year	Month	Item Code	Quantity
2023	1	CO-HK-CIC-CAT-19-000-C45OPC	557.773
2023	2	CO-HK-CIC-CAT-19-000-C45OPC	557.773
2023	3	CO-HK-CIC-CAT-19-000-C45OPC	557.773
2023	4	CO-HK-CIC-CAT-19-000-C45OPC	836.660
2023	5	CO-HK-CIC-CAT-19-000-C45OPC	557.773
2023	6	CO-HK-CIC-CAT-19-000-C45OPC	557.773
2023	7	CO-HK-CIC-CAT-19-000-C45OPC	557.773
2023	8	CO-HK-CIC-CAT-19-000-C45OPC	278.887
2023	1	CO-HK-CIC-CAT-19-000-C60OPC	139.275
2023	2	CO-HK-CIC-CAT-19-000-C60OPC	92.850
2023	3	CO-HK-CIC-CAT-19-000-C60OPC	92.850
2023	4	CO-HK-CIC-CAT-19-000-C60OPC	92.850
2023	5	CO-HK-CIC-CAT-19-000-C60OPC	92.850
2023	6	CO-HK-CIC-CAT-19-000-C60OPC	92.850
2023	7	CO-HK-CIC-CAT-19-000-C60OPC	139.275
2023	8	CO-HK-CIC-CAT-19-000-C60OPC	0.000

Figure 17-10 Use Case 12 Import the summary table to the CIC carbon Assessment Tool Platform



17.7 Conclusion

17.7.1 To summarise, sustainable construction practices are essential for minimising the environmental impact of building projects, and embodied carbon calculation plays a crucial role in achieving this objective. BIM has emerged as an effective tool for accurately estimating embodied carbon by providing detailed information about construction materials and components. BIM models can collect data on material quantities, types, and sources, which can be utilised in online platforms for embodied carbon calculation.

17.7.2 The creation of a detailed BIM model is vital to ensure accurate quantity take-off and carbon footprint calculation. Each BIM object should be assigned appropriate properties, including dimensions, weight, volume, area, and material type. BIM software, such as Revit, offers advanced features that facilitate precise quantity take-off. By incorporating embodied carbon calculation within BIM models, stakeholders can gain a comprehensive understanding of the project's environmental impact. This integration promotes sustainable construction practices and ensures compliance with environmental regulations. Overall, using BIM models for embodied carbon calculation provides a valuable tool for achieving sustainable construction practices and reducing the environmental impact of building projects.

18 USE CASE 13 – 3D PEDESTRIAN WALKABILITY AND NAVIGATION

18.1 General

18.1.1 The 3D Pedestrian Network is a specialised dataset that aims to support navigation services by providing detailed and accurate information about pedestrian infrastructure. This dataset includes various elements such as footpaths, indoor and outdoor venues, and transit units like escalators, stairs, ramps, and lifts. Its purpose is to enhance pedestrian navigation and improve overall pedestrian infrastructure planning.

18.1.2 The LandsD has developed a comprehensive dataset of the 3D Pedestrian Network, which is available through the Geospatial Datastore of the Hong Kong Cadastral Survey and Mapping Office (CSDI). This dataset covers the built-up areas of the entire territory, encompassing both aboveground and underground venues, including unpaid areas of the Mass Transit Railway (MTR). By leveraging this dataset, stakeholders can gain a more comprehensive understanding of pedestrian infrastructure and utilize this information to support decision-making and planning processes related to pedestrian navigation.

18.1.3 The 3D Pedestrian Network dataset in CSDI will be used as a reference to develop a guideline for indoor and outdoor geospatial data exchange between GIS and BIM. This guideline will include criteria and required information for forming a pedestrian route in BIM, which can be input into GIS software or the CSDI system. This will enable more accurate and efficient navigation services for pedestrians, both indoors and outdoors, and improve the overall management of pedestrian infrastructure.

18.2 The Process

18.2.1 The creation of the pedestrian network involves delineating footpaths and other pedestrian infrastructure based on existing 2D map features. For indoor pedestrian networks, data is derived from general building plans and on-field surveys. The goal is to establish a seamless 3D line network that covers the entire territory of Hong Kong, ensuring connectivity within the dataset. This comprehensive network enables accurate representation and analysis of pedestrian routes throughout the region.

18.2.2 The data specification for the 3D Pedestrian Network can be downloaded from CSDI. The Pedestrian Route is the parent entity of the 3D Pedestrian Network.

18.2.3 The Pedestrian Routes are associated with the attributes including location, feature type, alias name, weatherproof, wheelchair barrier, wheelchair access, obstacles type, gradient, direction, position certainty, enabled, street name, creation date, and length. These attributes help to describe and categorise the pedestrian network, facilitating analysis and decision-making processes related to pedestrian navigation.

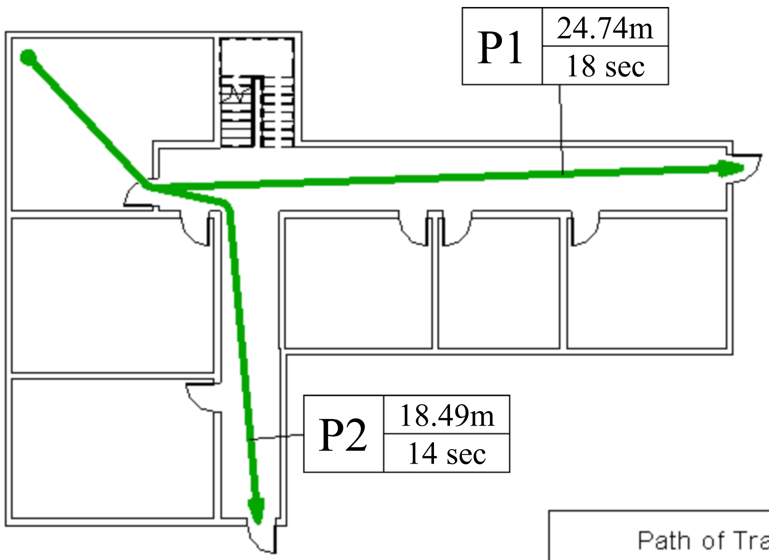
18.3 The Relation to BIM And GIS

18.3.1 The Pedestrian Route can be provided using BIM software's 3D "Path of Travel" line. To establish a path of travel in BIM, the user selects a start point and an end point in the plan view. The BIM software then analyses the model and generates a path of travel based on the model elements acting as obstacles along the path.

18.3.2 The path of travel calculated by BIM software will avoid contact with model elements in the analysis zone and calculate the shortest distance between the start and endpoints. The walking speed is usually set to a standard value, such as 3 mph (1.34 mps). This allows for accurate calculation of the time required to walk the path of travel and ensures that the path is safe and accessible for pedestrians.

18.3.3 The following figure demonstrates how a "Path of Travel" line can be used in BIM authoring software to establish pedestrian routes in the BIM model.

Figure 18-1 Use Case 13 Example of "Path of Travel" line



Path of Travel Schedule		
#	L	T
P1	18494	13.8 s
P2	24743	18.4 s

Remark: Length "L" is measured in 2D

18.3.4 The Pedestrian Route and the attributes associated with the pedestrian network can be provided by BIM:

a) To generate the Pedestrian Route in BIM, the user can create a centreline and coordinates for the start point and end point of the route, both for the indoor and outdoor pedestrian network.

Figure 18-2 Use Case 13 Generate pedestrian route in BIM model

b) The user can create shared parameters for attributes, such as location (indoor/outdoor), feature type (footway/footpath/crossing, etc.), name, weatherproof (covered/non-covered), wheelchair access (true/false), obstacles type, gradient, direction, street name.

c) The length of the Pedestrian Route can be determined by generating a schedule of the "Path of Travel".

Figure 18-3 Use Case 13 Length of pedestrian route

<Path of Travel Schedule>

A	B	C	D	E
Mark	Length	Time	Speed	Count
PedRoute 1	8968.97	6.7 s	4.8 km/h	1

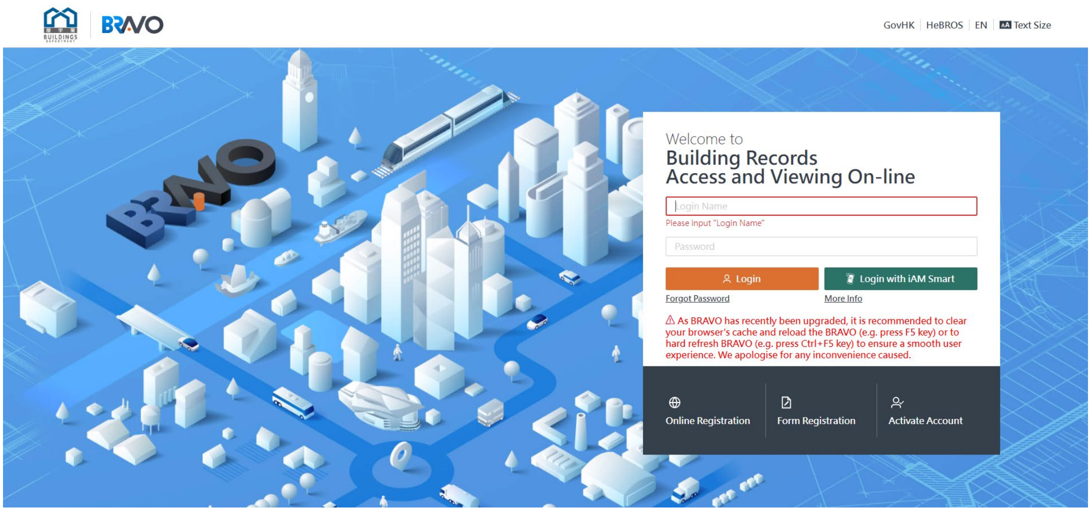
18.4 Additional Information Requirements of BIM Models

18.4.1 There is a need to study the criteria for forming a Pedestrian Route, including factors such as pedestrian safety, accessibility, efficiency, and emergency.

18.5 Information Available

18.5.1 The indoor pedestrian network can be derived from general building plans and data collected from on-field surveys. To access general building plans in Hong Kong, users can visit the Buildings Department website, which features a section dedicated to building plans and records, including general building plans. The website provides information on how to obtain the plans and any fees associated with the service.

Figure 18-4 Use Case 13 Welcoming page of the Building Records Access and Viewing On-line



(Source: https://bravo.bd.gov.hk/login?request_locale=en_US)

18.6 Method of Information Exchange

18.6.1 An IFC model for Road, Footbridge, Lift and Building Mass can be exported with attributes and imported GIS software from the BIM Model.

18.6.2 The schedule of attributes listed in appendix I can be exported from the BIM Model.

18.6.3 Once the "Path of Travel" line is generated in BIM, it can be exported in a compatible format such as DWG or DXF and imported into GIS software for further analysis and management or the CSDI system for sharing.

18.7 Conclusion

18.7.1 Integrating a 3D Pedestrian Network into BIM software offers significant benefits for the design and management of pedestrian infrastructure. By modeling the pedestrian network in 3D, BIM software provides a more accurate representation of the walking environment, enabling more effective analysis and optimization of pedestrian routes. Additionally, the use of BIM software facilitates seamless integration between the design and construction phases, enhancing collaboration and coordination among project stakeholders.

18.7.2 However, there are ongoing efforts to further improve and enhance the integration of the 3D Pedestrian Network and BIM. Here are some ways forward:

i. Continued development of BIM software: Further advancements in BIM software can include enhanced visualization and simulation tools, automated pathfinding algorithms, and real-time pedestrian tracking and analysis.

ii. Integration with GIS software: Seamless integration between the 3D Pedestrian Network in BIM and GIS software is crucial for maximising its benefits. This integration can be facilitated through the development of standardised data exchange formats, such as IFC, enabling interoperability between BIM and GIS platforms. This integration allows for comprehensive analysis and decision-making by considering both the physical design and geographical context of pedestrian infrastructure.

iii. Collaboration between stakeholders: The successful integration of 3D Pedestrian Network and BIM requires collaboration and coordination between different stakeholders in the construction process, including architects, engineers, contractors, and city planners. Continued efforts to promote collaboration and knowledge sharing can help improve the integration of the 3D Pedestrian Network and BIM.

iv. Adoption of open standards: The adoption of open standards and best practices can help ensure that the integration of 3D Pedestrian Network and BIM is consistent and effective across different projects and applications. This could involve the development of industry-wide standards and guidelines for modelling and analysing pedestrian infrastructure in BIM software.

19 WAY FORWARD

19.1 As set out in various use cases in this publication, the availability of the BIM and related data via centralised data platforms under the CSDI initiative was essential to support the development of different BIM use cases.

19.2 As stated in the "Roadmap on Adoption of BIM for Building Plan Preparation and Submission" promulgated by DEVB in December 2023 in which the tentative roadmap was drafted to provide a basis for consultation with stakeholders, there are proposed initiatives to explore further application of BIM data, including the better integration of BIM data with GIS and the CSDI Portal to facilitate city planning and policy formation, and the expansion of the GBDR to support the storage and sharing of private projects' BIM models as one of the spatial dataset under the initiative of CSDI in the future. On the other hand, DEVB together with LandsD have started the development of the UUIS to work towards a comprehensive 3D digital UU information database for Hong Kong.

19.3 By translating BIM data to the CSDI portal via the GBDR, we can achieve the integration of BIM-GIS data. This integration enables comprehensive spatial analysis, visualisation, providing valuable insights for different developments. The effective contribution of BIM data back to the government through the GBDR will not only promote data transparency and accessibility, but will also enhance the overall quality of the BIM data and unlock the potential for BIM data reuse to support city-wide analysis. This collaborative approach strengthens the government's capacity to develop informed policies, make well-informed decisions, and effectively plan for sustainable development.

19.4 Industry stakeholders are encouraged to actively participate in the CSDI initiative by sharing their BIM data through the GBDR in the future. Their valuable contributions will play an important role in fostering a robust and interconnected BIM-GIS ecosystem, benefiting the entire industry and supporting the government's vision for efficient and sustainable development.

APPENDIX 1 – SUMMARY OF ADDITIONAL INFORMATION ADDED TO BIM MODEL

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
Address	Text	Street name with District and Region	DSD Facilities	/	Text	/	/	1
AlignmentPoint	Integer	Alignment point	High Voltage Cable	/	Long Integer	/	/	1
AlignmentPoint	Integer	Alignment point	Low Voltage Cable	/	Long Integer	/	/	1
Bearing	Number	True bearing. A bearing measured relative to true north	Bollard	/	Double	/	Range: 0 – 360	1
Bearing	Number	True bearing. A bearing measured relative to true north	Connector	/	Double	/	Range: 0 – 360	1
Bearing	Number	True bearing. A bearing measured relative to true north	Control Cubicle	/	Double	/	Range: 0 – 360	1
Bearing	Number	True bearing. A bearing measured relative to true north	Gas CP	/	Double	/	Range: 0 – 360	1
Bearing	Number	True bearing. A bearing measured relative to true north	Fitting	/	Double	/	Range: 0 – 360	1
Bearing	Number	True bearing. A bearing measured relative to true north	Gas Governor	/	Double	/	Range: 0 – 360	1
Bearing	Number	True Bearing. A bearing measured relative to true north	Gas Riser	/	Double	/	Range: 0 – 360	1
Bearing	Number	True Bearing. A bearing measured relative to true north	Gas Syphon	/	Double	/	Range: 0 – 360	1
Bearing	Number	True Bearing. A bearing measured relative to true north	GAS Valve Chamber	/	Double	/	Range: 0 – 360	1
Bearing	Number	True Bearing. A bearing measured relative to true north	Gas Valve Pit	/	Double	/	Range: 0 – 360	1
Bearing	Number	True bearing. A bearing measured relative to true north	Highmast Pillar	/	Double	/	Range: 0 – 360	1
Bearing	Number	True bearing. A bearing measured relative to true north	Drawpit	/	Double	/	Range: 0 – 360	1
BuildingName	Text	Building Name of the feature	DSD Facilities	/	Text	/	/	1
BuriedDepth	Number	Buried Depth (m)	LV Cable Joint	/	Double	/	/	1
BuriedDepth	Number	Buried Depth (m)	MV Cable joint	/	Double	/	/	1
CellNum	Integer	Number of cells in Sewage Box Culvert/Tunnel Path	Box Culvert / Tunnel_Sewage	/	Integer	/	/	1
CellNum	Integer	Number of cells in Stormwater Box Culvert/Tunnel Path	Box Culvert / Tunnel_Stormwater	/	Integer	/	/	1

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
CL	Number	Cover Level (mPD)	Sewage Chamber	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Stormwater Chamber	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Drop Shaft	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Catchpit	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Combined Manhole	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Sewage Manhole	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Special Sewage Manhole	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Manhole_Stormwater	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Special Stormwater Manhole	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Sewage Terminal Manhole	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Stormwater Terminal Manhole	/	Double	/	/	1
CL	Number	Level of the cover (mPD)	Gully Sump	/	Double	/	/	1
CL	Number	Level of the cover of manhole (mPD)	Manhole	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Inlet	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Interface Valve Chamber	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Oil / Petrol Interceptor	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Combined Outfall	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Sewage Outfall	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Stormwater Outfall	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Outlet	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Sand Trap	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Sewage Tapping Point	/	Double	/	/	1
CL	Number	Cover Level (mPD)	Stormwater Tapping Point	/	Double	/	/	1
CompletionDate	Date	Completion date of the feature	Fresh Water Mains	/	Date	/	/	1
CompletionDate	Date	Completion date of the feature	Raw Water Mains	/	Date	/	/	1
CompletionDate	Date	Completion date of the feature	Saltwater Mains	/	Date	/	/	1
ComponentID	Integer	Component ID	High Voltage Cable	/	Long Integer	/	/	1

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
ComponentID	Integer	Component ID	Low Voltage Cable	/	Long Integer	/	/	1
ConcSurrounded	Text	Concrete Surrounded	Duct Boundary	/	Text	/	/	1
CoverDepth	Number	Cover depth of the water main (m)	Fresh Water Mains	/	Double	/	/	1
CoverDepth	Number	Cover depth of the water main (m)	Raw Water Mains	/	Double	/	/	1
CoverDepth	Number	Cover depth of the water main (m)	Saltwater Mains	/	Double	/	/	1
CoverShape	Text	Shape or appearance of cover	Gully Sump	/	Text	/	C – Circular; R – Rectangular; S – Square	1
Depth	Number	The depth of the Cable Duct (m)	Cable Duct	/	Double	/	/	1
Depth	Number	Cable Depth (m)	Highmast Cable	/	Double	/	/	1
Depth	Number	The depth of the Connector (m)	Connector	/	Double	/	/	1
Depth	Number	The depth of Highmast Connector (m)	Highmast connector	/	Double	/	/	1
Depth	Text	Pipe Depth (m)	GAS Pipe	/	Text	/	/	1
Depth	Number	Buried Depth (m)	Survey Point	/	Double	/	/	1
Depth	Number	Buried Depth (m)	LV Survey Point	/	Double	/	/	1
Depth	Number	Buried Depth (m)	MV Survey Point	/	Double	/	/	1
Depth	Number	Depth of the concrete planting (m)	Lamppost	/	Double	/	/	1
Diameter	Number	The diameter of the Cable Duct (mm)	Cable Duct	/	Double	/	/	1
Diameter	Number	Cable Duct Diameter (mm)	Highmast Cable	/	Double	/	/	1
Diameter	Number	Cable Size	LV Conductor	/	Double	/	/	1
Diameter	Number	Cable Size	MV Conductor	/	Double	/	/	1
Diameter	Number	Diameter the concrete planting (m)	Lamppost	/	Double	/	/	1
Diameter	Integer	Internal nominal diameter of the pipe in mm	Carrier Drain	/	Long Integer	/	/	1
Diameter	Integer	Internal nominal diameter of the pipe in mm	Connection Pipe	/	Long Integer	/	/	1
Diameter	Integer	Internal nominal diameter of the pipe in mm	Cross Road Drain	/	Long Integer	/	/	1
Diameter	Number	Diameter of the feature	Fresh Water Mains	/	Double	/	/	1
Diameter	Number	Diameter of the feature	Fresh Water Valve	/	Double	/	/	1
Diameter	Integer	Diameter of pipe	GAS Pipe	/	Long Integer	/	/	1
Diameter	Number	Cable diameter	LV Cable	/	Text	/	/	1
Diameter	Number	Diameter of the feature	Raw Water Mains	/	Double	/	/	1
Diameter	Number	Diameter of the feature	Raw Water Valve	/	Double	/	/	1

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
Diameter	Number	Diameter of the feature	Saltwater Mains	/	Double	/	/	1
Diameter	Number	Diameter of the feature	Saltwater Valve	/	Double	/	/	1
Diameter	Text	Duct Diameter (mm) of Each Duct	Cable Duct	/	Text	/	/	1
Diameter	Text	Duct Diameter (mm) of Each Duct	Duct Boundary	/	Text	/	/	1
District	Text	18 Districts of Hong Kong.	DSD Facilities	/	Text	/	/	1
DS_IL	Number	Invert level of the pipe at downstream end in mPD	Carrier Drain	/	Double	/	/	1
DS_IL	Number	Invert level of the pipe at downstream end in mPD	Connection Pipe	/	Double	/	/	1
DS_IL	Number	Invert level of the pipe at downstream end in mPD	Cross Road Drain	/	Double	/	/	1
DS_IL	Number	Downstream Invert Level (mPD)	Multiple Sewage Pipe	/	Double	/	/	1
DS_IL	Number	Downstream Invert Level (mPD)	Multiple Stormwater Pipe	/	Double	/	/	1
DS_IL	Number	Downstream Invert Level (mPD)	Multiple Sewage Rising Mains	/	Double	/	/	1
DS_IL	Number	Downstream Invert Level (mPD)	Multiple Stormwater Rising Mains	/	Double	/	/	1
DS_IL	Number	Downstream Invert Level (mPD)	Combined Pipe	/	Double	/	/	1
DS_IL	Number	Downstream Invert Level (mPD)	Sewage Pipe	/	Double	/	/	1
DS_IL	Number	Downstream Invert Level (mPD)	Stormwater Pipe	/	Double	/	/	1
DS_IL	Number	Downstream Invert Level (mPD)	Sewage Rising Mains	/	Double	/	/	1
DS_IL	Number	Downstream Invert Level (mPD)	Stormwater Rising Mains	/	Double	/	/	1
DuctNum	Number	Total No. of Ducts	Cable Duct	/	Double	/	/	1
DuctNum	Number	Total No. of Ducts	Duct Boundary	/	Double	/	/	1
FeatureClassID	Integer	Feature class identifier	High Voltage Cable	/	Long Integer	/	/	1
FeatureClassID	Integer	Feature class identifier	Low Voltage Cable	/	Long Integer	/	/	1
FeatureID	Text	Bollard facility number	Bollard	/	Text	/	/	1
FeatureID	Integer	Cable Duct facility number	Cable Duct	/	Long Integer	/	/	1
FeatureID	Integer	Highmast Cable Duct facility number.	Highmast Cable	/	Long Integer	/	/	1
FeatureID	Text	Cable Number	LV Conductor	/	Text	/	/	1
FeatureID	Text	Cable Number	MV Conductor	/	Text	/	/	1
FeatureID	Text	Connector facility number.	Connector	/	Text	/	/	1

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
FeatureID	Integer	Connector facility number	Highmast connector	/	Long Integer	/	/	1
FeatureID	Text	Controller facility number	Control Cubicle	/	Text	/	/	1
FeatureID	Text	Drawpit facility number.	Drawpit	/	Text	/	/	1
FeatureID	Text	Unique Identifier of valve	Fresh Water Mains	/	Text	/	/	1
FeatureID	Text	Unique Identifier of valve	Fresh Water Valve	/	Text	/	/	1
FeatureID	Text	Unique Identifier of valve	Raw Water Mains	/	Text	/	/	1
FeatureID	Text	Unique Identifier of valve	Raw Water Valve	/	Text	/	/	1
FeatureID	Text	Unique Identifier of valve	Saltwater Mains	/	Text	/	/	1
FeatureID	Text	Unique Identifier of valve	Saltwater Valve	/	Text	/	/	1
FeatureID	Text	Identifier of Sewage Box Culvert/Tunnel	Box Culvert / Tunnel_Sewage	/	Text	/	/	1
FeatureID	Text	Identifier of Stormwater Box Culvert/Tunnel	Box Culvert / Tunnel_Stormwater	/	Text	/	/	1
FeatureID	Text	Identifier of Sewage Box Culvert / Tunnel Polygon	Box Culvert / Tunnel_Sewage	/	Text	/	/	1
FeatureID	Text	Identifier of Stormwater Box Culvert / Tunnel Polygon	Box Culvert / Tunnel_Stormwater	/	Text	/	/	1
FeatureID	Text	Unique identifier of pipe, drain or surface channel	Carrier Drain	/	Text	/	/	1
FeatureID	Text	Identifier of Sewage Chamber	Sewage Chamber	/	Text	/	/	1
FeatureID	Text	Identifier of Stormwater Chamber	Stormwater Chamber	/	Text	/	/	1
FeatureID	Text	Feature Number. Identifier of Channel	Channel	/	Text	/	/	1
FeatureID	Text	Unique identifier of pipe, drain or surface channel	Connection Pipe	/	Text	/	/	1
FeatureID	Text	Unique identifier of pipe, drain or surface channel	Cross Road Drain	/	Text	/	/	1
FeatureID	Text	Identifier of Drop Shaft	Drop Shaft	/	Text	/	/	1
FeatureID	Text	Identifier of Catchpit	Catchpit	/	Text	/	/	1
FeatureID	Text	Identifier of Combined Manhole	Combined Manhole	/	Text	/	/	1
FeatureID	Text	Identifier of Sewage Manhole	Sewage Manhole	/	Text	/	/	1
FeatureID	Text	Identifier of Special Sewage Manhole	Special Sewage Manhole	/	Text	/	/	1
FeatureID	Text	Identifier of Stormwater Manhole	Manhole_Stormwater	/	Text	/	/	1

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
FeatureID	Text	Identifier of Special Stormwater Manhole	Special Stormwater Manhole	/	Text	/	/	1
FeatureID	Text	Identifier of Sewage Terminal Manhole	Sewage Terminal Manhole	/	Text	/	/	1
FeatureID	Text	Identifier of Storm Water Terminal Manhole	Stormwater Terminal Manhole	/	Text	/	/	1
FeatureID	Text	Feature Number. Identifier of Dry weather flow channel	Dry Weather Flow Channel	/	Text	/	/	1
FeatureID	Text	Feature Number. Identifier of U channel	U Channel	/	Text	/	/	1
FeatureID	Text	Feature system identifier	GAS Capping Plate	/	Text	/	/	1
FeatureID	Text	Feature system identifier	Gas CP	/	Text	/	HP – High Pressure; IPB – Intermediate Pressure B; IPA – Intermediate Pressure A; MP – Medium Pressure; LPB – Low Pressure B; LPA – Low Pressure A	1
FeatureID	Text	Feature system identifier	Fitting	/	Text	/	/	1
FeatureID	Text	Feature system identifier	GAS Governor	/	Text	/	/	1
FeatureID	Text	Feature system identifier	Gas Kiosk Frame	/	Text	/	/	1
FeatureID	Text	Feature system identifier	Gas Kiosk Frame	/	Text	/	/	1
FeatureID	Text	Feature system identifier	GAS Pipe	/	Text	/	/	1
FeatureID	Text	Feature system identifier	GAS Pipe	/	Text	/	/	1
FeatureID	Text	Feature system identifier	Gas Riser	/	Text	/	/	1
FeatureID	Text	Feature system identifier	GAS Sleeve	/	Text	/	/	1
FeatureID	Text	Lamppost facility number	Lamppost	/	Text	/	/	1
FeatureID	Text	Pillar facility number. Identifier of Pillar	Highmast Pillar	/	Text	/	/	1
FR_PNT	Text	From the start of another feature's feature number	Box Culvert / Tunnel_Sewage	/	Text	/	/	1
FR_PNT	Text	From the start of another feature's feature number	Box Culvert / Tunnel_Stormwater	/	Text	/	/	1
FR_PNT	Text	From the start of another feature's feature number	Channel	/	Text	/	/	1
FR_PNT	Text	From the start of another feature's feature number	Dry Weather Flow Channel	/	Text	/	/	1
FR_PNT	Text	From the start of another feature's feature number	U Channel	/	Text	/	/	1
FR_PNT	Text	From the start of another feature's feature number	Multiple Sewage Pipe	/	Text	/	/	1

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
FR_PNT	Text	From the start of another feature's feature number	Multiple Stormwater Pipe	/	Text	/	/	1
FR_PNT	Text	From the start of another feature's feature number	Multiple Sewage Rising Mains	/	Text	/	/	1
FR_PNT	Text	From the start of another feature's feature number	Multiple Stormwater Rising Mains	/	Text	/	/	1
FR_PNT	Text	From the start of another feature's feature number	Combined Pipe	/	Text	/	/	1
FR_PNT	Text	From the start of another feature's feature number	Sewage Pipe	/	Text	/	/	1
FR_PNT	Text	From the start of another feature's feature number	Stormwater Pipe	/	Text	/	/	1
FR_PNT	Text	From the start of another feature's feature number	Sewage Rising Mains	/	Text	/	/	1
FR_PNT	Text	From the start of another feature's feature number	Stormwater Rising Mains	/	Text	/	/	1
GeometryArea	Number	Area Calculation of Geometry (sqm)	Box Culvert / Tunnel_Sewage	/	Double	/	/	1
GeometryArea	Number	Area Calculation of Geometry (sqm)	Box Culvert / Tunnel_Stormwater	/	Double	/	/	1
GeometryArea	Number	Area Calculation of Geometry (sqm)	Sewage Chamber	/	Double	/	/	1
GeometryArea	Number	Area Calculation of Geometry (sqm)	Stormwater Chamber	/	Double	/	/	1
GeometryArea	Number	Area Calculation of Geometry (sqm)	Drop Shaft	/	Double	/	/	1
GeometryArea	Number	Area Calculation of Geometry (sqm)	Special Sewage Manhole	/	Double	/	/	1
GeometryArea	Number	Area Calculation of Geometry (sqm)	Special Stormwater Manhole	/	Double	/	/	1
GeometryArea	Number	Area Calculation of Geometry (sqm)	Tunnel Protection Zone	/	Double	/	/	1
GratingType	Text	Grating Type	Grating Gully	/	Text	/	/	1
Height	Integer	Height (mm)	Box Culvert / Tunnel_Sewage	/	Long Integer	/	/	1
Height	Integer	Height (mm)	Box Culvert / Tunnel_Stormwater	/	Long Integer	/	/	1
Height	Integer	Internal height of pipe in mm	Carrier Drain	/	Long Integer	/	/	1
Height	Integer	Height (mm)	Channel	/	Long Integer	/	/	1
Height	Integer	Internal height of pipe in mm	Connection Pipe	/	Long Integer	/	/	1
Height	Integer	Internal height of pipe in mm	Cross Road Drain	/	Long Integer	/	/	1

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
Height	Integer	Height (mm)	Dry Weather Flow Channel	/	Long Integer	/	/	1
Height	Integer	Height (mm)	U Channel	/	Long Integer	/	/	1
Height	Number	Internal height of Catchpit (m)	Catchpit	/	Double	/	/	1
Height	Number	Height (mm)	Multiple Sewage Pipe	/	Double	/	/	1
Height	Number	Height (mm)	Multiple Stormwater Pipe	/	Double	/	/	1
Height	Number	Height (mm)	Multiple Sewage Rising Mains	/	Double	/	/	1
Height	Number	Height (mm)	Multiple Stormwater Rising Mains	/	Double	/	/	1
Height	Number	Height (mm)	Combined Pipe	/	Double	/	/	1
Height	Number	Height (mm)	Sewage Pipe	/	Double	/	/	1
Height	Number	Height (mm)	Stormwater Pipe	/	Double	/	/	1
Height	Number	Height (mm)	Sewage Rising Mains	/	Double	/	/	1
Height	Number	Height (mm)	Stormwater Rising Mains	/	Double	/	/	1
IL	Number	Invert Level (mPD)	Sewage Chamber	/	Double	/	/	1
IL	Number	Invert Level (mPD)	Stormwater Chamber	/	Double	/	/	1
InstallDate	Date	Installation date of the feature	Fresh Water Valve	/	Date	/	/	1
InstallDate	Date	Installation date of the feature	Raw Water Valve	/	Date	/	/	1
InstallDate	Date	Installation date of the feature	Saltwater Valve	/	Date	/	/	1
Latitude	Number	Coordinate in WGS 84 Coordinates System	DSD Facilities	/	Double	/	/	1
Length	Number	Length of the concrete planting (m)	Lamppost	/	Double	/	/	1
Length	Number	Length Calculation of Geometry (m)	Box Culvert / Tunnel_Sewage	/	Double	/	/	1
Length	Number	Length Calculation of Geometry (m)	Box Culvert / Tunnel_Stormwater	/	Double	/	/	1
Length	Number	Perimeter of a polygon Calculation of Geometry (m)	Box Culvert / Tunnel_Sewage	/	Double	/	/	1
Length	Number	Perimeter of a polygon Calculation of Geometry (m)	Box Culvert / Tunnel_Stormwater	/	Double	/	/	1
Length	Number	Perimeter of a polygon Calculation of Geometry (m)	Sewage Chamber	/	Double	/	/	1
Length	Number	Perimeter of a polygon Calculation of Geometry (m)	Stormwater Chamber	/	Double	/	/	1

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
Length	Number	Length Calculation of Geometry (m)	Channel	/	Double	/	/	1
Length	Number	Perimeter of a polygon Calculation of Geometry (m)	Drop Shaft	/	Double	/	/	1
Length	Number	Perimeter of a polygon Calculation of Geometry (m)	Special Sewage Manhole	/	Double	/	/	1
Length	Number	Perimeter of a polygon Calculation of Geometry (m)	Special Stormwater Manhole	/	Double	/	/	1
Length	Number	Length Calculation of Geometry (m)	Dry Weather Flow Channel	/	Double	/	/	1
Length	Number	Length Calculation of Geometry (m)	U Channel	/	Double	/	/	1
Length	Number	Length Calculation of Geometry (metre, m)	Multiple Sewage Pipe	/	Double	/	/	1
Length	Number	Length Calculation of Geometry (metre, m)	Multiple Stormwater Pipe	/	Double	/	/	1
Length	Number	Length Calculation of Geometry (m)	Multiple Sewage Rising Mains	/	Double	/	/	1
Length	Number	Length Calculation of Geometry (m)	Multiple Stormwater Rising Mains	/	Double	/	/	1
Length	Number	Length Calculation of Geometry (m)	Combined Pipe	/	Double	/	/	1
Length	Number	Length Calculation of Geometry (metre, m)	Sewage Pipe	/	Double	/	/	1
Length	Number	Length Calculation of Geometry (m)	Stormwater Pipe	/	Double	/	/	1
Length	Number	Length Calculation of Geometry (m)	Sewage Rising Mains	/	Double	/	/	1
Length	Number	Length Calculation of Geometry (m)	Stormwater Rising Mains	/	Double	/	/	1
Length	Number	Perimeter of a polygon Calculation of Geometry (m)	Tunnel Protection Zone	/	Double	/	/	1
Length	Number	Length of the pipe in m	Carrier Drain	/	Double	/	/	1
Length	Number	Length of the pipe in m	Connection Pipe	/	Double	/	/	1
Length	Number	Length of the pipe in m	Cross Road Drain	/	Double	/	/	1
Length	Number	Internal length of Catchpit (m)	Catchpit	/	Double	/	/	1
Length	Number	Length calculation of cable duct geometry (m)	Cable Duct	/	Double	/	/	1
Length	Number	Length calculation of water main geometry (m)	Fresh Water Mains	/	Double	/	/	1
Length	Number	Length Calculation of Geometry (m)	Highmast Cable	/	Double	/	/	1
Length	Number	Length Calculation of Geometry (m)	High Voltage Cable	/	Double	/	/	1
Length	Number	Length Calculation of Geometry (m)	Low Voltage Cable	/	Double	/	/	1

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
Length	Number	Length calculation of water main geometry (m)	Raw Water Mains	/	Double	/	/	1
Length	Number	Length calculation of water main geometry (m)	Saltwater Mains	/	Double	/	/	1
Level	Integer	Level of features from ground	Carrier Drain	/	Long Integer	/	-3/-2/-1/0/1/2/3	1
Level	Integer	Level of features from ground	Connection Pipe	/	Long Integer	/	-3/-2/-1/0/1/2/3	1
Level	Integer	Level of features from ground	Cross Road Drain	/	Long Integer	/	-3/-2/-1/0/1/2/3	1
Level	Integer	Level of features from ground	Gully Sump	/	Long Integer	/	-3/-2/-1/0/1/2/3	1
Level	Integer	Level of features from ground	Gully Sump	/	Long Integer	/	-3/-2/-1/0/1/2/3	1
Level	Integer	Level of features from ground	Catchpit	/	Long Integer	/	-3/-2/-1/0/1/2/3	1
Level	Integer	Level of features from ground	Manhole	/	Long Integer	/	-3/-2/-1/0/1/2/3	1
LevelType	Integer	Position of Cable Duct	Cable Duct	/	Short Integer	/	1/2/3/4/5/6/7	1
LevelType	Integer	Type of position of Highmast Cable Duct	Highmast Cable	/	Short Integer	/	1/2/3/4/5/6/7	1
longitude	Number	Coordinate in WGS 84 Coordinates System	DSD Facilities	/	Double	/	/	1
ManholeType	Integer	Type of manhole	Manhole	/	Long Integer	/	1 – Foul water manhole; 2 – Storm water manhole	1
MapName	Text	Map reference number	Cable	/	Text	/	/	1
Material	Text	Material of pipe	GAS Pipe	/	Text	/	/	1
Nature	Text	Nature of the building	DSD Facilities	/	Text	/	SPS – Sewage Pumping Station; STW – Sewage Treatment Work Storm; PS – Stormwater Pumping Station; RWP – Rain Water Pipe; PTW – Preliminary Treatment Works; LFPS – Low Flow Pumping Station; LFI – Low Flow Interceptor; ID – Inflatable Dam	1
Pressure	Text	Pressure class	GAS Capping Plate	/	Text	/	HP – High Pressure; IPB – Intermediate Pressure B; IPA – Intermediate Pressure A; MP – Medium Pressure; LPB – Low Pressure B; LPA – Low Pressure A	1
Pressure	Text	Pressure class	Gas CP	/	Text	/	/	1
Pressure	Text	Pressure class	GAS Fitting	/	Text	/	HP – High Pressure; IPB – Intermediate Pressure B; IPA – Intermediate Pressure A; MP – Medium Pressure; LPB – Low Pressure B; LPA – Low Pressure A	1
Pressure	Text	Pressure class	GAS Governor	/	Text	/	IPA – Intermediate Pressure A; MP – Medium Pressure; LPB – Low Pressure B; LPA – Low Pressure A	1

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
Pressure	Text	Pressure class	GAS Kiosk Frame	/	Text	/	IPB – Intermediate Pressure B; IPA – Intermediate Pressure A; MP – Medium Pressure; LPB – Low Pressure B; LPA – Low Pressure A	1
Pressure	Text	Pressure class	Gas Kiosk Frame	/	Text	/	IPB – Intermediate Pressure B; IPA – Intermediate Pressure A; MP – Medium Pressure; LPB – Low Pressure B; LPA – Low Pressure A	1
Pressure	Text	Pressure class	GAS Pipe	/	Text	/	HP – High Pressure; IPB – Intermediate Pressure B; IPA – Intermediate Pressure A; MP – Medium Pressure; LPB – Low Pressure B; LPA – Low Pressure A	1
Pressure	Text	Pressure class	Gas Riser	/	Text	/	MP – Medium Pressure; LPB – Low Pressure B; LPA – Low Pressure A	1
Pressure	Text	Pressure class	GAS Sleeve	/	Text	/	HP – High Pressure; IPB – Intermediate Pressure B; IPA – Intermediate Pressure A; MP – Medium Pressure; LPB – Low Pressure B; LPA – Low Pressure A	1
Pressure	Text	Pressure class	GAS Syphon	/	Text	/	HP – High Pressure; IPB – Intermediate Pressure B; IPA – Intermediate Pressure A; MP – Medium Pressure; LPB – Low Pressure B; LPA – Low Pressure A	1
Pressure	Text	Pressure class	GAS Valve Chamber	/	Text	/	HP – High Pressure; IPB – Intermediate Pressure B	1
Pressure	Text	Pressure class	GAS Valve Pit	/	Text	/	IPA – Intermediate Pressure A; MP – Medium Pressure; LPB – Low Pressure B; LPA – Low Pressure A	1
Region	Text	3 Regions of Hong Kong	DSD Facilities	/	Text	/	Hong Kong Island / Kowloon / New Territories	1
ShapeDescription	Text	Shape or appearance of Box Culvert/Tunnel	Box Culvert / Tunnel_Sewage	/	Text	/	/	1
ShapeDescription	Text	Shape or appearance of Box Culvert/TunneL	Box Culvert / Tunnel_Stormwater	/	Text	/	/	1
ShapeDescription	Text	Shape or appearance of Channel	Channel	/	Text	/	/	1
ShapeDescription	Text	Shape or appearance of Dry weather flow channel	Dry Weather Flow Channel	/	Text	/	/	1
ShapeDescription	Text	Shape or appearance of U channel	U Channel	/	Text	/	/	1
ShapeDescription	Text	Shape or appearance of Pipe	Multiple Sewage Pipe	/	Text	/	/	1
ShapeDescription	Text	Shape or appearance of Pipe	Multiple Stormwater Pipe	/	Text	/	/	1

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
ShapeDescription	Text	Shape or appearance of Rising Mains	Multiple Sewage Rising Mains	/	Text	/	/	1
ShapeDescription	Text	Shape or appearance of Rising Mains	Multiple Stormwater Rising Mains	/	Text	/	/	1
ShapeDescription	Text	Shape or appearance of Pipe	Combined Pipe	/	Text	/	/	1
ShapeDescription	Text	Shape or appearance of Pipe	Sewage Pipe	/	Text	/	/	1
ShapeDescription	Text	Shape or appearance of Pipe	Stormwater Pipe	/	Text	/	/	1
ShapeDescription	Text	Shape or appearance of Rising Main	Sewage Rising Mains	/	Text	/	/	1
ShapeDescription	Text	Shape or appearance of Rising Main	Stormwater Rising Mains	/	Text	/	/	1
State	Text	“LIVE” and “LAID” are the gas pipes in operation, while “RP”(Reserved) is gas pipe not currently in use.	GAS Pipe	/	Text	/	LIVE / LAID / RP	1
Status	Text	Life Cycle Status	LV Cable Joint	/	Text	/	/	1
Status	Text	Life Cycle Status	LV Conductor	/	Text	/	/	1
Status	Text	Life Cycle Status	MV Cable joint	/	Text	/	/	1
Status	Text	Life Cycle Status	MV Conductor	/	Text	/	/	1
StrNum	Text	Structure facility number.	Highmast	/	Text	/	/	1
SurveyType	Text	Survey Type	Survey Point	/	Text	/	P,PF – Footpath; C,CF – Carriageway	1
SurveyType	Text	Survey Type	LV Cable Joint	/	Text	/	P,PF – Footpath; C,CF – Carriageway	1
SurveyType	Text	Survey Type	LV Survey Point	/	Text	/	P,PF – Footpath; C,CF – Carriageway	1
SurveyType	Text	Survey Type	MV Cable joint	/	Text	/	P,PF – Footpath; C,CF – Carriageway	1
SurveyType	Text	Survey Type	MV Survey Point	/	Text	/	P,PF – Footpath; C,CF – Carriageway	1
System	Text	Water Type (English)/ Water Type (Chinese)	Fresh Water Valve	/	Text	/	/	1
TO_PNT	Text	To the end of another feature’s feature number	Box Culvert / Tunnel_Sewage	/	Text	/	/	1
TO_PNT	Text	To the end of another feature’s feature number	Box Culvert / Tunnel_Stormwater	/	Text	/	/	1
TO_PNT	Text	To the end of another feature’s feature number	Channel	/	Text	/	/	1
TO_PNT	Text	To the end of another feature’s feature number	Dry Weather Flow Channel	/	Text	/	/	1
TO_PNT	Text	To the end of another feature’s feature number	U Channel	/	Text	/	/	1
TO_PNT	Text	To the end of another feature’s feature number	Multiple Sewage Pipe	/	Text	/	/	1

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
TO_PNT	Text	To the end of another feature's feature number	Multiple Stormwater Pipe	/	Text	/	/	1
TO_PNT	Text	To the end of another feature's feature number	Multiple Sewage Rising Mains	/	Text	/	/	1
TO_PNT	Text	To the end of another feature's feature number	Multiple Stormwater Rising Mains	/	Text	/	/	1
TO_PNT	Text	To the end of another feature's feature number	Combined Pipe	/	Text	/	/	1
TO_PNT	Text	To the end of another feature's feature number	Sewage Pipe	/	Text	/	/	1
TO_PNT	Text	To the end of another feature's feature number	Stormwater Pipe	/	Text	/	/	1
TO_PNT	Text	To the end of another feature's feature number	Sewage Rising Mains	/	Text	/	/	1
TO_PNT	Text	To the end of another feature's feature number	Stormwater Rising Mains	/	Text	/	/	1
TopLevel	Number	Level of the top of the grating (mPD)	Grating Gully	/	Double	/	/	1
TrapGully	Text	Trapped gully	Grating Gully	/	Text	/	/	1
Type	Text	Box Culvert / Tunnel	Box Culvert / Tunnel_Sewage	/	Text	/	/	1
Type	Text	Box Culvert / Tunnel	Box Culvert / Tunnel_Stormwat er	/	Text	/	/	1
Type	Integer	Type of the pipe	Carrier Drain	/	Long Integer	/	/	1
Type	Integer	Type of the pipe	Connection Pipe	/	Long Integer	/	/	1
Type	Integer	Type of the pipe	Cross Road Drain	/	Long Integer	/	/	1
Units	Text	Unit of Diameter	Fresh Water Mains	/	Text	/	/	1
Units	Text	Unit of Diameter	Fresh Water Valve	/	Text	/	/	1
Units	Text	Unit of diameter	GAS Pipe	/	Text	/	/	1
Units	Text	Unit of Diameter	Raw Water Mains	/	Text	/	/	1
Units	Text	Unit of Diameter	Raw Water Valve	/	Text	/	/	1
Units	Text	Unit of Diameter	Saltwater Mains	/	Text	/	/	1
Units	Text	Unit of Diameter	Saltwater Valve	/	Text	/	/	1
US_IL	Number	Invert level of the pipe at upstream end in mPD	Carrier Drain	/	Double	/	/	1
US_IL	Number	Invert level of the pipe at upstream end in mPD	Connection Pipe	/	Double	/	/	1
US_IL	Number	Invert level of the pipe at upstream end in mPD	Cross Road Drain	/	Double	/	/	1

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
US_IL	Number	Upstream Invert Level (mPD)	Multiple Sewage Pipe	/	Double	/	/	1
US_IL	Number	Upstream Invert Level (mPD)	Multiple Stormwater Pipe	/	Double	/	/	1
US_IL	Number	Upstream Invert Level (mPD)	Multiple Sewage Rising Mains	/	Double	/	/	1
US_IL	Number	Upstream Invert Level (mPD)	Multiple Stormwater Rising Mains	/	Double	/	/	1
US_IL	Number	Upstream Invert Level (mPD)	Combined Pipe	/	Double	/	/	1
US_IL	Number	Upstream Invert Level (mPD)	Sewage Pipe	/	Double	/	/	1
US_IL	Number	Upstream Invert Level (mPD)	Stormwater Pipe	/	Double	/	/	1
US_IL	Number	Upstream Invert Level (mPD)	Sewage Rising Mains	/	Double	/	/	1
US_IL	Number	Upstream Invert Level (mPD)	Stormwater Rising Mains	/	Double	/	/	1
Voltage	Text	Voltage	Cable	/	Text	/	/	1
WaterType	Text	Water Type (English)	Fresh Water Mains	/	Text	/	/	1
WaterType	Text	Water Type (English)	Raw Water Mains	/	Text	/	/	1
WaterType	Text	Water Type (English)	Raw Water Valve	/	Text	/	/	1
WaterType	Text	Water Type (English)	Saltwater Mains	/	Text	/	/	1
WaterType	Text	Water Type (English)	Saltwater Valve	/	Text	/	/	1
WaterType_TC	Text	Water Type (Chinese)	Fresh Water Mains	/	Text	/	/	1
WaterType_TC	Text	Water Type (Chinese)	Raw Water Mains	/	Text	/	/	1
WaterType_TC	Text	Water Type (Chinese)	Raw Water Valve	/	Text	/	/	1
WaterType_TC	Text	Water Type (Chinese)	Saltwater Mains	/	Text	/	/	1
WaterType_TC	Text	Water Type (Chinese)	Saltwater Valve	/	Text	/	/	1
Width	Number	Width of the concrete planting (m)	Lamppost	/	Double	/	/	1
Width	Integer	Width (mm)	Box Culvert / Tunnel_Sewage	/	Long Integer	/	/	1
Width	Integer	Width (mm)	Box Culvert / Tunnel_Stormwat er	/	Long Integer	/	/	1
Width	Integer	Internal width of pipe in mm	Carrier Drain	/	Long Integer	/	/	1
Width	Integer	Width (mm)	Channel	/	Long Integer	/	/	1
Width	Integer	Internal width of pipe in mm	Connection Pipe	/	Long Integer	/	/	1
Width	Integer	Internal width of pipe in mm	Cross Road Drain	/	Long Integer	/	/	1
Width	Integer	Width (mm)	Dry Weather Flow Channel	/	Long Integer	/	/	1

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
Width	Integer	Width (mm)	U Channel	/	Long Integer	/	/	1
Width	Number	Internal width of Catchpit (m)	Catchpit	/	Double	/	/	1
Width	Number	Width (mm)	Multiple Sewage Pipe	/	Double	/	/	1
Width	Number	Width (mm)	Multiple Stormwater Pipe	/	Double	/	/	1
Width	Number	Width (mm)	Multiple Sewage Rising Mains	/	Double	/	/	1
Width	Number	Width (mm)	Multiple Stormwater Rising Mains	/	Double	/	/	1
Width	Number	Width (mm)	Combined Pipe	/	Double	/	/	1
Width	Number	Width (mm)	Sewage Pipe	/	Double	/	/	1
Width	Number	Width (mm)	Stormwater Pipe	/	Double	/	/	1
Width	Number	Width (mm)	Sewage Rising Mains	/	Double	/	/	1
Width	Number	Width (mm)	Stormwater Rising Mains	/	Double	/	/	1
X_COOR	Number	x coordinate	GAS Pipe	/	Double	/	/	1
Y_COOR	Number	y coordinate	GAS Pipe	/	Double	/	/	1
Z_COOR	Number	Z coordinate. Represent the level information	Bollard	/	Double	/	/	1
Z_COOR	Number	Z coordinate. Represent the level information	Connector	/	Double	/	/	1
Z_COOR	Number	Z coordinate. Represent the level information	Control Cubicle	/	Double	/	/	1
Z_COOR	Number	Z coordinate. Represent the level information	Highmast	/	Double	/	/	1
Z_COOR	Text	Z coordinate. Represent the level information	Lamppost	/	Text	/	/	1
ActivityID	Text	Unique identifier of each activity	/	Elements required for simulation and visualisation. i.e., Site, Topography, Temporary Works, Foundation, Framing, Column, Wall, Floor, Façade, Window, Plants, etc	Text	/	1F_Column	2

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
EndDate	Date & Time	Ending date/time of each activity (yyyy-MM-dd HH:mm:ss)	/	Elements required for simulation and visualisation. i.e., Site, Topography, Temporary Works, Foundation, Framing, Column, Wall, Floor, Façade, Window, Plants, etc	Date & Time	/	2023-12-31 16:30:00	2
StartDate	Date & Time	Starting date/time of each activity (yyyy-MM-dd HH:mm:ss)	/	Elements required for simulation and visualisation. i.e., Site, Topography, Temporary Works, Foundation, Framing, Column, Wall, Floor, Façade, Window, Plants, etc	Date & Time	/	2023-08-01 08:00:00	2
BottomLevel	Number	Bottom Level of each point	Rock and Soil Layer	Topography	Number	mPD	-40.5	3
Easting	Number	Easting of each point	Rock and Soil Layer	Topography	Number	m	842726.470	3
Elevation	Number	Elevation (Top Level) of each point	Rock and Soil Layer	Topography	Number	mPD	12.345	3
LayerName	Text	Soil/Rock Layer Name	Rock and Soil Layer	Topography	Text	/	HD Granite	3
Northing	Number	Northing of each point	Rock and Soil Layer	Topography	Number	m	817363.470	3
ProjectName	Text	Project Name	Rock and Soil Layer	Topography	Text	/	Yau Tong Estate Ph5 Addtitional G.I. for Footbridge	3
ReportNum	Text	GI Report Number	Rock and Soil Layer	Topography	Text	/	31524	3
Height	Text	Height	/	Massing model of SPA Space Limit	Text	mm	2400	4
Width	Number	Width	/	Massing model of SPA Space Limit	Number	mm	2100	4
BelloutDepth	Number	Bell-out Depth of Bored Pile	Bored Pile	Bored Pile	Number	m	5	5
BelloutDiameter	Number	Bell-out Diameter of Bored pile	Bored Pile	Bored Pile	Number	m	17	5

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
BottomLevel	Number	Bottom Level of each point	Rock Stratum	Topography	Number	mPD	-40.5	5
Easting	Number	Easting of each point	Rock Stratum	Topography	Number	m	842726.470	5
Elevation	Number	Elevation (Top Level) of each point	Rock Stratum	Topography	Number	mPD	-12.345	5
Length	Number	Length of Bored Pile	Bored Pile	Bored Pile	Number	m	50	5
Northing	Number	Northing of each point	Rock Stratum	Topography	Number	m	817363.470	5
Properties	Text	Properties of Rock Stratum	Rock Stratum	Topography	Text	/	Granite	5
ShaftDiameter	Number	Diameter of Bored Pile Shaft	Bored Pile	Bored Pile	Number	m	12	5
TopLevel	Number	Top Level of Bored Pile	Bored Pile	Bored Pile	Number	mPD	5	5
ApprovedExtent	Text	Approved Extent	/	Massing model of excavation area	Text	/	Y: Approved Extent N / Null: Non-narrow trench excavation[1]	6
Depth	Text	Depth of the concrete planting (m)	/	Massing model of excavation area	Text	m	4	6
EndDate	Date	Ending date of the permit (In YYYY/MM/DD format)	/	Massing model of excavation area	Date	/	2024/01/15	6
Length	Text	Length	/	Massing model of excavation area	Text	m	12	6
Level	Text	Level of Highway polygon	/	Massing model of excavation area	Text	/	-3: Underground level 3 -2: Underground level 2 -1: Underground level 1 0: Ground level polygon 1: Level 1 bridge 2: Level 2 bridge 3: Level 3 bridge	6
PlanArea	Text	Area (sqm)	/	Massing model of excavation area	Text	/	72	6
Purpose	Text	The purpose of the excavation	/	Massing model of excavation area	Text	/	Lay ducting and ATC draw pit Replace sewer Provision of lifts	6
StartDate	Date	Starting date of the permit (In YYYY/MM/DD format)	/	Massing model of excavation area	Date	/	2024/01/13	6

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
Type	Text	Type of excavation permit	/	Massing model of excavation area	Text	/	Emergency: The excavations within the validity period with maximum 7 days; Capital Works: The site area of the Capital Works project should exceed a 450m diameter circular boundary; Excavation: An excavation area which can be completely bounded by a circle with 450m diameter; Small Scale Works: Total area of a Small-Scale Works job of excavation shall not exceed 4 sq. meters.	6
Width	Text	Width (m)	/	Massing model of excavation area	Text	/	6	6
Air_Mitigation	Text	Mitigation Measures for Air Quality	/	Massing model of building blocks by level	Text	/		7
AirLevel	Text	Level of Air Quality Impact Assessment	/	Massing model of building blocks by level	Text	/	Complied with the criteria, Exceeded the criteria	7
AirMitigation	Text	Mitigation Measures for Air Quality	/	Massing model of building blocks by level	Text	/	Not necessary, Watering of on-site construction area to control construction dust	7
BuildingMaterialVisible	Text	Visibility of Building Appearance	/	Massing model of building blocks	Text	/	Visible, Not Visible	7
NoiseLevel	Text	Level of Noise Impact Assessment	/	Massing model of building blocks by level	Text	/	Complied with the criteria, Exceeded the criteria	7
NoiseMitigation	Text	Mitigation Measures for Noise Level	/	Massing model of building blocks by level	Text	/	Enclosed noise barrier along highway, Low noise road surface	7
FM Attributes (Varies)	Text	Data required for facility management (Parameter naming / Attributes list may varies, subject to the Project Owner's requirement.)	/	Equipment, IoT	Text	/	EMSD.Elecctrical Distribution Type: Radial EMSD.Electrical.Date of Last PITC: 2023-08-30 EMSD.Electrucal.Dimensions: 600 x 1160 x 200	8
FeatureID	Text	Unique identifier of the object (Organisation Name-Project Name-Location-Equipment Type-Sequence No.)	/	Equipment, IoT	Text	/	CIC-PROJ-L1-AHU-001	8
X_COOR	Number	Geometric location of an object (Centre)	/	Equipment, IoT	Number	m	/	8

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
Y_COOR	Number	Geometric location of an object (Centre)	/	Equipment, IoT	Number	m	/	8
Z_COOR	Number	Geometric location of an object (Centre)	/	Equipment, IoT	Number	m	/	8
Location	Text	Location of each Premise	/	Massing model of building blocks and flat units	Text	/	Block A, Block B, Tower 1, Tower 2	10
PremisesName	Text	Name for each Premise	/	Massing model of building blocks and flat units	Text	/	Flat D	10
BottomLevel	Number	Bottom level of each building	/	Massing model of building blocks	Number	mPD	-5	11
BuildingID	Text	Unique identifier of each building	/	Massing model of building blocks	Text	/	BD157612	11
BuildingName	Text	Nmame of each building	/	Massing model of building blocks	Text	/	Enterprise Square Five (Megabox)	11
TopLevel	Text	Top level of each building	/	Massing model of building blocks	Text	/	45	11
MaterialOrigin	Text	Country of origin of the construction materials	/	Structural Elements	Text	/	China	12
StructuralMaterial	Text	Construction materials of the structural elements	/	Structural Elements	Text	/	Concrete_C60	12
CreationDate	Date	Creation Date	/	Path of Travel Line	Date	/	February 28, 2021	13
CrossingFeature	Text	To indicate the type of feature across the road crossing	/	Path of Travel Line	Text	/	LightRail / BicycleTrack / Road / Tramway / PublicTransportInterchange	13
DataSource	Text	Data source for the feature	/	Path of Travel Line	Text	/	Estimation / 3DSpatialData / iB1000 / Other / TD / HyD / AFCD / Proposal / AsBuilt / MMS / DAP / FieldChecking	13
DayCode	Text	Day Code	/	Path of Travel Line	Text	/	Every Thursday / Every Sunday / Everyday (Monday - Sunday) / Every Saturday / Every Friday / Every Wednesday / Every Tuesday / Every Monday / Eve of all Public Holiday / All Weekend (Saturday - Sunday) / All Public Holiday / All Weekday (Monday - Friday)	13
Direction	Text	To indicate the permissible travel direction of the segment in relation to its drawn direction	/	Path of Travel Line	Text	/	One Way Backward / Both Ways / One Way Forward	13

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
Enabled	Text	To indicate whether the segment is ready and opened for public access	/	Path of Travel Line	Text	/	True / False	13
FeatureType	Text	Type of pedestrian segment	/	Path of Travel Line	Text	/	Footway / Footbridge / Footpath / Service Lane / Subway / Generalized Walkway Inside Park / Traffic Island / RunIn / Escalator / Travelator / M_Lift / M_Ramp / Lift / Ramp / Staircase / Stairlift / Village / Track / Crossing - Signalized / Crossing - Zebra / Crossing – Cautionary / Crossing - Others / M_Others / M_Stairlift / M_Staircase / M_Travelator / M_Escalator / M_Footway / Other	13
FromTime	Time	From Time in HHMM	/	Path of Travel Line	Time	/	0800	13
Gradient	Number	The gradient of the segment in radian	/	Path of Travel Line	Number	radian	0.25	13
LastAmendmentDate	Date	Last edited date	/	Path of Travel Line	Date	/	June 26, 2022	13
Length	Number	Length	/	Path of Travel Line	Number	m		13
LevelSource	Text	Data source for the vertical height information of the feature	/	Path of Travel Line	Text	/	CEDD / FieldChecking / Estimation / TD / Proposal / AsBuilt / MMS / LiDAR / Photo / Other / iB1000 / 3DSpatialData	13
Location	Text	To indicate whether the segment is located outdoor or indoor	/	Path of Travel Line	Text	/	Outdoor / Indoor	13
ModifiedBy	Text	Name of user who last edited	/	Path of Travel Line	Text	/	LANDSD	13
Name	Text	Generic name of the segment in English	/	Path of Travel Line	Text	/	Kam Tin Road	13
Name_TC	Text	Generic name of the segment in Traditional Chinese	/	Path of Travel Line	Text	/	錦田公路	13
ObstaclesType	Text	To indicate the presence and the type of obstacles (immovable / permanent) on the pedestrian walkway, which might hinder access for mobility aided users	/	Path of Travel Line	Text	/	FireHydrant / Accessible / Light Pole / BusStop / ParkingMeter / ElectricBox / Tree / Bollard / BridgePier / TrafficLight / SignPole / TrafficSign / RoadSign	13
PositionCertainty	Text	To indicate the position certainty of the segment in Country Park and Rural Village Area	/	Path of Travel Line	Text	/	Certain / Uncertain	13
StreetCode	Text	Street_code of gazetted street on which the pedestrian walkway is running parallel along	/	Path of Travel Line	Text	/	10,961	13
StreetName	Text	English name of the street in which the pedestrian route is spatially related to	/	Path of Travel Line	Text	/	Kam Tin Road	13

Parameter Name in BIM	Data Type in BIM	Description	Type of Works Items in BIM	Relevant BIM Objects	Data Type in Systems	Unit	Example	Applicable to Use Case
StreetName_TC	Text	Traditional Chinese name of the street in which the pedestrian route is spatially related to	/	Path of Travel Line	Text	/	錦田公路	13
ToTime	Time	To Time in HHMM	/	Path of Travel Line	Time	/	2000	13
WeatherProof	Text	To indicate whether the segment is covered or non-covered	/	Path of Travel Line	Text	/	Covered / NonCovered / Unclassified	13
WheelchairAccess	Text	To indicate the network segment is a mobility accessible entrance/exit to a public building/site	/	Path of Travel Line	Text	/	True / False	13
WheelchairBarrier	Text	To indicate the network segment is assessed to be unsuitable for mobility access, particularly for wheelchair users	/	Path of Travel Line	Text	/	True / False	13

Level of features from ground
(3: Level 3 bridge/flyover/structure above ground level 2; 2:Level 2 bridge/flyover/structure above ground level 1; 1: Level 1 bridge/flyover/structure above ground level; 0: Ground level; -1: Underground level 1 subway/tunnel/structure below ground level; -2: Underground level 2 subway/tunnel/structure below ground level -1; -3: Underground level 3 subway/tunnel/structure below ground level -2)

Position of Cable Duct / Hightmast Cable Duct
(1: Underground; 2: Underground (Shallow); 3: Overhead; 4: Wall Mounted (include surface fixing); 5: Spare Cable Duct (>=900mm); 6: Spare Cable Duct (<900mm); 7: Suspected Cable Duct)

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(Please put a "✓" in the appropriate box.)

1. As a whole, I feel that the publication is:	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Informative	☐	☐	☐	☐	☐
Comprehensive	☐	☐	☐	☐	☐
Useful	☐	☐	☐	☐	☐
Practical	☐	☐	☐	☐	☐

2. Does the publication enable you to understand more about the subject?	Yes	No	No Comment
	☐	☐	☐

3. Have you made reference to the publication in your work?	Quite Often	Sometimes	Never
	☐	☐	☐

4. To what extent the publication benefits you?	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Supply chain Information integrity	☐	☐	☐	☐	☐
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Project Collaborations					

5. Overall, how would you rate our publication?	Excellent	Very Good	Satisfactory	Fair	Poor
	☐	☐	☐	☐	☐

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