



# CORENETX AUTOMATED MODEL CHECKER FUNCTIONALITIES

04 SEPT 2024



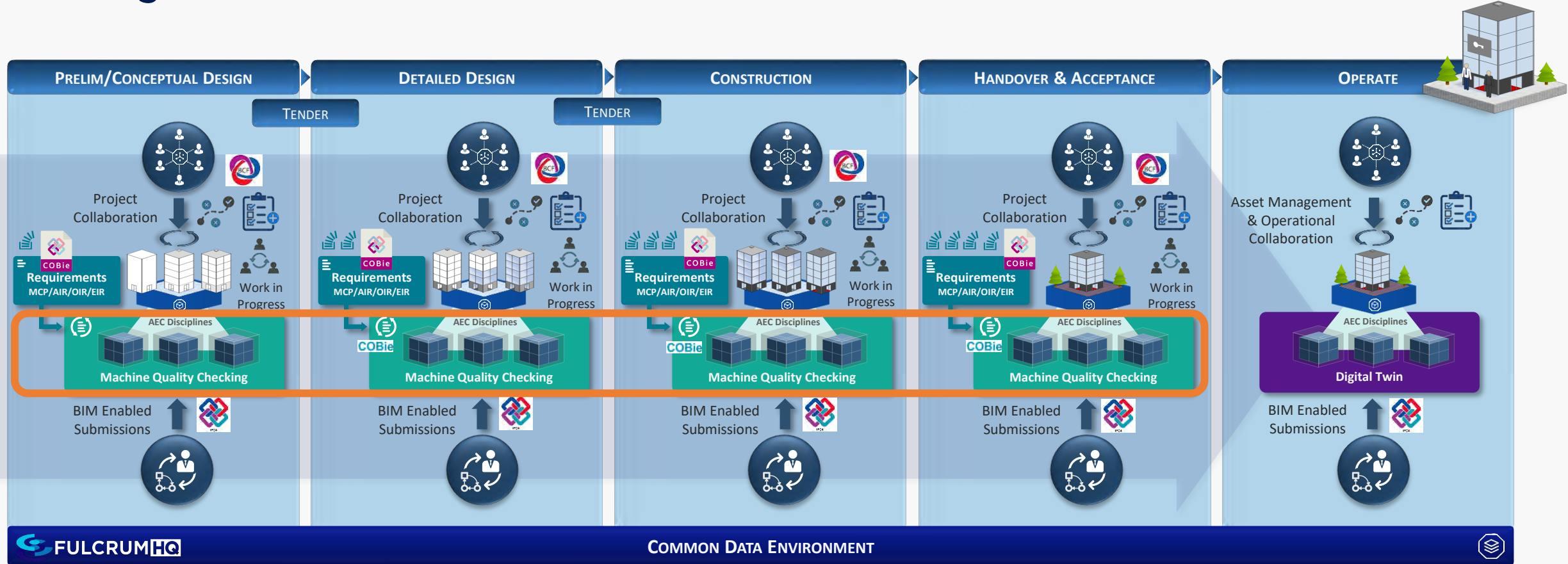
# **Introduction to CORENETX**

One-Stop Portal for All Co-ordinated BIM  
Submissions and Regulatory Processing Across All  
Agencies - powered by FulcrumHQ



# Trusted Source of Truth

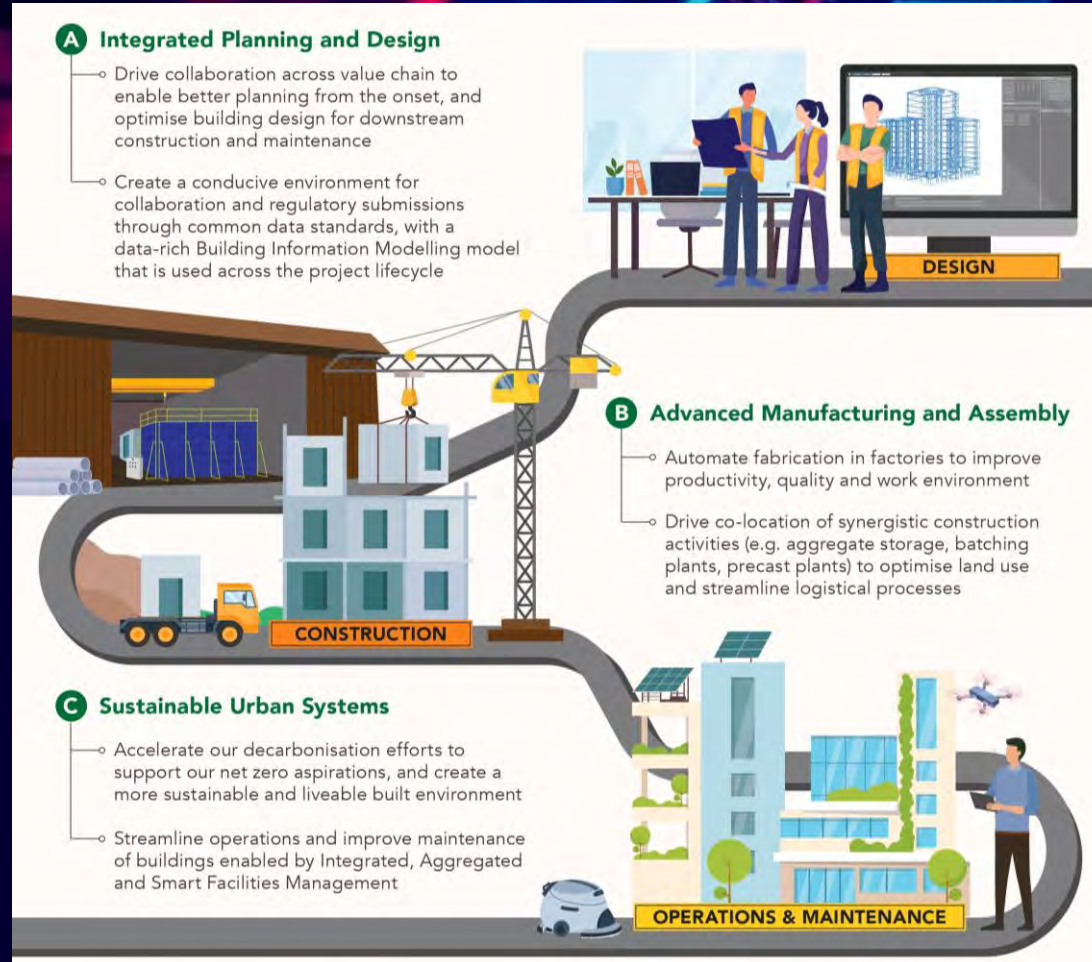
Safe-guarding and future-proofing Asset Owners and Operators by ensuring BIM Models are trusted and reliable sources of truth.



FULCRUM OFFERS FULL CONFORMANCE TO THE FOLLOWING OPEN STANDARDS:

buildingSMART openBIM IFC RCF COBie ISO19650-1 & 2

# Industry Transformation Map



## Integrated Planning and Design

Streamlining project approval processes by centralizing submissions, facilitating collaboration among government agencies, and ensuring consistent decision-making.



# CORENETX

## AUTOMATED MODEL CHECKER

### Key Transformation #1 Redesigned Process

#### Current regulatory approval process

All building developments in Singapore are regulated by **8 key regulatory agencies**



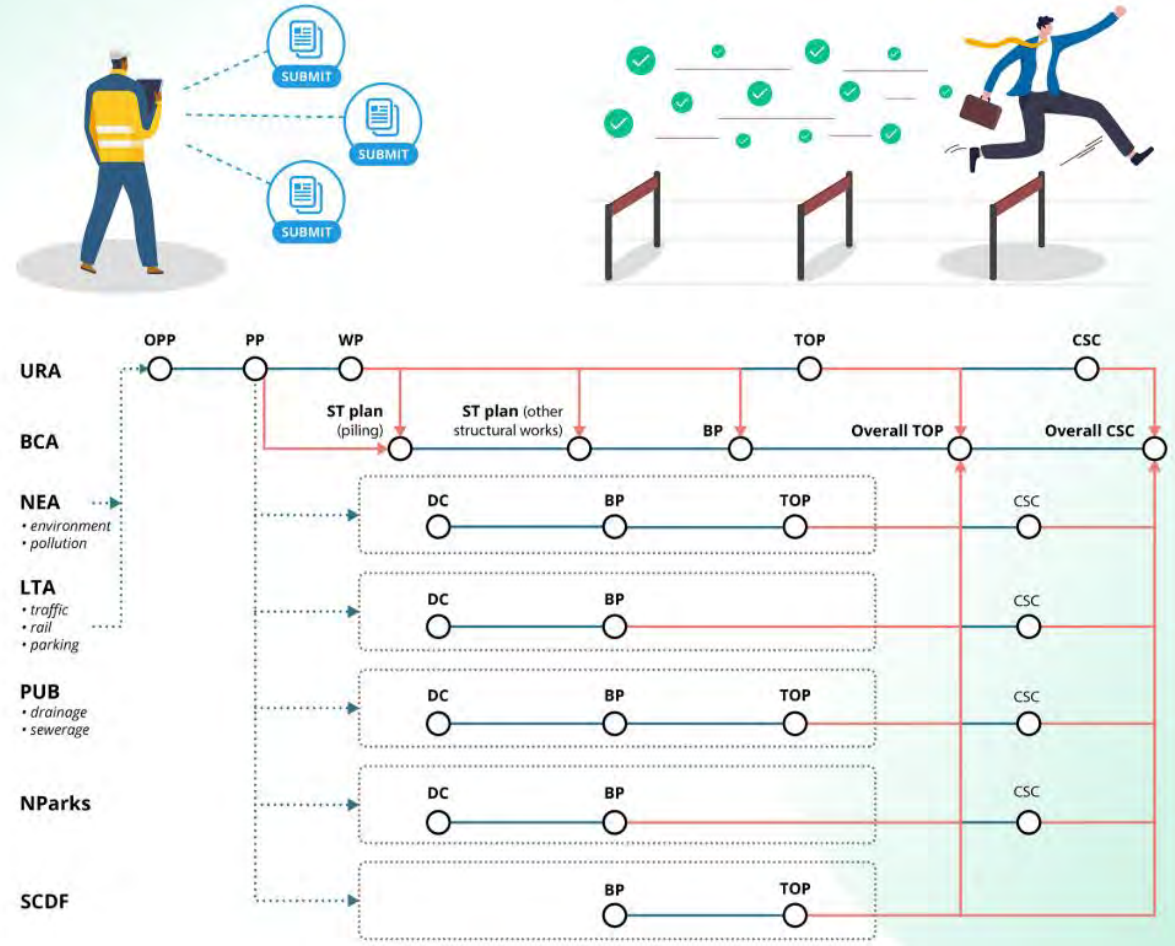
Currently, building professionals (e.g. architects, civil and structural engineers, mechanical and electrical engineers) can make **separate submissions** to individual agencies based on project progress.



Projects are required to obtain **regulatory approvals** from the relevant agencies at various milestones of the project.

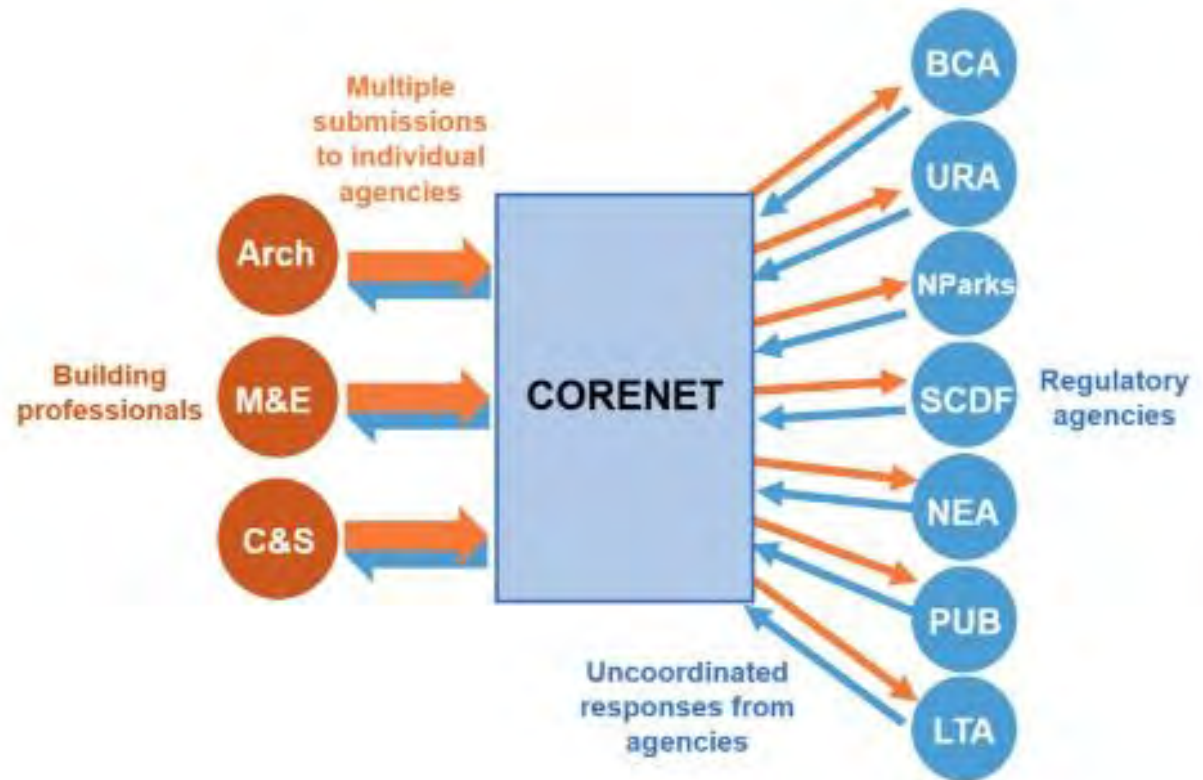


Under the current approval process, a typical building project will need to undergo **over 20 approval gates** across **8 agencies**.



# CORENETX

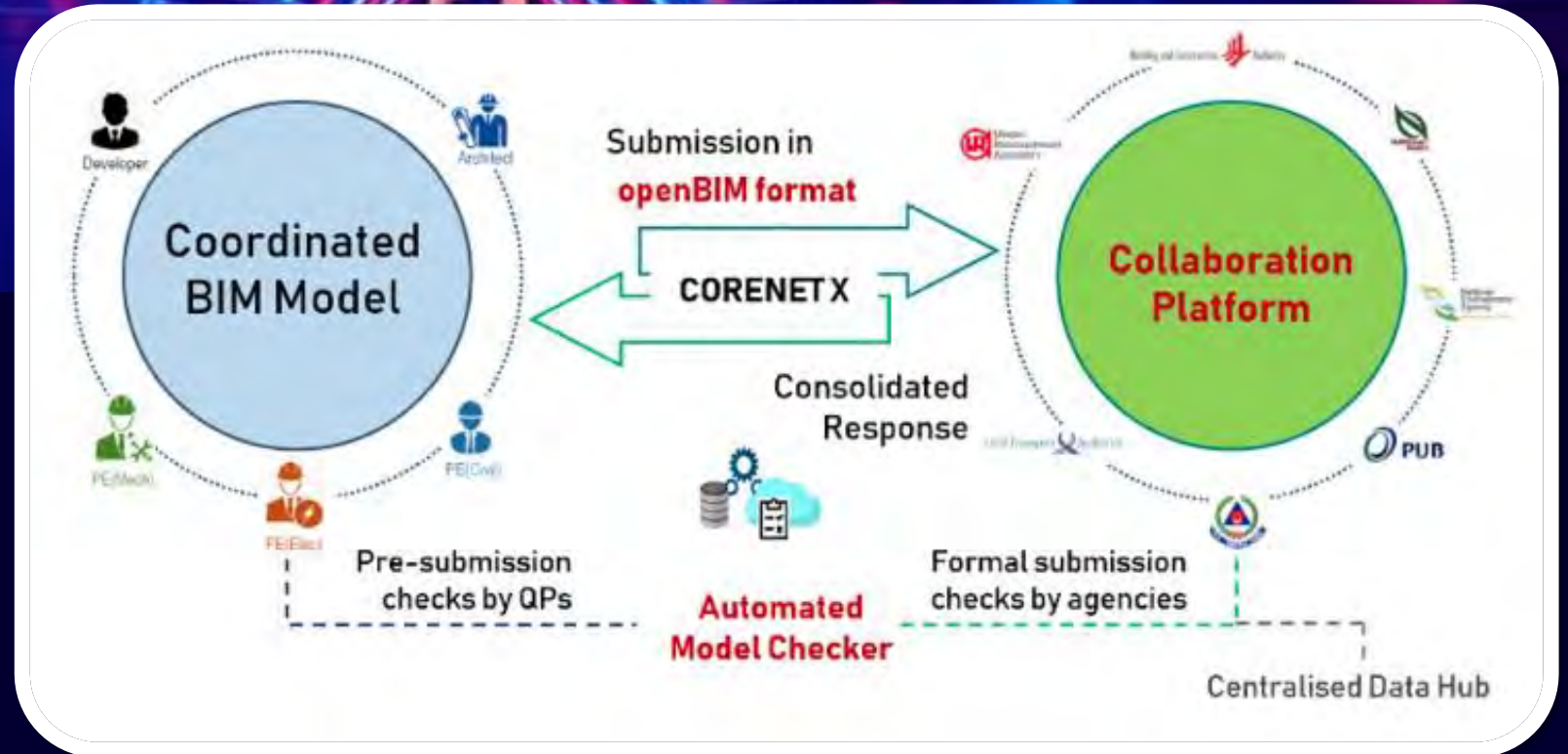
- The current regulatory process allows **concurrent** submissions, where industry consultants submit plans to various agencies separately.
- This approach does not incentivise consultants to conduct proper design coordination, which is important for productive construction practices.
- The plans approval process and response time of the regulatory agencies are also largely dependent on the project teams' own coordination as each individual agency assesses the submissions independently.





# CORENETX

- CORENET X requires the consultants to collaborate upfront to de-conflict their designs
- Submit a coordinated BIM model to the authorities
- Agencies will collectively review the submission and provide a consolidated response to the consultants.
- This integrated submission process provides a one-stop shopfront experience and improves regulatory governance and synergy among agencies.



# CORENETX

Hamessing the power of digitalisation and technology, CORENET X will allow Qualified Persons (QPs, i.e. professional engineers and registered architects) to submit a three-dimensional model of a development or building - created and developed digitally through Building Information Modelling (BIM) - to the regulatory agencies.

A large, dark blue circle with a white border is centered over a blurred aerial photograph of a city. The text 'CORENET X' is written in white, bold, sans-serif capital letters inside the circle.

**CORENET X**



1



### **Receiving Submissions and Project Information**

Incoming submissions are available on the Submissions Dashboard, with specific project and submissions details

2



### **Processing Submissions with Model Analytics**

Processing Officers can process submission BIM models and documents, create Issues for further collaboration and as part of responses to QP

3



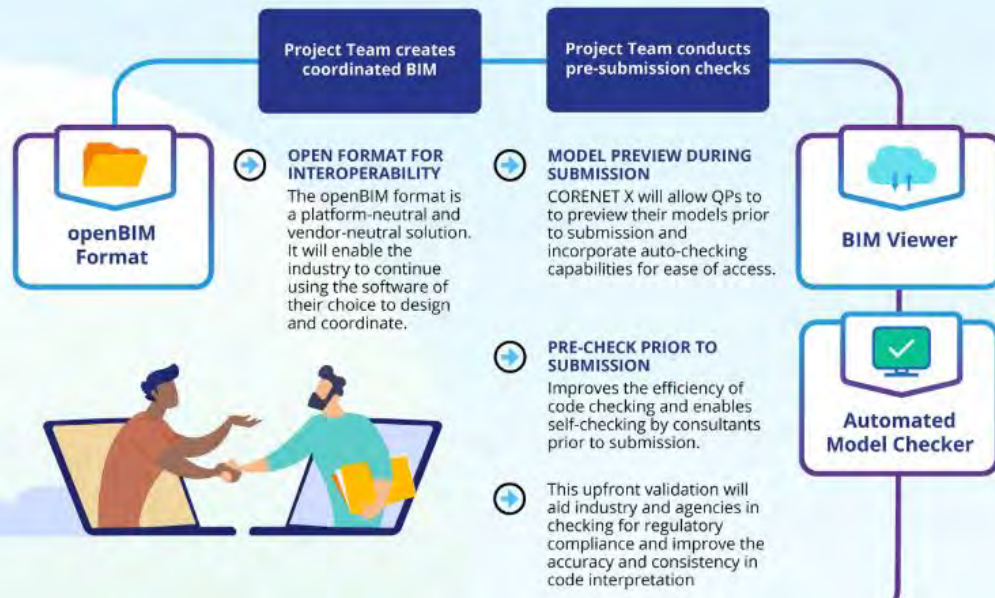
### **Coordinated Response and Packaging**

Processing Officers can promote Issues along collaboration workflow stages, create Response Letters and upload documents for Response Packaging

# CORENETX

## AUTOMATED MODEL CHECKER

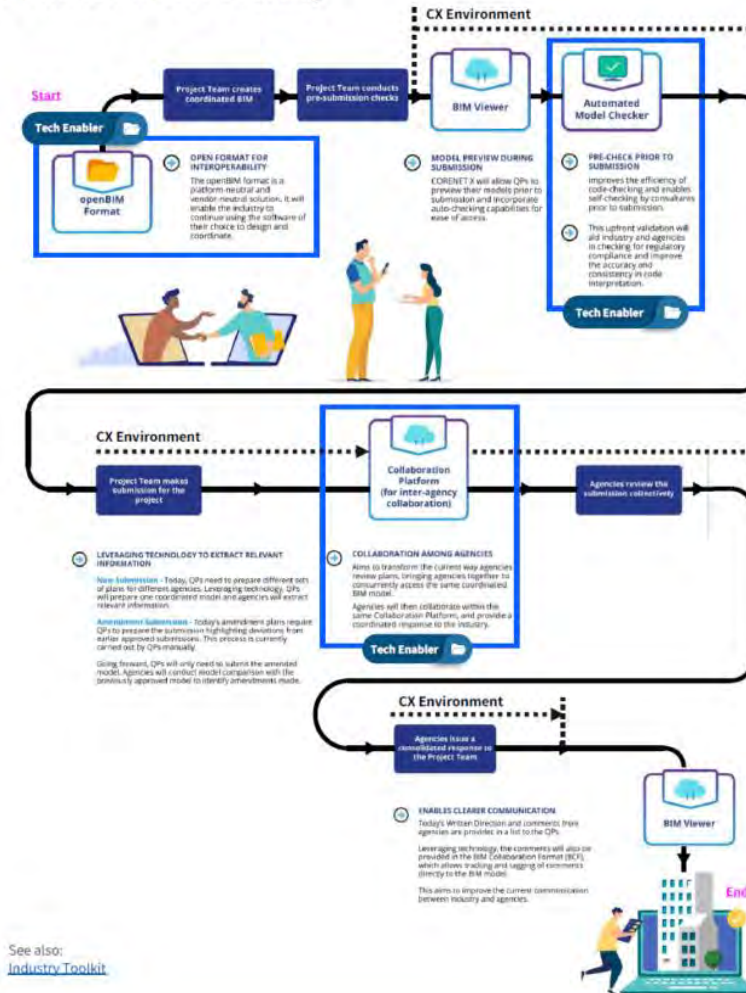
Through an industry-facing portal, CORENET X will utilize technological enablers to bring about collaboration, automation and interoperability.



### Section 1: Introduction to CORENET X User Journey

INTRODUCTION TO CX | GENERAL REQUIREMENTS | REGULATORY AGENCIES | KEY GATEWAYS | OTHER BUILDING WORKS | BIM DATA REPRESENTATION

### CORENET X User Journey







## **Quality Checker (QC)**

Automated Quality Checks ensuring Model Hygiene  
and Optimized Processing for BIM Submissions to  
CORENETX



# CORENETX

## AUTOMATED MODEL CHECKER



### **Computational BIM enabled Quality Control**

Computational automated checks driving conformity against modelling guidelines, AIR, EIR on Project Information and Asset Information models.



### **Computational BIM enabled Compliance Checks**

Computational automated checks driving conformity against regulatory and design requirements.

# INTRODUCTION TO FULCRUMHQ'S QUALITY CHECKS

## 5 Types of Quality Checks

### QC 1 - Building Level Naming Convention

QC 1 analyses if building levels follow established naming conventions.

### QC 2 - Clash Detection

QC 2 checks for meaningful clashes between select IFC4 Entities

### QC 3 - Parameter Value Analysis

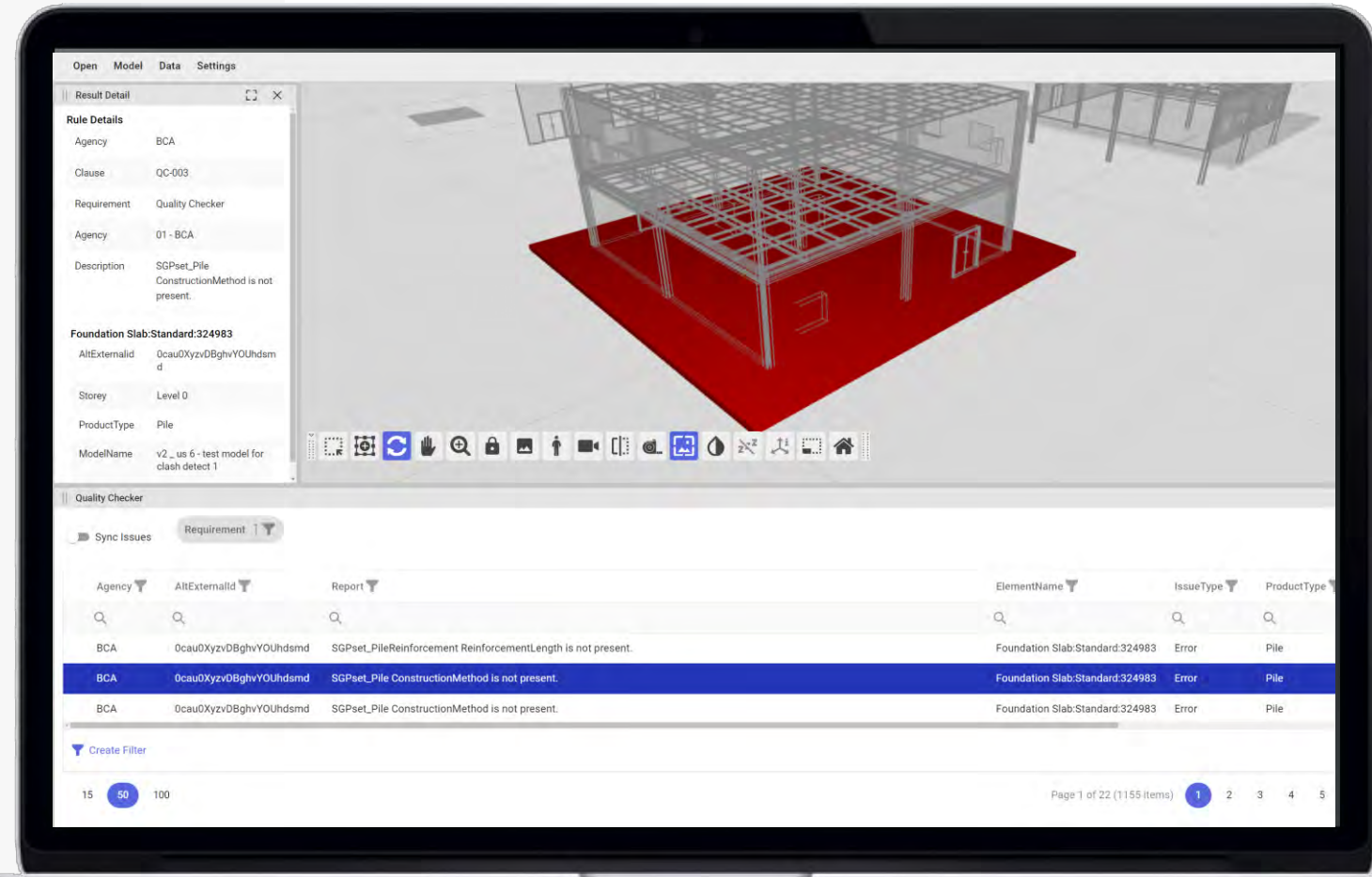
QC 3 checks for the presence of parameters associated with specific IFC4 Entities

### QC 4 - Space Identification

QC 4 checks that every slab area in the model has an associated IfcSpace for identification

### QC 5 - Alignment of BIM Model Coordinates

QC 5 ensures that the submitted trade BIM models contain the same coordinates





# QC 1 - BUILDING LEVEL NAMING CONVENTION

## Objective

To ensure **building levels** follow established naming conventions.

## Key Considerations

The check is also **designed to allow for some variation** in the way building levels may be named - for instance whether numerals or ordinal numerals should be indicated before or after fields such as 'Storey'

The current verification method is case-sensitive.

## Verification Methodology

**Step 1:** Check for presence of IfcBuilding. This is a necessary condition.

**Step 2:** FHQ evaluates each IfcBuildingStorey present in the submitted model for its name

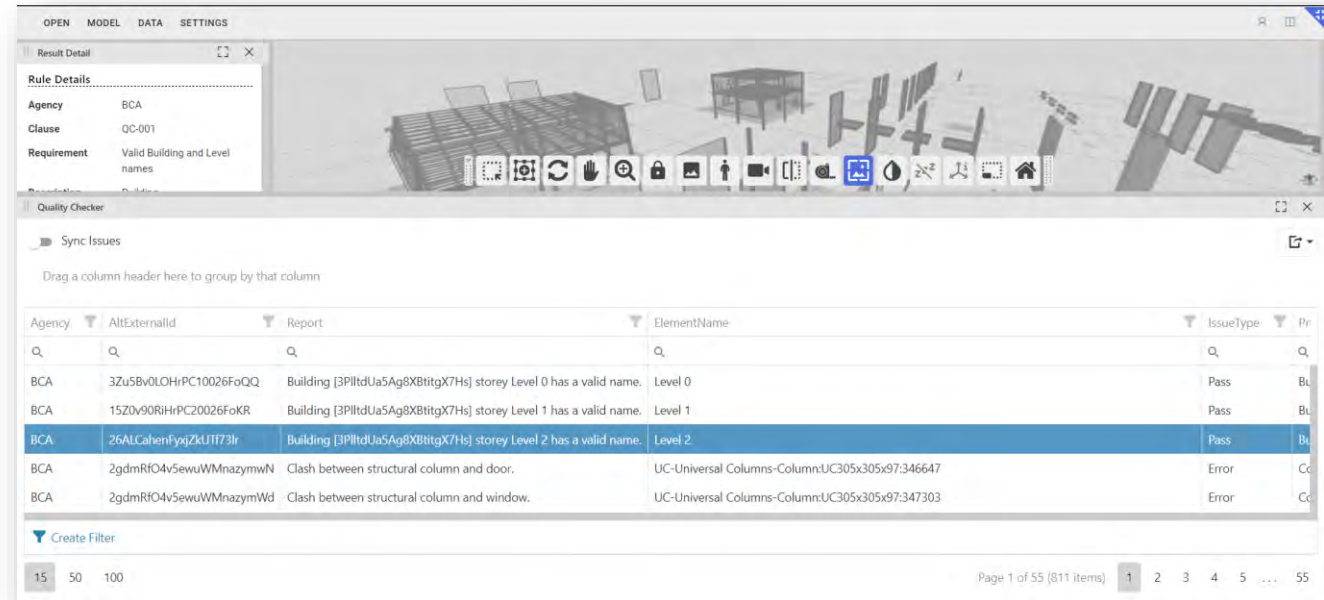
**Step 3:** IfcBuildingStorey name would be deemed acceptable if it adheres to any of the following conventions:

- ❖ 'Basement' followed by a numeral. E.g. Basement 1
- ❖ 'Level' followed by a numeral. E.g. Level 1
- ❖ 'Storey': Followed or preceded by a numeral. E.g. Storey 1, 1 Storey
- ❖ 'Storey': Followed or preceded by an ordinal numeral. E.g. Storey 1st, 1st Storey

## Expected Outcomes

### IssueTypes:

- **Pass Example:** for an IfcBuildingStorey named as 'Basement 1', QC 1 Report would state "Building storey has a valid name"
- **Warning Example:** for an IfcBuildingStorey named as 'Last Floor', QC 1 Report would state "Building storey Last Floor has an invalid name"



The screenshot shows the QC 1 report interface. At the top, there's a 'Result Detail' panel with the following information:

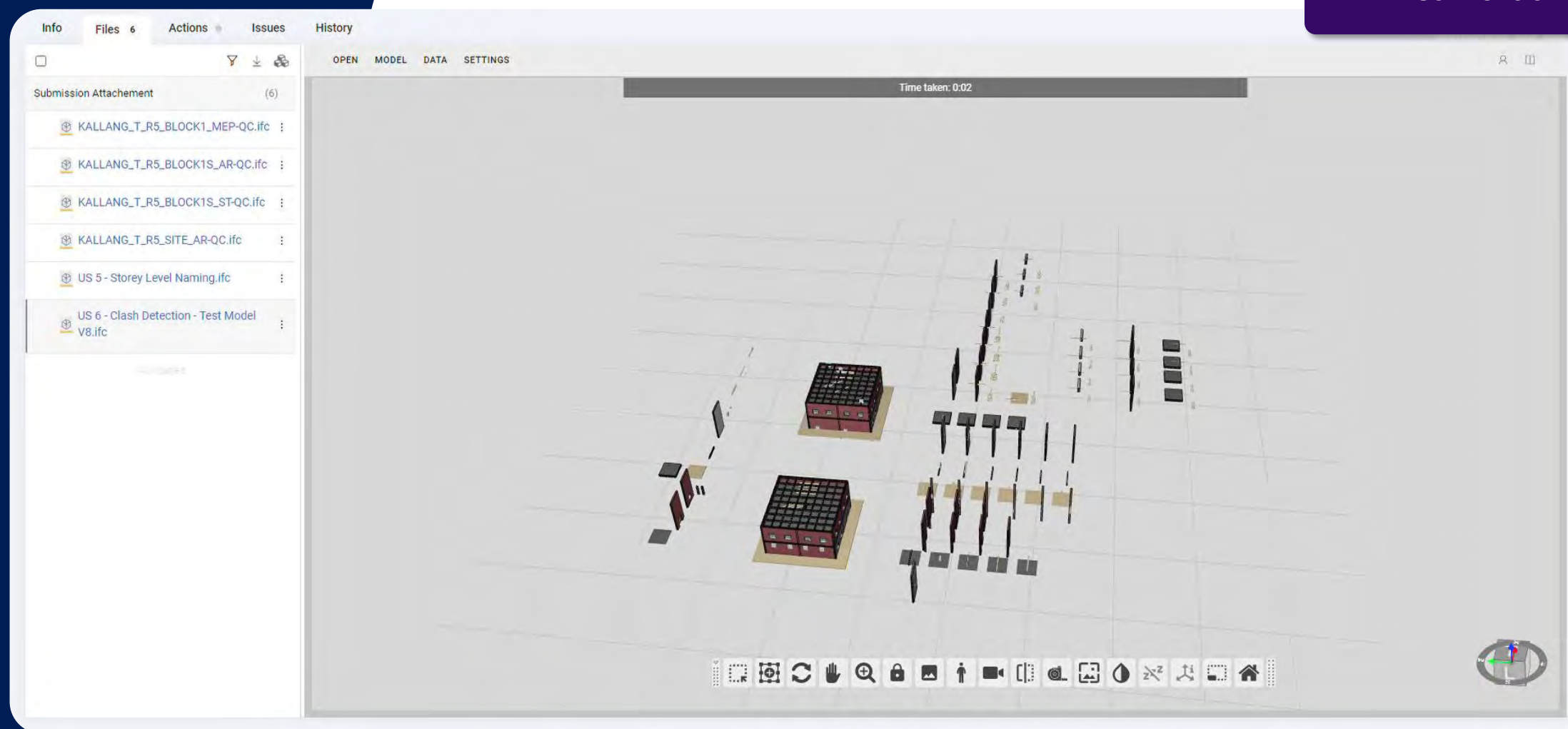
Agency	BCA
Clause	QC-001
Requirement	Valid Building and Level names

Below this is a 'Quality Checker' panel with a 'Sync Issues' button and a 'Drag a column header here to group by that column' instruction. The main table displays the results of the check:

Agency	AltExternalId	Report	ElementName	IssueType	Pr
BCA	3Zu5Bv0LOHrPC10026FoQQ	Building [3PlltdUa5Ag8XBttgX7Hs] storey Level 0 has a valid name.	Level 0	Pass	BU
BCA	15ZDv90RiHrPC20026FoKR	Building [3PlltdUa5Ag8XBttgX7Hs] storey Level 1 has a valid name.	Level 1	Pass	BU
BCA	26ALCahenFyqZkUJT73lr	Building [3PlltdUa5Ag8XBttgX7Hs] storey Level 2 has a valid name.	Level 2	Pass	BU
BCA	2gdmRfO4v5ewuWMnazymwN	Clash between structural column and door.	UC-Universal Columns-ColumnUC305x305x97:346647	Error	Co
BCA	2gdmRfO4v5ewuWMnazymWd	Clash between structural column and window.	UC-Universal Columns-ColumnUC305x305x97:347303	Error	Co

At the bottom, there's a 'Create Filter' button and a pagination bar showing 'Page 1 of 55 (811 items)' with a '1' button and a '55' button.

## Quality Check 01 - Building Storey Convention





# QC 2 - CLASH DETECTION

## Objective

To check for **meaningful clashes** between select IFC4 Entities

## Key Considerations

The check is based on an **established Clash Detection Matrix**, where geometrical overlaps between mapped IFC4 Entities generates various IssueTypes.

As this check evaluates many elements in a BIM model, it is designed to **show only IssueType: Fail or Warning results.**

## Verification Methodology

**Step 1:** Check for presence of IFC4 Entities in the Clash Detection Matrix

**Step 2:** FHQ evaluates if each of the IFC4 Entity has a geometrical clash with corresponding IFC4 Entity in the Clash Detection Matrix

**Step 3:** For certain IFC4 Entities, the clash would result in IssueType as Warning, depending on specific dimensions of these IFC4 Entities. For others, the clash would result in IssueType:Fail

## Expected Outcomes

### IssueTypes:

- Fail Example:** An IfcDoor clashing with IfcColumn, QC 2 Report would state "Clash between Door and Column"  
Example: An IfcPipeSegment (Diameter  $\geq 200$ mm) clashing with an IfcWall, QC 2 Report would state "Clash between Pipe Segment and Wall"
- Warning Example:** An IfcPipeSegment (Diameter  $> 100$  and  $< 200$ mm) clashing with an IfcWall, QC 2 Report would state "Clash between Pipe Segment and Wall"

		Architectural					Structural				
		Floor (IfcSlab)	Wall (IfcWall)	Ceiling (IfcCovering)	Door (IfcDoor)	Window (IfcWindow)	Structural Column (IfcColumn)	Structural Foundation (IfcPile, IfcFootin)	Structural Framing (IfcBeam)	Structural Wall (IfcWall)	Slab (IfcSlab)
Structural	Structural Column (IfcColumn)			1							
	Structural Foundations (IfcPile, IfcFootin)		2								
	Structural Framing (IfcBeam)			3							
	Structural Wall (IfcWall)										
	Slab (IfcSlab)										
MEP	Generic Models (IfcBuildingElementPro- xy)		4								12
	Mechanical Equipment (IfcTank, IfcPump, IfcUtilityEquipment)		5								13
	Ducts (IfcDuctSegment)		6								14
	Air Terminals (IfcAirTerminal)										15
	Pipes (IfcPipeSegment)										16
	Plumbing Fixtures (IfcSanitaryTerminal)		7								17
	Cable Tray (IfcCableCarrierSegme- nt)										18

Note: All yellow boxes = Generate fail with any penetration

(Pass if diameter is  $\leq$  or = 100, warning if  $> 100$  and  $< 200$ , fail if  $> 200$ )

(Pass if any length is  $\leq$  or = 100, warning if  $> 100$  and  $< 200$ , fail if  $> 200$ )

## Quality Check 02 - Clash Detection



# QC 3 - PARAMETER VALUE ANALYSIS

## Objective

To check for the **presence of parameters** associated with specific IFC4 Entities

## Key Considerations

The Parameter Checks work with **user defined Excel sheets** to validate precise rules for checking parameters in your BIM models. By adjusting the values in the Excel table, you can create a quality assurance process that aligns with your project requirements.

(Refer to next slide for sample of Excel table for parameter checks.)

## Verification Methodology

**Step 1:** Check for the presence of IfcEntity, ObjectType, Property Set and Property Name

**Step 2:** Depending on Type of Check indicated (Boolean, Null Check Only, Numerical Range, Regex, Text), corresponding checks are conducted for the identified IfcEntity

## Expected Outcomes

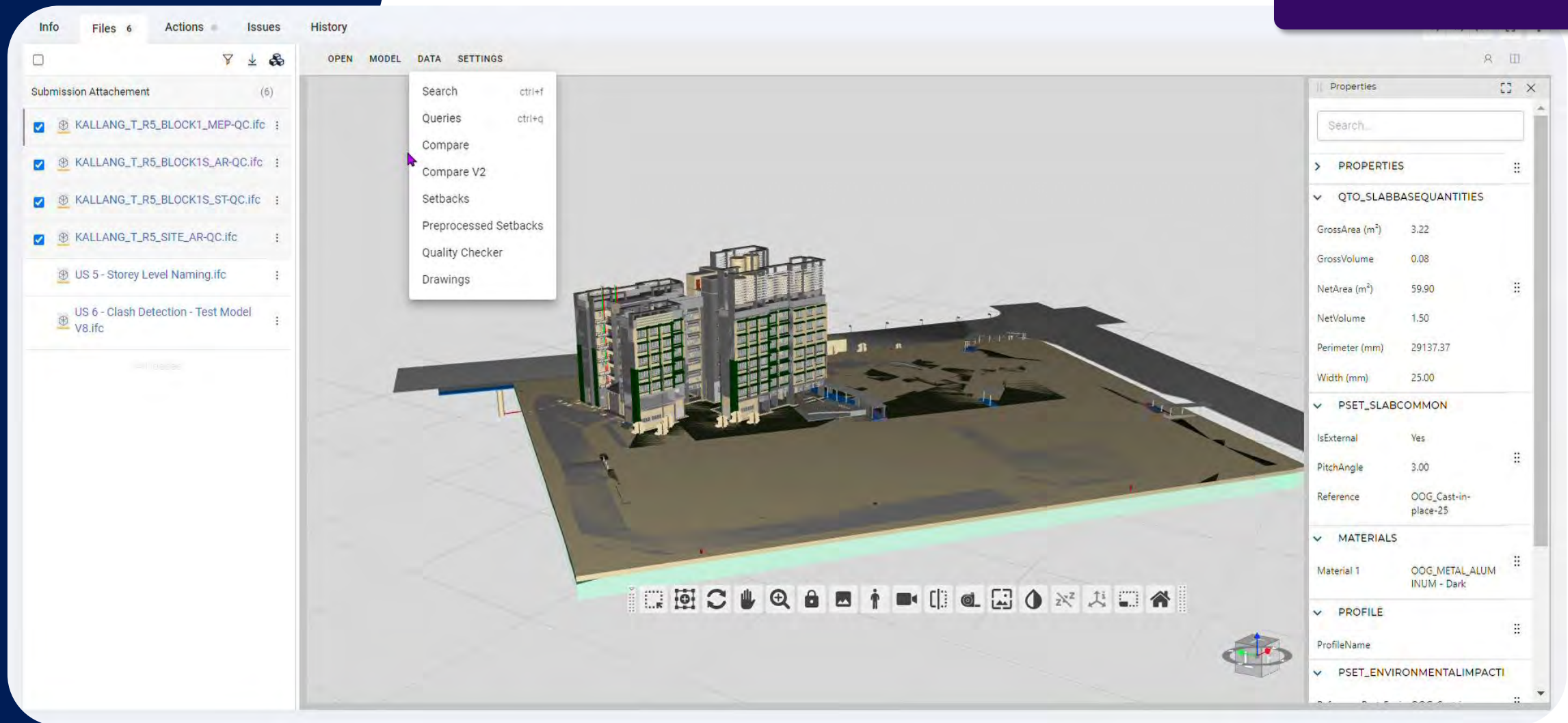
### IssueTypes:

- **Pass Example:** An IfcSpace with Parameter 'BarrierFreeAccessibility' contains the expected values for a Boolean Check, and QC 3 Report would state "BarrierFreeAccessibility contains True | False"
- **Fail Example:** An IfcBeam with Parameter 'ConstructionMethod' does not contain the expected values for a Text Check, and QC 3 Report would state "ConstructionMethod does not contain precast | prefabricated"
- **Warning Example:** An IfcSpace with Parameter 'Egress' does not contain the expected values for a Boolean Check, and QC 3 Report would state "Egress does not contain True | False"

IFC4 Entities	ObjectType	Property Set	Property Name	Type of Check	Property Unit	Null Check	Inclusion (Values are Acceptable or Exclusion (Values are Unacceptable) List for Warning	Corresponding Values (Each Value separated by "   ")	Inclusion or Exclusion List for Fail	Corresponding Values (Each Value separated by "   ")
IfcSpace	Need not specify	SGPset_SpaceDimension	Height	Numerical Range	mm	Y	NIL	NIL	Inclusion	# > 0
IfcTransportElement	*LIFT	SGPset_TransportElementTypeLiftDimension	Length	Numerical Range	mm	Y	NIL	NIL	Inclusion	# > 0
IfcTransportElement	*LIFT	SGPset_TransportElementTypeLiftDimension	Width	Numerical Range	mm	Y	NIL	NIL	Inclusion	# > 0
IfcPile	Need not specify	SGPset_PileDimension	Length	Numerical Range	N.A	Y	NIL	NIL	Inclusion	# > 0
IfcPile	Need not specify	SGPset_PileReinforcement	ReinforcementLength	Text	mm	Y	NIL	NIL	Inclusion	Fully reinforced   Partial reinforced   12m   24m   36m
IfcRamp	Need not specify	SGPset_RampDimension	Width	Numerical Range	mm	Y	NIL	NIL	Inclusion	# > 0
IfcSlab	Need not specify	SGPset_SlabDimension	Length	Numerical Range	mm	Y	NIL	NIL	Inclusion	# > 0
IfcSlab	FLOOR	SGPset_SlabDimension	Thickness	Numerical Range	mm	Y	NIL	NIL	Inclusion	# > 0
IfcStair	Need not specify	SGPset_StairDimension	Thickness	Numerical Range	mm	Y	NIL	NIL	Inclusion	# > 0
IfcStair	Need not specify	SGPset_StairDimension	Width	Numerical Range	mm	Y	NIL	NIL	Inclusion	# > 0
IfcSpace	Need not specify	SGPset_SpaceDimension	Height	Numerical Range	mm	Y	NIL	NIL	Inclusion	# > 0
IfcFooting	STRIP   FOOTING	SGPset_FootingDimension	Width	Numerical Range	mm	Y	NIL	NIL	Inclusion	# > 0
IfcWindow	*VENTILATIONSLEEVE	SGPset_WindowDimension	InnerDiameter	Numerical Range	mm	Y	NIL	NIL	Inclusion	# > 0
IfcWindow	*VENTILATIONSLEEVE	SGPset_WindowDimension	OuterDiameter	Numerical Range	mm	Y	NIL	NIL	Inclusion	# > 0
IfcWall	Need not specify	SGPset_WallDimension	Length	Numerical Range	mm	Y	NIL	NIL	Inclusion	# > 0
IfcWall	STANDARD	SGPset_WallDimension	Thickness	Numerical Range	mm	Y	NIL	NIL	Inclusion	# > 0
IfcBeam	BEAM	SGPset_Beam	BeamSpanType	Text	N.A	Y	NIL	NIL	Inclusion	Single   Single span   End   End span   Interior   Interior span   Cantilever   Cantilever span
IfcBeam	BEAM	SGPset_Beam	ConstructionMethod	Text	N.A	Y	NIL	NIL	Inclusion	Cast in situ   CIS   Precast   PC   Prestress   Post tensioning   PT   Prefabricated   PPVC   PV
IfcBeam	Need not specify	SGPset_SteelConnection	LeftConnectionType	Text	N.A	NIL	NIL	NIL	Inclusion	Pinned   pin   Fixed   fx   Free
IfcBeam	Need not specify	SGPset_SteelConnection	RightConnectionType	Text	N.A	NIL	NIL	NIL	Inclusion	Pinned   pin   Fixed   fx   Free
IfcColumn	COLUMN	SGPset_ColumnReinforcement	BreadthInnerStirrupsType	Text	N.A	NIL	NIL	NIL	Inclusion	Normal   Normal Link   U Link   U-Link   C Link   C-Link   Torsion   Torsion Link
IfcColumn	COLUMN	SGPset_SteelConnection	ConnectionTypeBottom	Text	N.A	NIL	NIL	NIL	Inclusion	Pinned   pin   Fixed   fx   Free
IfcColumn	COLUMN	SGPset_SteelConnection	ConnectionTypeTop	Text	N.A	NIL	NIL	NIL	Inclusion	Pinned   pin   Fixed   fx   Free
IfcColumn	COLUMN	SGPset_ColumnReinforcement	WidthInnerStirrupsType	Text	N.A	NIL	NIL	NIL	Inclusion	Normal   Normal Link   U Link   U-Link   C Link   C-Link   Torsion   Torsion Link
IfcBeam	BEAM	SGPset_BeamReinforcement	InnerStirrupsTypeLeft	Text	N.A	NIL	NIL	NIL	Inclusion	Normal   Normal Link   U Link   U-Link   C Link   C-Link   Torsion   Torsion Link
IfcBeam	BEAM	SGPset_BeamReinforcement	InnerStirrupsTypeMiddle	Text	N.A	NIL	NIL	NIL	Inclusion	Normal   Normal Link   U Link   U-Link   C Link   C-Link   Torsion   Torsion Link



## Quality Check 03 - Parameters



# QC 4 - SPACE IDENTIFICATION

## Objective

To check that every slab area in the model has an **associated IfcSpace for identification.**

## Key Considerations

All slabs should be **identified by an associated IfcSpace**

Taking into consideration IfcSlabs, whether sheltered or open-to-sky  
However, there may be certain IfcSlabs that are small and do not warrant an association with IfcSpace

## Verification Methodology

**Step 1:** Shortlist all IfcSlabs and IfcSpaces in the model

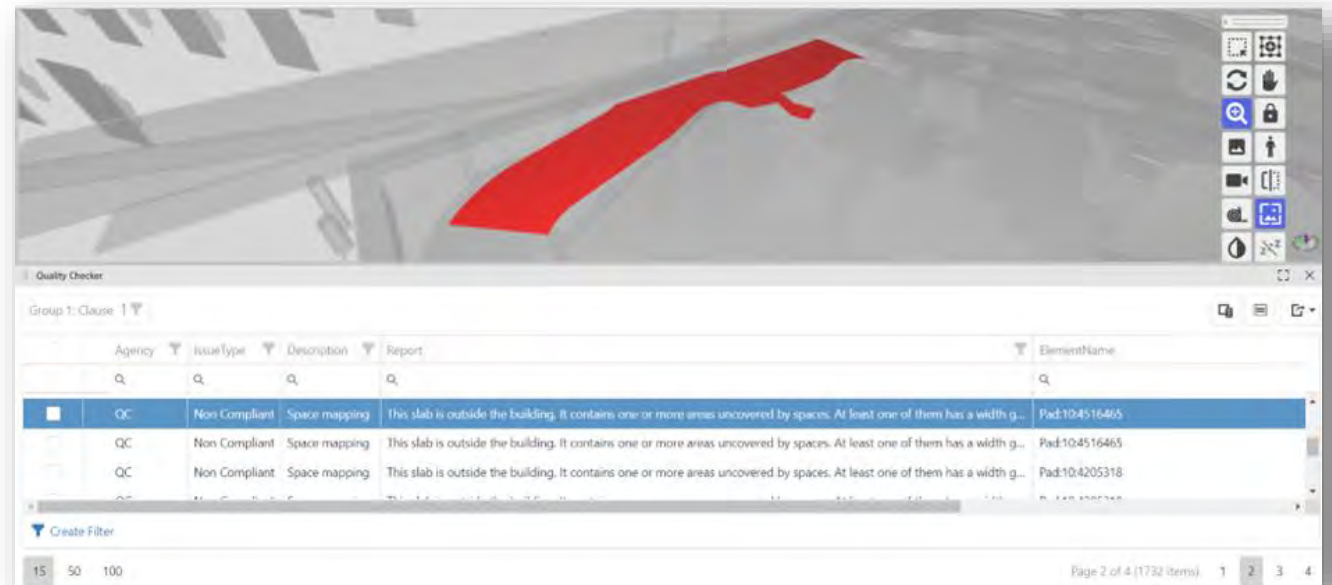
**Step 2:** IfcSlabs that are covered shall have an associated IfcSpace.

**Step 3:** IfcSlabs that are not covered, only those with a width of >1.5m would be analysed for an associated IfcSpace

## Expected Outcomes

### IssueTypes:

- **Pass Example:** An IfcSpace that is sheltered and fully in contact with IfcSpaces. The QC 4 Report would state "The entire slab is covered by spaces."
- **Fail Example:** An IfcSpace that is open-to-sky, with 41.23m2 area that is not in contact with an IfcSpace. QC 4 Report would state "This slab is outside the building. It contains one or more areas uncovered by Spaces. At least one of them has a width greater than 1.5m. Total remaining area: 41.23m2."



## Quality Check 04 - Space Above Slabs

Info Files 6 Actions Issues History

Submission Attachment (6)

- ☒ KALLANG\_T\_R5\_BLOCK1\_MEP-QC.ifc
- ☒ KALLANG\_T\_R5\_BLOCK1S\_AR-QC.ifc
- ☒ KALLANG\_T\_R5\_BLOCK1S\_ST-QC.ifc
- ☒ KALLANG\_T\_R5\_SITE\_AR-QC.ifc
- ☐ US 5 - Storey Level Naming.ifc
- ☐ US 6 - Clash Detection - Test Model V8.ifc

OPEN MODEL DATA SETTINGS

Properties

Search...

Unit: Millimetres

PROPERTIES

QTO\_COLUMNBASEQUANTITIES

CrossSectionArea (m<sup>2</sup>) 3.88

GrossVolume 10905.10

Length (mm) 2814.21

Quality Checker

Drag a column header here to group by that column

<input type="checkbox"/>	AltExternalId	Agency	Clause	Description	Report	ElementName	IssueType	ProductType	SerialNumber	Storey
<input type="checkbox"/>	1t6ScfGRLEoBIDzI3RGTL	QC	QC-001	Valid Building and Level names	Building storey has a valid name.	8TH STOREY	Pass	IfcBuildingStorey	66	8TH S
<input type="checkbox"/>	1t6ScfGRLEoBIDzI3RGTV	QC	QC-001	Valid Building and Level names	Building storey has a valid name.	9TH STOREY	Pass	IfcBuildingStorey	67	9TH S
<input type="checkbox"/>	2qozlukkDC4xxN5suU9sD6	QC	QC-001	Valid Building and Level names	Building storey has a valid name.	LEVEL 1	Pass	IfcBuildingStorey	68	LEVEL
<input type="checkbox"/>	2qozlukkDC4xxN5suUktsU	QC	QC-001	Valid Building and Level names	Building storey has a valid name.	LEVEL 2	Pass	IfcBuildingStorey	69	LEVEL
<input type="checkbox"/>	2qozlukkDC4xxN5suV6VD2	QC	QC-001	Valid Building and Level names	Building storey has a valid name.	LEVEL 3	Pass	IfcBuildingStorey	70	LEVEL

Create Filter

15 50 100

Page 4 of 2037 (30550 items) 1 2 3 4 5 ... 2037



# QC 5 - ALIGNMENT OF BIM MODEL COORDINATES

## Objective

To ensure submitted trade BIM models contain the **same model coordinates**

## Key Considerations

Comparison of coordinates across all submitted models is necessary to ensure that the models are **geographically aligned** and can be federated as a project.

## Verification Methodology

**Step 1:** Shortlist geographic (latitude and longitude) coordinates across all submitted models

**Step 2:** Verify if geographic coordinates are the same across all submitted models

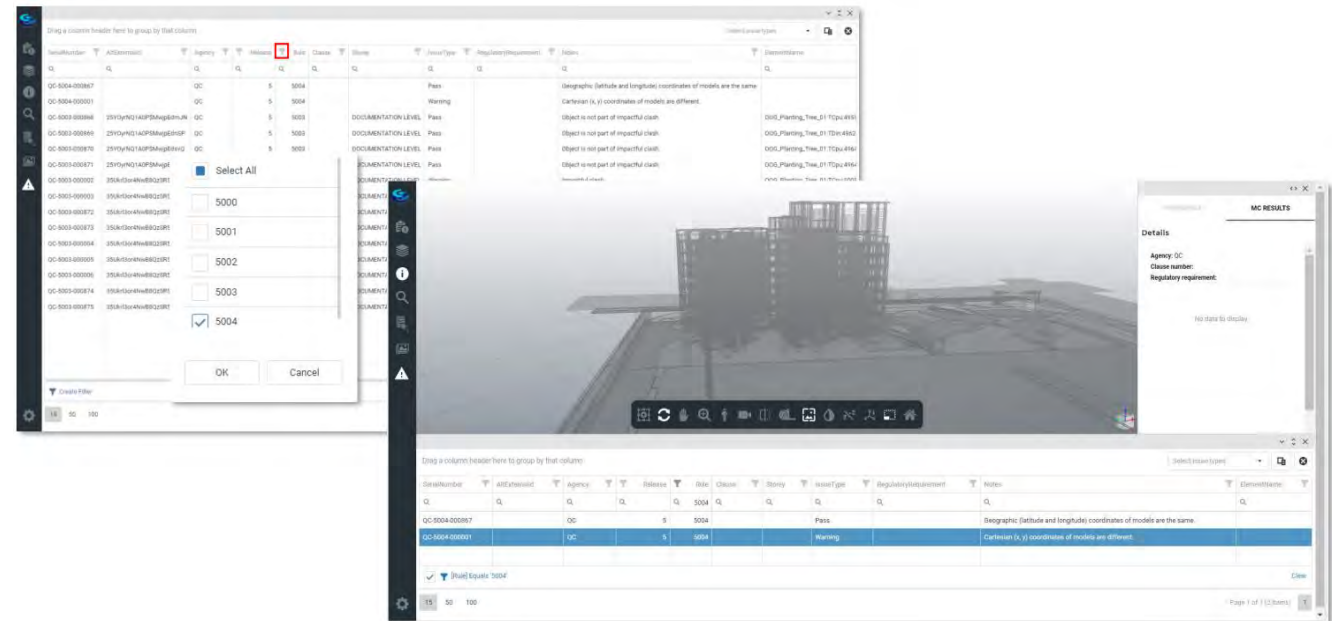
**Step 3:** Shortlist cartesian coordinates across all submitted models

**Step 4:** Verify if cartesian coordinates are the same across all submitted models

## Expected Outcomes

### IssueTypes:

- **Pass Example:** Geographic coordinates are the same across all submitted models. The QC 5 Report would state "Geographic (latitude and longitude) coordinates of models are the same"
- **Warning Example:** Cartesian coordinates are not the same across all submitted models. The QC 5 Report would state "Cartesian (x,y) coordinates of models are not the same."



## Quality Check 05 - Georeference

The screenshot displays the FulcrumHQ software interface. On the left, a sidebar shows a list of submission attachments, including several IFC files for the KALLANG\_T\_R5 project and a clash detection test model. The main view shows a 3D architectural model of a building with a red roof and green structural elements. A toolbar with various navigation and editing tools is visible below the model. In the foreground, a 'Quality Checker' dialog box is open, displaying a table of quality check results. The table has columns for Description, Report, ElementName, IssueType, ProductType, SerialNumber, and Status. Two items are listed, both related to 'Geo-Reference' issues with 'Warning' status. A 'Select All' checkbox is checked, and a 'Clear' button is visible at the bottom right of the table. The page number 'Page 1 of 1 (2 items)' is shown at the bottom right.

Submission Attachment (6)

- ☒ KALLANG\_T\_R5\_BLOCK1\_MEP-QC.ifc
- ☒ KALLANG\_T\_R5\_BLOCK1S\_AR-QC.ifc
- ☒ KALLANG\_T\_R5\_BLOCK1S\_ST-QC.ifc
- ☒ KALLANG\_T\_R5\_SITE\_AR-QC.ifc
- ☒ US 5 - Storey Level Naming.ifc
- ☒ US 6 - Clash Detection - Test Model V8.ifc

Quality Checker

Drag a column header here to group by that column

☒ Select All

- ☐ QC-001
- ☐ QC-002
- ☐ QC-003
- ☐ QC-004
- ☒ QC-005

Description	Report	ElementName	IssueType	ProductType	SerialNumber	Status
Geo-Reference	Geographic (latitude and longitude) coordinates of models are different.	Default	Warning	IfcSite	32068	
Geo-Reference	Cartesian (x, y) coordinates of models are different.	Default	Warning	IfcSite	32069	

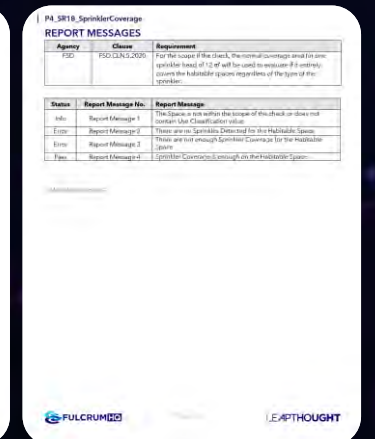
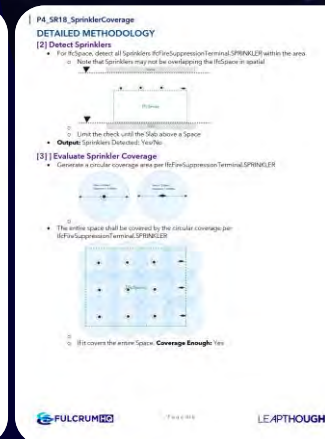
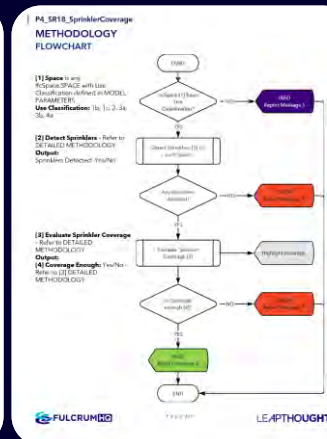
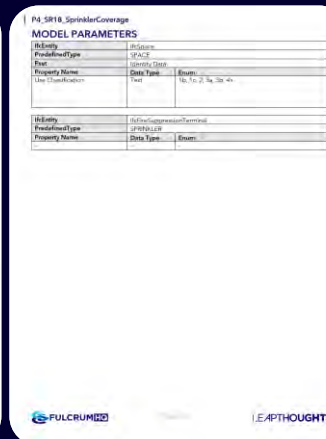
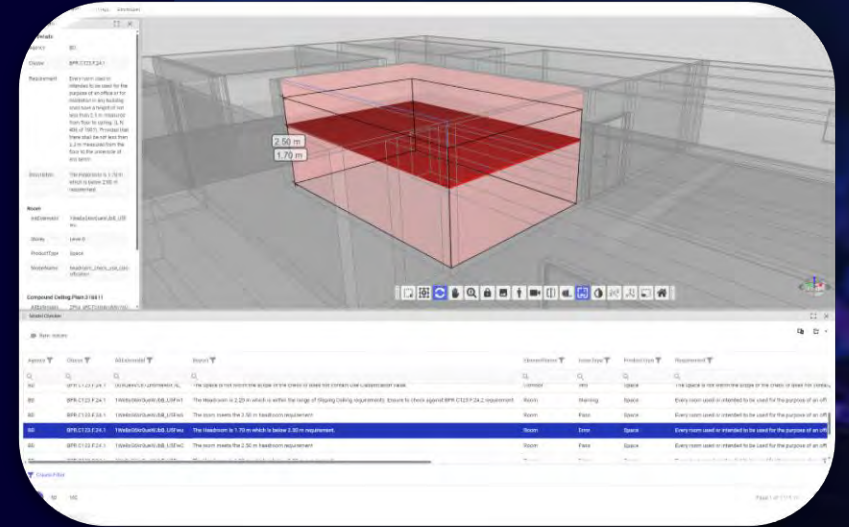
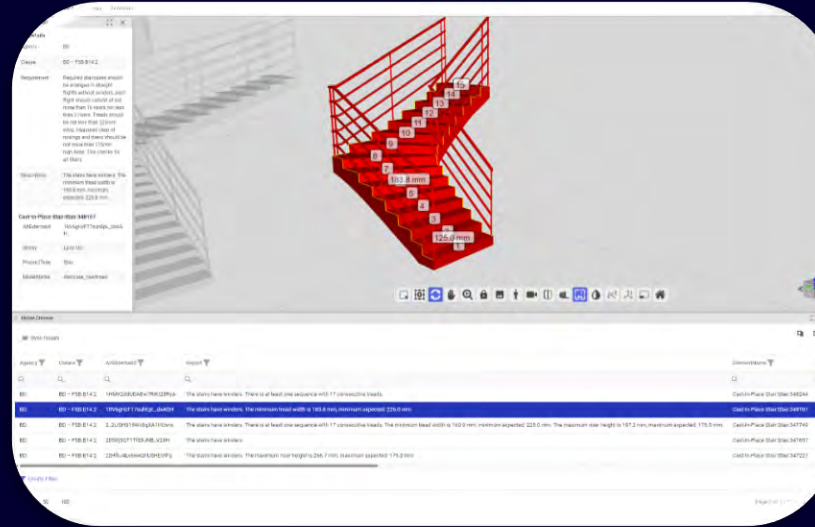
Clear

Page 1 of 1 (2 items)



# SBI-CIC Model Checker

	Check Details	Status
P1	SR01_CICNamingCompliance	Live
P1	SR23_MEPNamingCompliance	Live
P1	SR02_OmniClass	Live
P1	SR03_BuildingElementProxy	Live
P1	SR08_UnallocatedSpace	Live
P1	SR09_CorridorWidth	Live
P1	SR10_CorridorHeight	Live
P1	SR13_StaircaseHeadroomExcMEP	Live
P1	SR14_StaircaseHeadroomIncMEP	Live
P1	SR15_WindowSillHeight	Live
P1	SR17_DoorOpeningClearance	Live
P2	SR05_BIMDiscipline	
P2	SR20_ColumnSettingOut	
P3	SR11_Headroom	
P3	SR12_StairRiserTread	
P3	SR21_WallSettingOut	
P4	SR04_ModelHygieneColumnWall	
P4	SR06_ModelHygieneElementType	
P4	SR07_ModelHygieneElementLevel	
P4	SR16_DoorThresholdHeight	
P4	SR18_SprinklerCoverage	
P4	SR19_StaircaseDiscrepancies	
P4	SR22_TopOfSlabDiscrepancies	
P4	SR24_HVACSetback	





# SBI-CIC Model Checker

	Check Details	Status
P1	SR01_CICNamingCompliance	Live
P1	SR23_MEPNamingCompliance	Live
P1	SR02_OmniClass	Live
P1	SR03_BuildingElementProxy	Live
P1	SR08_UnallocatedSpace	Live
P1	SR09_CorridorWidth	Live
P1	SR10_CorridorHeight	Live
P1	SR13_StaircaseHeadroomExcMEP	Live
P1	SR14_StaircaseHeadroomIncMEP	Live
P1	SR15_WindowSillHeight	Live
P1	SR17_DoorOpeningClearance	Live
P2	SR05_BIMDiscipline	
P2	SR20_ColumnSettingOut	
P3	SR11_Headroom	
P3	SR12_StairRiserTread	
P3	SR21_WallSettingOut	
P4	SR04_ModelHygieneColumnWall	
P4	SR06_ModelHygieneElementType	
P4	<b>SR07_ModelHygieneElementLevel</b>	
P4	SR16_DoorThresholdHeight	
P4	SR18_SprinklerCoverage	
P4	SR19_StaircaseDiscrepancies	
P4	SR22_TopOfSlabDiscrepancies	
P4	SR24_HVACSetback	

**Model Checker**

Sync Issues

Agency	Clause	AltExternalId	Report	ElementName	IssueType	ProductType	Requirement	SequenceCode	Status
Model Hygiene	ElementLevel	0zVC29dub8ZxhHxGuNaRKv	The Level Property do not match the Level in space.	M_Window-Casement-Double:1050 x 1350mm:1600507	Error	Window	Flag elements with the Level Property do not match with the Level in Spatial.	Model Hygiene--000001	L1
Model Hygiene	ElementLevel	0zVC29dub8ZxhHxGuNaRGG	The Level Property do not match the Level in space.	M_Window-Casement-Double:1050 x 1350mm:1600210	Error	Window	Flag elements with the Level Property do not match with the Level in Spatial.	Model Hygiene--000002	L1
Model Hygiene	ElementLevel	10i0qcj596Lh007rvV70i3	The Level Property matches the Level in space.	M_Window-Fixed:600 x 900mm:1600058	Pass	Window	Flag elements with the Level Property do not match with the Level in Spatial.	Model Hygiene--000025	L1
Model Hygiene	ElementLevel	00C9BVLHz2vugwFe0hv7x6	The Level Property do not match the Level in space.	M_Door-Exterior-Single-Two_Lite:900 x 2000mm:1597536	Error	Door	Flag elements with the Level Property do not match with the Level in Spatial.	Model Hygiene--000003	L1
Model Hygiene	ElementLevel	00C9BVLHz2vugwFe0hv47h	The Level Property do not match the Level in space.	M_Door-Exterior-Single-Two_Lite:900 x 2000mm:1597261	Error	Door	Flag elements with the Level Property do not match with the Level in Spatial.	Model Hygiene--000004	L1

Create Filter

Page 1 of 9 (34 items)

# SBI-CIC Model Checker

	Check Details	Status
P1	SR01_CICNamingCompliance	Live
P1	SR23_MEPNamingCompliance	Live
P1	SR02_OmniClass	Live
P1	SR03_BuildingElementProxy	Live
P1	SR08_UnallocatedSpace	Live
P1	SR09_CorridorWidth	Live
P1	SR10_CorridorHeight	Live
P1	SR13_StaircaseHeadroomExcMEP	Live
P1	SR14_StaircaseHeadroomIncMEP	Live
P1	SR15_WindowSillHeight	Live
P1	SR17_DoorOpeningClearance	Live
P2	SR05_BIMDiscipline	
P2	SR20_ColumnSettingOut	
P3	SR11_Headroom	
P3	SR12_StairRiserTread	
P3	SR21_WallSettingOut	
P4	SR04_ModelHygieneColumnWall	
P4	SR06_ModelHygieneElementType	
P4	SR07_ModelHygieneElementLevel	
P4	SR16_DoorThresholdHeight	
P4	<b>SR18_SprinklerCoverage</b>	
P4	SR19_StaircaseDiscrepancies	
P4	SR22_TopOfSlabDiscrepancies	
P4	SR24_HVACSetback	

**Result Detail**

**Rule Details**

Agency: FSD

Clause: FSD.CLN.5.2020

Requirement: For the scope if the check, the normal coverage area for one sprinkler head of 12 m² will be used to evaluate if it entirely covers the habitable spaces regardless of the type of the sprinkler.

Description: There are no Sprinkles Detected for the Habitable Space

**Corridor1**

AltExternalId: 13EGdEPpP2yB9Bv8v48w37

Storey: Level 0

ProductType: Space

ModelName: sprinkler\_coverage\_use\_classification\_V2023

**Model Checker**

Sync Issues

Agency	Clause	AltExternalId	Report	ElementName	IssueType	ProductType	Requirement
FSD	FSD.CLN.5.2020	13EGdEPpP2yB9Bv8v48w3T	There are no Sprinkles Detected for the Habitable Space	Corr 2	Error	Space	For the scope if the check, the normal coverage area for one sprinkler head of 12 m² will be used to evaluate if it entirely covers the habitable spaces regardless of the type of the sprinkler.
FSD	FSD.CLN.5.2020	13EGdEPpP2yB9Bv8v48w37	There are no Sprinkles Detected for the Habitable Space	Corridor1	Error	Space	For the scope if the check, the normal coverage area for one sprinkler head of 12 m² will be used to evaluate if it entirely covers the habitable spaces regardless of the type of the sprinkler.
FSD	FSD.CLN.5.2020	13EGdEPpP2yB9Bv8v48w3p	There are not enough Sprinkler Coverage for the Habitable Space	Corridor 3	Error	Space	For the scope if the check, the normal coverage area for one sprinkler head of 12 m² will be used to evaluate if it entirely covers the habitable spaces regardless of the type of the sprinkler.
FSD	FSD.CLN.5.2020	2Clodf5O1CUAdY1dbebL76	Sprinkler Coverage is enough on the Habitable Space	Corr5	Pass	Space	For the scope if the check, the normal coverage area for one sprinkler head of 12 m² will be used to evaluate if it entirely covers the habitable spaces regardless of the type of the sprinkler.
FSD	FSD.CLN.5.2020	2Clodf5O1CUAdY1dbebkur	There are no Sprinkles Detected for the Habitable Space	Corr4	Error	Space	For the scope if the check, the normal coverage area for one sprinkler head of 12 m² will be used to evaluate if it entirely covers the habitable spaces regardless of the type of the sprinkler.

Create Filter

15 50 100

Page 1 of 1 (15 items)

## **Rule Interpretation (RI)**

Interpretation of Regulatory Code Compliance with Stakeholders with Comprehensive Documentation, Test Scenarios and Models to Facilitate Rule Development



# Agencies



## URA Urban Redevelopment Authority

Land use planning and conservation agency.



## BCA Building and Construction Authority

Built environment sector. Oversees safety, quality, inclusiveness, sustainability and productivity.



## SCDF Singapore Civil Defence Force

Fire safety standards for local buildings and is used by the industry in designing fire safety works in buildings.



## LTA Land Transport Agency

Planning, operating and maintaining Singapore's land transport infrastructure and systems.



## PUB Public Utilities Board

National water agency, managing Singapore's water supply, water catchment, and used water in an integrated way.



## NEA National Environment Agency

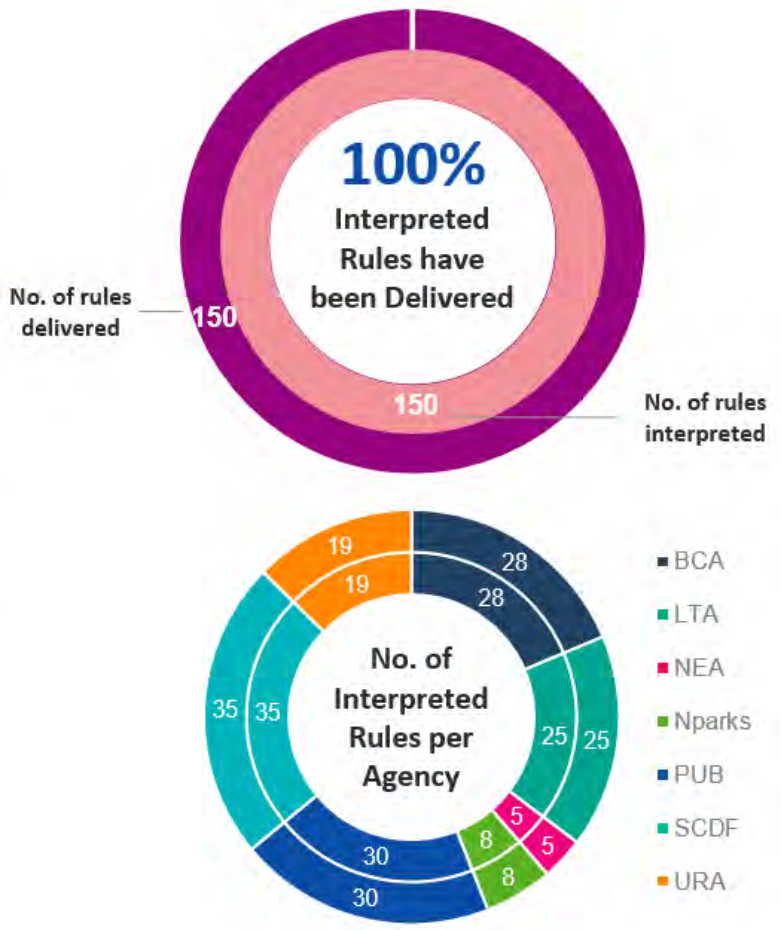
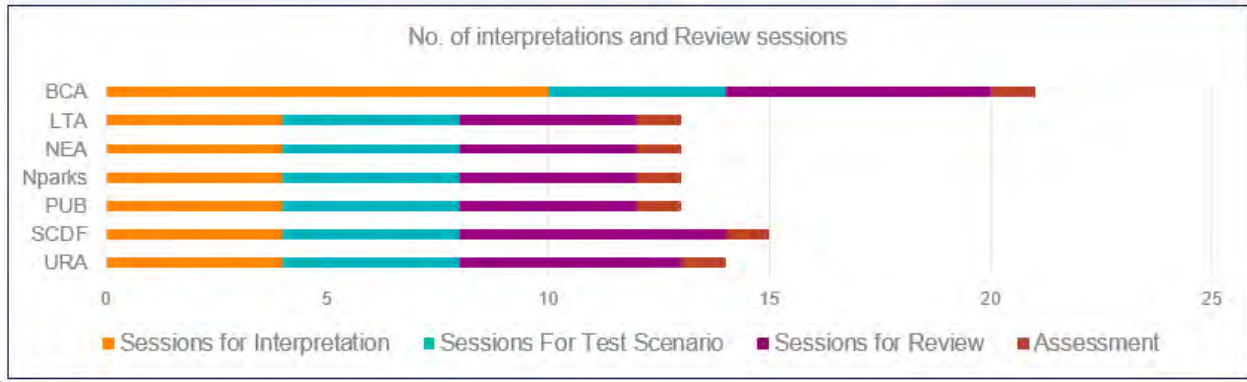
Environmental health concerns in the design of buildings.



## NParks National Parks Board

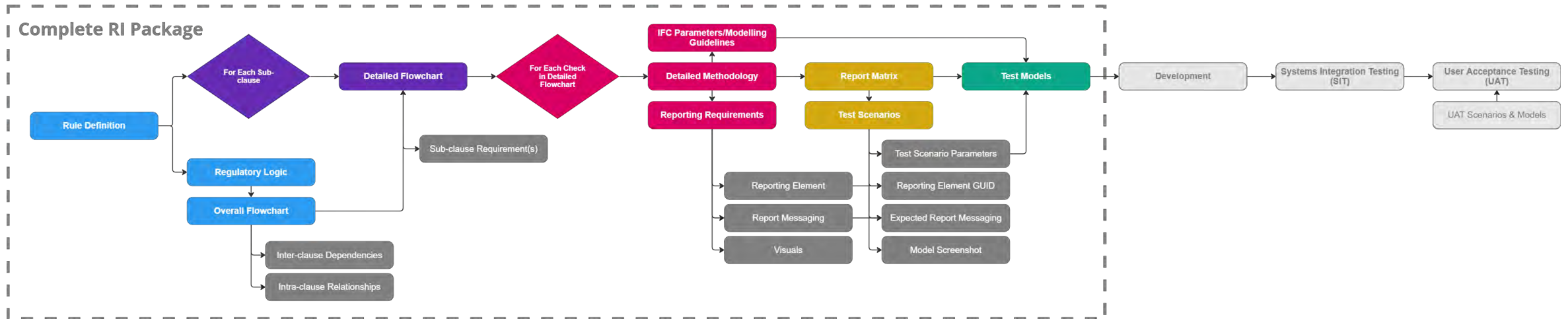
Statutory requirements on greenery provision, tree planting and conservation for development projects in Singapore.

# CORENETX Automated Model Checker Pilot Phase (Completed)



# Rule Interpretation Process

## Overview



Workflow of RI Package (Consisting of RI document, Test Scenarios, and Test Models)



# Rule Interpretation Process

## Interpreting the Code of Practice

### (4) Exception

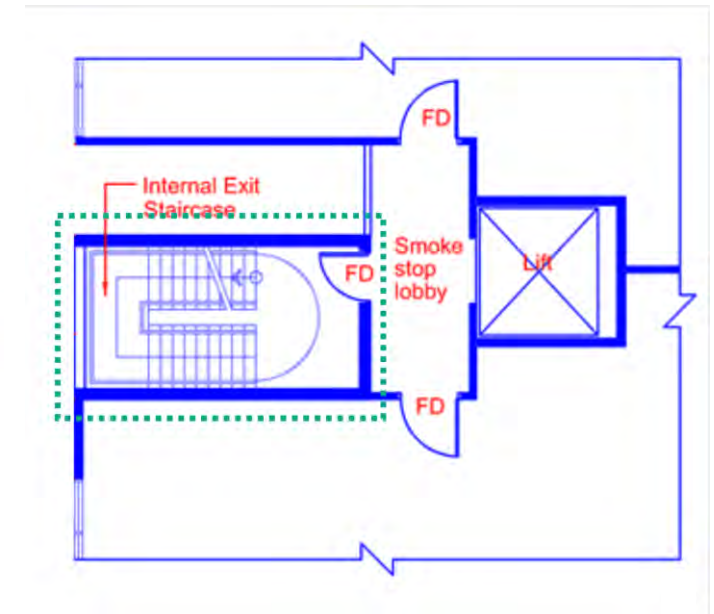
#### (a) Single storey basement car park

Exit staircases serving a single storey basement of PG II to VII buildings are not required to be protected with fire-rated enclosures, provided the travel distances in the car park measured to the exit doors at ground level comply with Table 2.2A.

Requirement 1

Exemption

Requirement 2



Excerpt from SCDF Fire Code 2023 Cl.2.3.3a(4)(a). Exit staircases meeting Requirements 1 & 2 are qualified for non-provision of fire-rated enclosure, but not provision of non-fire-rated enclosure.

# Rule Interpretation Process

## Clause Dependencies

### 2.3.2 Exit passageways

#### a. Fire resistance

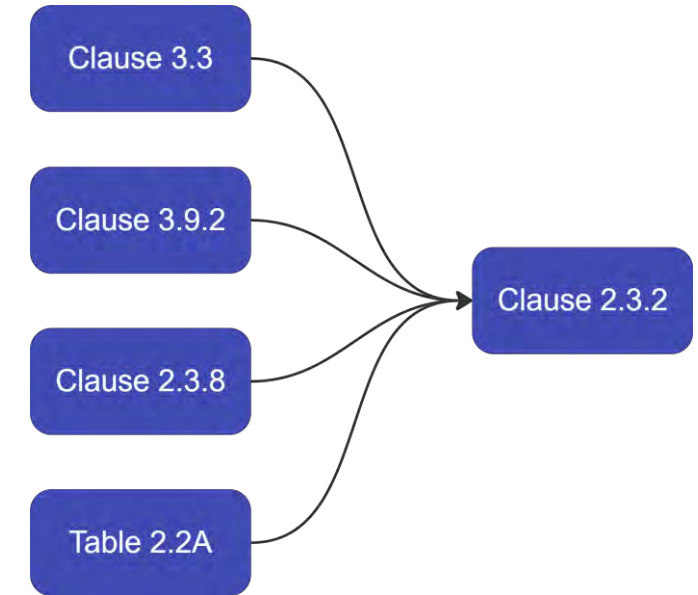
Exit passageways that serve as a means of escape or required exits from any building or storey of a building shall have the requisite fire resistance as specified under [Cl.3.3](#).

#### b. Internal exit passageway

An internal exit passageway which serves as required exit of a building shall comply with the following requirements:

- (1) it shall be enclosed with construction complying with the provisions of [Cl.3.3](#);
- (2) the enclosure walls shall have not more than two exit doors, excluding the final discharge door and exit staircase door, opening into the exit passageway;
- (3) exit doors opening into an exit passageway shall have fire resistance rating as required for exit doors opening into exit staircases, be fitted with automatic self-closing device and comply with the requirements of [Cl.3.9.2](#) for fire resisting doors;
- (4) the minimum width and capacity of exit passageway shall comply with the requirements as provided in [Table 2.2A](#);
- (5) changes in level along an exit passageway requiring less than two risers shall be via a ramp complying with the provisions under [Cl.2.3.8](#); and
- (6) if the exit staircase which connects to the internal exit passageway is pressurised, the internal exit passageway shall also be pressurised to comply with the requirements in Chapter 7.

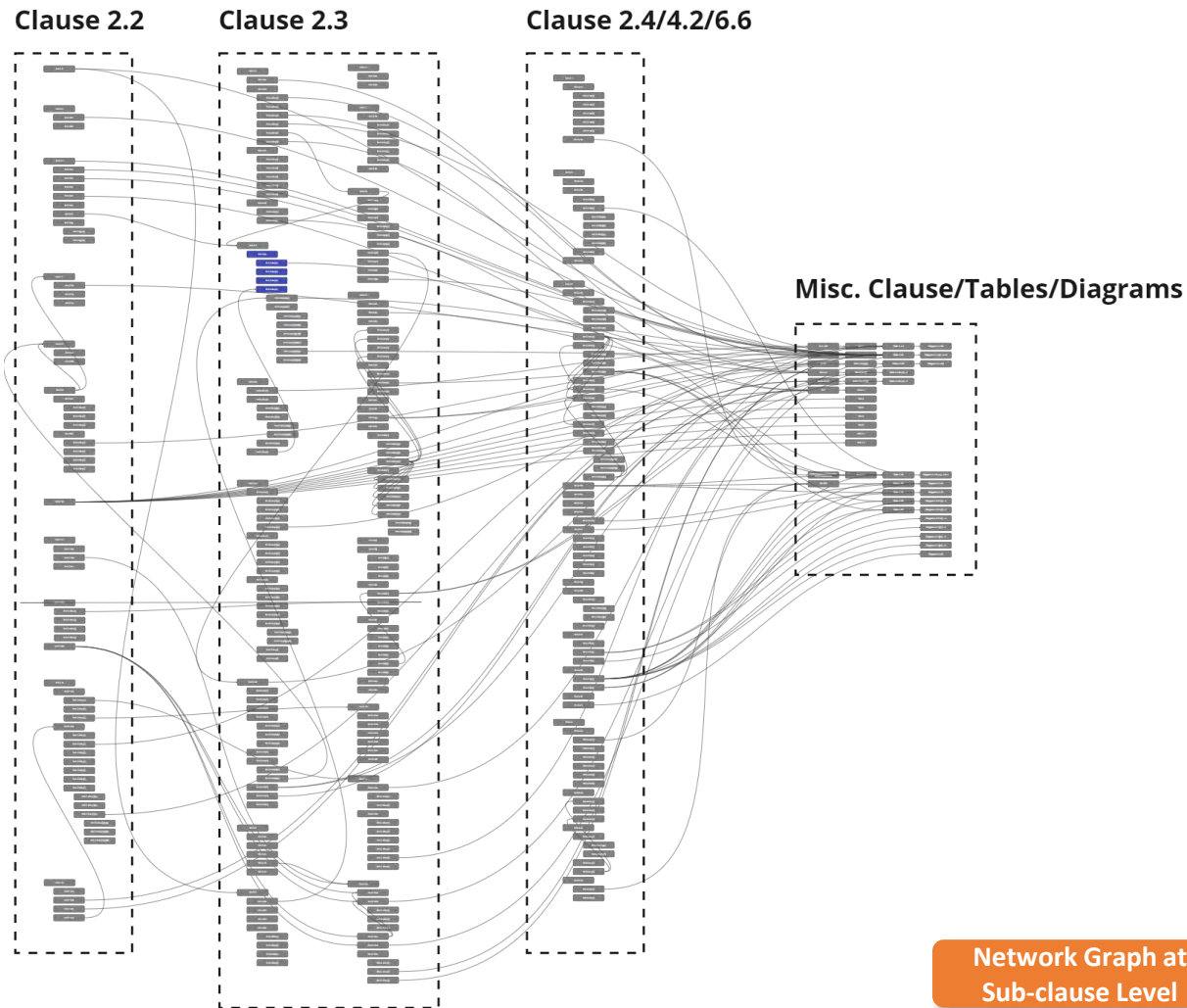
E



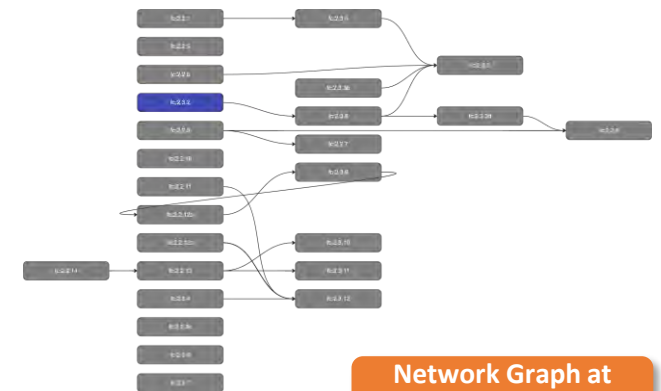
Network Graph of Inter-clause Dependencies for 2.3.2a-b

# Rule Interpretation Process

## Clause Dependencies



- The clauses of each agency's COP can be densely interrelated.
- Some dependencies may not be explicitly stated in the COP, which requires agency's input to highlight.
- Having an overall mapping of clause dependencies is important to determine the order of the clauses to be developed.

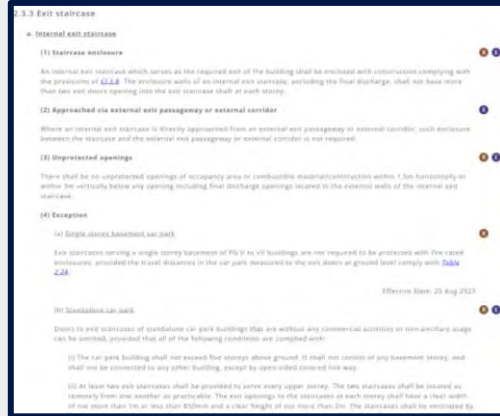




# Rule Interpretation Process

## Regulatory Logic

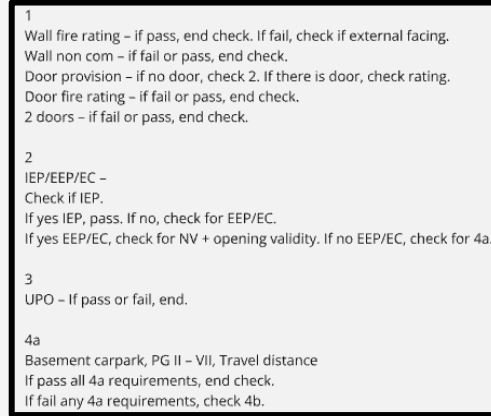
1



### Regulatory Clause from Code of Practice

Agency provides accurate interpretation of clauses and the required conditions for checking.

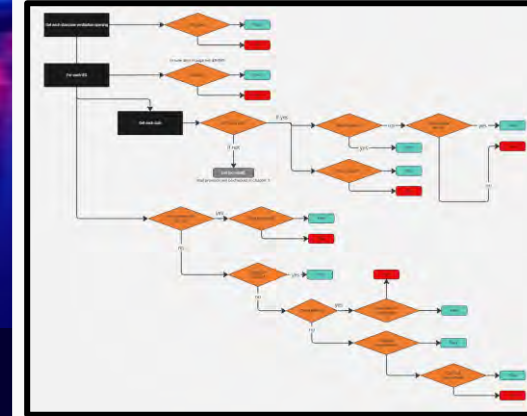
2



### Simplified Clause Description

The checking order of sub-clauses and conditions are reordered for simplicity and easier readability.

3

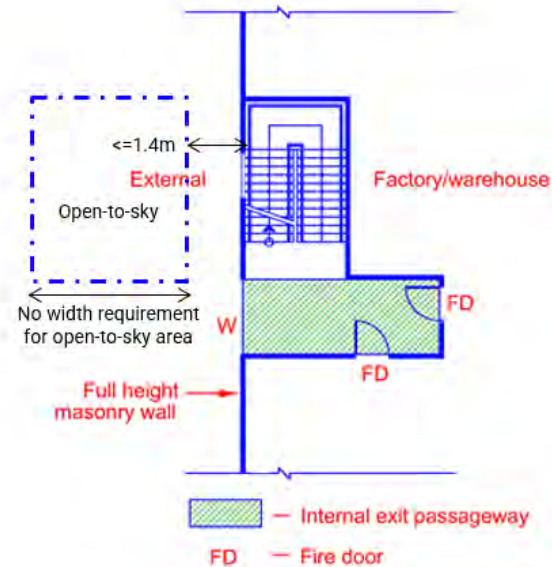


### Detailed Flowchart and Methodology

The relationships detailed in the simplified description are transposed to form the overall flowchart.

# Rule Interpretation Process

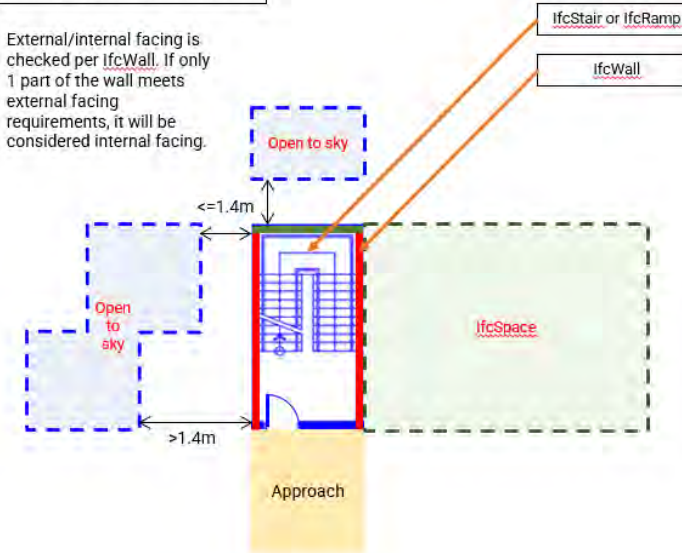
## Detailed Methodology



External of building here refers to areas which are not more than 1.4m away from open-to-sky areas, regardless if it is a void or a space with usage (e.g. open-to-sky roof garden).

Identifying external facing walls:

External/internal facing is checked per `IfcWall`. If only 1 part of the wall meets external facing requirements, it will be considered internal facing.



External facing, has to be non-combustible, but fire rating is optional.

Internal facing, has to be fire rated and non-combustible.

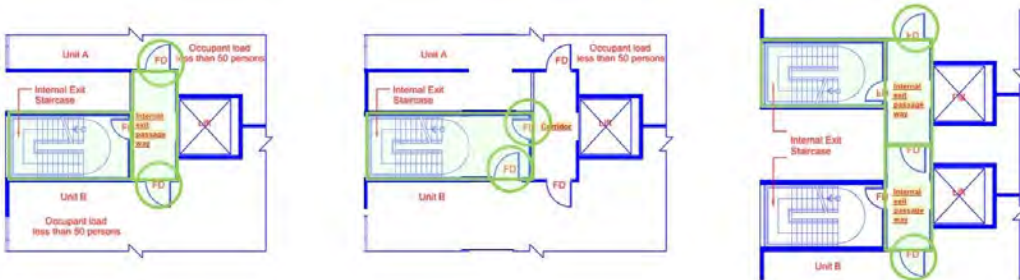
Example of diagrams illustrating the condition to be checked. Here, it details how to perform open-to-sky checks for external-facing walls. (SCDF fc:2.3.3a(1))

# Rule Interpretation Process

## Reporting Requirements

### PASS

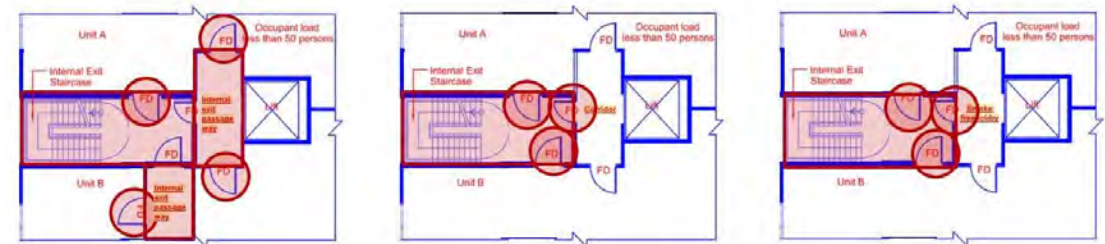
Result to be reported per ifcSpace.SpaceName = Internal Exit Staircase or Internal Exit Ramp  
ifcSpace.SpaceName = Internal Exit Staircase/Internal Exit Ramp, Internal Exit Passageway/External Exit Passageway/External Corridor, and doors to be highlighted in Green



Each staircase will be checked individually. Results will also be shown for each individual IES.

### FAIL

Result to be reported per ifcSpace.SpaceName = Internal Exit Staircase/Internal exit ramp  
ifcSpace.SpaceName = Internal Exit Staircase/Internal exit ramp, Internal Exit Passageway/External Exit Passageway/External Corridor, and doors which are not complied to be highlighted in Red.



Example of expected reporting visualizations in ModelViewer for the provision check of fire-rated enclosures of exit staircases. (SCDF fc:2.3.3a(1))



# Rule Interpretation Process




## Test Scenarios

[illegible][illegible][illegible]

**Example of detailed Test Scenarios for GreenMark Natural Ventilation, Concrete Usage Index (CUI), Residential Envelop Thermal Transmittance (RETV) rule checks.**

# Rule Interpretation Process

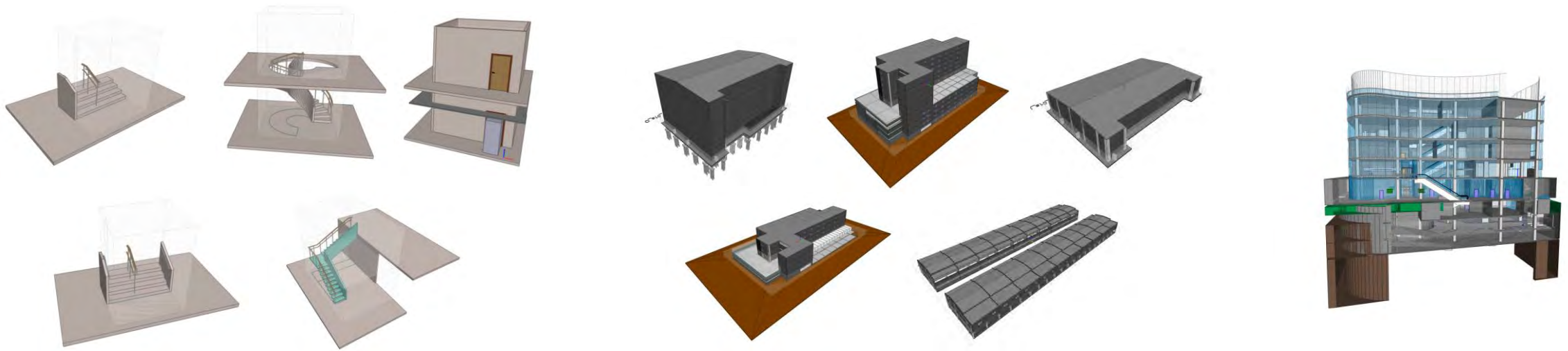
## Test Scenarios

S/N	CLAUSE	SERIALISED NO.	SCENARIO	ILLUSTRATION	TEST PARAMETERS	RESULT	REPORT MESSAGE	GUID	PRODUCTTYPE
4	RBE 01-2	BC140020202_01s	Non-landed residential development without basement  Total 40 residential units:  20 units of Type A units: Living Room, 2 Bedrooms, study ->only Living Room c/w <b>Entrance Gate with lockable grille provided by developer and balcony with sliding door</b> having good cross ventilation  20 units of Type B units: Living Room, 3 Bedrooms ->only 1 Bedrooms with <b>operable windows on adjacent walls</b> have good cross ventilation, and 1 bedrooms with <b>operable window openings on opposite walls</b>  Coverage of rooms with good cross ventilation > 25%		Development use = Residential (Nonlanded) (From SP)  IfcSpace.USERDEFINED.AREA_GFA SGPSet_SpaceArea_GFA.AGF_Name = Balcony, Dwelling Unit (Nett)  IfcSpace.SPACE SGPSet_Space.OccupancyType = Multi-unit residential SGPSet_Space.SpaceName = Bedrooms, Master Bedroom/Living, Dining, Study  IfcDoor.DOOR_GATE SGPSet_Door.PercentageOfOpening SGPSet_Door.MainEntrance  IfcOpeningElement.OPENING  IfcWindow.WINDOW, USERDEFINED.LOUVRE, USERDEFINED.BAYWINDOW SGPSet_Window.PercentageOfOpening > 0%	Pass	Meeting - 25% of dwelling units that provide good cross ventilation for #Value passing rooms out of #Value total rooms, the percentage is #Value.	IfcProject	
			Landed residential development  Total 30 residential units:  10 units of Type A units: Living room, study room, 2 bedrooms ->Only 2 bedrooms with <b>curved facade non-fixed window on one side, living Room with balcony with sliding door, back door with gate which the distance between door and gate more than the width of the door (will not consider as opening), main entrance door with gate which the distance between door and gate is not more than the width of the main entrance door (consider as opening)</b> provided by developer with good cross ventilation  20 units of Type B units: Living room, study, 3 bedrooms ->1 Bedroom with <b>fixed window openings on opposite walls</b>  Coverage of rooms with good cross ventilation < 25%		Development use = Residential (Landed) (From SP)  IfcSpace.USERDEFINED.AREA_GFA SGPSet_SpaceArea_GFA.AGF_Name = Dwelling Unit (Nett), Balcony  IfcSpace.SPACE SGPSet_Space.OccupancyType = Multi-unit residential SGPSet_Space.SpaceName = Bedrooms, Master Bedroom, Living, Dining, Study  IfcDoor.DOOR_GATE SGPSet_Door.PercentageOfOpening SGPSet_Door.MainEntrance  IfcOpeningElement.OPENING  IfcWindow.WINDOW, USERDEFINED.LOUVRE, USERDEFINED.BAYWINDOW SGPSet_Window.PercentageOfOpening > 0% SGPSet_Window.PercentageOfOpening < 0% (fixed window)	Fail	Not meeting - 25% of dwelling units that provide good cross ventilation for #Value passing rooms out of #Value total rooms, the percentage is #Value.	IfcProject	
			Mixed-use development with residential > 2000m <sup>2</sup> and non-residential < 2000m <sup>2</sup>  Total 40 units of two types units:  20 units of type A: living room, 2 bedrooms ->bedroom 1 and living room having window openings on opposite walls, bedroom 2 having window openings on adjacent walls, are having good cross ventilation  20 units of type B: living room, 2 bedrooms ->2 Bedrooms are only have window openings on one side wall, living room having window openings on opposite of balcony with sliding door having good cross ventilation.		IfcSpace.USERDEFINED.AREA_GFA SGPSet_SpaceArea_GFA.AGF_DevelopmentUse: Residential (Non-landed) Residential component GFA (Use GFA + Bonus GFA): 2000m <sup>2</sup> (From SP) SGPSet_SpaceArea_GFA.AGF_DevelopmentUse: Commercial Non-residential component GFA (Use GFA + Bonus GFA): 2000m <sup>2</sup> (From SP)  IfcSpace.USERDEFINED.AREA_GFA SGPSet_SpaceArea_GFA.AGF_Name = Balcony, Dwelling Unit (Nett)  IfcSpace.SPACE SGPSet_Space.OccupancyType = Multi-unit residential SGPSet_Space.SpaceName = Bedrooms, Master Bedroom, Living, Dining  IfcDoor.DOOR_GATE SGPSet_Door.PercentageOfOpening SGPSet_Door.MainEntrance  IfcOpeningElement.OPENING  IfcWindow.WINDOW, USERDEFINED.LOUVRE, USERDEFINED.BAYWINDOW SGPSet_Window.PercentageOfOpening > 0%	Pass	Meeting - 25% of dwelling units that provide good cross ventilation for #Value passing rooms out of #Value total rooms, the percentage is #Value.	IfcProject	

Each Test Scenario is detailed with testing and modelling parameters, as well as reporting requirements. This identifies the expected checking and reporting capabilities of ModelChecker to be developed and tested.

# Rule Interpretation Process

Test Models



Example of Test Models demonstrating a wide range of scales, from unit test models (left) to project-sized models (right).



# Rule Interpretation Process

## Configurable Parameters

Items	IFC Entity	IFC Properties	Data Type	Reference
Number of doors opening into Internal Exit Staircase ( $\leq 2$ )	IfcDoor, EGRESSINDICATORBOX, and/or IfcOpening	N/A	N/A	2.3.3a(1)
Fire-Rating of IES enclosure wall ( $\geq 1$ h)	IfcWall	FireRating	Real	2.3.3a(1), 3.8
Fire-Rating of IES doors ( $\geq 0.5$ h)	IfcDoor	FireRating	Real	2.3.3a(1), 3.8
Distance from unprotected openings ( $\leq 3$ m, $\leq 1.5$ m)	N/A	N/A	N/A	2.3.3a(3)
Accepted PG of exit staircase	IfcSpace	OccupancyType		2.3.3a(4)(a)
No. of storeys of standalone carpark ( $\leq 5$ )	N/A	N/A	N/A	2.3.3a(4)(b)(i)
Clear width of exit opening (850-1000mm)	EGRESSINDICATORBOX	N/A	N/A	2.3.3a(4)(b)(ii)
Clear height of exit opening ( $\leq 2$ m)	EGRESSINDICATORBOX	N/A	N/A	2.3.3a(4)(b)(ii)

Each RI document comes with a list of configurable parameters that agencies can use to modify the check to adapt to future COP changes, after ModelChecker goes live.

# **Automated Model Checker (AMC)**

Preview of CORENETX AMC's Suite of Rule Checks,  
Methodologies and Use Cases

# CORENETX

## AUTOMATED MODEL CHECKER



### **Computational BIM enabled Quality Control**

Computational automated checks driving conformity against modelling guidelines, AIR, EIR on Project Information and Asset Information models.



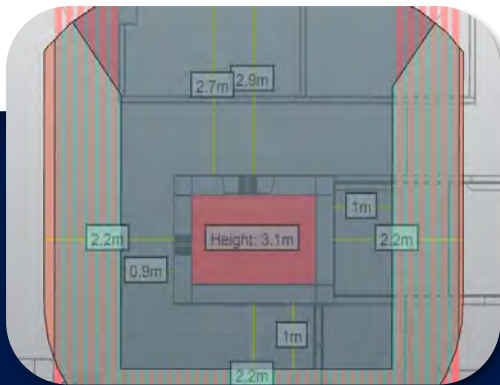
### **Computational BIM enabled Compliance Checks**

Computational automated checks driving conformity against regulatory and design requirements.



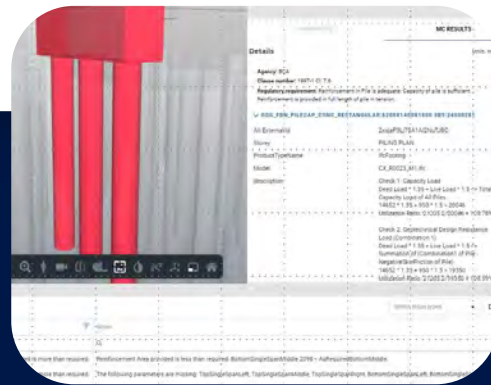
## Geometric Analyses

Removes dependency on user-defined attributes or parameters for specific rules



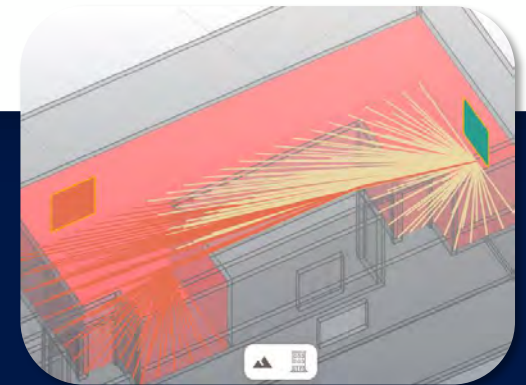
## Parametric Analyses

User-defined parameters can be checked directly by the system given required value ranges.



# Pathfinding Analyses

With known starting and ending points, the pathfinding algorithm determines path lengths and best possible path based on various criteria



## Setback and Projection Analyses

---

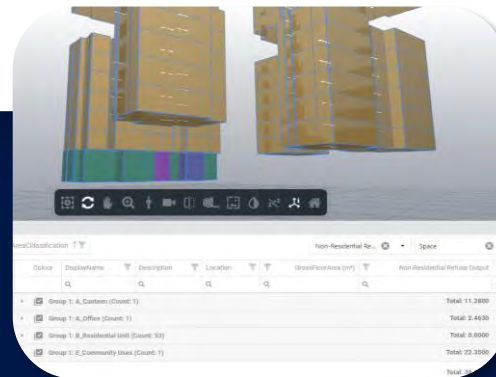
The algorithm is able to pick up various model elements and generate setbacks and projections to check for any clashes.



## Computational Analyses

---

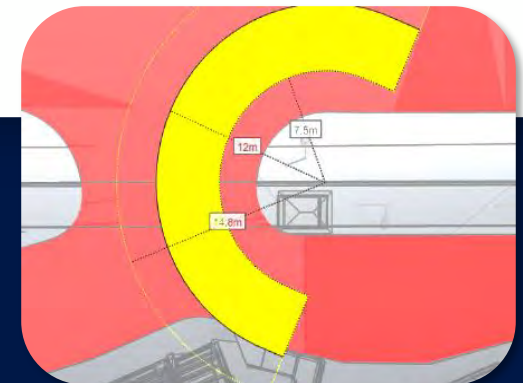
FulcrumHQ is capable of computing vast amounts of values based on model properties



## Shape-related Analyses

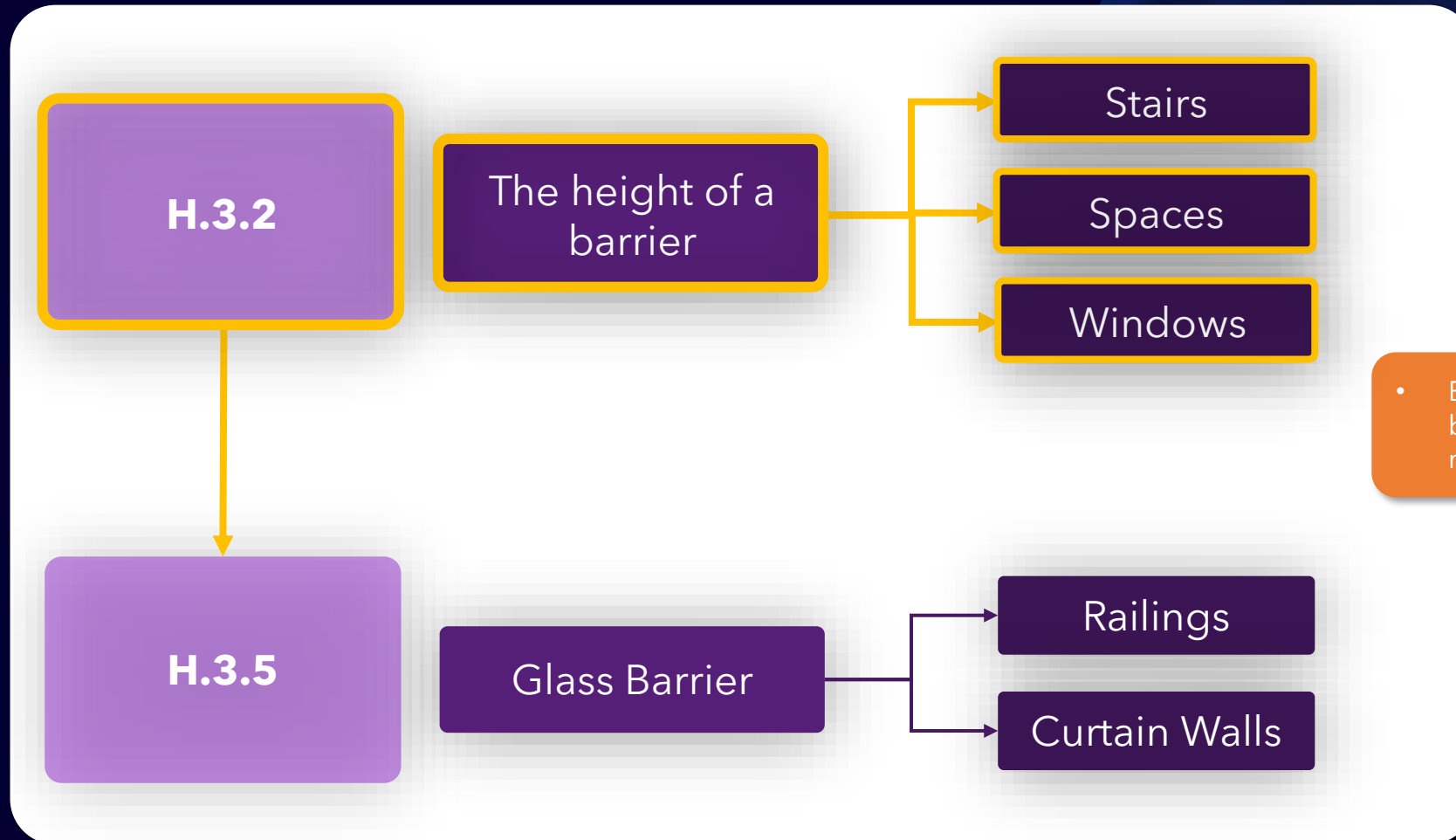
---

The system is capable of generating shapes determined by a combination of requirements such as turning radius, to consider suitability of driveways, roads and fire engine accessways.



# Height of Barrier

## Geometric and Parametric Check



The height of a barrier shall not be less than –  
(a) 1.0 metre; or  
(b) 900 mm at the lower edge of the window and gallery or balcony with fixed seating in areas such as theatres, cinemas and assembling halls.

- Execution of the H.3.2 rule stores a list of barriers that can be accessed by another rule



# Height of Barrier

## Geometric and Parametric Check

1

Window

Edges with edge will not be detected as drop since it is hosted on a full height wall. In this case, we will for check Safety Barrier Height of window.

If Safety Barrier Height property is presence, The check will be parametric. `SafetyBarrierHeight >= 900mm`.

If property is missing, check geometrically measuring from FFL to lowest point of window.

Reason: Full height window / window system will require SafetyBarrierHeight parameter since MC cannot detect exactly which panel is openable or fixed, for non-full height window or simple window, we can check geometrically



SafetyScreenHeight &lt; 100mm

0000

If SafetyBarrierHeight is < 0.9m, Check for provision of barrier (railing only). Railing Height must be >= 1m.

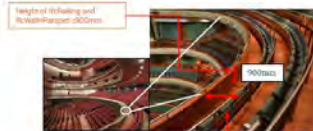


McRolling located internally as safety barrier when McWindow Safety Barrier Height is  $\leq 900\text{mm}$

Cinema, Theatre, Assembling Hall

If SpaceName = CINEMA, THEATRE, ASSEMBLINGHALL, ... See full list in Ifc Info page

If drop edge have chair (IfcFurniture) within 1m bounding box, the barrier height can be  $\geq 900\text{mm}$  instead of  $\geq 1\text{m}$ .

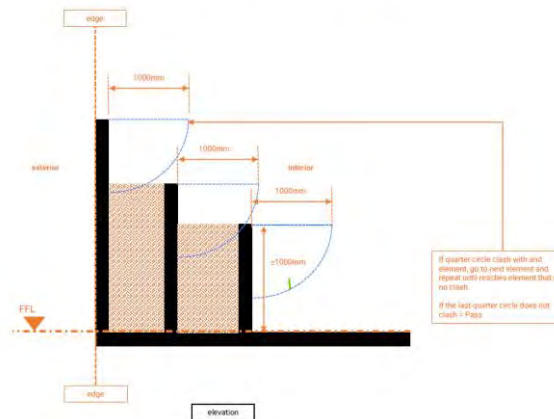


Revised Papered 500mm

900THRU

**Referring to:**

1. Check of validity of barrier  $\geq 1\text{m}$  and Check Vertical Drop in level  $\geq 1\text{m}$  (detect edge with a drop)

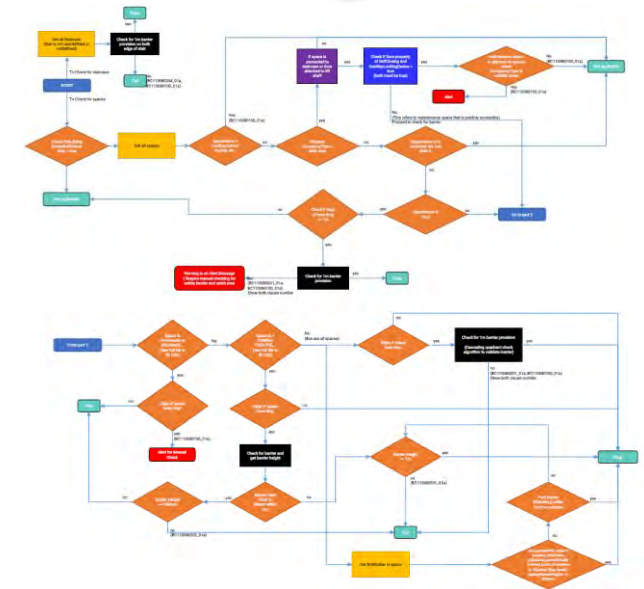


If quarter circle clash with an element, go to next element and repeat until reaches element that no clash.

## Methodology

Qualifying IfcEntities to be checked, IfcSpaces to be exempted or subject to specific height requirements, checking validity of barrier

2



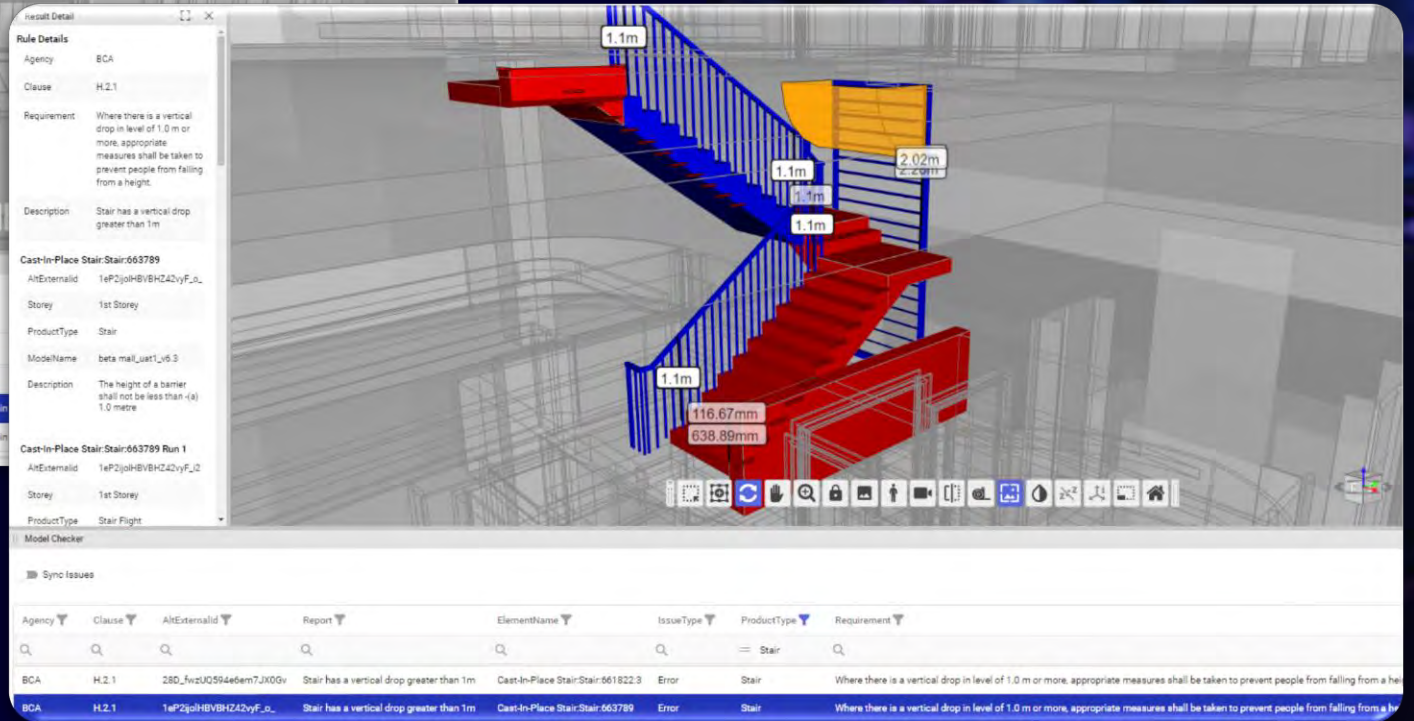
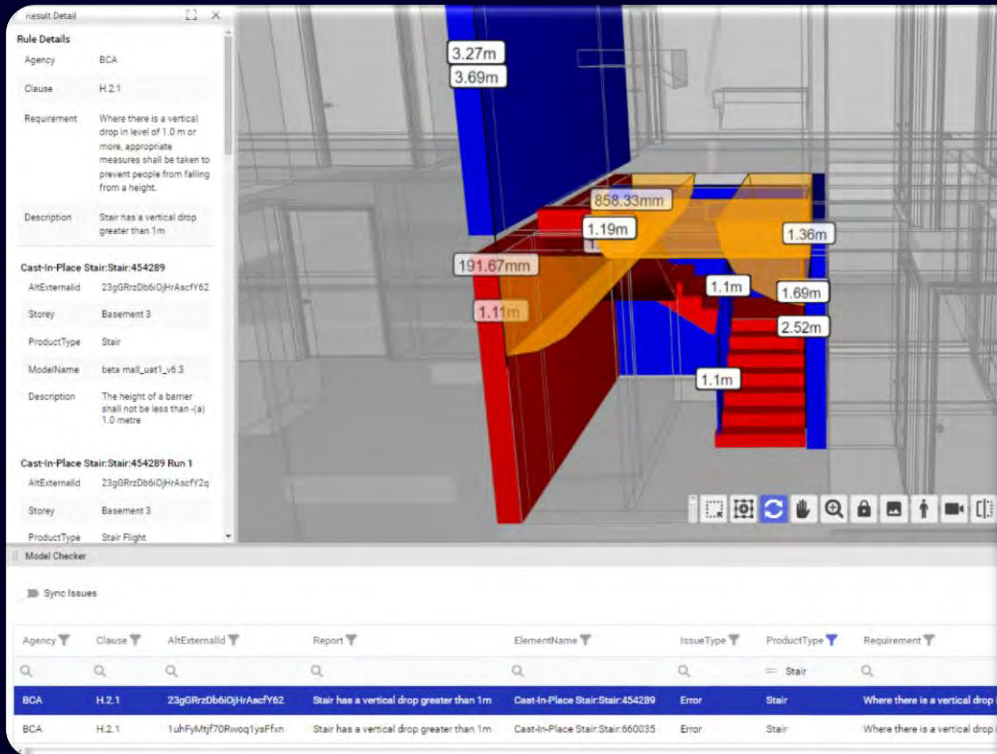
## Flowchart

The relationships between IfcEntities, processes or methods, and results based on conditions.

# Height of Barrier

## Stairs

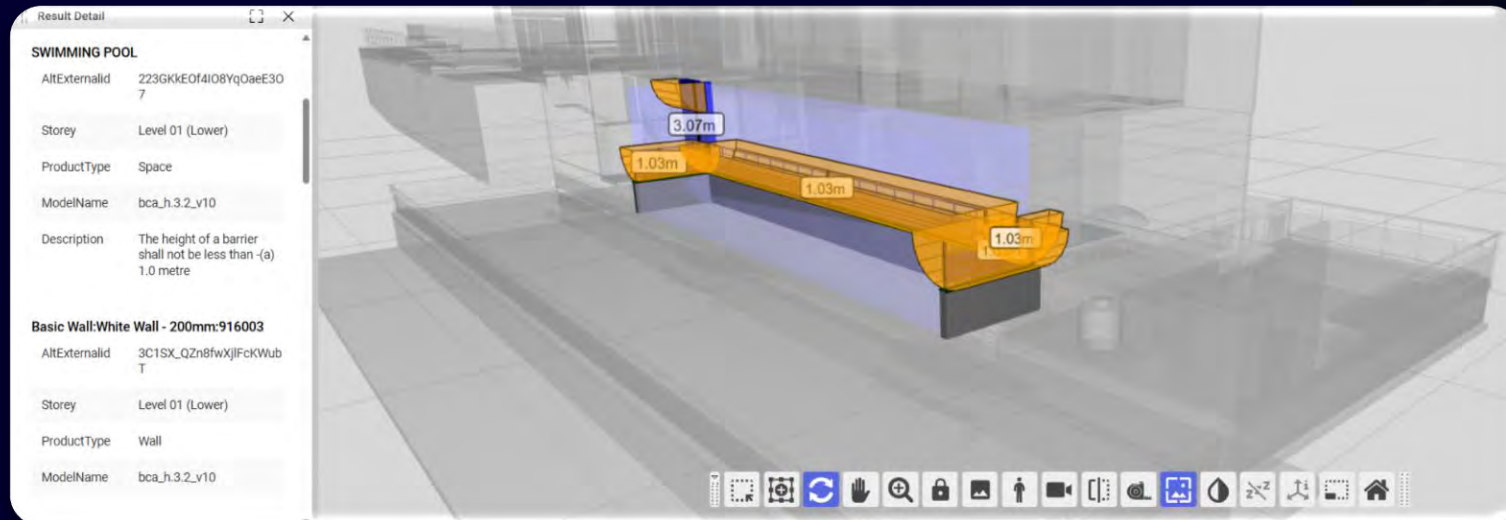
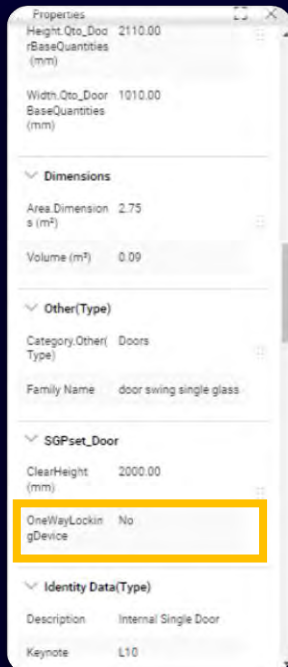
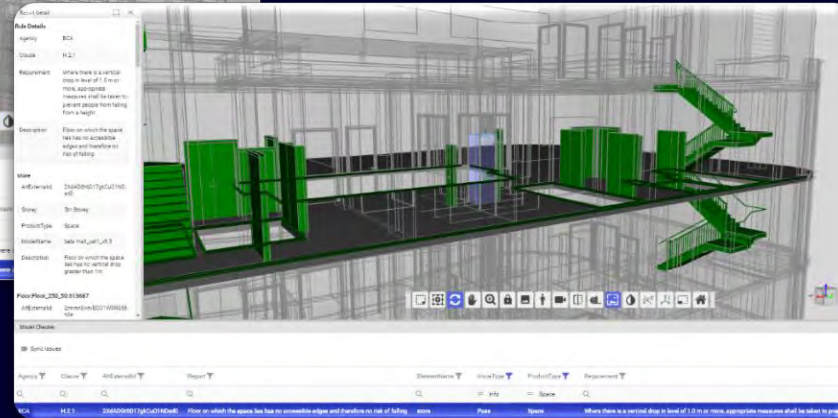
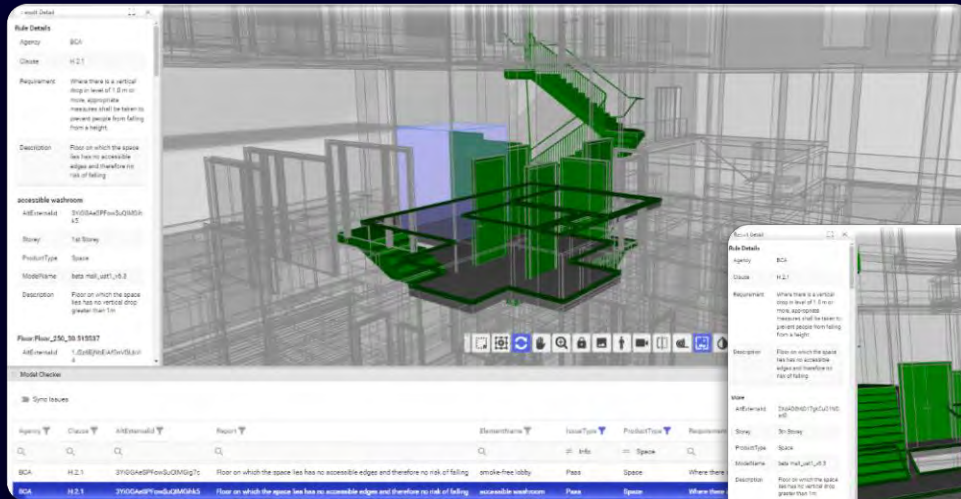
- 1m quadrant extrusion to check validity of barrier.





# Height of Barrier Spaces

- Slab associated with space is checked for drops.
- If space is connected to staircase or door attached to lift shaft, doors will be checked for SelfClosing and OneWayLockingDevice property.
- Check if edge of space has drop, and if so, check for barrier and barrier height.

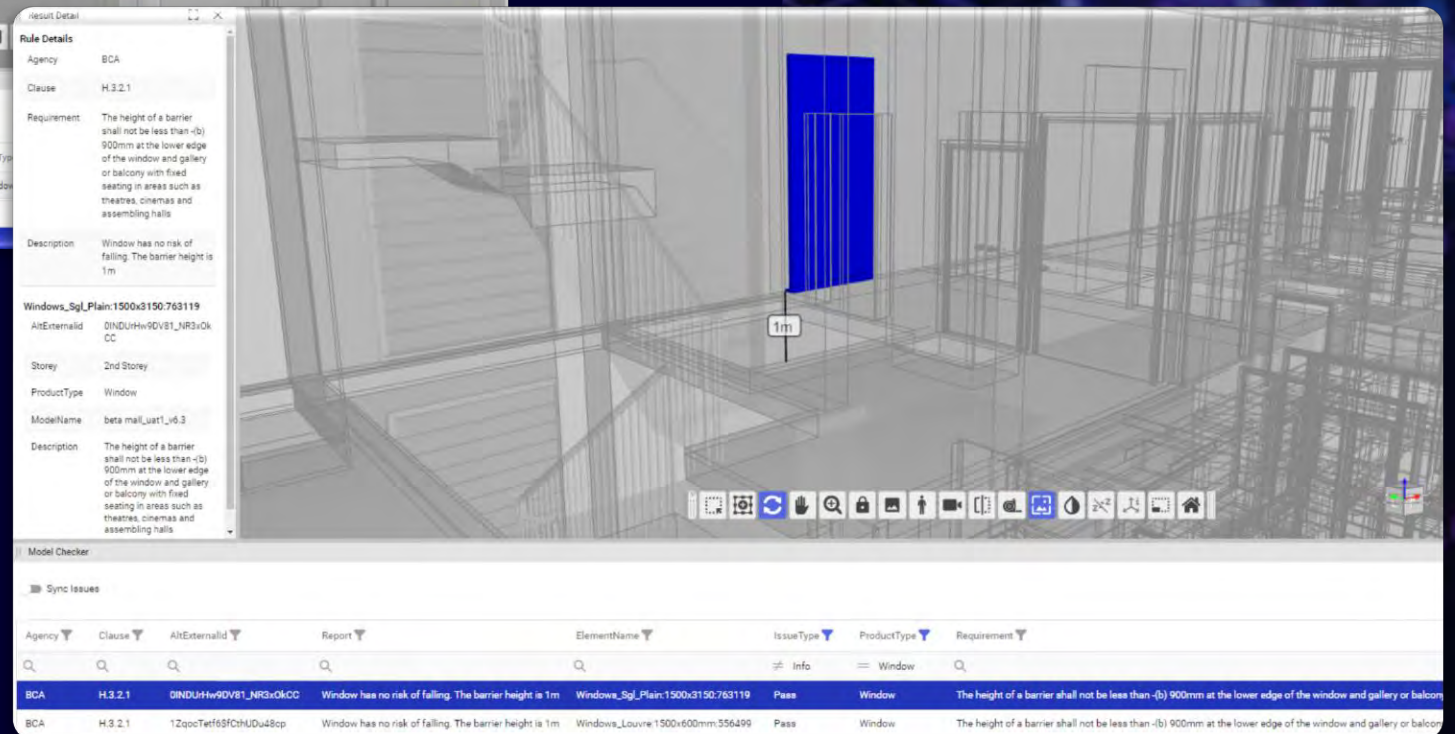
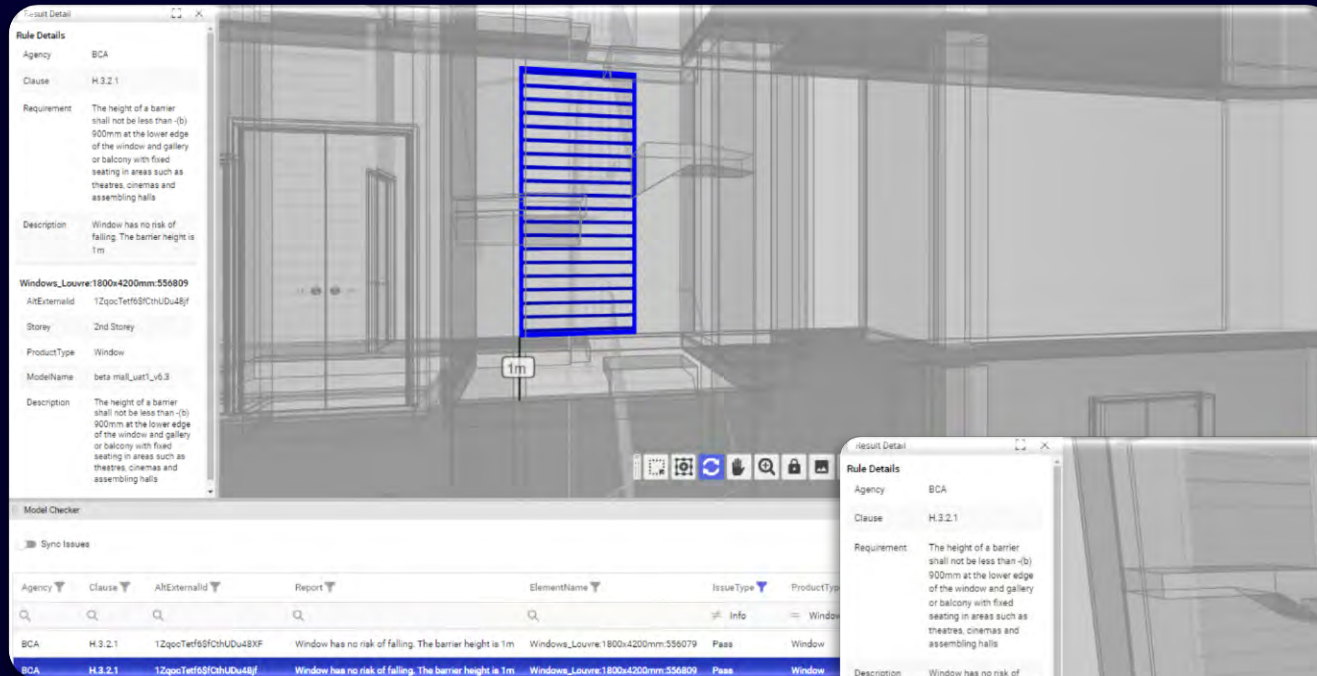




# Height of Barrier

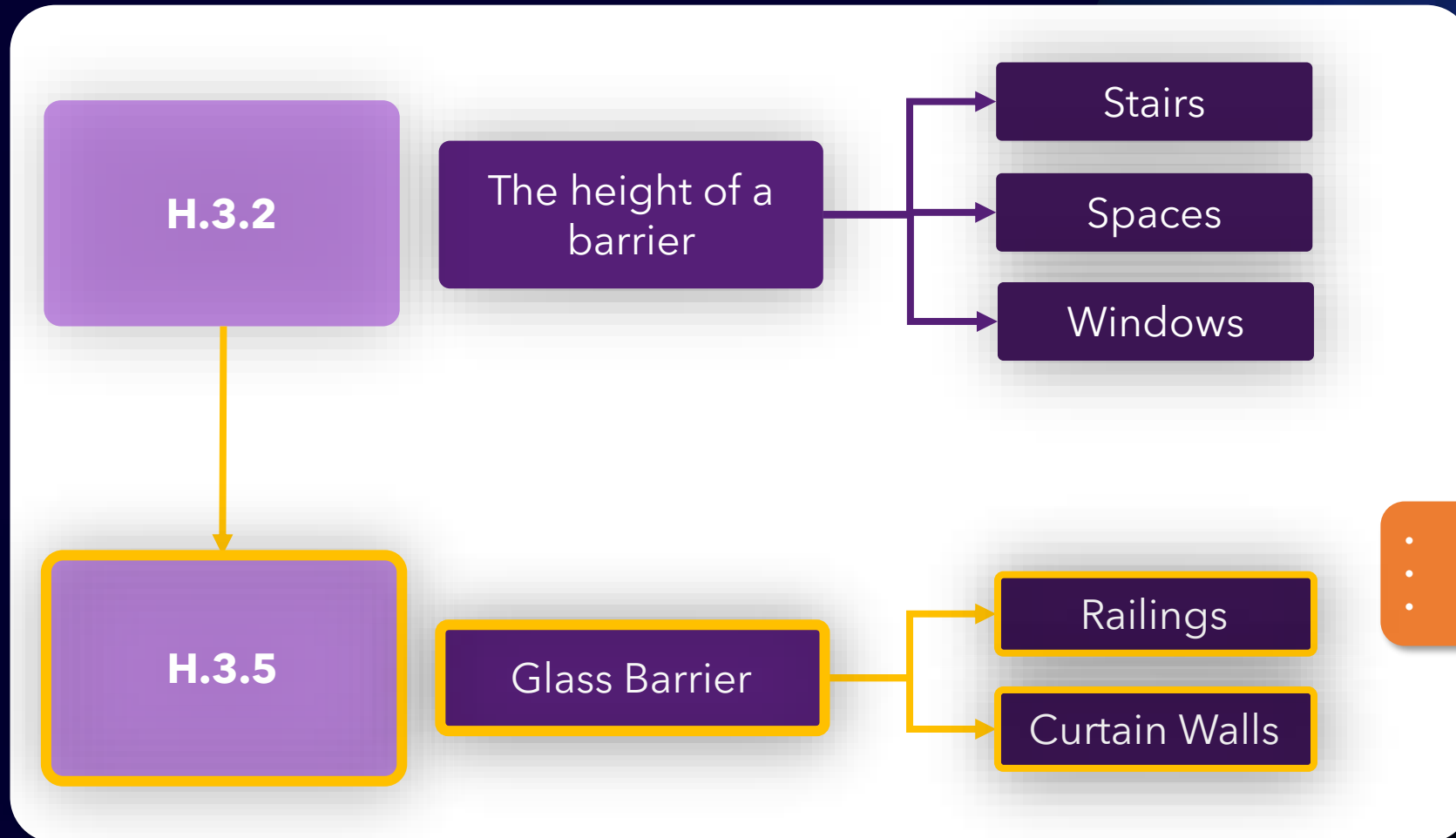
## Windows

- Search for presence of parameter: SafetyBarrierHeight >= 900mm
- Otherwise measure geometrically (lowest point of window to finished floor level).



# Glass Barrier

## Parametric Check

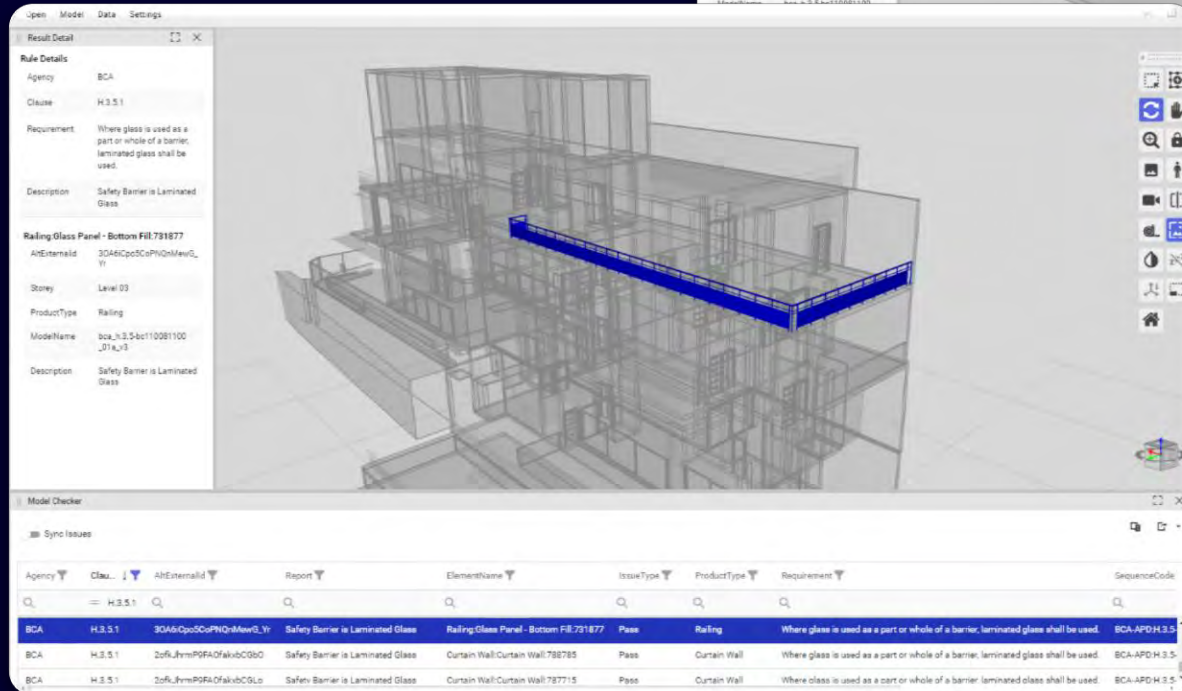
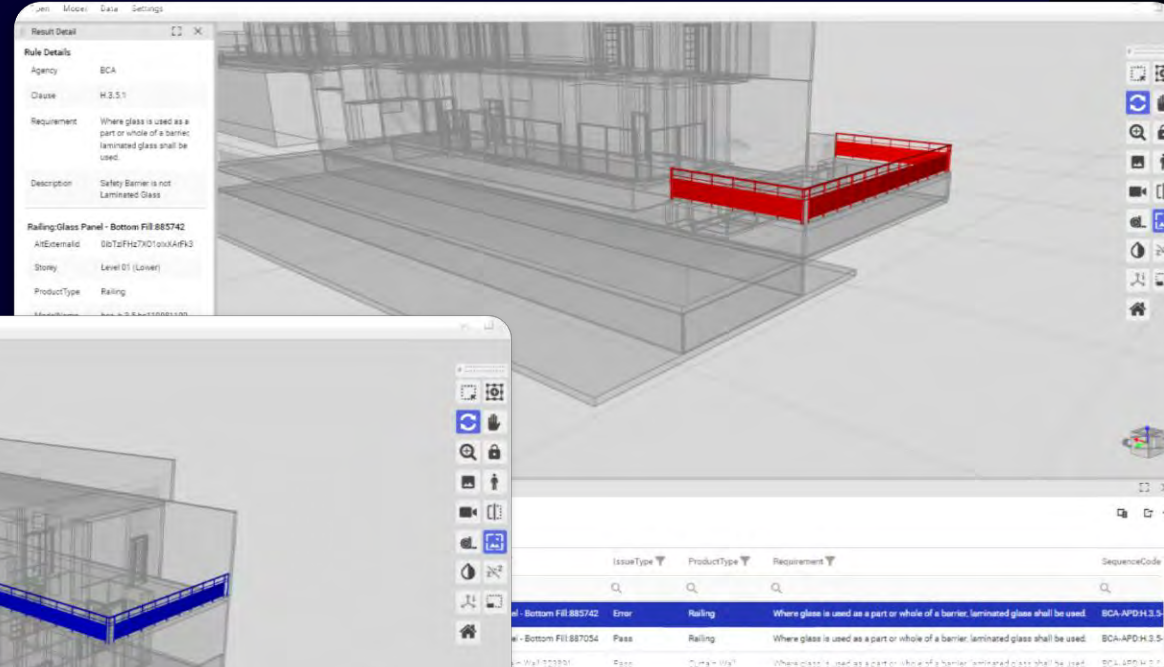


- Access list of stored barriers
- Filter for IfcRailing and IfcCurtainWall
- Use as input for H.3.5 check

Where glass is used as a part or whole of a barrier, laminated glass shall be used.



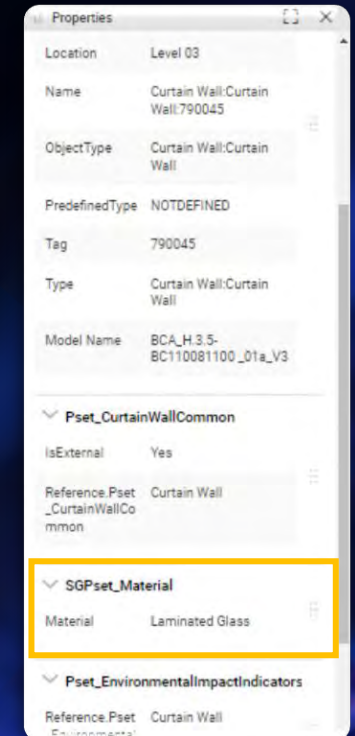
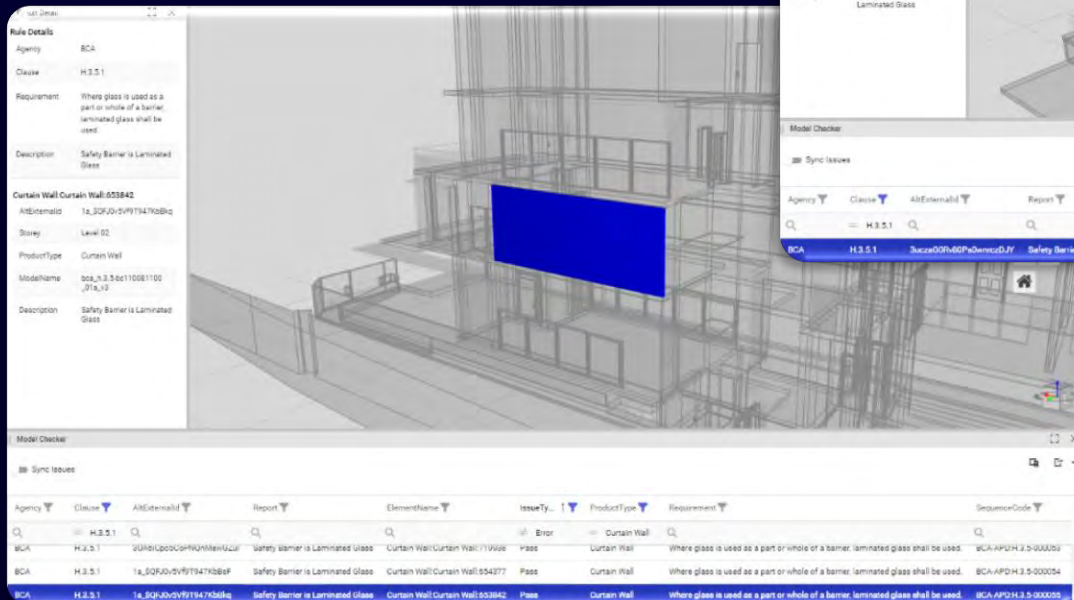
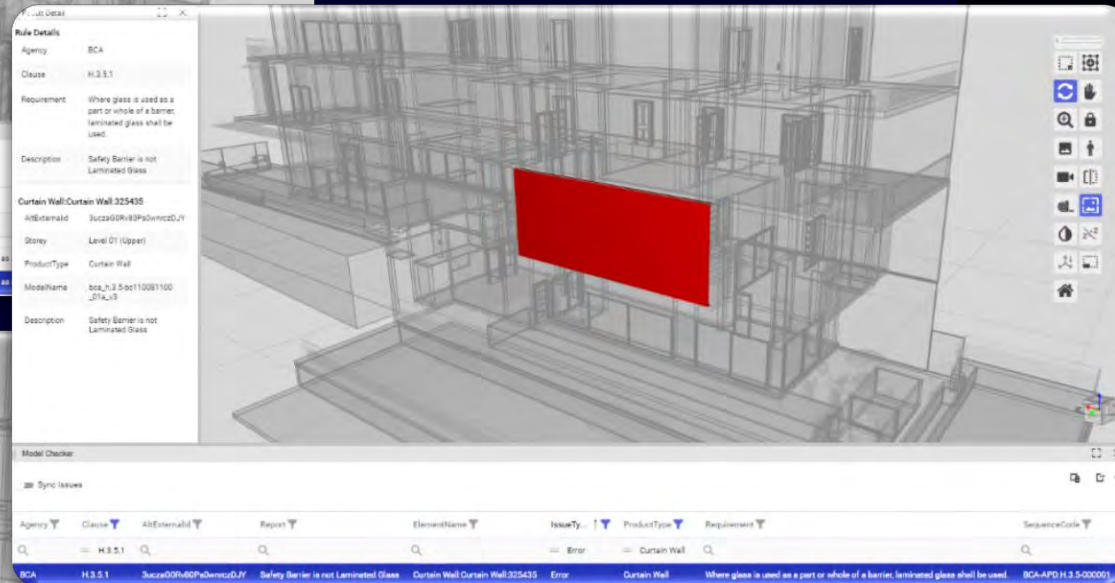
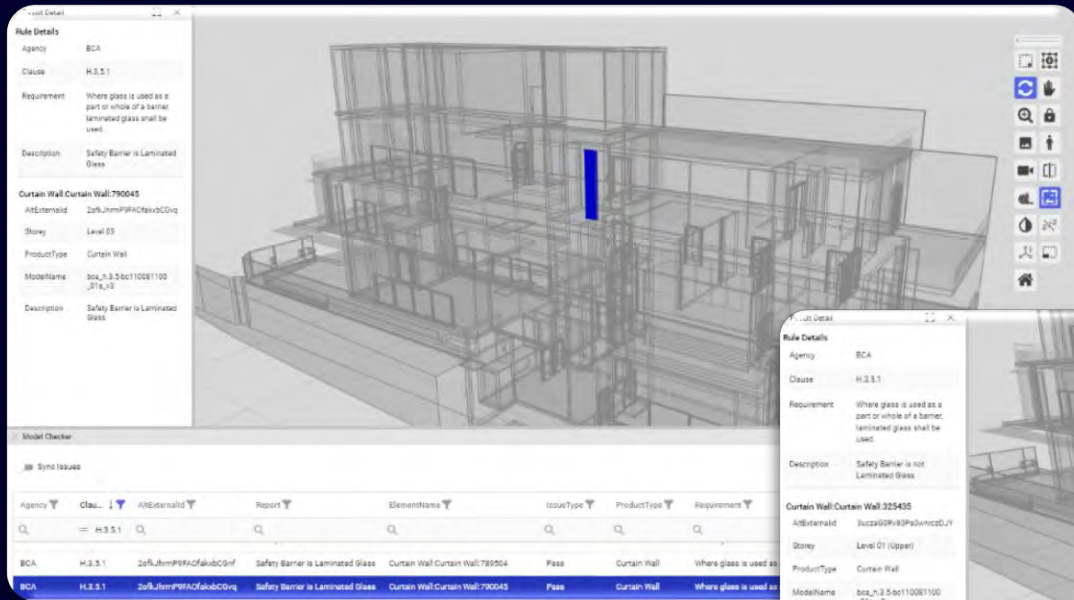
# Glass Barrier Railings





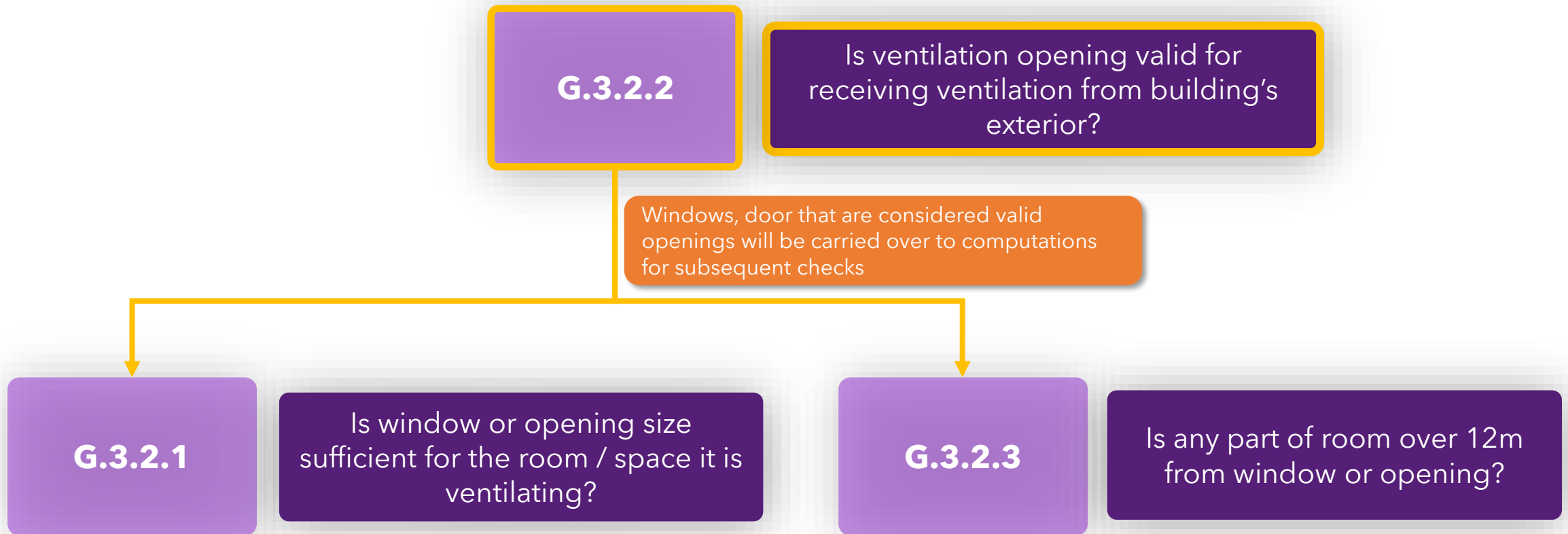
# Glass Barrier

## Curtain Walls



# Natural Ventilation

Geometric Check, Shape Generation, Computation and Pathfinding



# Natural Ventilation

## Valid Ventilation Opening - Geometric Check, Shape Generation

- G.3.2.2 All windows and openings intended for natural ventilation shall be located such that they open to –
- (a) the exterior of the building;
  - (b) an airwell with a minimum width of 3.0m and a minimum area open to the sky complying with Table G.3.2.2(a); or
  - (c) a recess, exceeding 3.0m from the external building wall, and of minimum width 3.0m. See Figure G.3.2.2(b) for illustration.

Regulatory Clause from Code of Practice

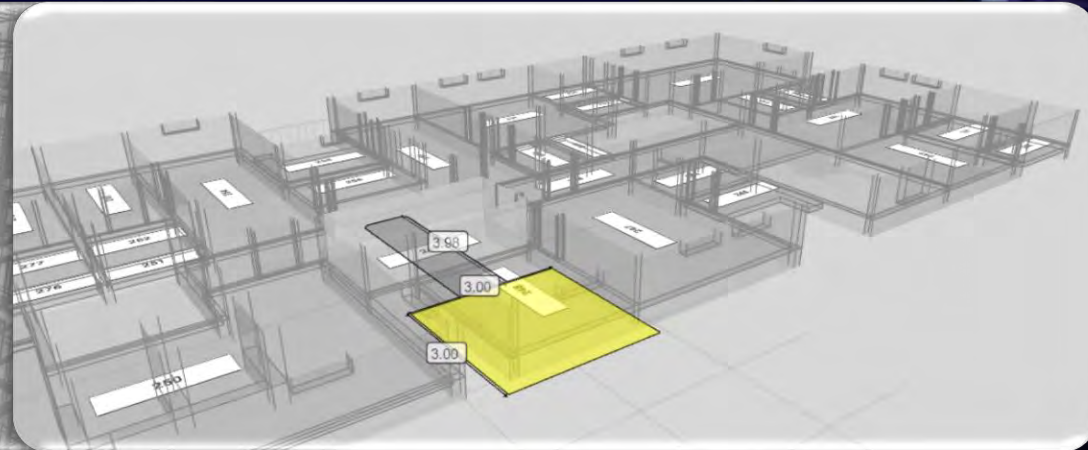
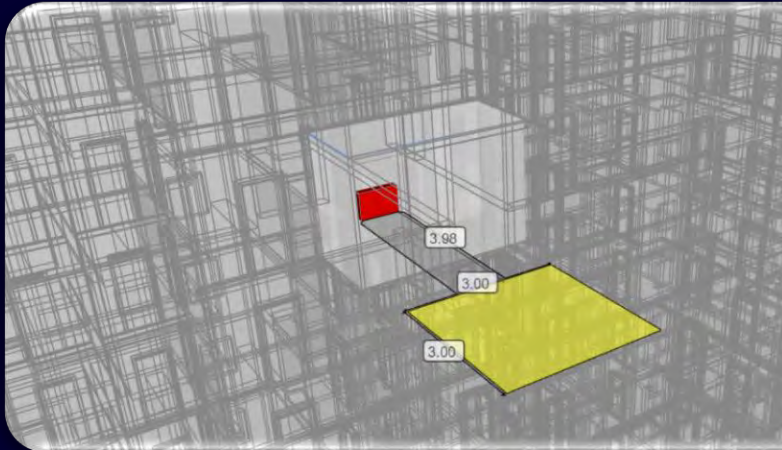
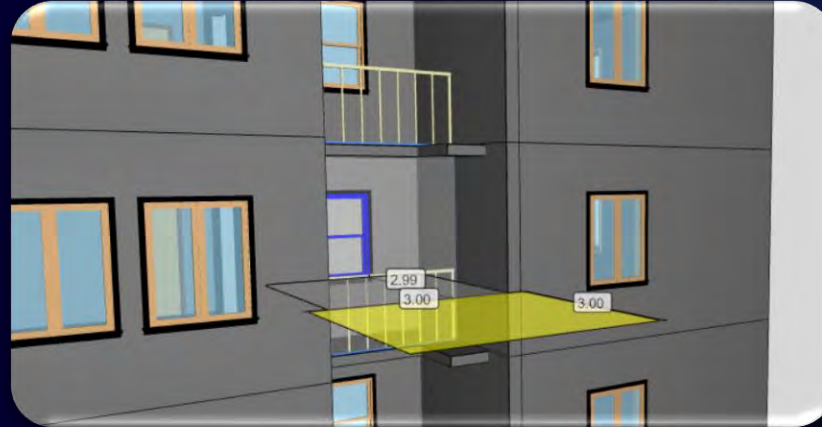
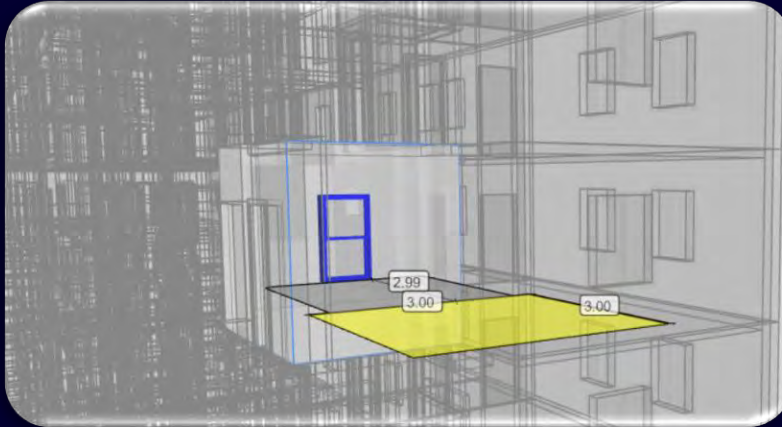
What constitutes building outline to be able to inform “exterior of building”?





# Natural Ventilation

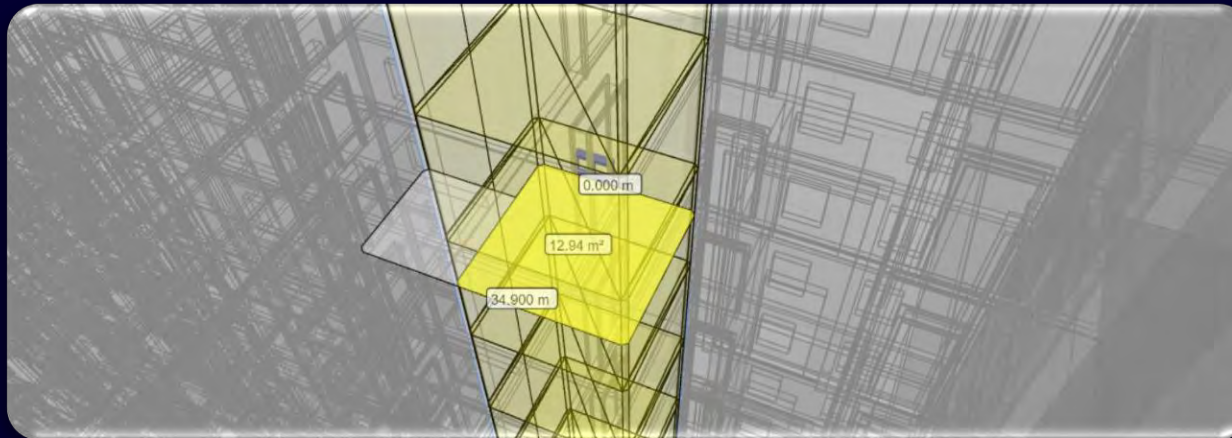
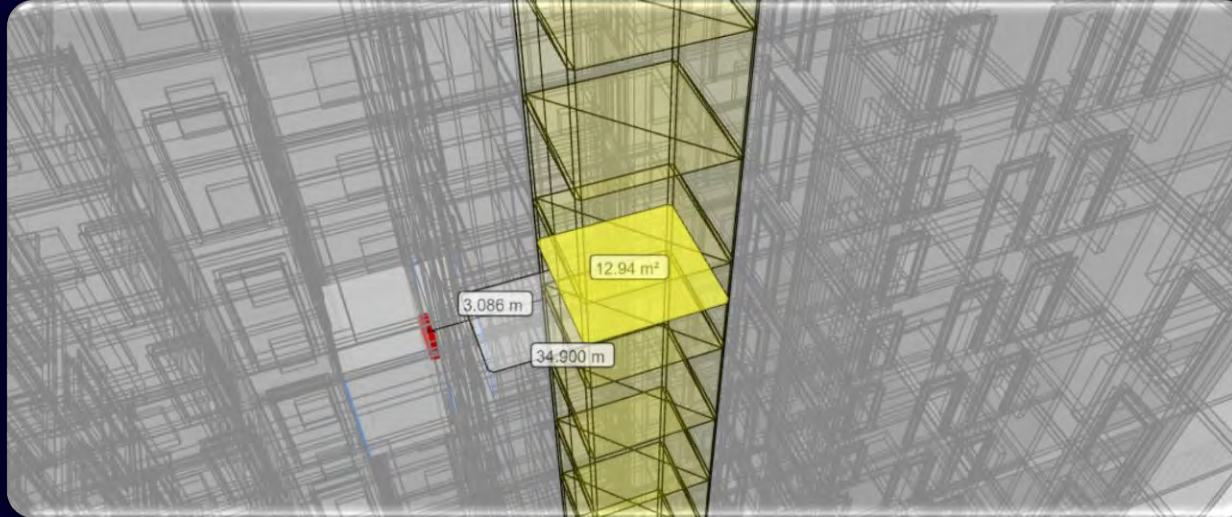
Valid Ventilation Opening - Geometric Check, Shape Generation



Opening that opens to a recess from external building wall.

# Natural Ventilation

Valid Ventilation Opening - Geometric Check, Shape Generation



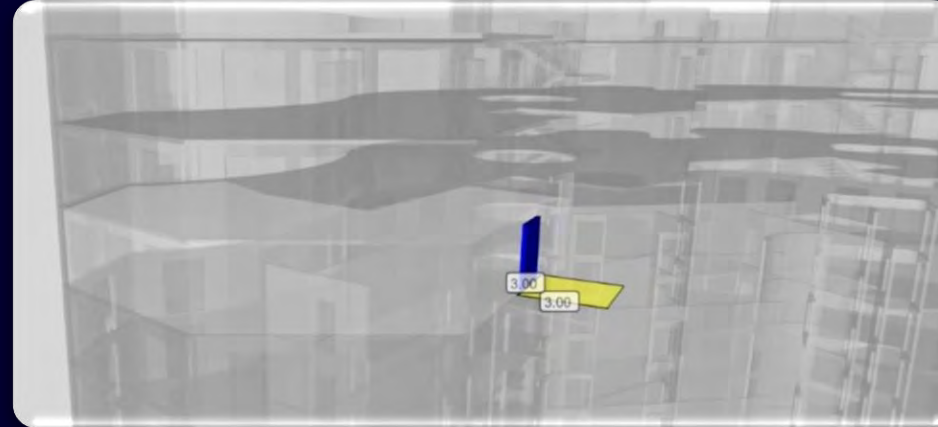
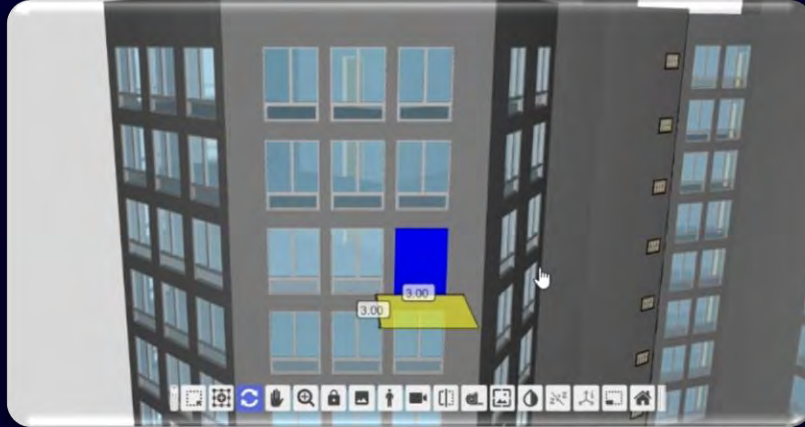
Opening that opens to an airwell.





# Natural Ventilation

## Valid Ventilation Opening - Geometric Check, Shape Generation

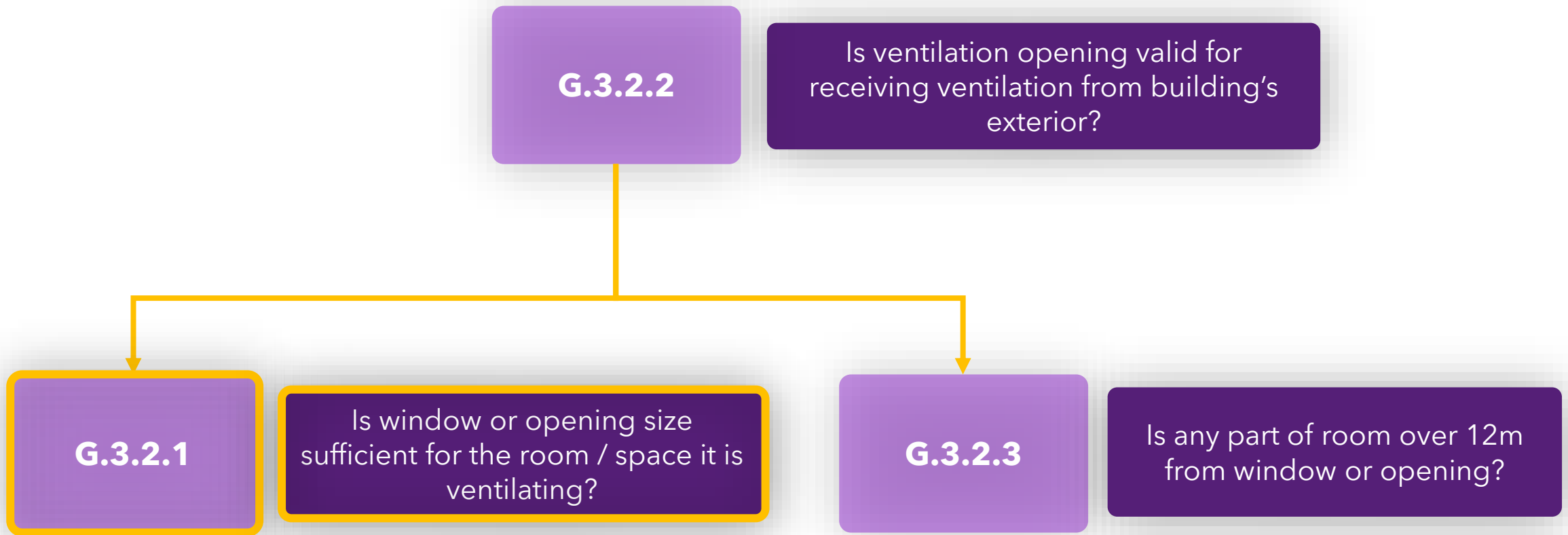


Opening that opens to exterior of building.



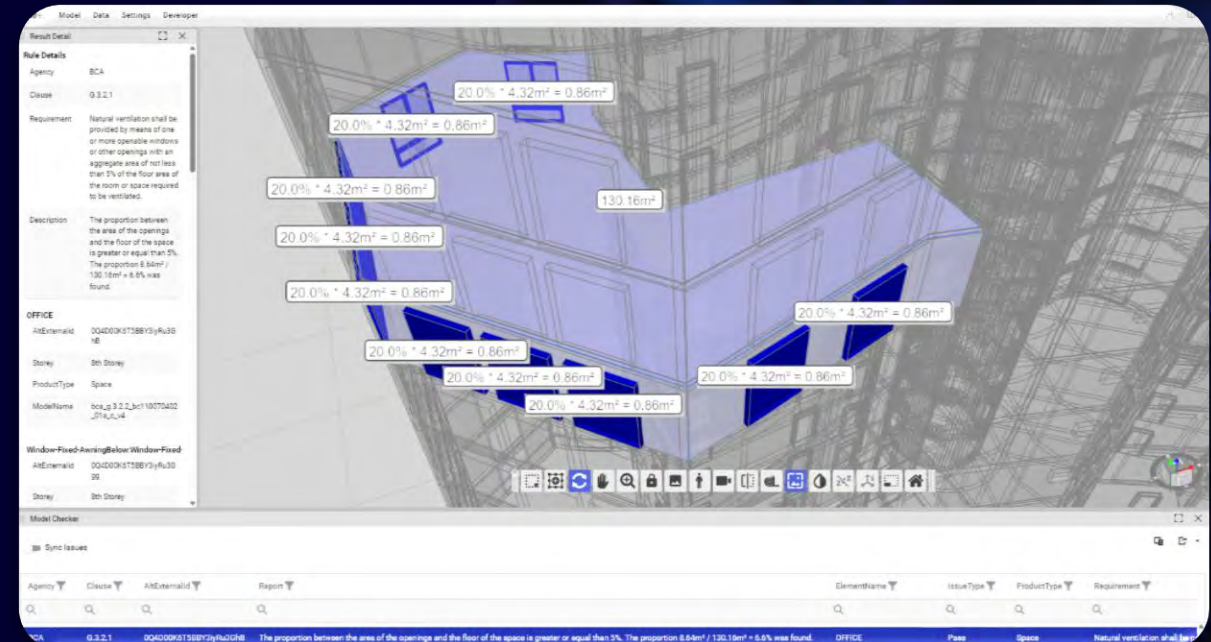
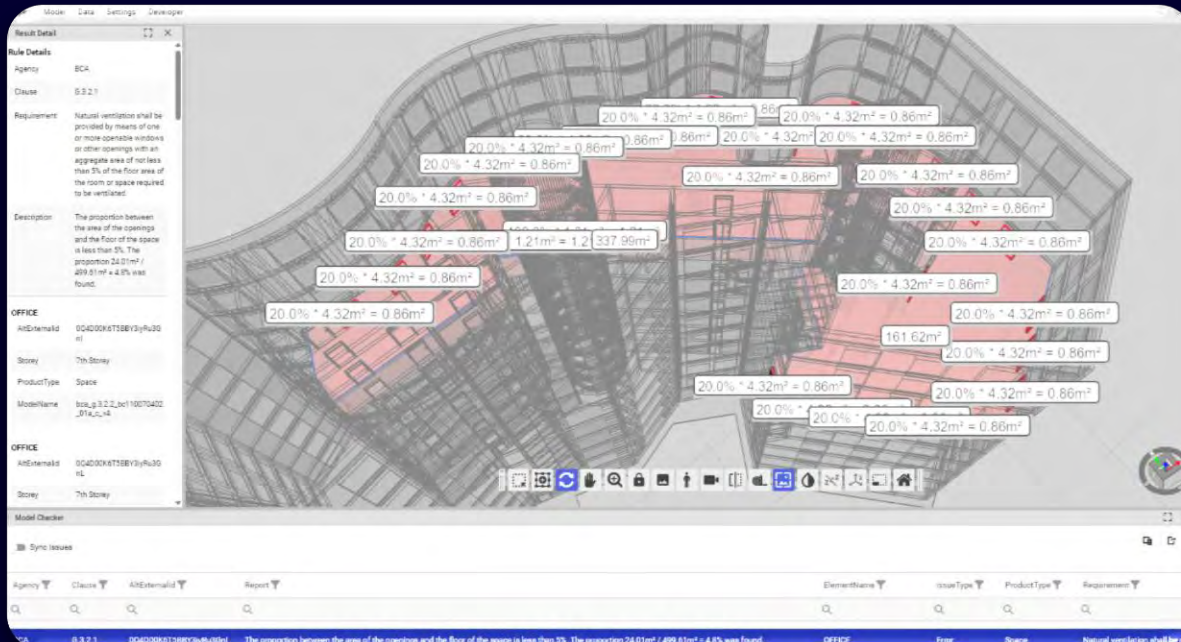
# Natural Ventilation

Geometric Check, Shape Generation, Computation and Pathfinding



# Natural Ventilation

## Ratio of Ventilation Opening to Floor Area - Computation



# Natural Ventilation

## Ratio of Ventilation Opening to Floor Area - Computation



Qto\_WindowBaseQuantities

Area (m²) 4.32

Height (mm) 2400.00

Perimeter (mm) 3332.00

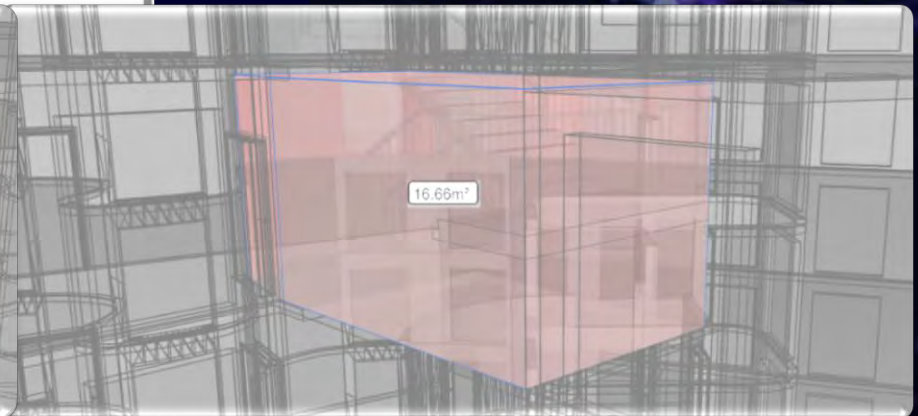
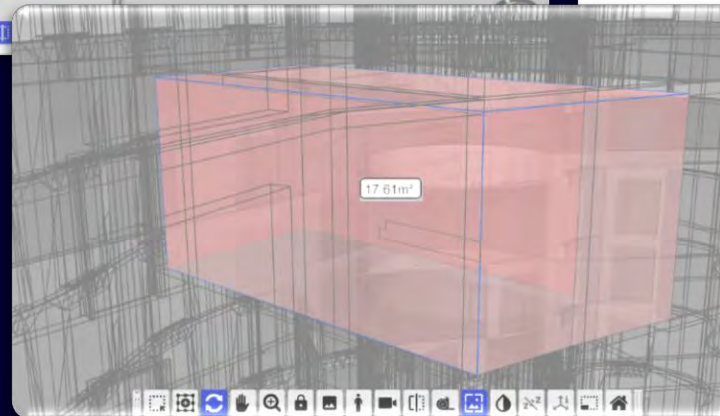
Width (mm) 1800.00

SGPset\_Window

PercentageOfOpening 20.00

Profile

Profile Name Window-Fixed-AwningBelow

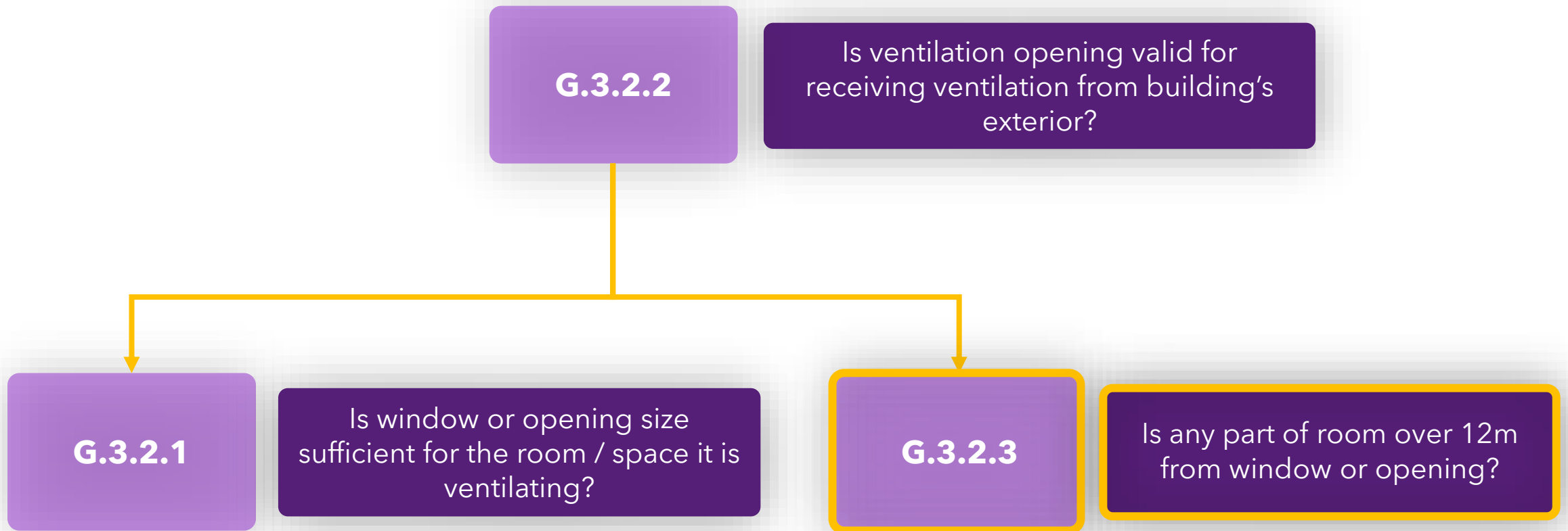


Agency	Clause	AltExternalId	Report	ElementName	IssueType	ProductType
BCA	G 3.2.1	DQ4D00K6T5B8Y3yRu3GfI	The proportion between the area of the openings and the floor of the space is less than 5%. The proportion $0.00\text{m}^2 / 17.61\text{m}^2 = 0.0\%$ was found.	INTERNAL EXIT STAIRCASE	Error	Space
BCA	G 3.2.1	DQ4D00K6T5B8Y3yRu3GfL	The proportion between the area of the openings and the floor of the space is less than 5%. The proportion $0.00\text{m}^2 / 16.66\text{m}^2 = 0.0\%$ was found.	INTERNAL EXIT STAIRCASE	Error	Space



# Natural Ventilation

Geometric Check, Shape Generation, Computation and Pathfinding



# Natural Ventilation

## Distance between Ventilation Opening and Part of Space/Room - Pathfinding

The screenshot displays a software interface for natural ventilation analysis. The top section shows a 3D model of a building with various distance measurements (e.g., 6.024 m, 3.387 m, 5.674 m, 5.866 m, 3.680 m, 3.980 m, 3.556 m, 6.891 m, 5.691 m, 5.556 m) indicating the distance between ventilation openings and parts of the space. The bottom section shows a table of results.

**Result Detail**

**Rule Details**

Agency: BCA

Clause: G.3.2.3

Requirement: No part of any room or space (other than a room in a warehouse) that is designed for natural ventilation shall be more than 12.0m from any window/opening ventilating the space.

Description: All parts within this space are situated at a distance of less than 12.000 m from any window or opening that provides ventilation.

**OFFICE**

AltExternalId: 0Q4D00K6T5BBY3iyRu3GiY

Storey: 9th Storey

**Model Checker**

Sync Issues

Agency	Clause	AltExternalId	Report	ElementName	IssueType	ProductType	Requireme
BCA	G.3.2.3	0Q4D00K6T5BBY3iyRu3GiZ	All parts within this space are situated at a distance of less than 12.000 m from any window or opening that provides ventilation.	OFFICE	Pass	Space	No part of
BCA	G.3.2.3	0Q4D00K6T5BBY3iyRu3GiY	All parts within this space are situated at a distance of less than 12.000 m from any window or opening that provides ventilation.	OFFICE	Pass	Space	No part of
BCA	G.3.2.3	0Q4D00K6T5BBY3iyRu3Gib	All parts within this space are situated at a distance of less than 12.000 m from any window or opening that provides ventilation.	OFFICE	Pass	Space	No part of

Create Filter

# Clear Path from Refuse Chute Chamber to Bin Center

## Pathfinding

**Rule Details**

Agency: NEA  
Clause: 1.4  
Requirement: The refuse chute chamber shall be suitably located to facilitate easy and nuisance-free conveyance of refuse. The refuse chute chamber shall meet the following requirements:  
Description: Route or path between Refuse Chute Chamber to Bin centre shall be free of obstacles or obstruction.

**REFUSE CHUTE CHAMBER**  
AltExternalId: 3VH\_LNjibFRhDiHjhiWyla  
Storey: 1ST STOREY

**Model Checker**

Agency	Clause	AltExternalId	Report	ElementName	IssueType	ProductType	Requirement
NEA	1.4	3VH_LNjibFRhDiHjhiWyla	Route or path between Refuse Chute Chamber to Bin centre shall be free of obstacles or obstruction.	REFUSE CHUTE CHAMBER	Pass	Space	The refuse chute chamber shall be suitably located to facilitate easy and nuisance-free conveyance of refuse.
NEA	1.4	0B4WsJCabOWe8ZonoR3J5w	Refuse Chute Chamber must not face any resident unit, lift (or its lobby), carpark, swimming pool, garden and structure components e.g. staircase, column, wall.	REFUSE CHUTE CHAMBER	Pass	Space	The refuse chute chamber shall be suitably located to facilitate easy and nuisance-free conveyance of refuse.
NEA	1.4	0B4WsJCabOWe8ZonoR3J5w	Route or path between Refuse Chute Chamber to Bin centre shall be free of obstacles or obstruction.	REFUSE CHUTE CHAMBER	Pass	Space	The refuse chute chamber shall be suitably located to facilitate easy and nuisance-free conveyance of refuse.

Page 1 of 1 (6 items)

1

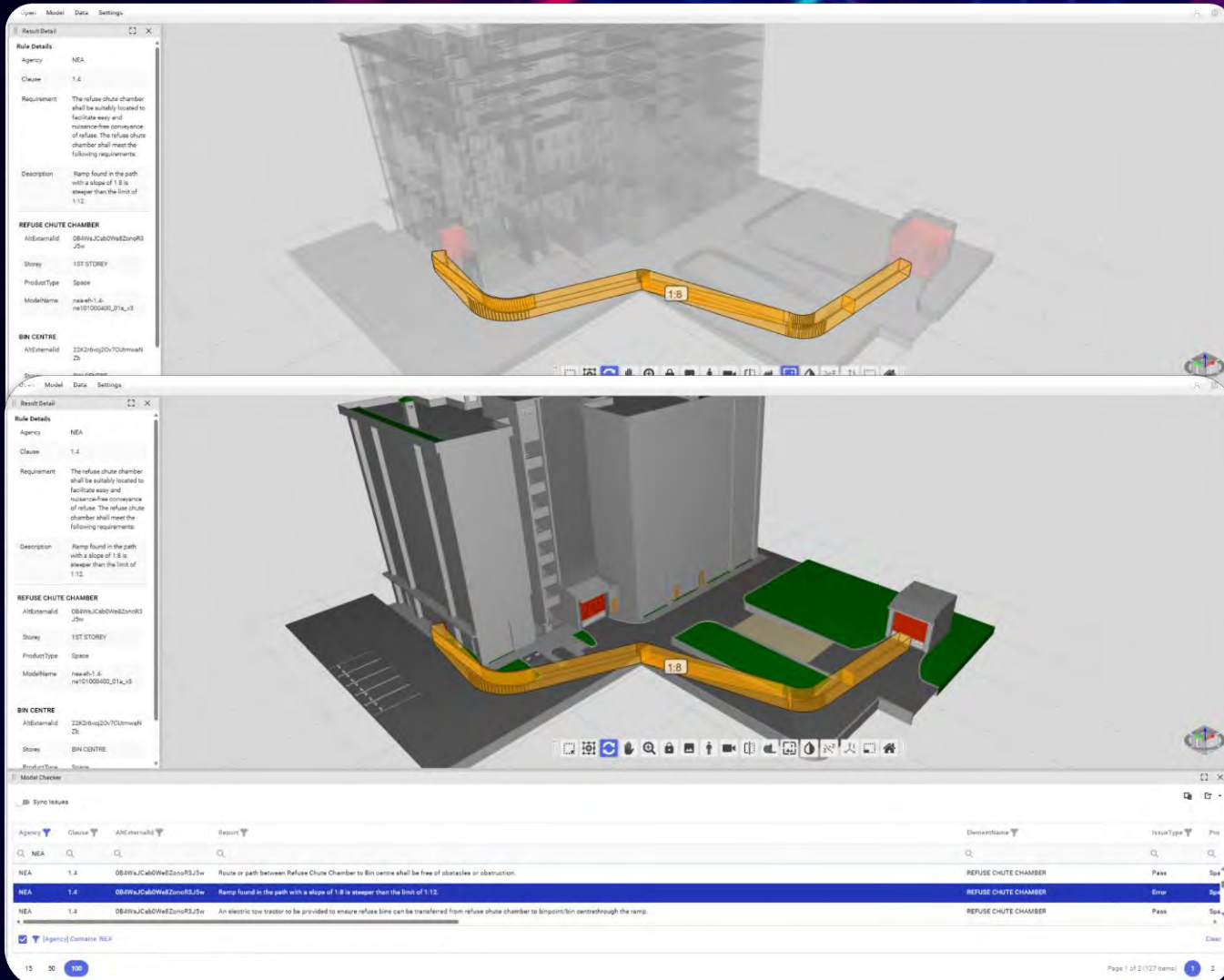
### Generating Shortest Path

Shortest path between 2 predefined IfcSpaces: Refuse Chute Chamber room and the Bin Centre



# Clear Path from Refuse Chute Chamber to Bin Center

## Pathfinding

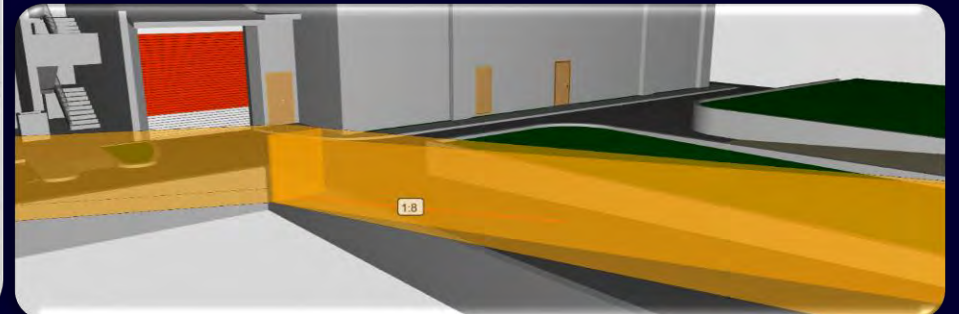


1

**Generating Shortest Path**  
Shortest path between 2 predefined IfcSpaces: Refuse Chute Chamber room and the Bin Centre

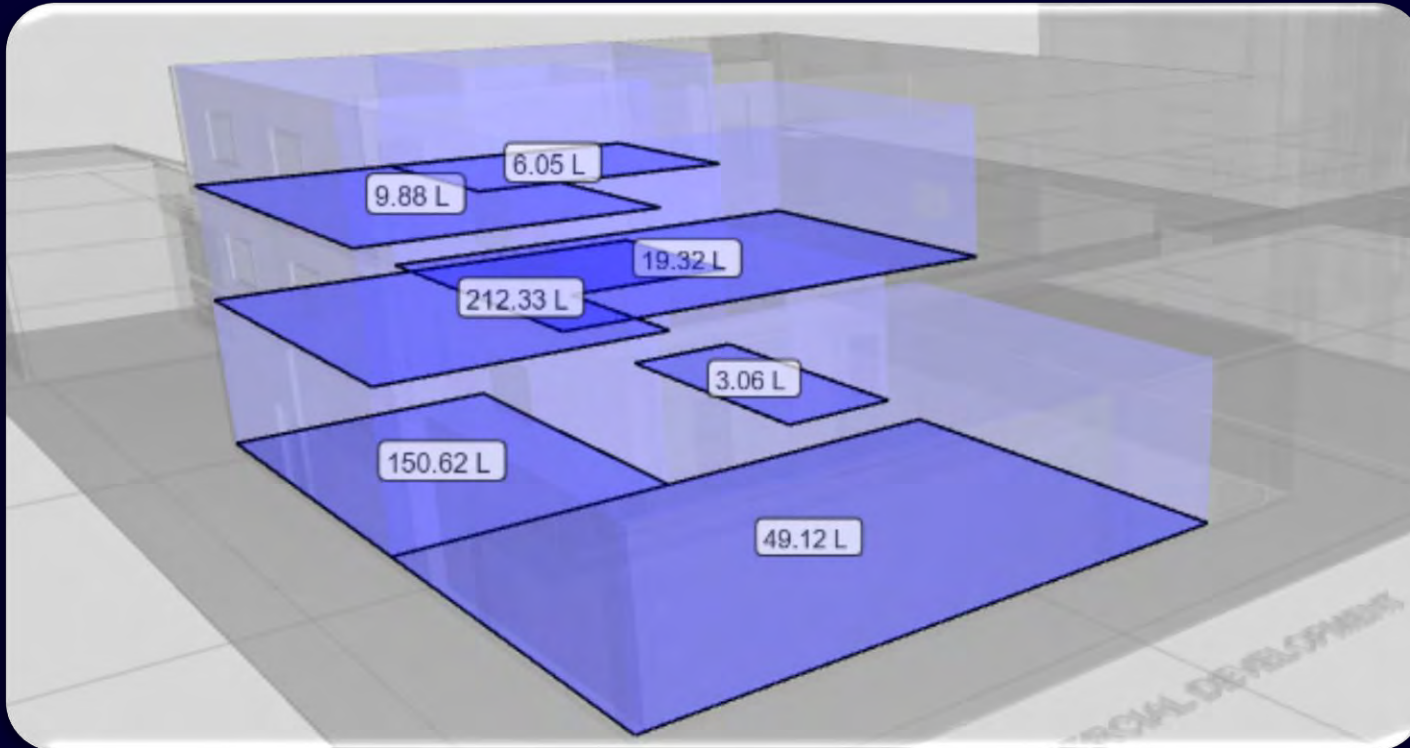
2

**Checking Gradient**  
Gradient of shortest path is measured, and checked against max. allowable gradient



# Total Refuse Output

## Calculation



Different Space usage has an equivalent Refuse Output which is based on two different computation

### Fixed Value


Eg. Each Dwelling Unit will have an output of 20L per day

### Per Area

Eg. An Office space will have an output of 0.15L per sqm per day

# Total Refuse Output Calculation

Open Model Data Settings



Model Checker

Sync Issues

Agency	Clause	AltExternalId	Report	ElementName	IssueType	ProductType	Requirement
NEA	1.2(b)	3d\$sezL_DDPFUUDTJ0l595	The total refuse output per day from all premises is 278.92 L.	DWELLING UNIT (NETT)	Info	Space	Where a proposed development has a combination of different types of premises (for example, a shopping complex with office
NEA	1.2(b)	2Z3nX_Hf8Kfbn1ZZ7gb8mX	The total refuse output per day from all premises is 278.92 L.	DWELLING UNIT (NETT)	Info	Space	Where a proposed development has a combination of different types of premises (for example, a shopping complex with office
NEA	1.2(b)	2TnfLloMTAXE6RFDXe8zgz	The total refuse output per day from all premises is 450.38 L.	STAFF QUARTERS	Info	Space	Where a proposed development has a combination of different types of premises (for example, a shopping complex with office

Create Filter

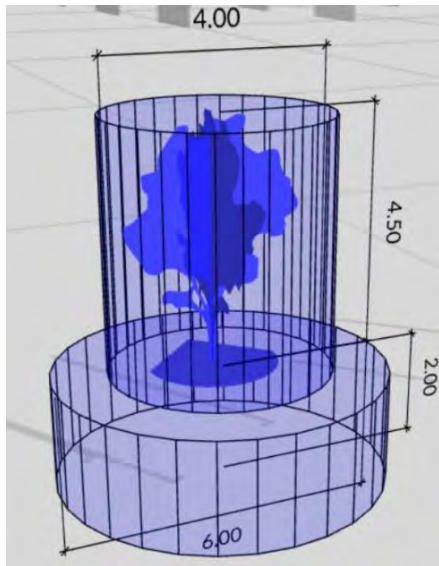
15 50 100

Page 1 of 1 (3 items)



# Tree Protection Zone

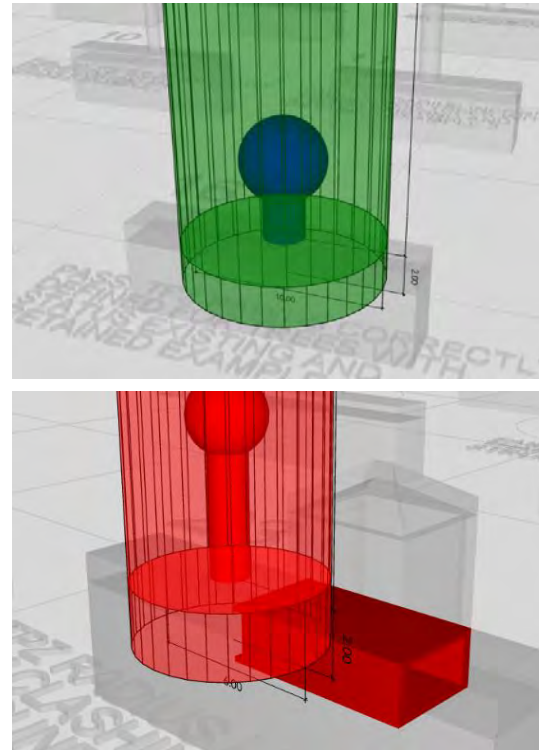
Collision Check with Generated Radius



Minimum Protection Zone from the Centre of a Tree

Girth (m)	Minimum Protection Zone
≤1.0m	2.0m
>1.0m but ≤1.5m	3.0m
>1.5m but ≤2.0m	4.0m
>2.0m	5.0m

Source: <https://www.nparks.gov.sg/-/media/nparks-real-content/partners-us/developers-architects-and-engineers/gdp-handbook-aug-2018.pdf>



- The set-back on Tree Protection Zone (TPZ) is based on the Girth size of the Tree.
- Permanent Structures that are not allowed to be built within the TPZ.
- New trees cannot be planted nearby existing or proposed permanent structures.
- Other Application: Heritage Tree

Cylinder is generated based on girth of tree. The TPZ is then checked for clashes.

# Tree Protection Zone

## Collision Check with Generated Radius

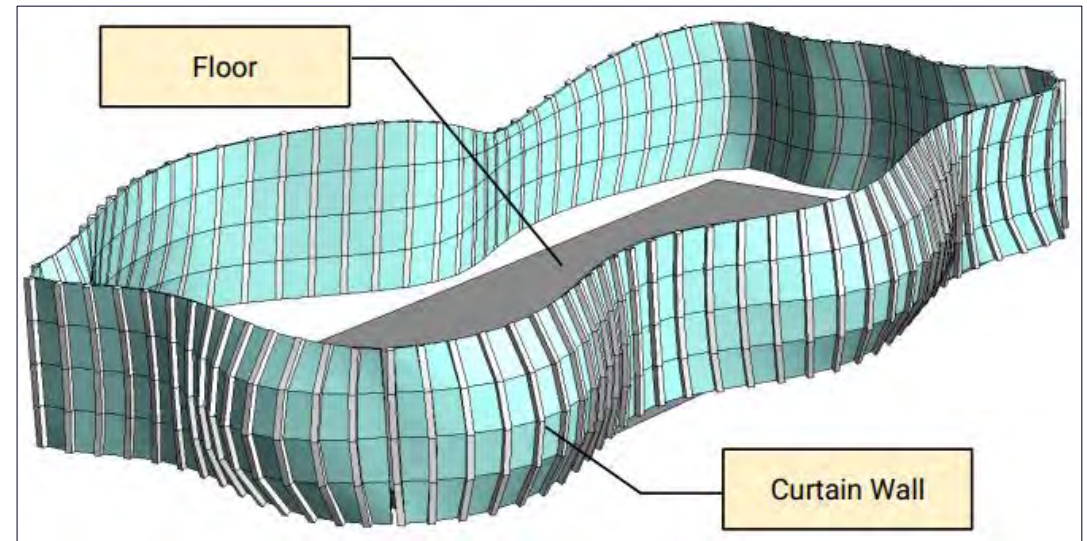
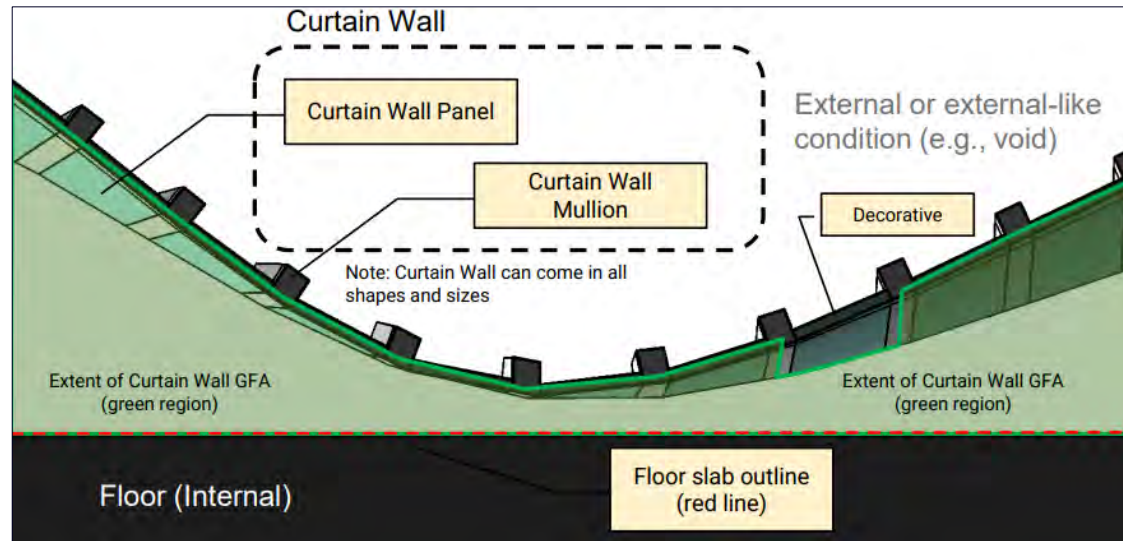
The screenshot displays a software interface for a Tree Protection Zone (TPZ) collision check. The main window shows a 3D model of a site with a tree protection zone highlighted in green. A 'Model Checker' dialog box is open, showing settings for the 'Tree Protection Zone' rule. The dialog includes a 'Requirement' section with a dropdown menu set to 'Yes', and a 'Description' section with a dropdown menu set to 'Hide'. The dialog also has a 'Reset' button and 'Cancel' and 'Save' buttons.

Below the dialog, a table displays the results of the collision check. The table has columns for Agency, Clause, AltExternalId, Report, ElementName, IssueType, ProductType, and Requirement. The table shows three rows of results, all for the 'Tree Protection Zone' rule.

Agency	Clause	AltExternalId	Report	ElementName	IssueType	ProductType	Requirement
NPARKS	Tree Protection Zone	3Y7drBP1f1jTh6ZngSaSa	Tree 015 TPZ is Pass; Tree 015 - No clash detected	LANDSCAPE_TREE_TPZ 6 LANDSCAPE_TREE.395715	Pass	Geographic Element	Depending on both the crown and root spread, a larger tree protection zone may be required as de
NPARKS	Tree Protection Zone	3Y7drBP1f1jTh6ZngSa6	Tree 016 TPZ is Pass; Tree 016 - Clash detected	LANDSCAPE_TREE_TPZ 6 LANDSCAPE_TREE.396705	Error	Geographic Element	Depending on both the crown and root spread, a larger tree protection zone may be required as de
NPARKS	Tree Protection Zone	3Y7drBP1f1jTh6ZngSaWX	Tree 017 TPZ is Pass; Tree 017 - No clash detected	LANDSCAPE_TREE_TPZ 6 LANDSCAPE_TREE.396805	Pass	Geographic Element	Depending on both the crown and root spread, a larger tree protection zone may be required as de

Page 1 of 1 (25 items)



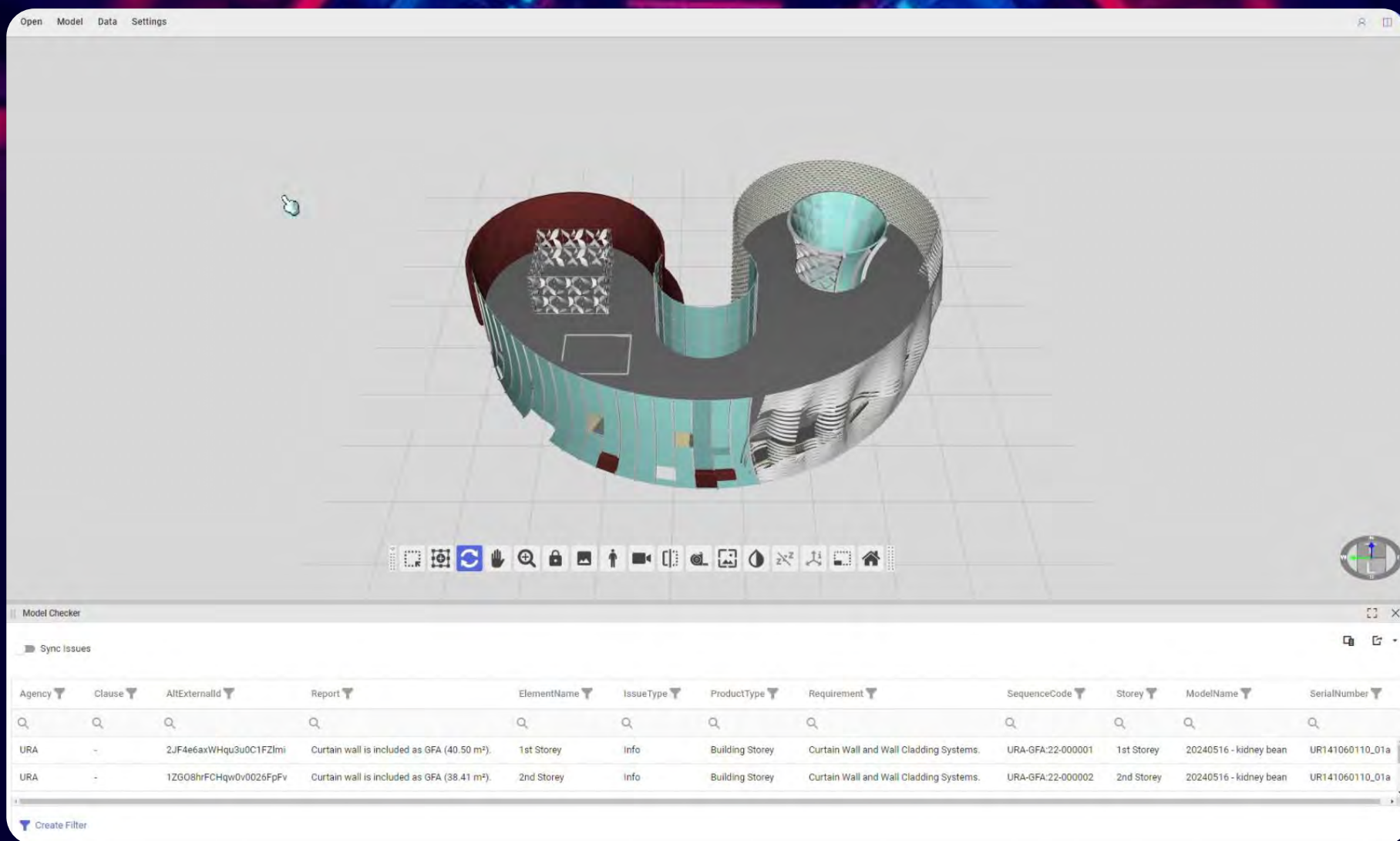


Curtain Walls are included as GFA – area between floor slab outline and centerline of vertical façade element.

Finding the region formed by the floor slab outline and the centre of the Curtain Wall's outermost vertical facade element by generating medial axis.



# GFA Curtain Wall



### Location

Balconies shall be located away from M&E areas

### Openness

Continuous perimeter opening of at least 40%

### Size

Capped at 15% of the internal nett dwelling unit size

### Width

minimum width of 1.5m as measured from the external building wall

### Access

Balconies with exclusive access from the kitchen/yard/utility space are treated as service balconies

### Screens

Balconies shall not be enclosed with walls or glass panels

To include balcony's area as GFA, the balcony designs shall adhere to certain guidelines and submission requirements.

OpenModelDataSettingsDeveloper

Result Detail

Rule Details

AgencyURA

Clause2(b)

RequirementThe balcony must be unenclosed.

DescriptionThe ratio between the balcony outline unobstructed over the balcony outline must be 50.00 % and this is 36.47 %.

Area

AltExternalid3KMhaod9jBURXR3G6YZKBz

Storey12th Storey

ProductTypeSpace

Properties

Filter...

Unit: MillimetresProperties: 29

Properties

NameFloor:Flr 175:3352957

LayerA-FLOR

TypeFloor:Flr 175

Predefined TypeFLOOR

Object TypeFloor:Flr 175

External EntityIfcSlab

Model Name20240116\_MC.5  
Derbyshire Rd\_Balcony  
Level 12

External Id15841

Model Checker

Sync Issues

Agency	Clause	AltExternalid	Report	ElementName	IssueType	ProductType	Rec
URA	2(b)	3KMhaod9jBURXR3G6YZKBz	The ratio between the balcony outline unobstructed over the balcony outline must be 50.00 % and this is 31.43 %.	Area	Pass	Space	The
URA	2(b)	3KMhaod9jBURXR3G6YZKBp	The ratio between the balcony outline unobstructed over the balcony outline must be 50.00 % and this is 90.43 %.	Area	Pass	Space	The
URA	2(b)	3KMhaod9jBURXR3G6YZKBz	The ratio between the balcony outline unobstructed over the balcony outline must be 50.00 % and this is 36.47 %.	Area	Error	Space	The

☒ [Clause] Equals '2(b)'

FULCRUMHQ

LEAPTHOUGHT



# Residential Envelope Transmittance Value

## Computational Analysis

1

### Identifying Relevant Areas

non-basement blocks  
living areas vs non-living areas

2

### Determining External Facade

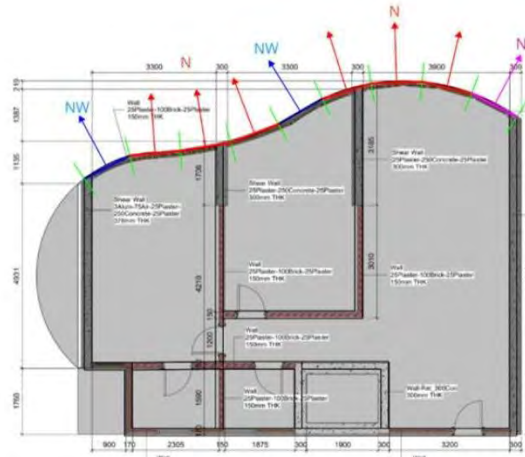
Checking that walls are not abutting any  
IfcSpaces

Walls abutting IfcSpace:Airwell or  
Abutting spaces are naturally ventilated  
and width of space < storey height



# Residential Envelope Transmittance Value

## Computational Analysis



1

### Identifying Relevant Areas

non-basement blocks  
living areas vs non-living areas

2

### Determining External Facade

Checking that walls are not abutting any  
IfcSpaces

Walls abutting IfcSpace:Airwell or  
Abutting spaces are naturally ventilated  
and width of space < storey height

3

### Determining Orientation of Walls and Fenestrations

Using surface normal to categorise  
facades into one of 8 directions(N, NE, E,  
SE, S, SW, W, NW)

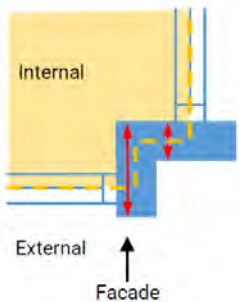
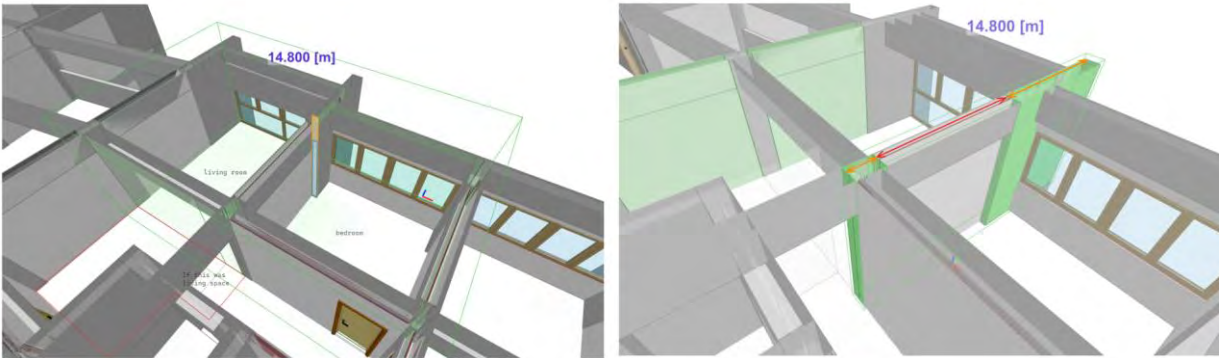
# Residential Envelope Transmittance Value

## Computational Analysis

4

### For Each Orientation

- Compute U values for Walls and Fenestration
  - Assigning default values for elements without material property
  - Compute area of Walls and Fenestration
- Calculate RETV for single direction





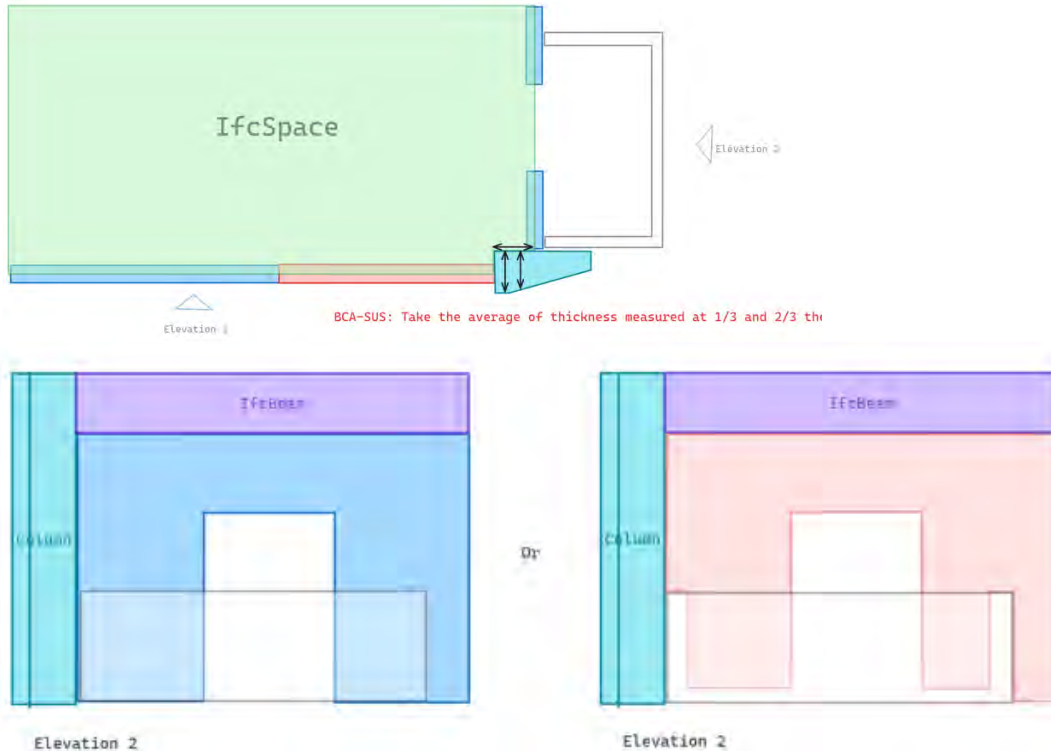
# Residential Envelope Transmittance Value

## Computational Analysis

4

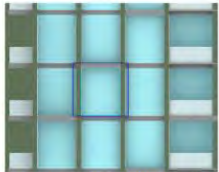
### For Each Orientation

- Compute U values for Walls and Fenestration
  - Assigning default values for elements without material property
  - Compute area of Walls and Fenestration
- Calculate RETV for single direction

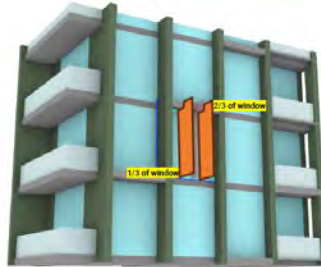


# Residential Envelope Transmittance Value

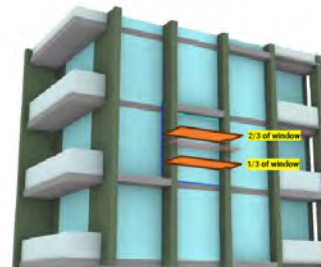
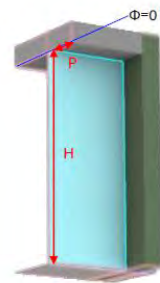
## Computational Analysis



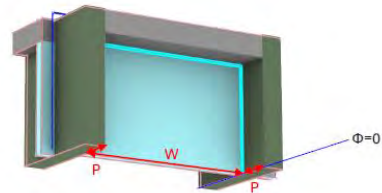
Blue rectangle denotes boundary offset from window that will be analyzed for shading device.



Vertical clipping plane (red) to assess horizontal projections.



Horizontal clipping plane (red) to assess vertical projections.



4

### For Each Orientation

- Compute U values for Walls and Fenestration
- Assigning default values for elements without material property
- Compute area of Walls and Fenestration
- Calculate RETV for single direction

5

### Compute Overall RETV of Development

## BIM Quality Checks

8

Number of  
Models  
Federated

5276

Number of  
Elements  
Checked

21,104

Number of Results  
from QC 1 to 5

Geo-referencing of  
Federated Models



Naming Convention  
of Spaces



Clash Detection



Presence of  
Mandatory  
Information



■ Non-Compliant  
■ Warning  
■ Pass

## Regulatory Compliance Checks

150

Number of  
Compliance  
Rules

369,320

Total Number of  
Results

153,304

Total Number of Pass  
Results

114,969

Total Number of Non-  
Compliant Results

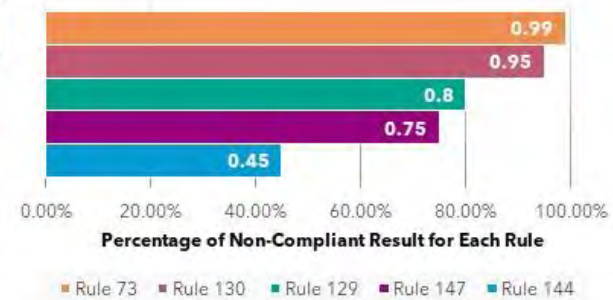
■ Non-Compliant  
■ Warning  
■ Pass  
■ Info



### Compliance Rules

(Ranked by highest to lowest percentages of Non-Compliant Results)

Rank	Rule Number	Agency & Requirement
1	73	SCDF - FEA Access to Façade
2	130	BCA - Natural Ventilation
3	129	BCA - RETV
4	147	SCDF - Travel Distance
5	144	NEA - Refuse Handling Capacity







# LEAPTHOUGHT



All content from this presentation are protected by copyright and may not be reproduced or appropriated in any manner without the written permission of LeapThought