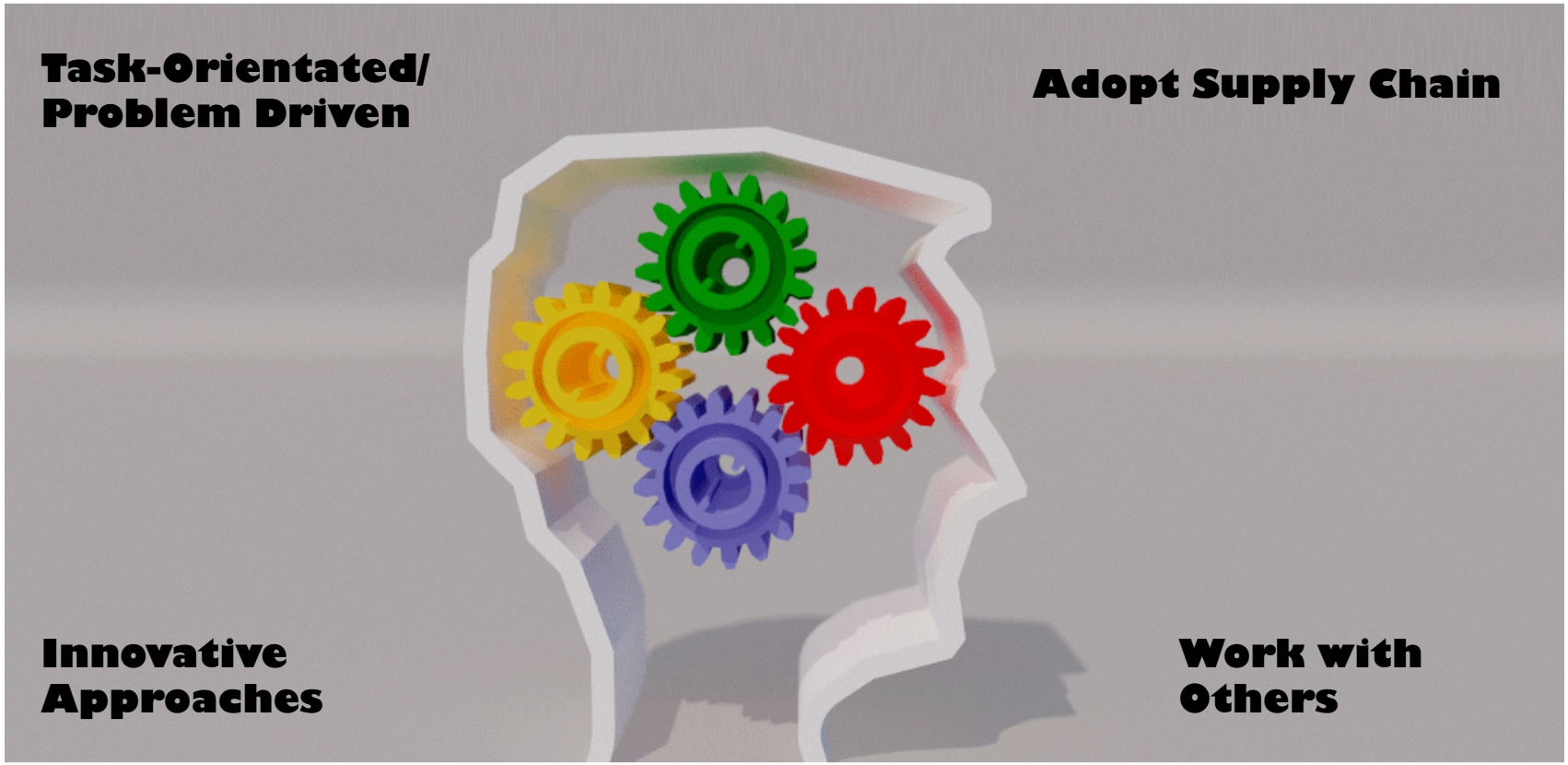
Integrated Digital Delivery – Diversified BIM
Building a Multi-dimensional User-hub

Source: Autodesk BIM360 and Gammon projects - 30 May 2019

Industry-wide Strategy

- Co-creative
- Create better solutions



BIM & Engineering

Task-Orientated/ Problem Driven

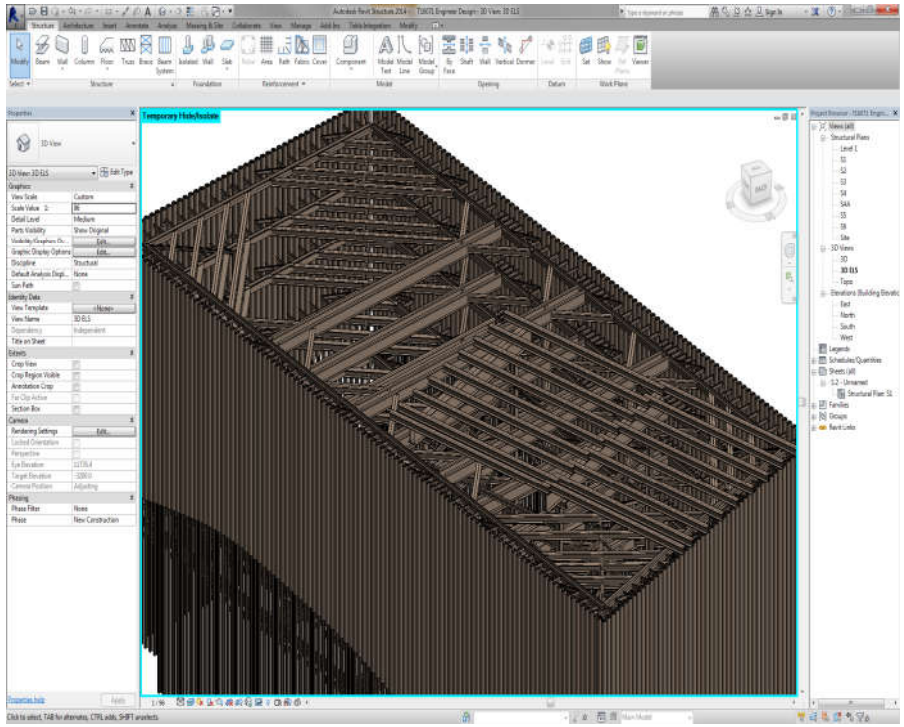
Adopt Supply Chain

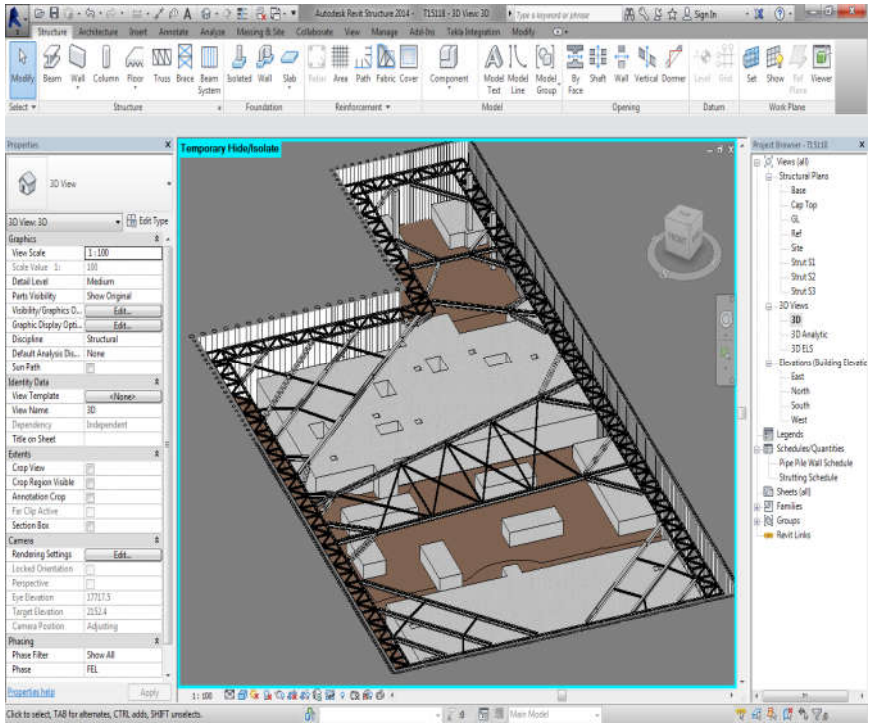
Innovative Approaches

Work with Others

BIM in Design

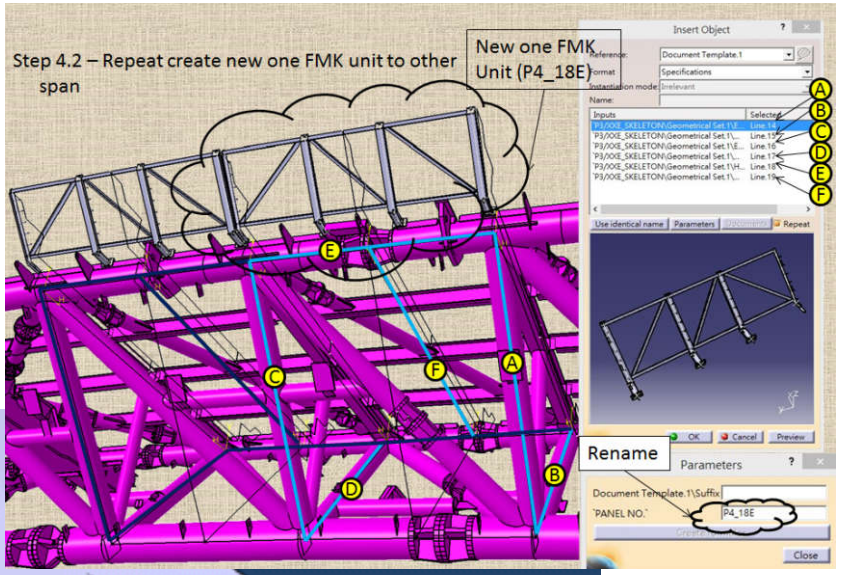
- Stable design workflow for
  - ELS design
  - Piling and Pile Cap design
- Constantly collect design information and set up BIM model in semi-automatic way

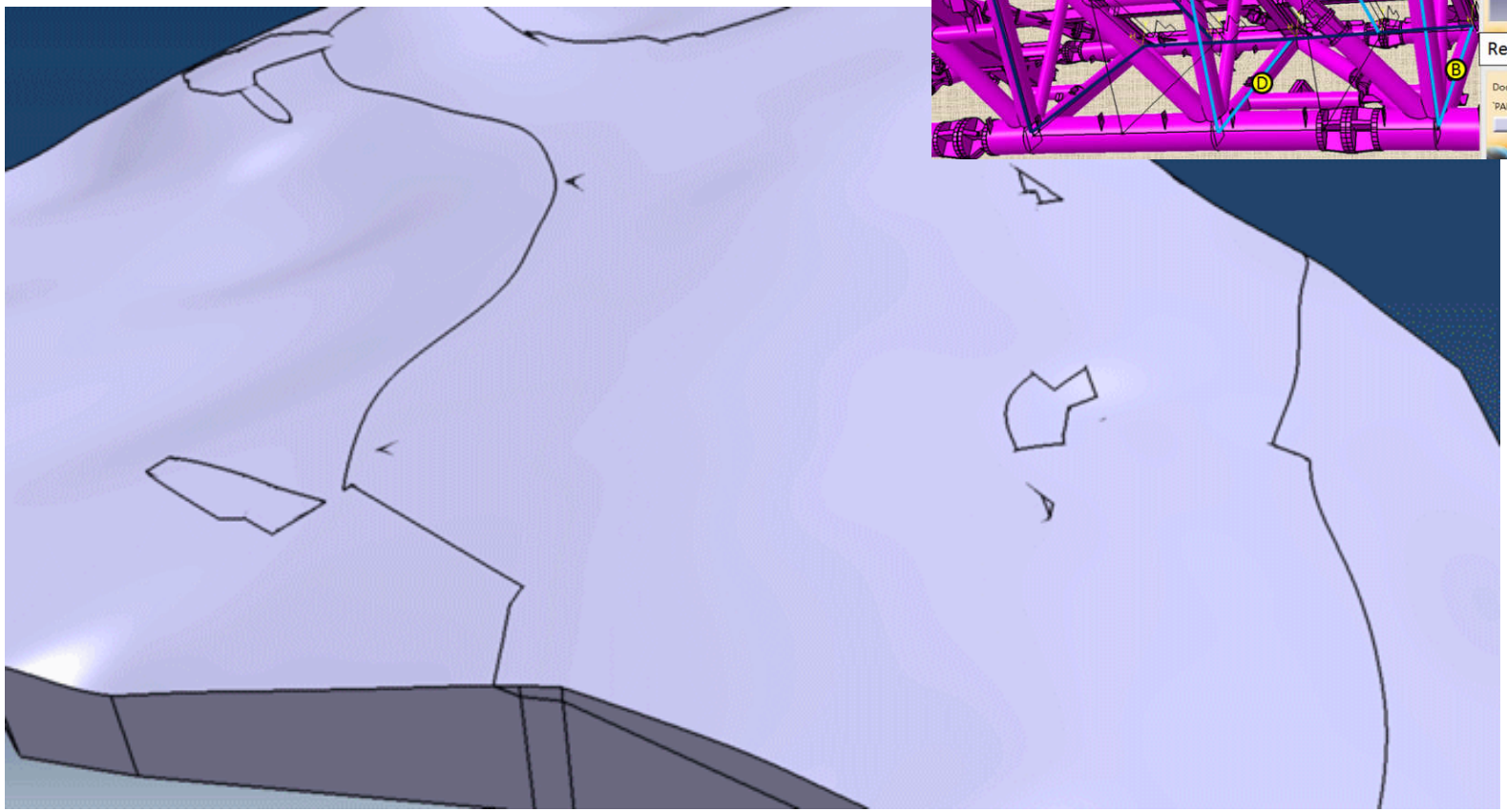




BIM in Design

- Site Formation
- Topological Verifications
- Falsework Design





BIM & Planning

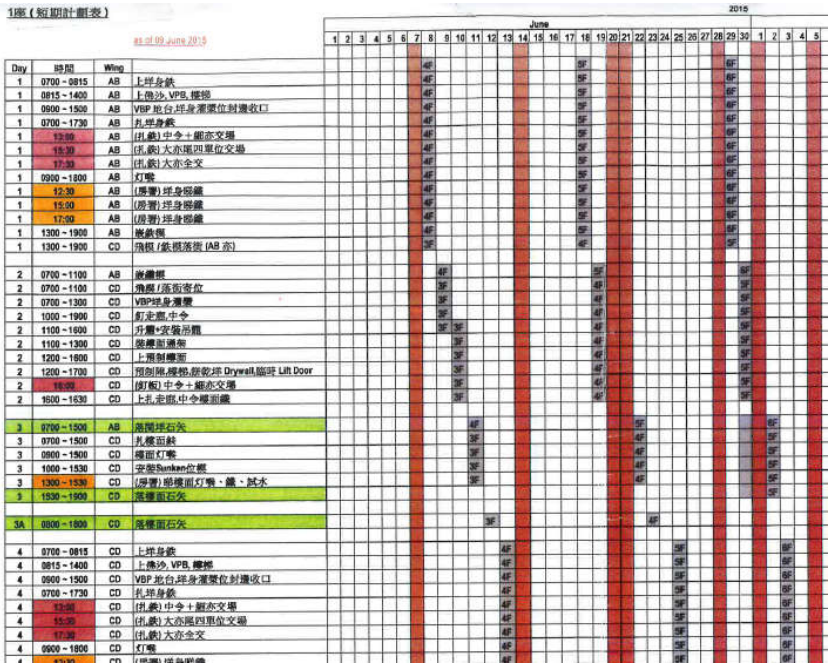
Task-Orientated/ Problem Driven

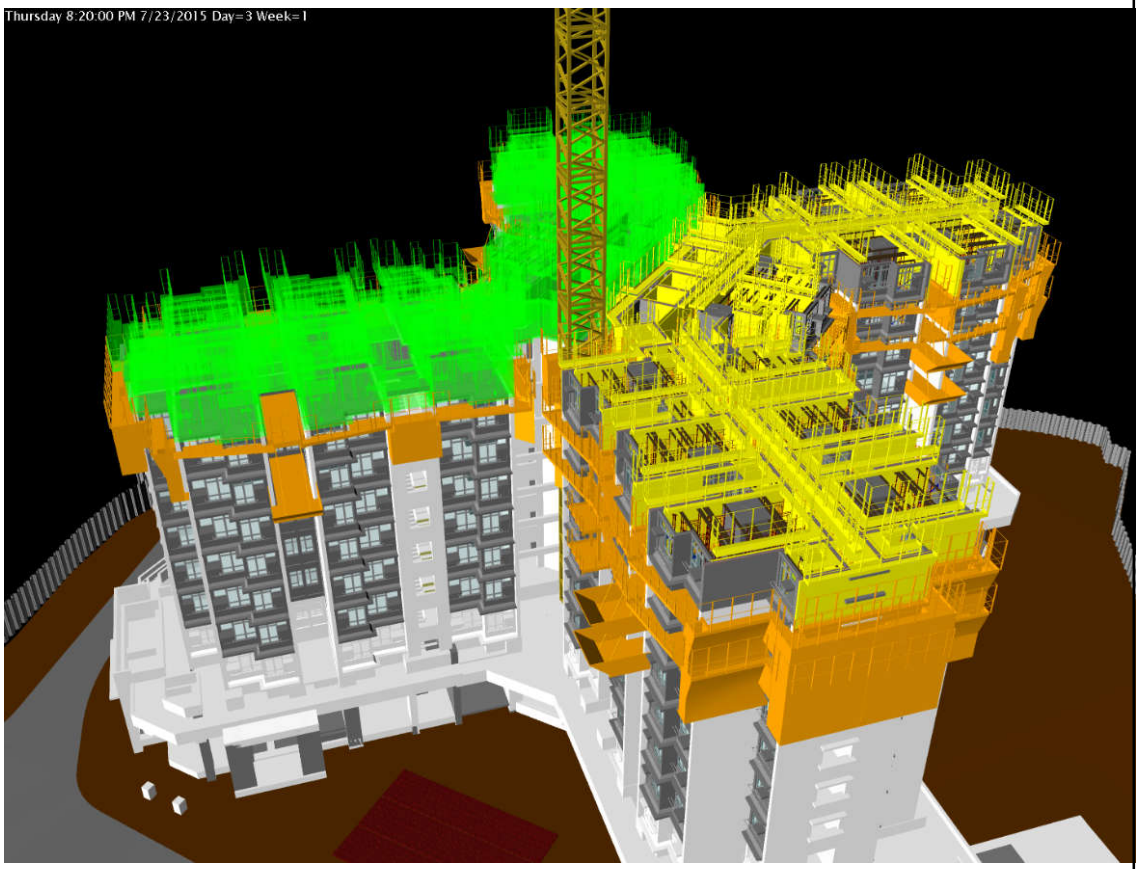
Adopt Supply Chain

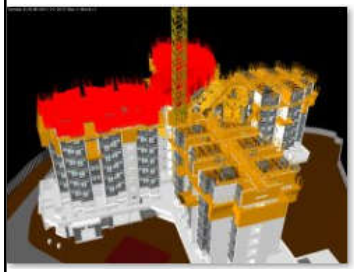
Innovative Approaches

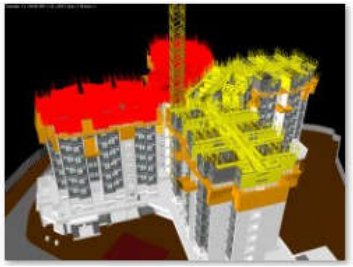
Work with Others

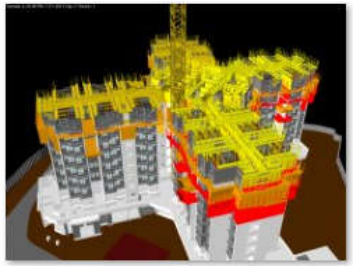
Precast Highrise Construction

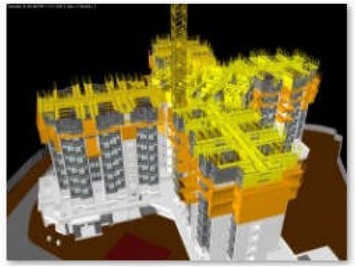


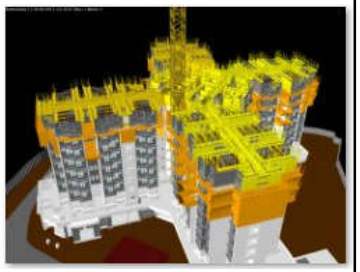




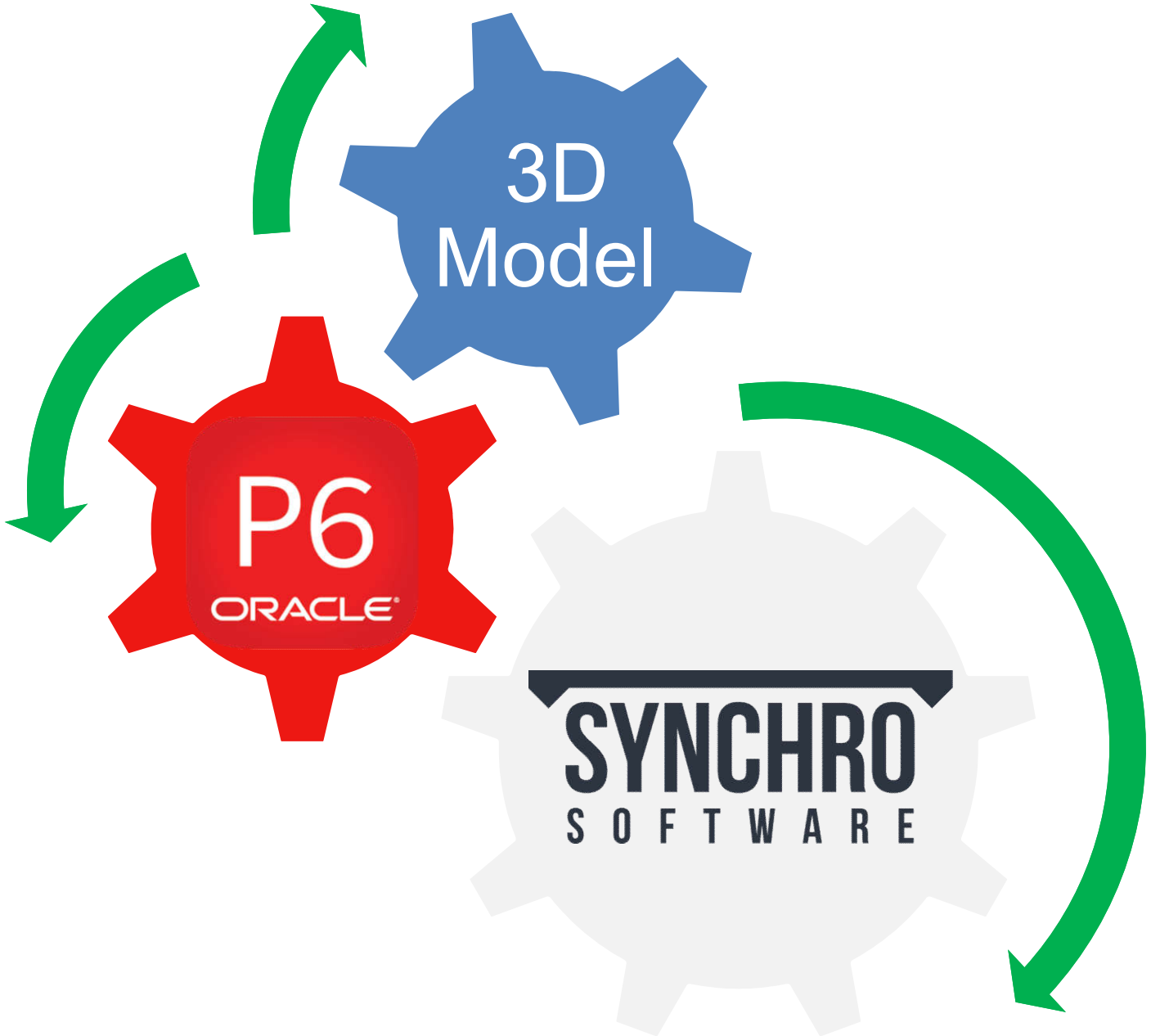




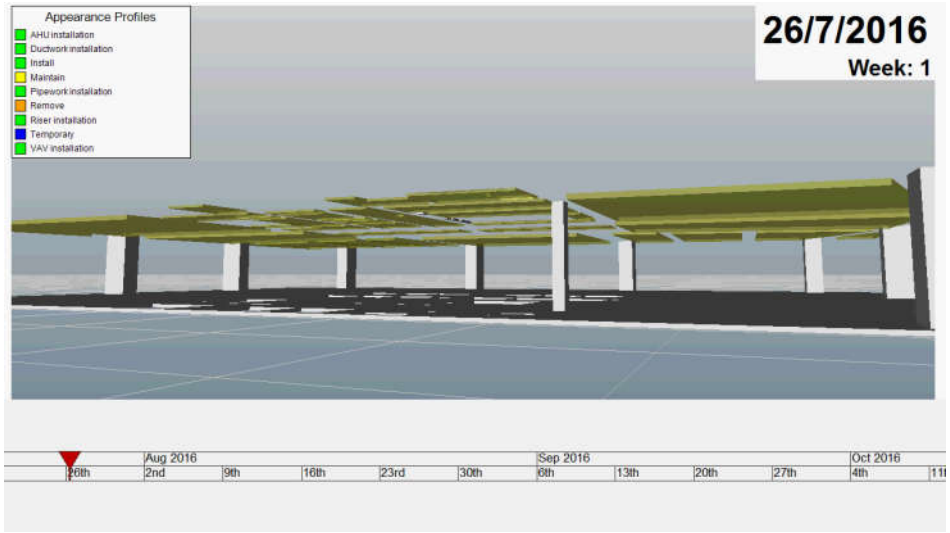


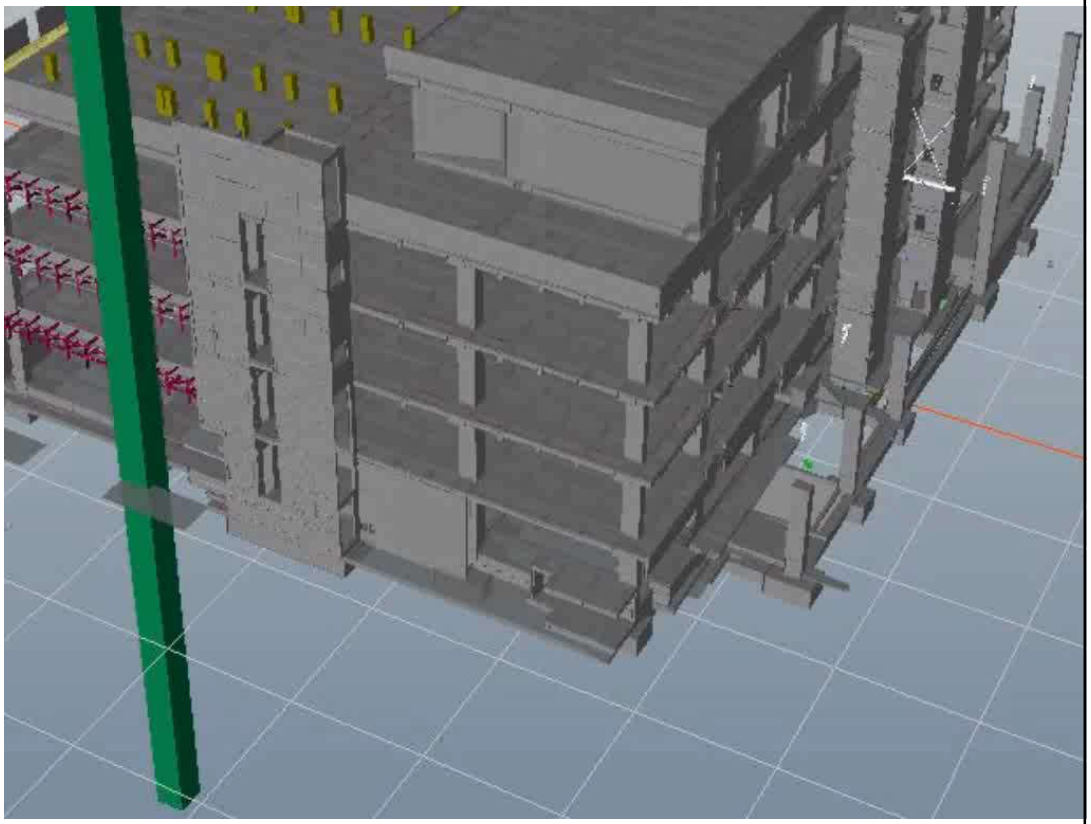


4D BIM
Time



4D BIM – E&M Planning





BIM & Surveying

Task-Orientated/ Problem Driven

Adopt Supply Chain

Innovative Approaches

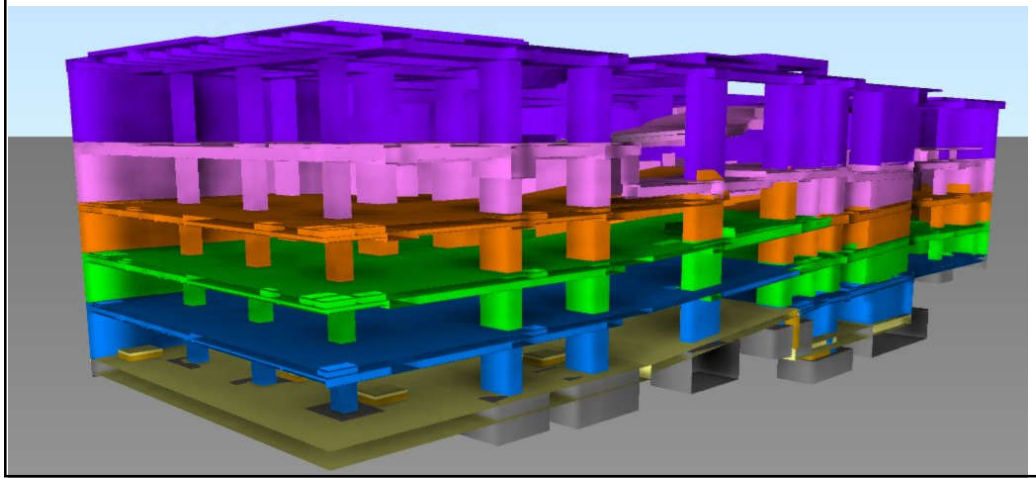
Work with Others

Trial Project – Office development

☑ BIM Model Ready.

☑ Modification of BIM Model to align with Simpler SMM Rules (GSMM).

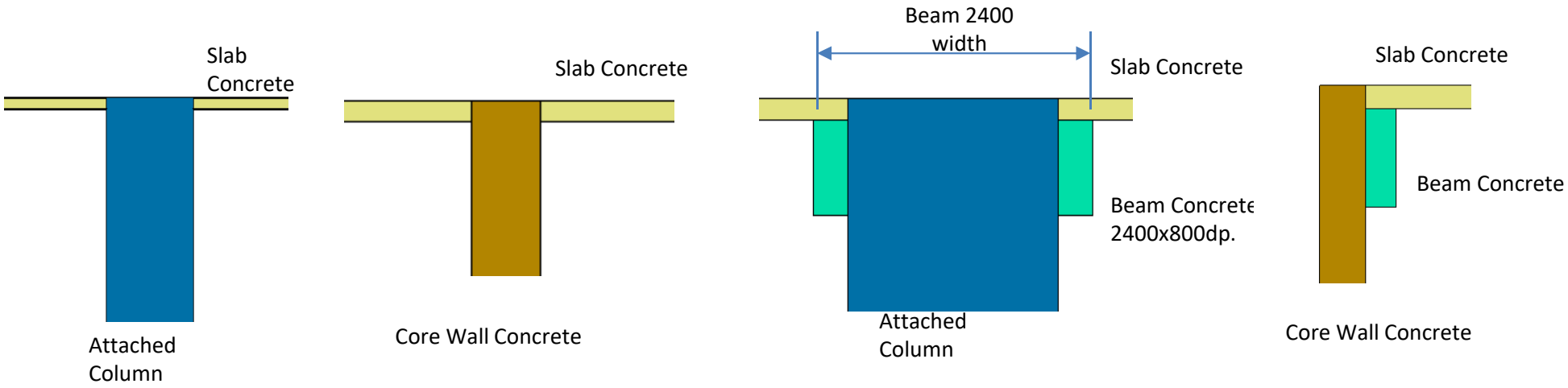
☑ Start the 1st level information BIM taking off.



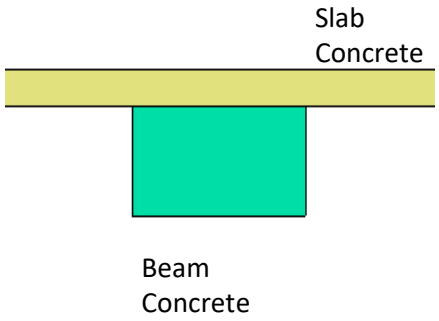
Sample BIM Concrete Measure Simple Rules - Level 1

Superstructure BIM modeling role : Column & Core Wall > Slab> Beam

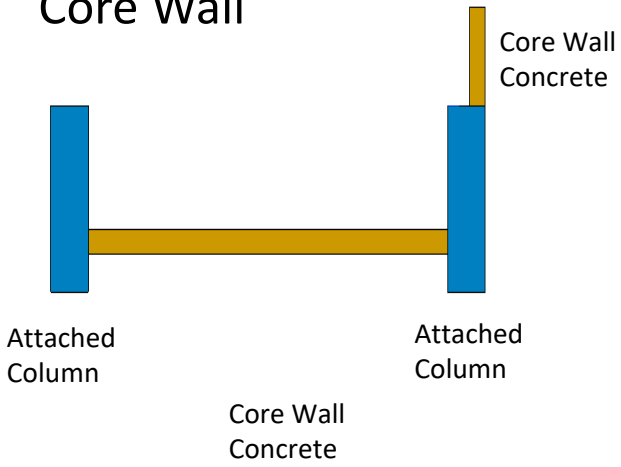
Rule 1 – Column/ Core Wall Across Slab/ Beam



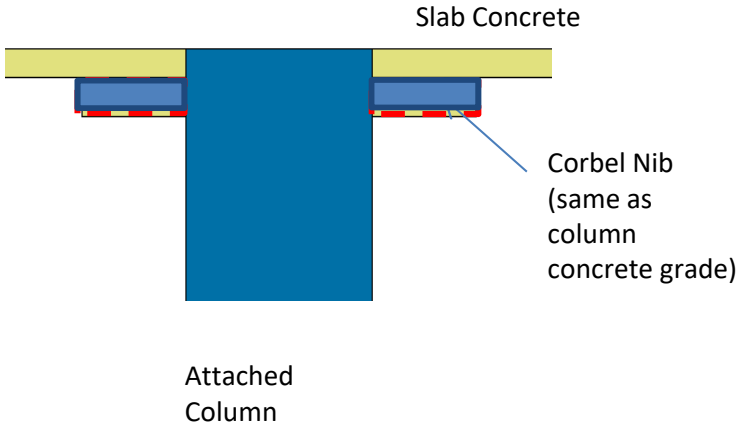
Rule 2 – Slab Across Beam



Rule 3 – Column Across Core Wall

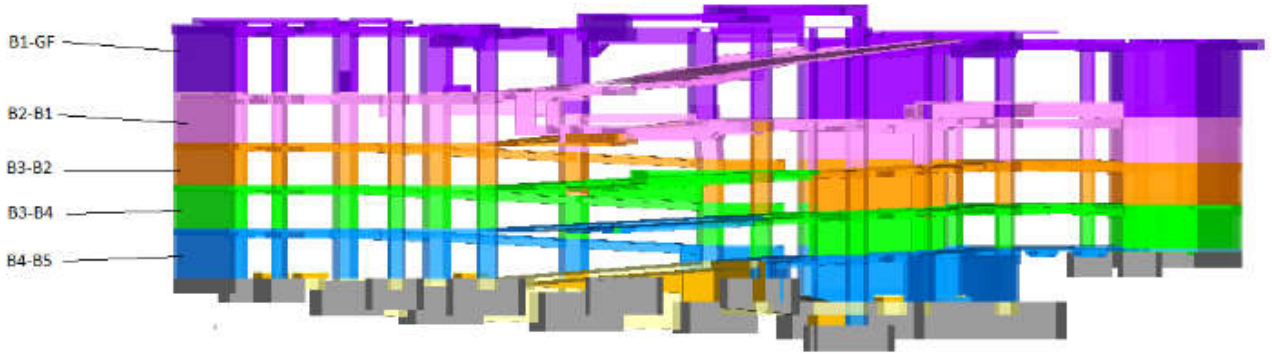


Rule 4 – Corbel Follow Column



BIM Measure Results – BasementLevel (Below Ground Level)

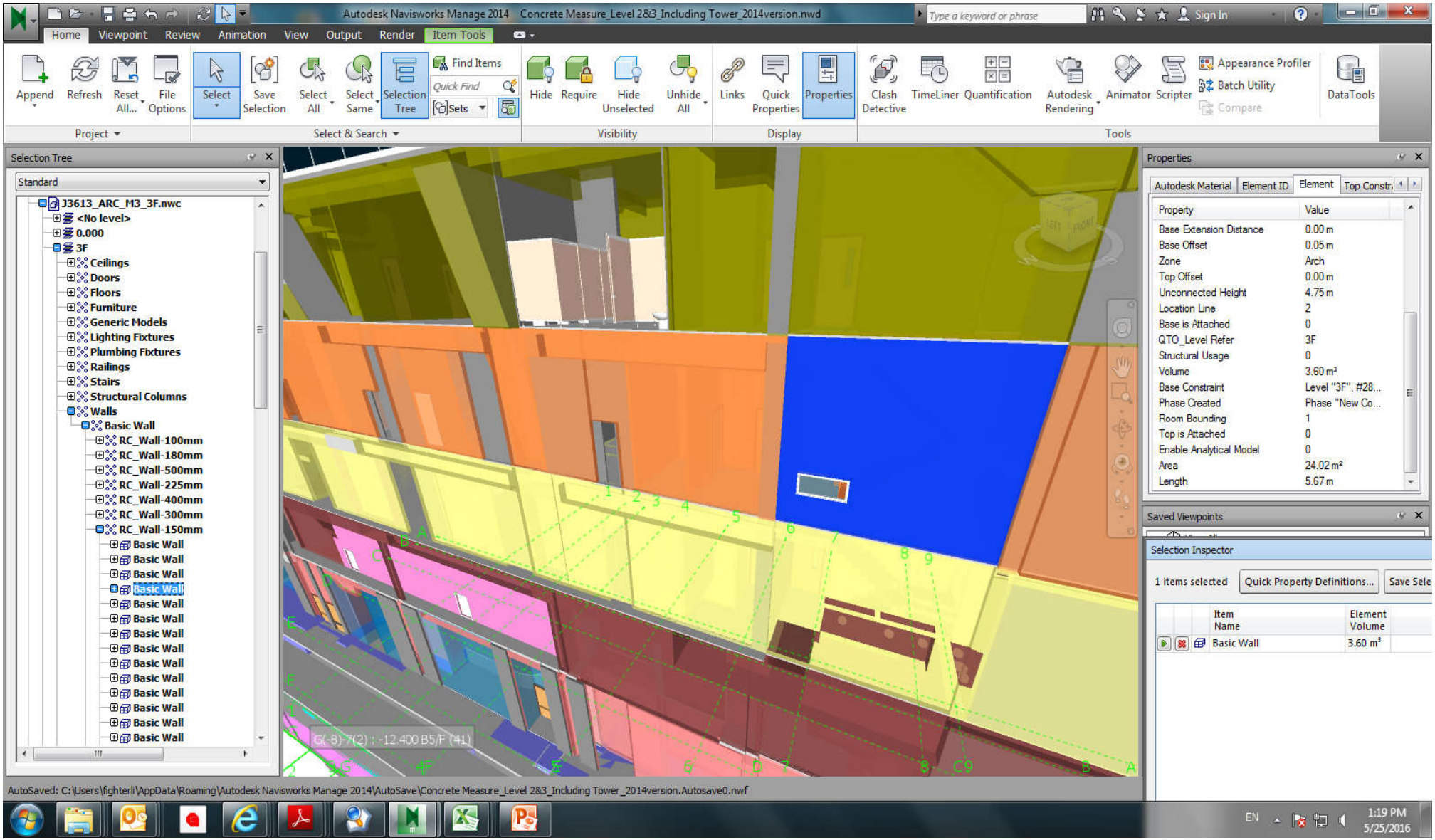
Row Labels	Length	Width	Thickness	Height	Perimeter	Area	Volume	Weight	Count	PrimaryQuant
⊟B1-GF										
C20	0	0	2.24	0	343.2824804	743.763591	267.124846	0	7	
C45	1343.213554	162.08	3.025	68.44178057	1155.317166	2698.927956	1458.349157	0	199	
C60	172.5398449	39.75	0	21.05	0	141.1433812	575.9000665	0	27	
⊟B2-B1										
C20	0	1	0.3	0	0	0	0	0	1	
C45	1478.163155	188.54	7.825	100.5272323	1574.541057	3180.0322	1639.797755	0	311	
C60	98.25819674	30.35	0	10.5	0	75.8476547	342.4142072	0	25	
⊟B3-B2										
C20	0	0	0.07	0	7.498287815	3.21188691	0.224832084	0	2	
C45	1006.060373	137.24	4.155	76.19566631	1029.809135	2375.550432	1020.493071	0	195	
C60	110.2318656	37.45	0.25	11.61	11.89103793	86.99505762	379.4798851	0	28	
⊟B4-B3										
C20	0	1	0.76	0	40.76586631	20.91574669	2.115806861	0	5	
C45	1080.58009	150.9	5.75	96.34378943	1072.552288	2661.066599	1181.997928	0	221	
C60	106.2758729	37.45	0.25	9.25	11.89103793	84.10521077	353.4482672	0	28	
⊟B4-B4										
C20	0	1	4.355	0	57.57228908	38.87211129	105.0639591	0	5	
C45	941.9269308	120.03	4.975	121.9051889	1181.337414	3360.488719	1362.530059	0	188	
C60	103.907204	32.65	0	11.28	0	77.00506878	388.7645118	0	23	



All Data | Resources Raw | Resources Pivot Table | Items Raw | Items Pivot Table | Groups Raw | Groups Pivot Table

Use of Navisworks to Obtain the Quantity

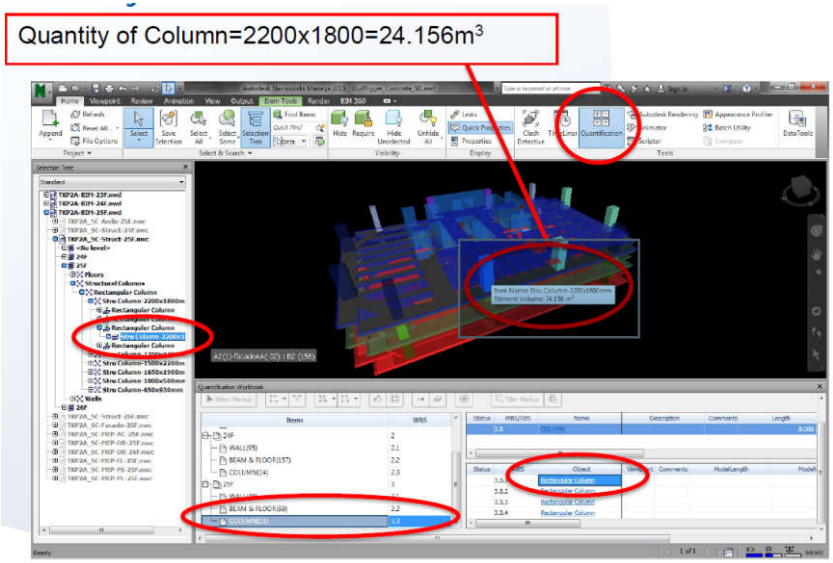
- Use the Navisworks to check the module and obtain the quantity in 3D view



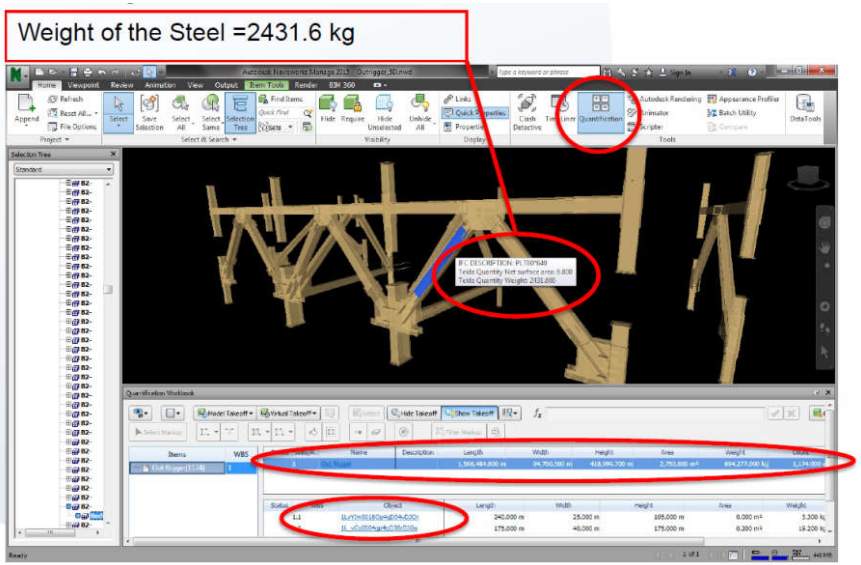
Applications

- Ordering of Concrete
- Wastage Control (Consumption Projection)
- Operational Planning (Concrete Pour Qty)
- Check BQ Errors

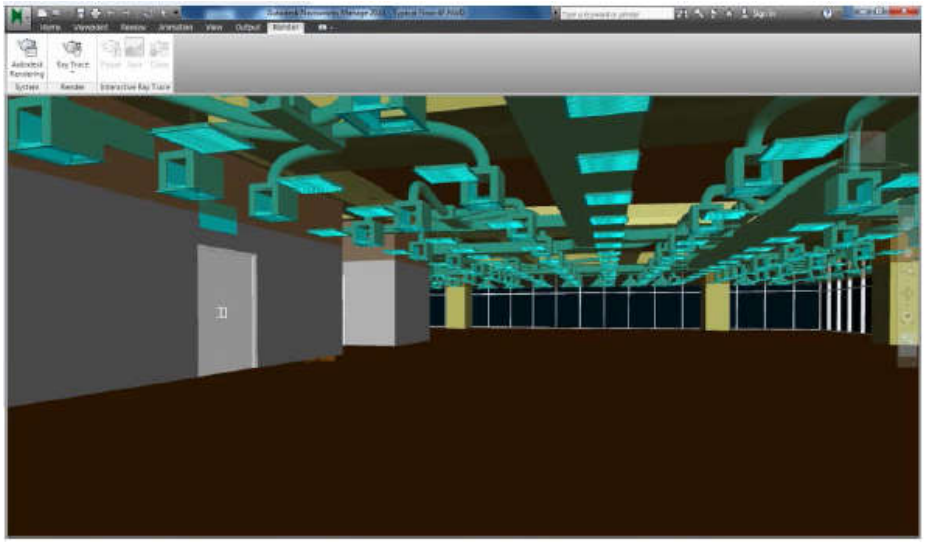
BIM for Quantification



Building 5thD Pilot – RC



Building 5thD Pilot – Structural Steel



Building 5thD Pilot – M&E Fittings and Equipments

Type	Size	Count
VAV BOX	1460X400	59
AHU(04-01)	2250X2580	1
AHU(04-02)	2250X2580	1

Diameter	Length
200 mm	580.08 mm

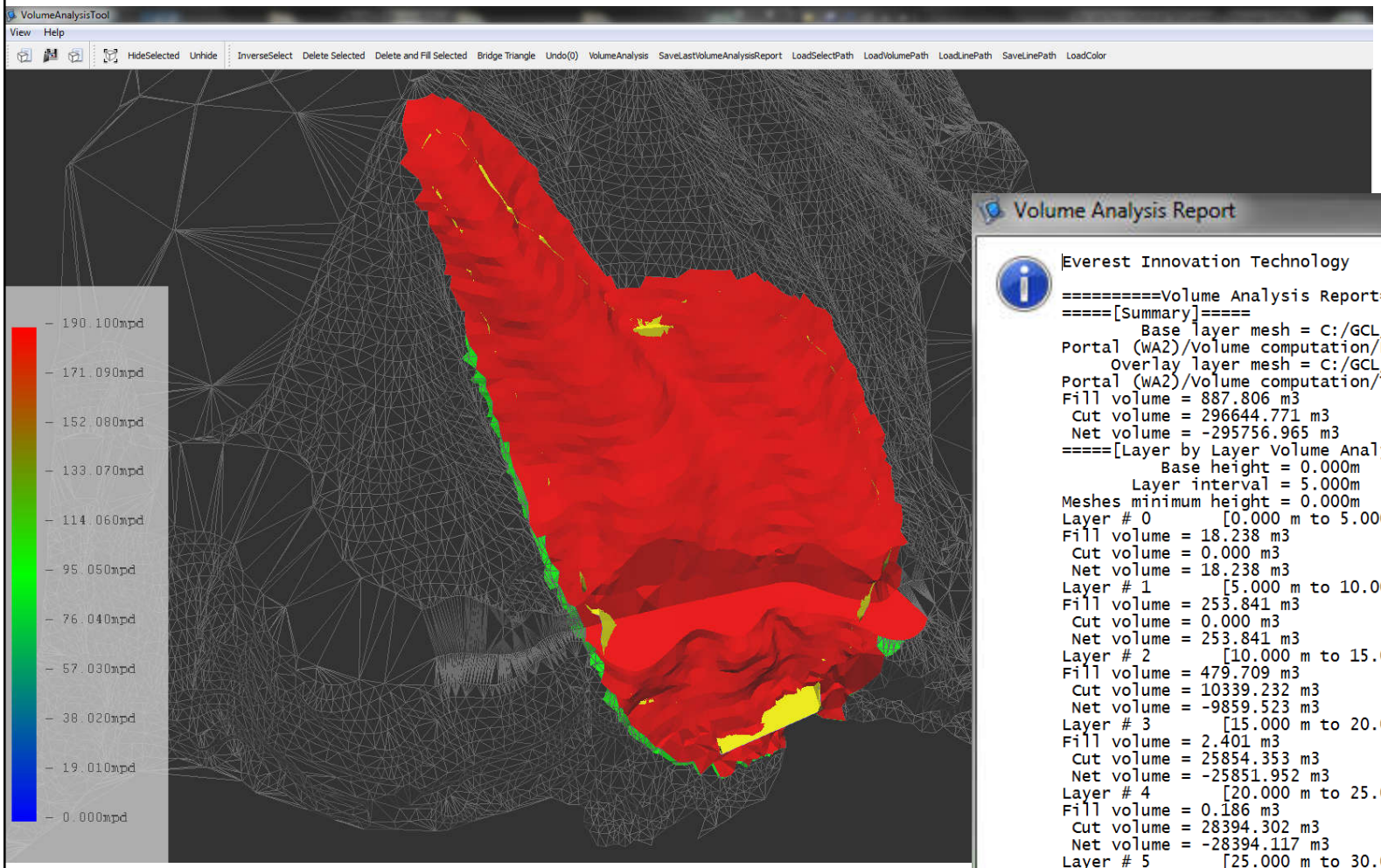
Type	Size	Type Name	Count
115X1200 SAG	1200X115	SAG	79
400X200 SAG	400X200	SAG	8
450X300-EAG	450X300	EAG	1

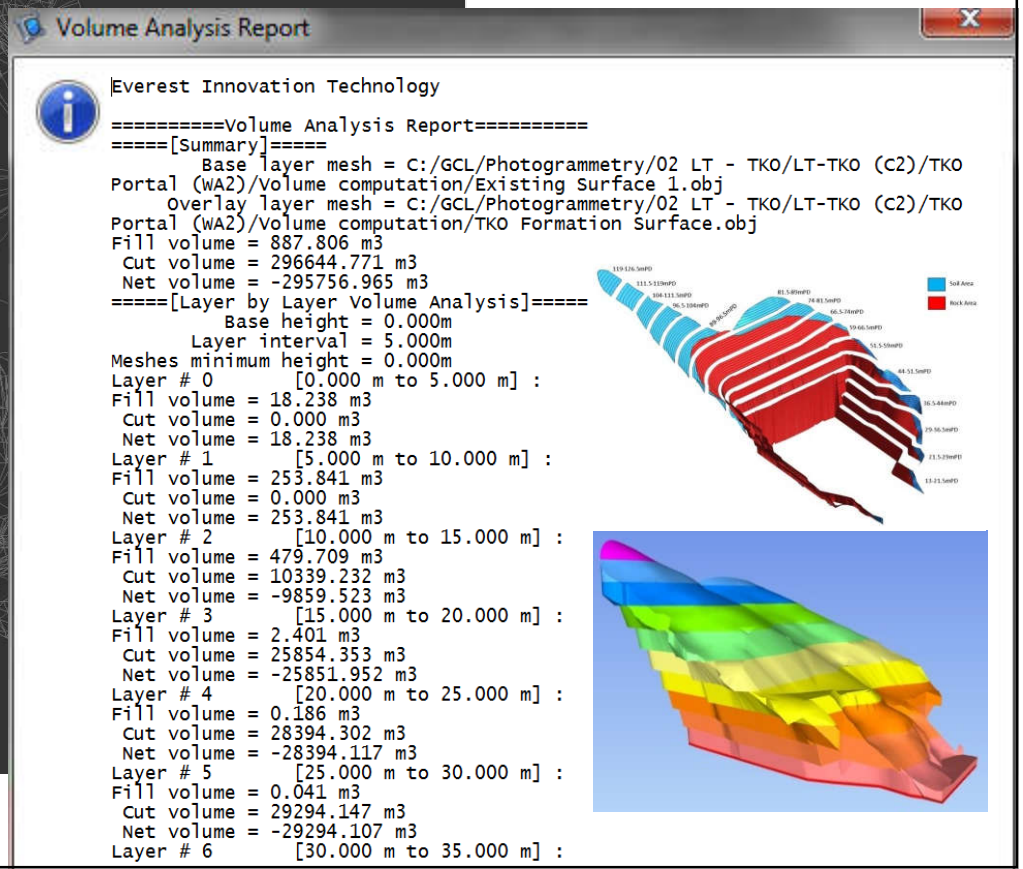
Type	Size	Count
1100x350 Silencer	1100 mmx350 mm-1100 mmx350 mm	1
1250x400 Silencer	1250 mmx400 mm-1250 mmx400 mm	1
F.D	150 mmx150 mm-150 mmx150 mm	1
F.D	450 mmx300 mm-450 mmx300 mm	2

Duct Type	Width	Height	Depth	Area
SAD	345 mm	200 mm	0.6 mm	0.9
SAD	345 mm	200 mm	0.6 mm	2.92
SAD	345 mm	200 mm	0.6 mm	0.89
SAD	345 mm	200 mm	0.6 mm	0.95

Volumetric Computation
Cut & Fill Quantity Automation

1) Compare 2 models for volumetric computation
2) Custom setup depth interval (e.g. 5m) for layer to layer computation





BIM & Operation

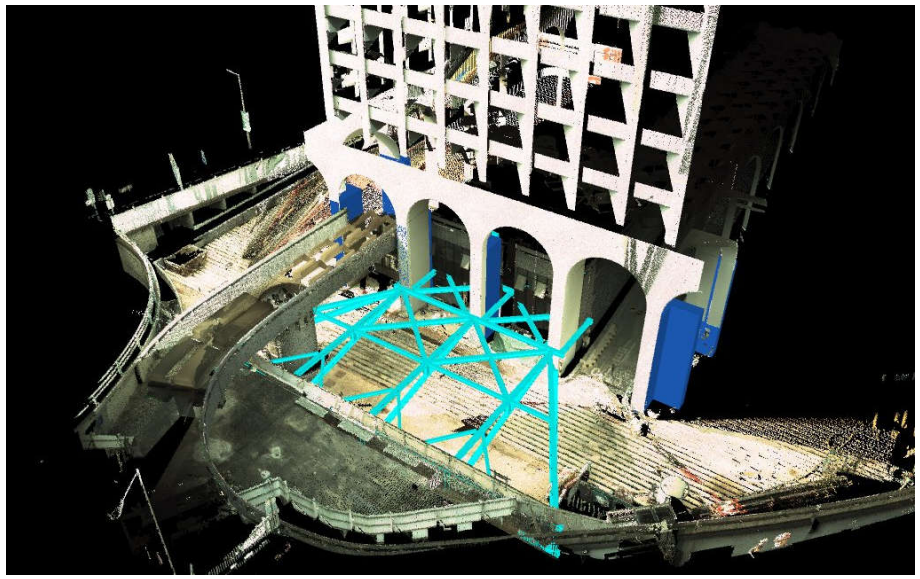
Task-Orientated/ Problem Driven

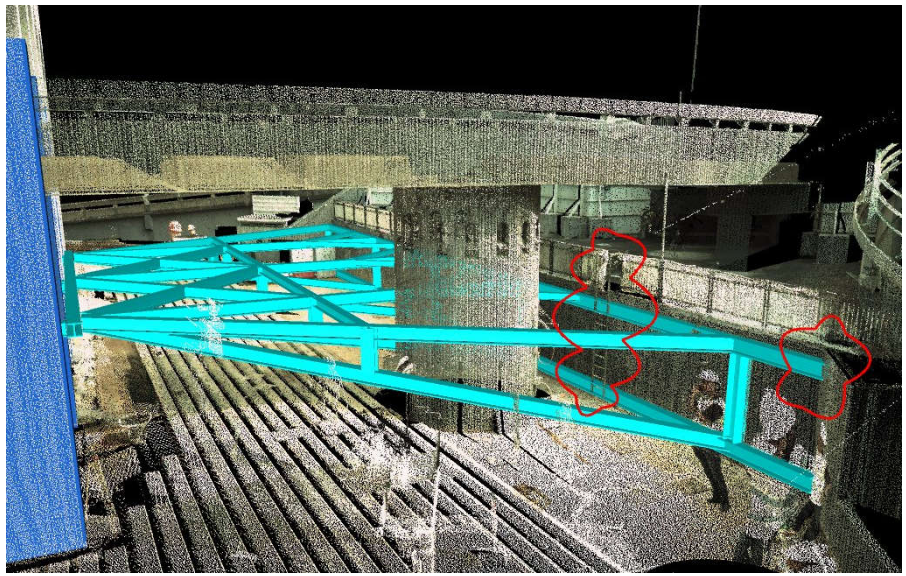
Adopt Supply Chain

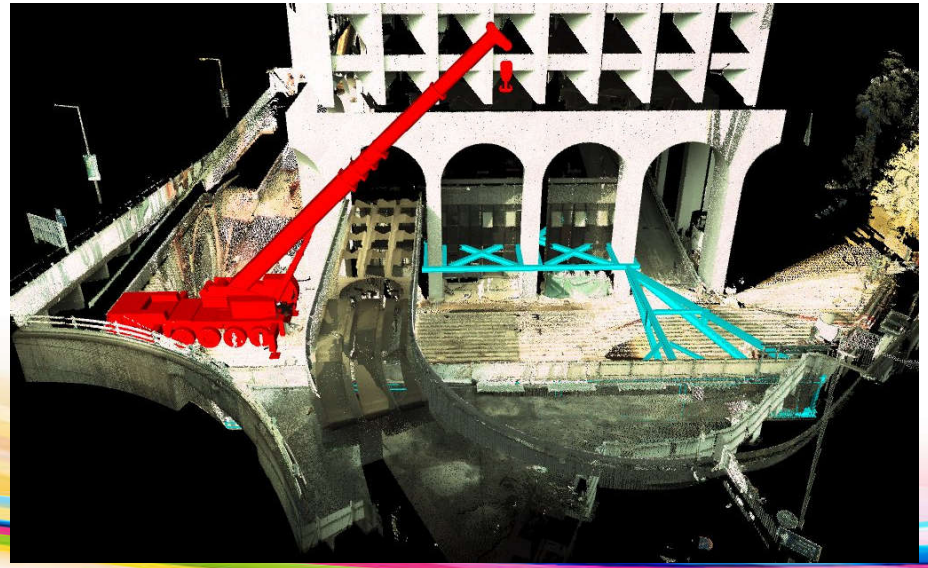
Innovative Approaches

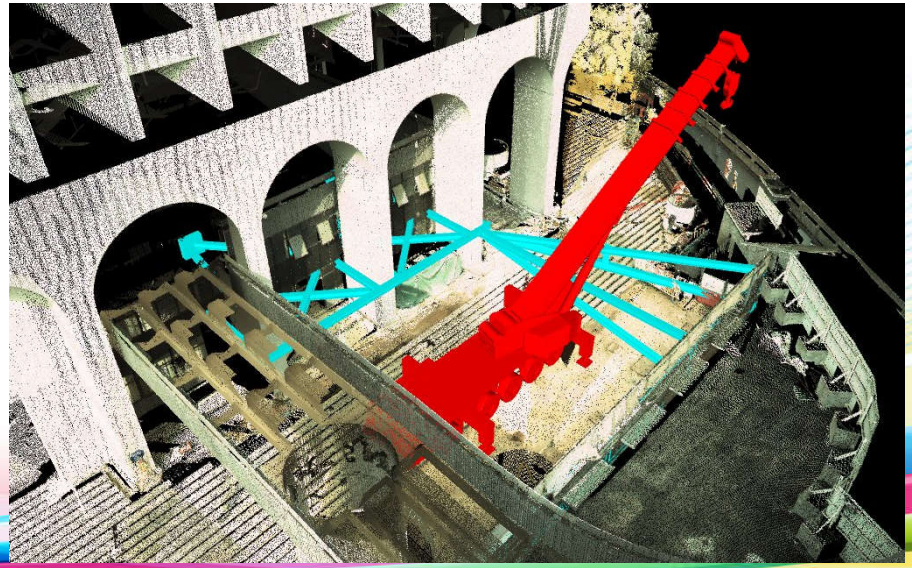
Work with Others

Site Planning for Alteration Works

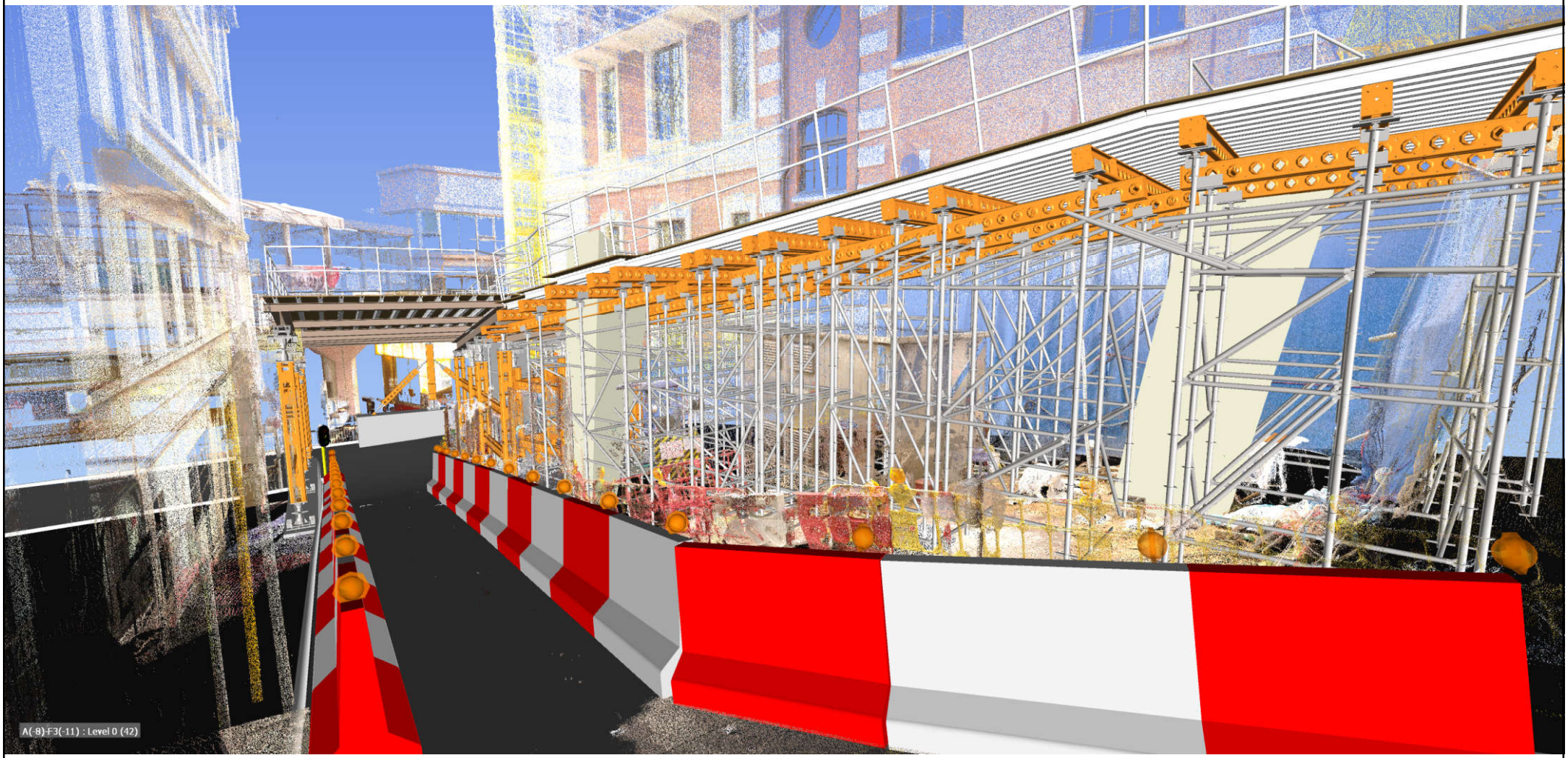




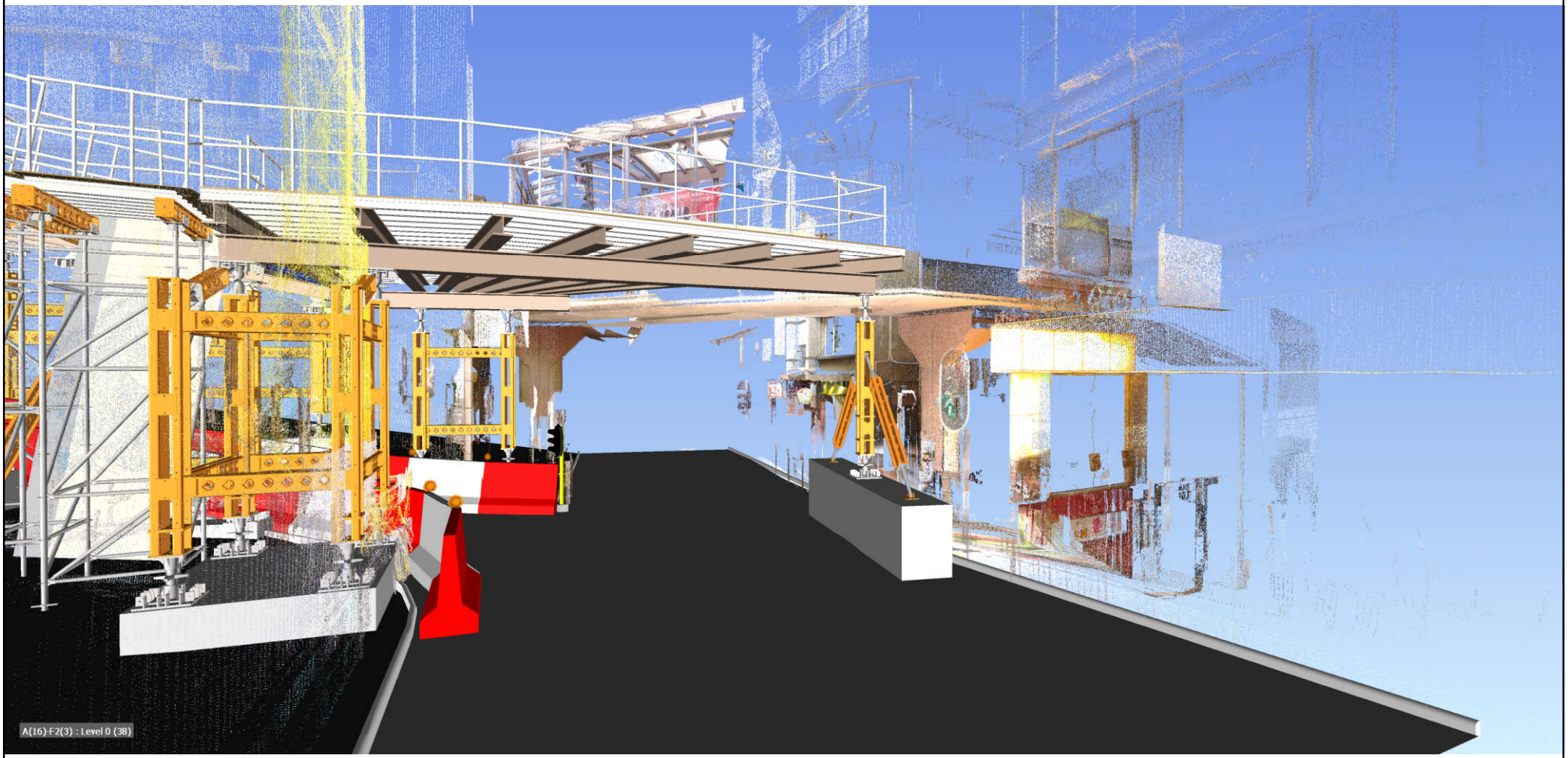




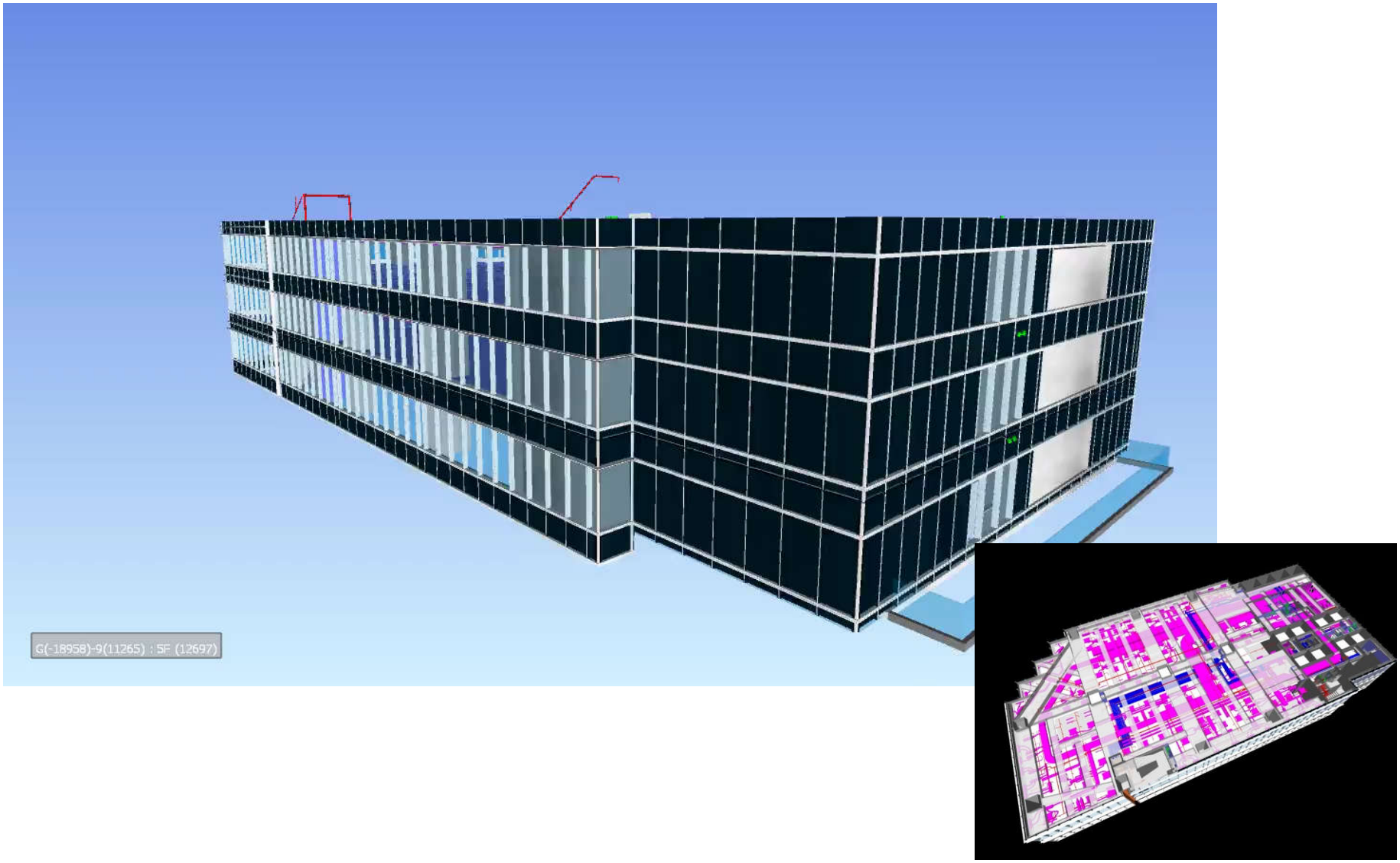
Site Planning for Footbridges



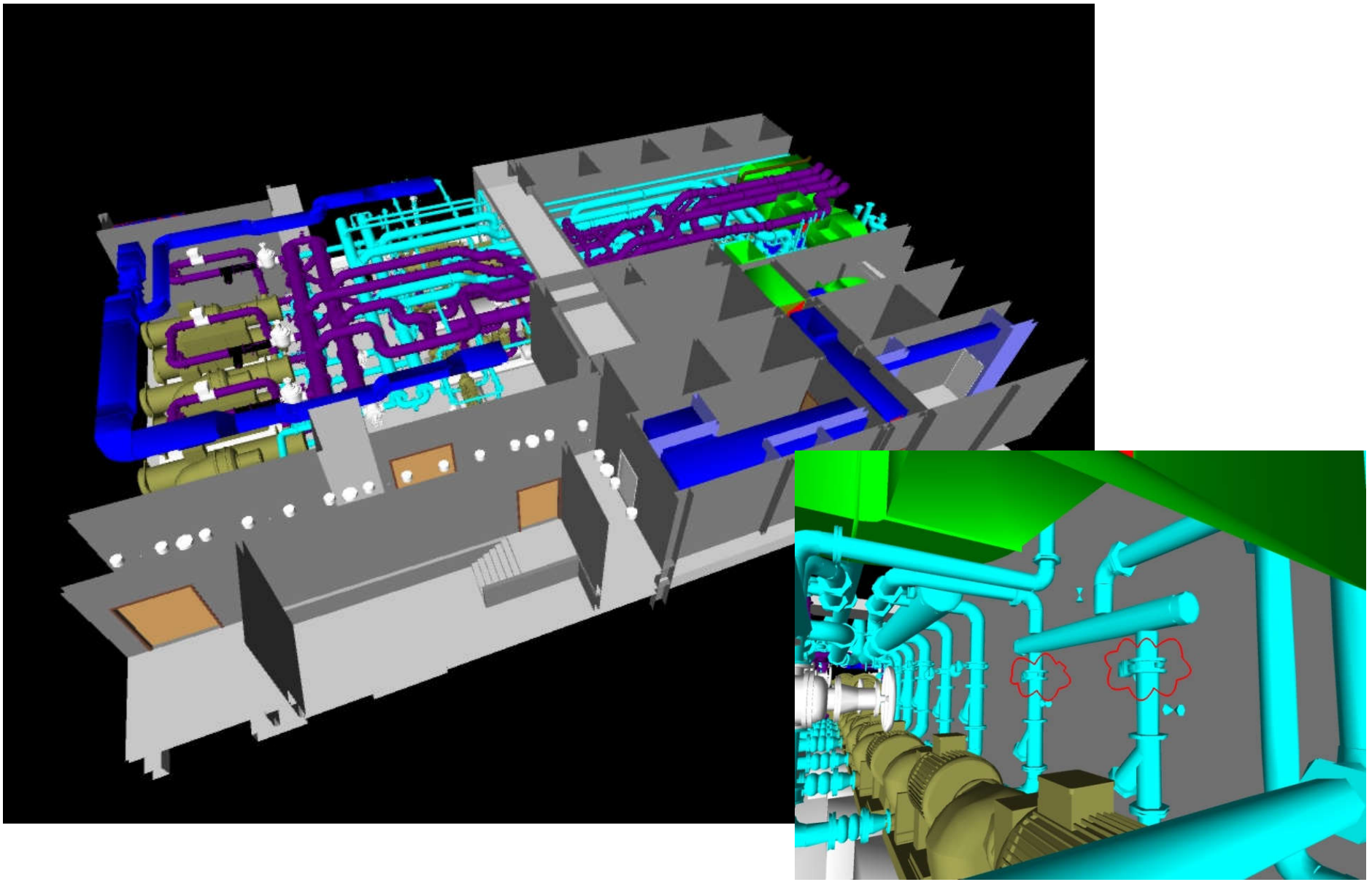
Site Planning for Footbridges



BIM Development –Optimizing Headroom



BIM Development – Built for Maintenance



BIM & Production

Task-Orientated/ Problem Driven

Adopt Supply Chain

Innovative Approaches

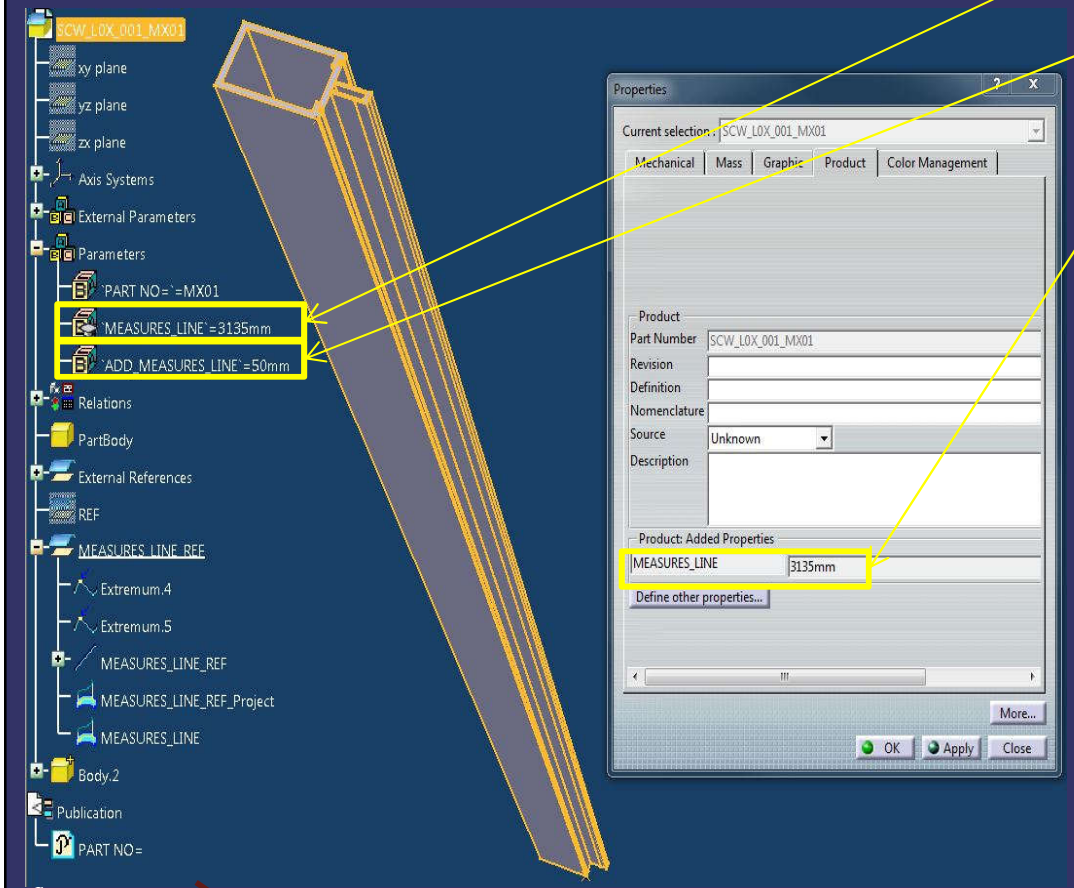
Work with Others

3D for Curtainwall Production

Extrusion Model measure length = 3035mm

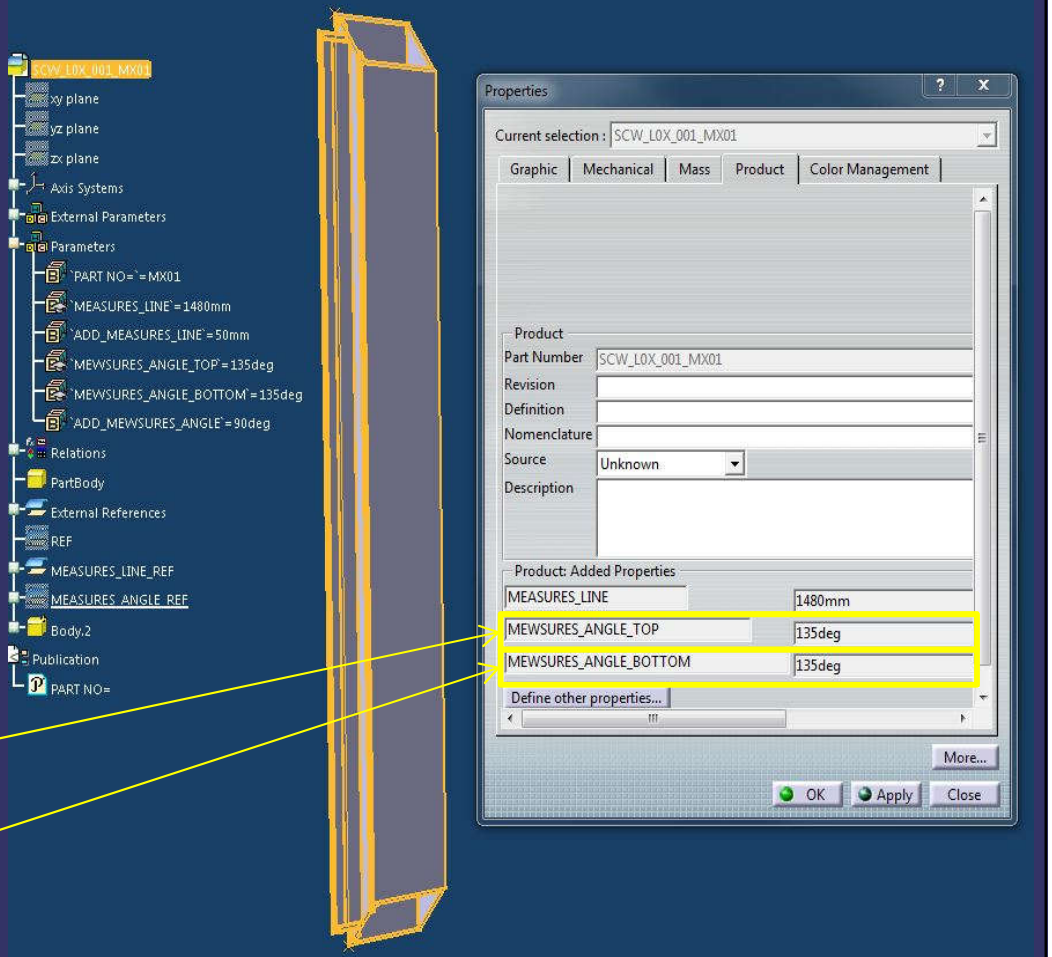
Extend length for fabricate fixing space = 100mm

Total length = 3135mm



Horizontal Cutting Case

Angle Cutting Case



Extrusion Model measure cutting angle (Top) = 135deg

Extrusion Model measure cutting angle (Bottom) = 135deg

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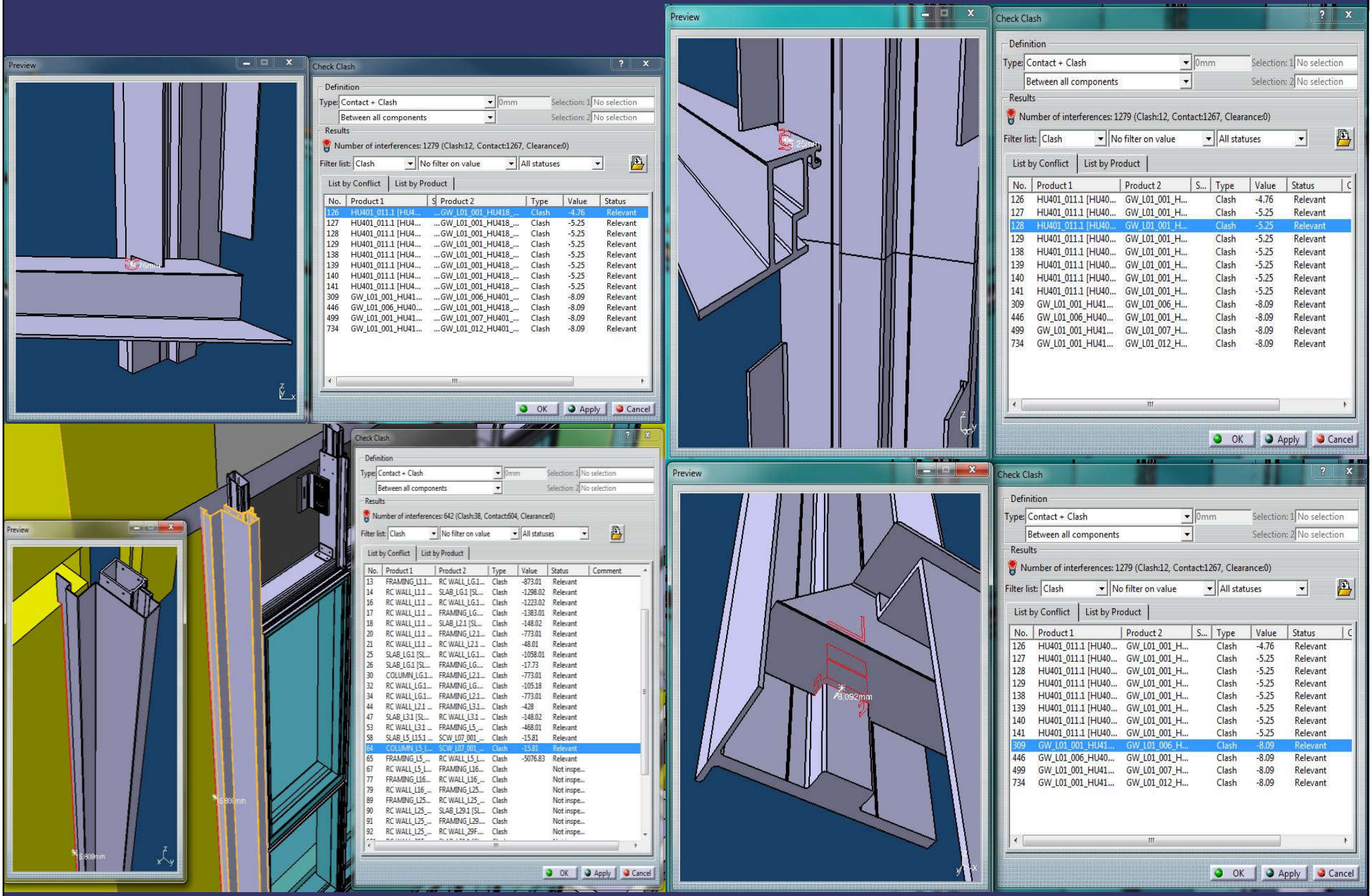
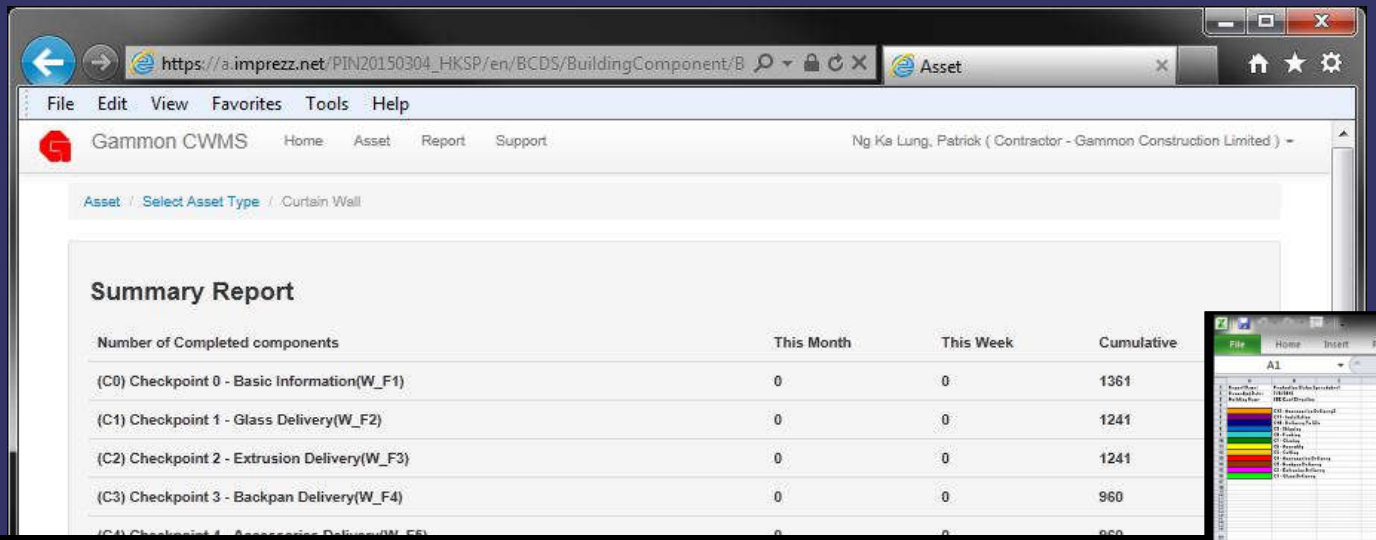
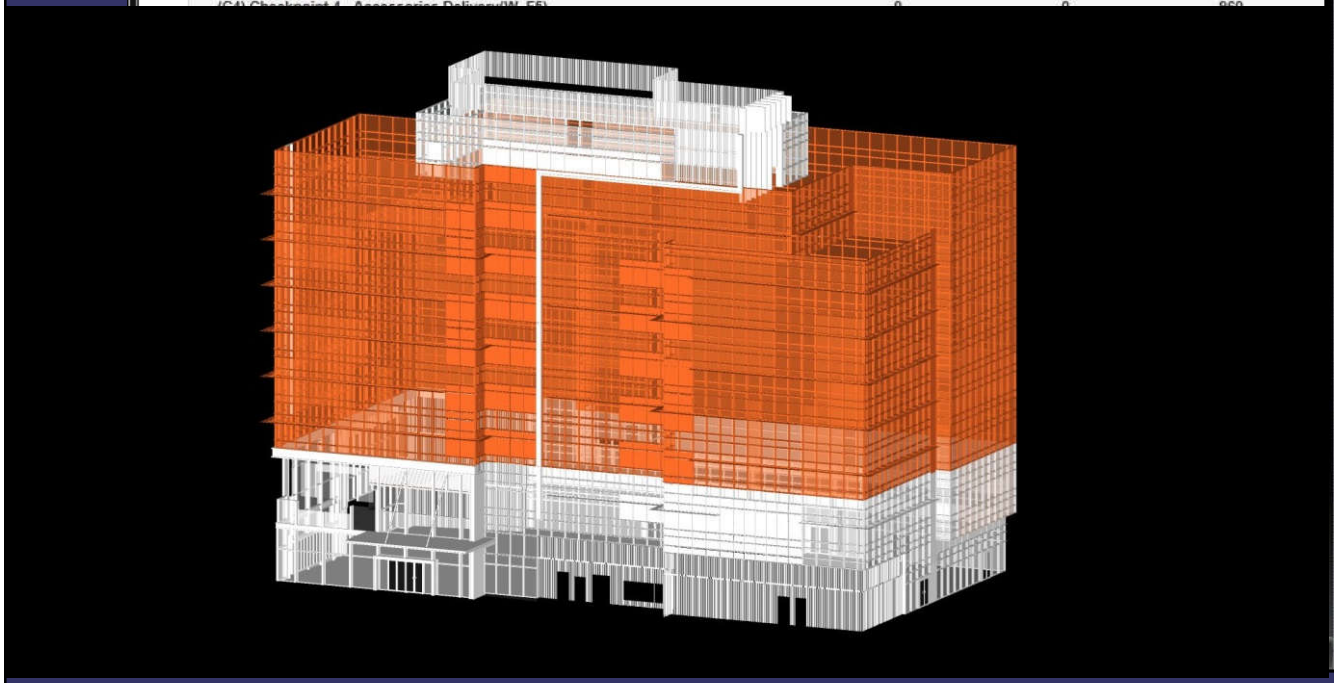
3D for Curtainwall Production

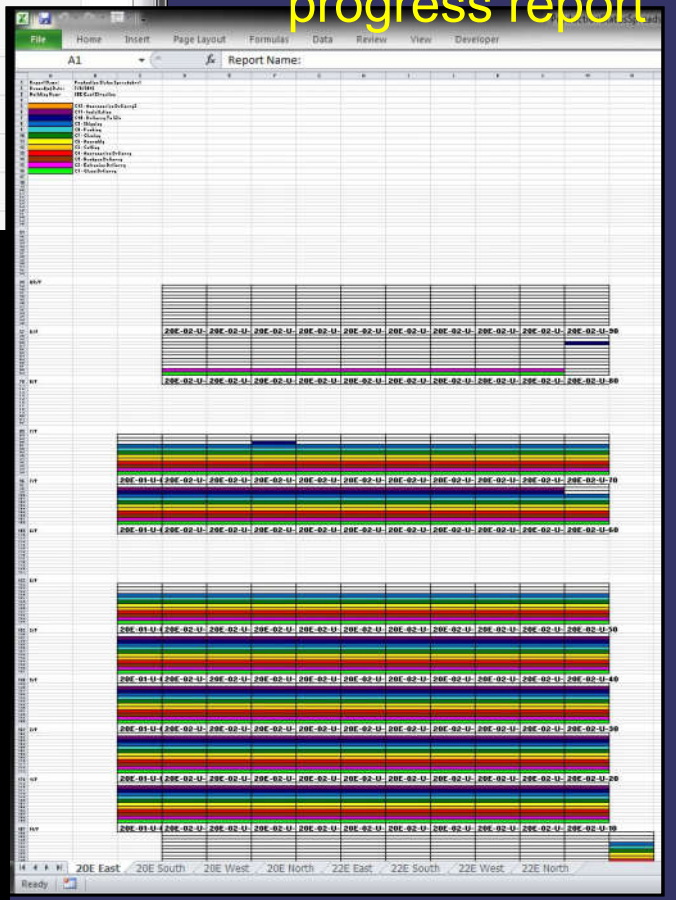


RFID – BIM Work Delivery Tracking

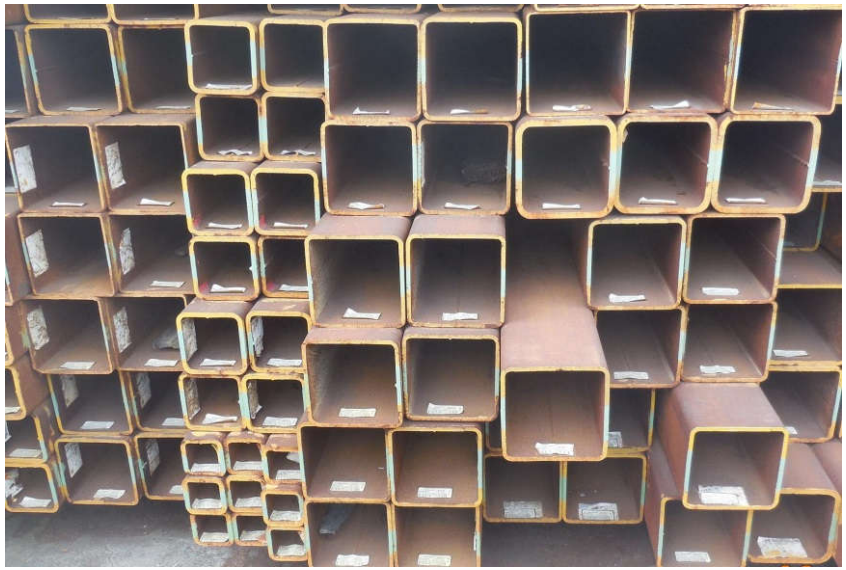


Collated RFID status via online portal integrated with BIM for executive progress report



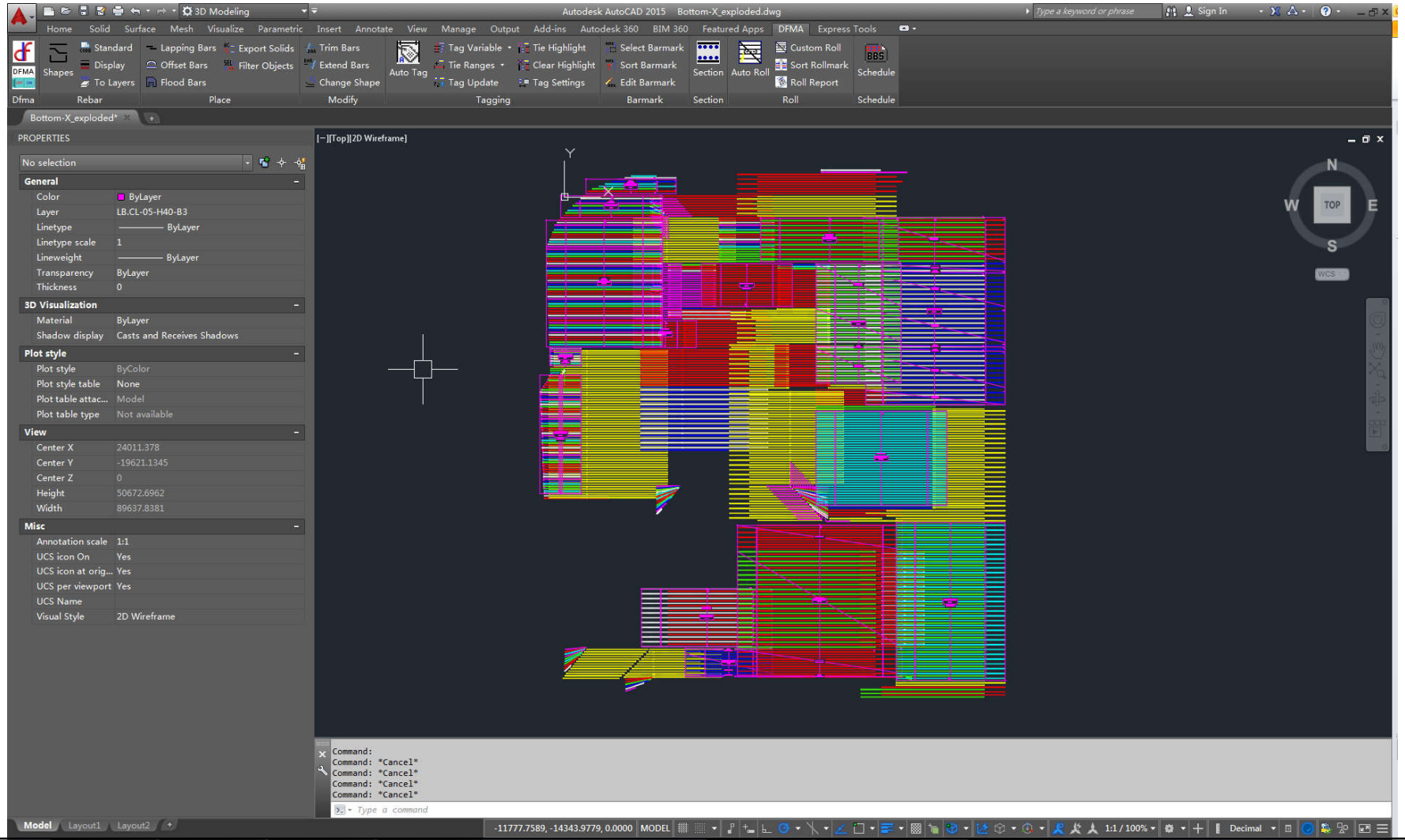


8D in Steel Fabrication Tracking



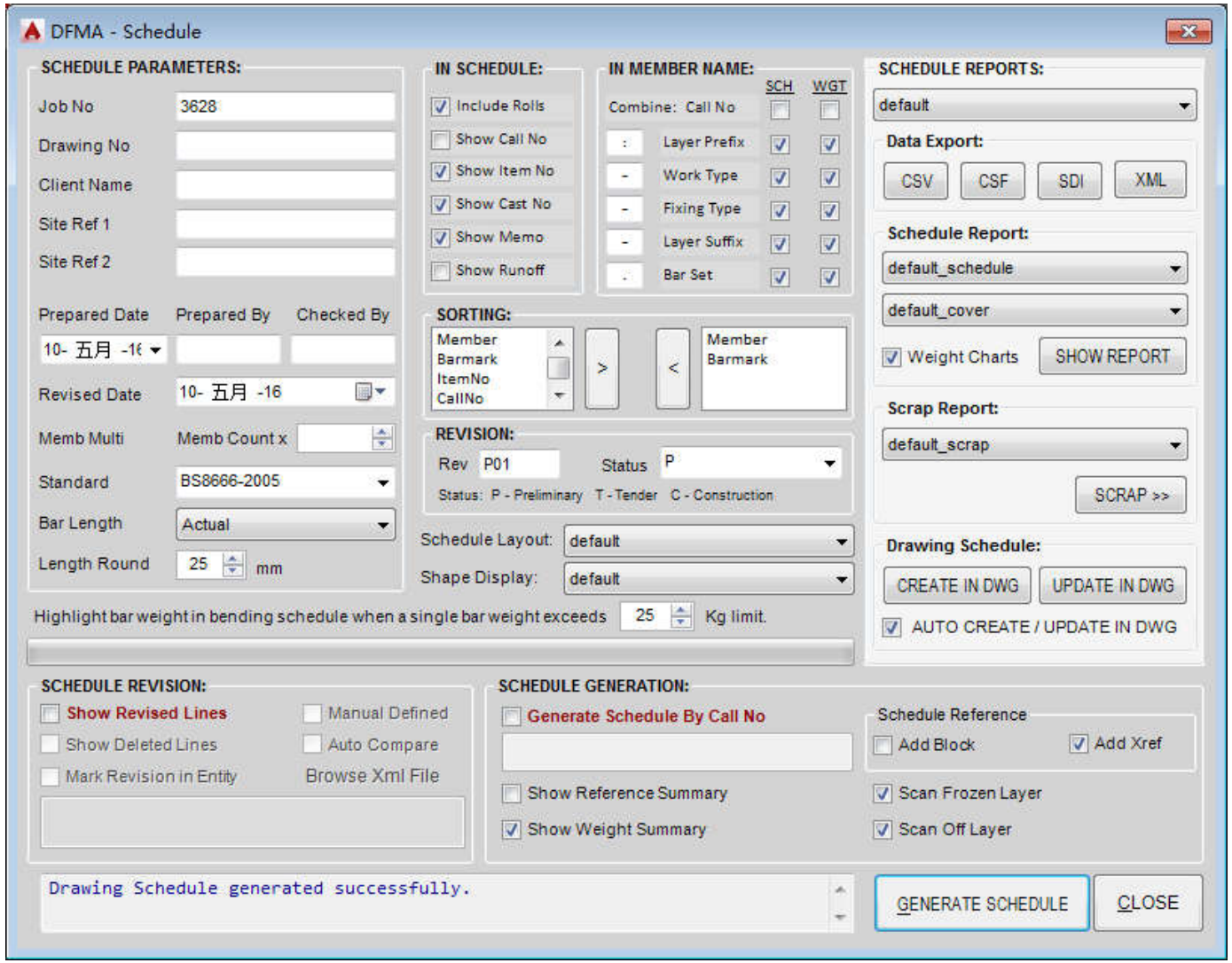
Pile Cap Reinforcement

- Pilot – layer B3 for example



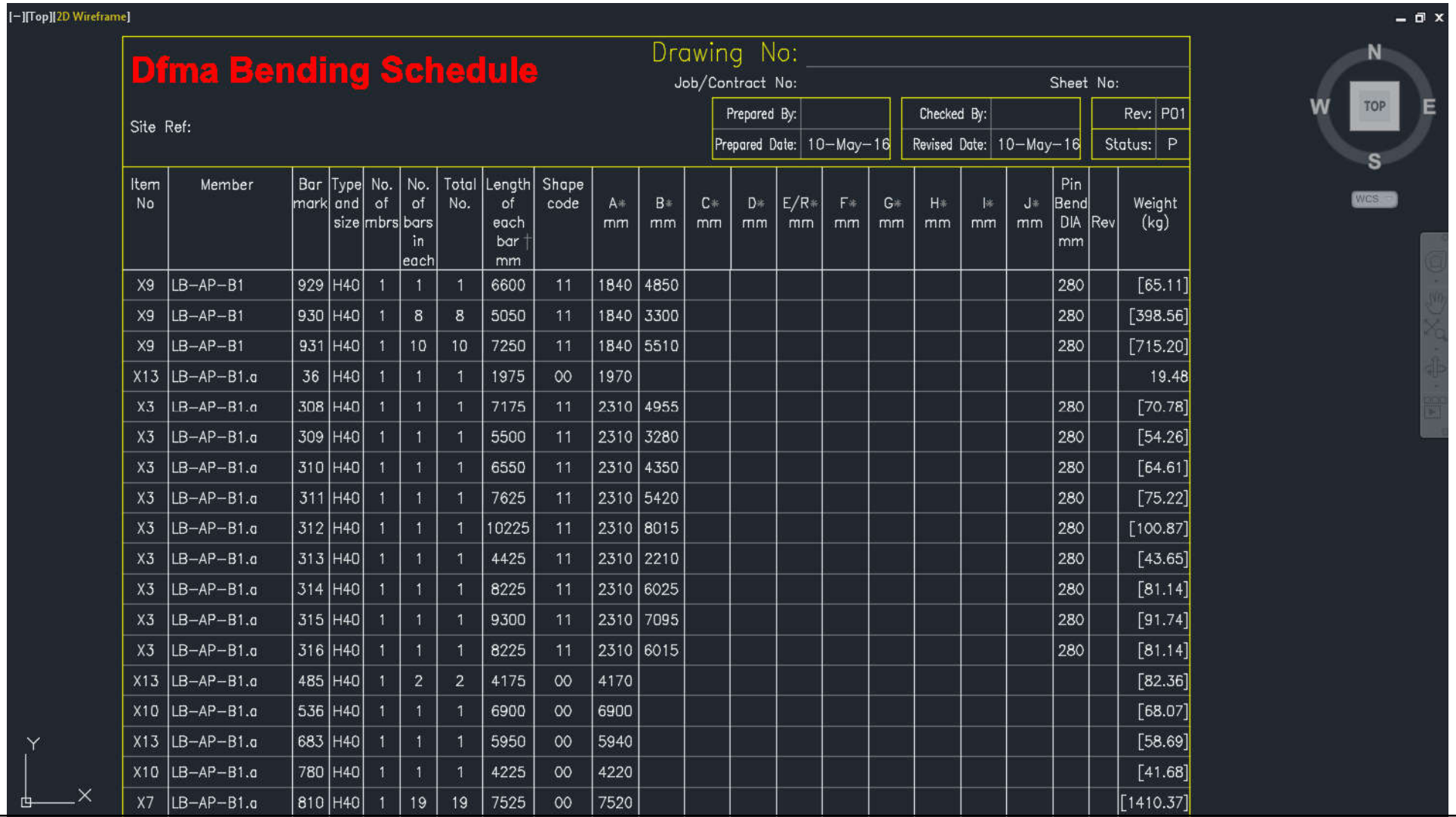
Bar Bending Schedule

- Configuration



Bar Bending Schedule

- BBS Table Generation



Dfma Bending Schedule

Drawing No:

Job/Contract No: Sheet No:

Site Ref:

Prepared By:		Checked By:		Rev:	P01
Prepared Date:	10−May−16	Revised Date:	10−May−16	Status:	P

Item No	Member	Bar mark	Type and size	No. of mbrs	No. of bars in each	Total No.	Length of each bar † mm	Shape code	A* mm	B* mm	C* mm	D* mm	E/R* mm	F* mm	G* mm	H* mm	I* mm	J* mm	Pin Bend DIA mm	Rev	Weight (kg)
X9	LB−AP−B1	929	H40	1	1	1	6600	11	1840	4850									280		[65.11]
X9	LB−AP−B1	930	H40	1	8	8	5050	11	1840	3300									280		[398.56]
X9	LB−AP−B1	931	H40	1	10	10	7250	11	1840	5510									280		[715.20]
X13	LB−AP−B1.a	36	H40	1	1	1	1975	00	1970												19.48
X3	LB−AP−B1.a	308	H40	1	1	1	7175	11	2310	4955									280		[70.78]
X3	LB−AP−B1.a	309	H40	1	1	1	5500	11	2310	3280									280		[54.26]
X3	LB−AP−B1.a	310	H40	1	1	1	6550	11	2310	4350									280		[64.61]
X3	LB−AP−B1.a	311	H40	1	1	1	7625	11	2310	5420									280		[75.22]
X3	LB−AP−B1.a	312	H40	1	1	1	10225	11	2310	8015									280		[100.87]
X3	LB−AP−B1.a	313	H40	1	1	1	4425	11	2310	2210									280		[43.65]
X3	LB−AP−B1.a	314	H40	1	1	1	8225	11	2310	6025									280		[81.14]
X3	LB−AP−B1.a	315	H40	1	1	1	9300	11	2310	7095									280		[91.74]
X3	LB−AP−B1.a	316	H40	1	1	1	8225	11	2310	6015									280		[81.14]
X13	LB−AP−B1.a	485	H40	1	2	2	4175	00	4170												[82.36]
X10	LB−AP−B1.a	536	H40	1	1	1	6900	00	6900												[68.07]
X13	LB−AP−B1.a	683	H40	1	1	1	5950	00	5940												[58.69]
X10	LB−AP−B1.a	780	H40	1	1	1	4225	00	4220												[41.68]
X7	LB−AP−B1.a	810	H40	1	19	19	7525	00	7520												[1410.37]

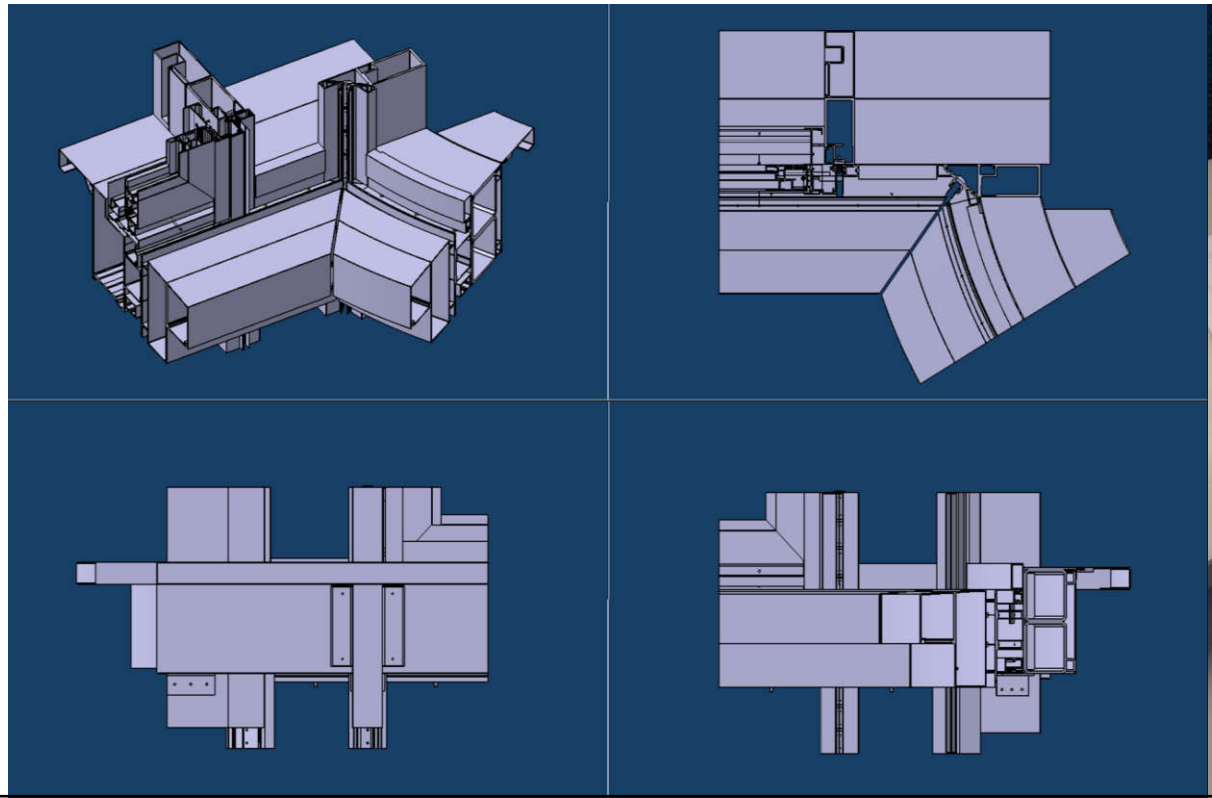
Re-bar Fabrication

- Real Fabrication

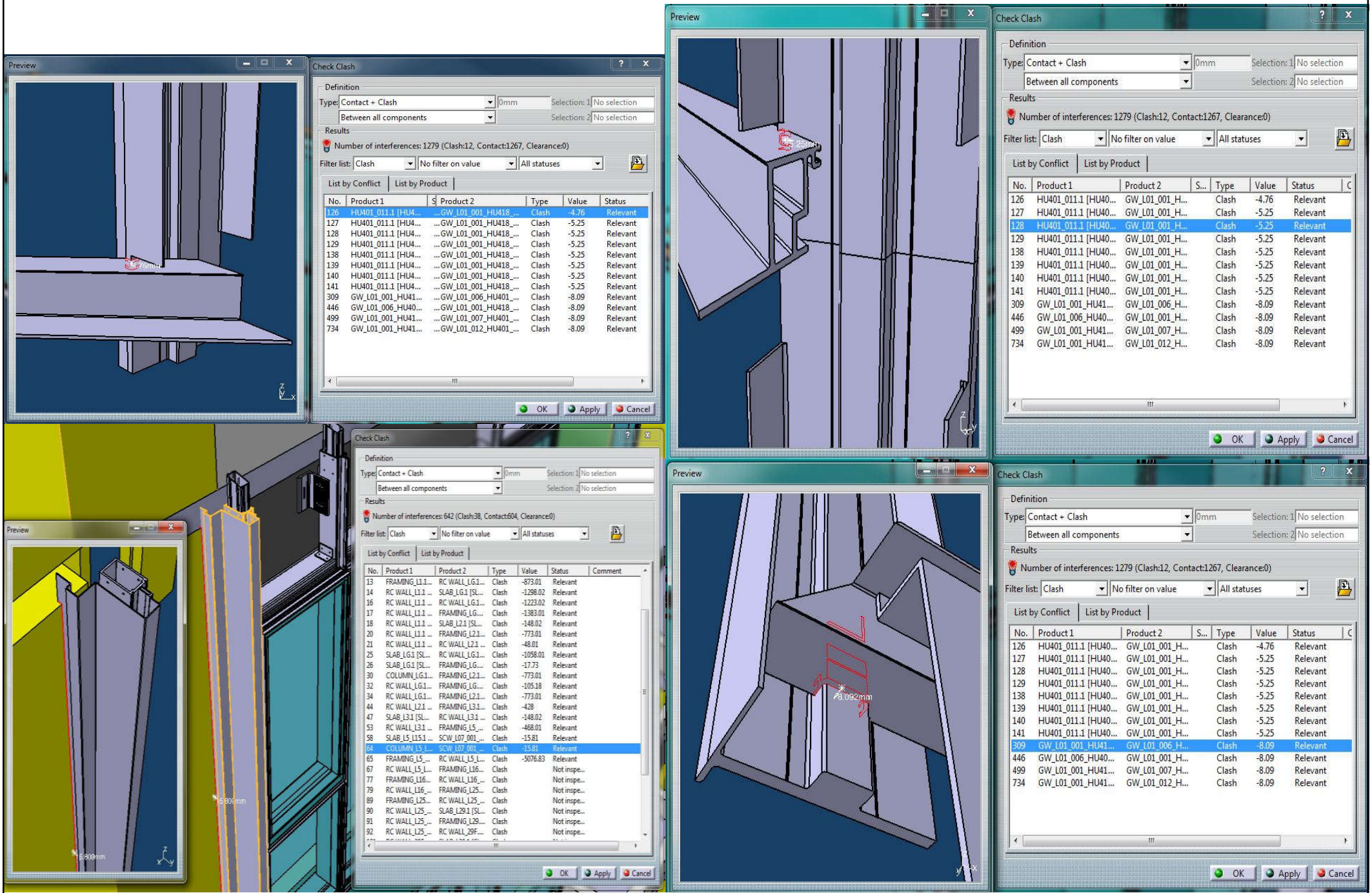
- Desktop Prototyping

DfMA for Facade Units

- Design Aesthetic Evaluation
- Joinery Investigation & Assembly Trial
- Detail Design Study & Improvement
- Enhance client communication
- Speed up approval process



Design Coordination in Panel Assembly & RC

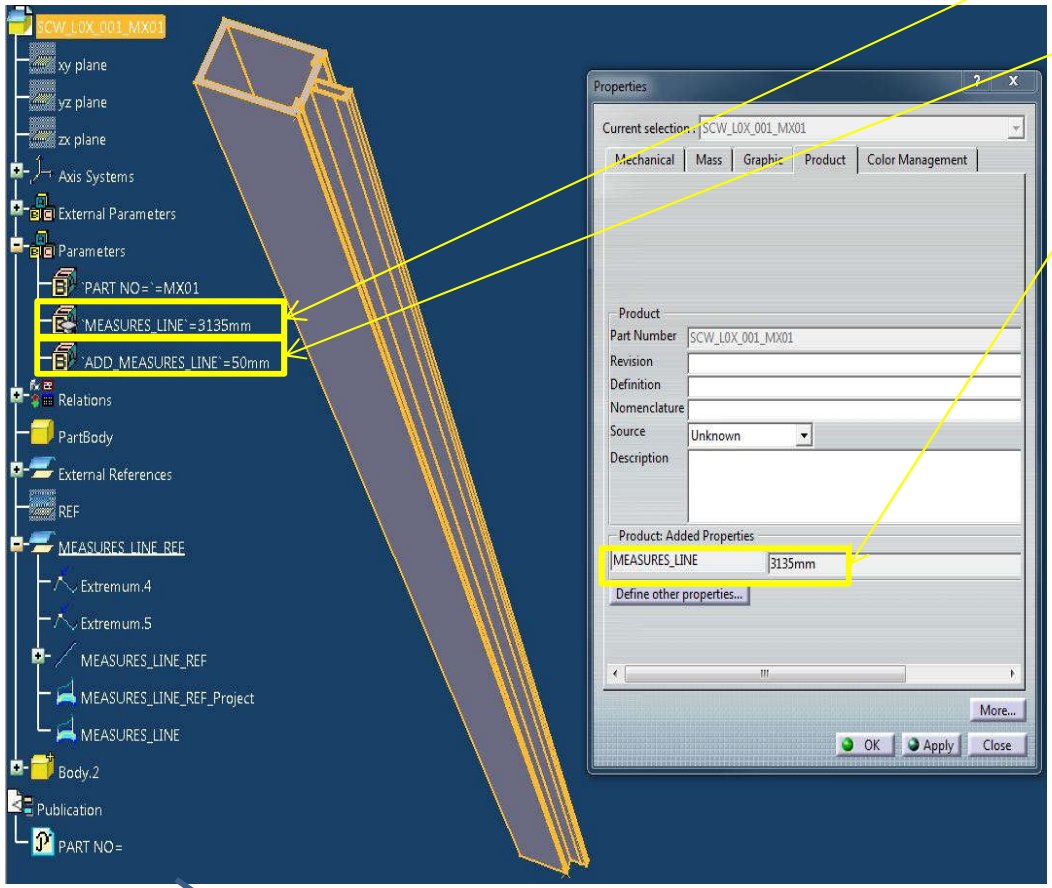


Extrusion length measure for take-off & Fabrication

Extrusion Model measure length = 3035mm

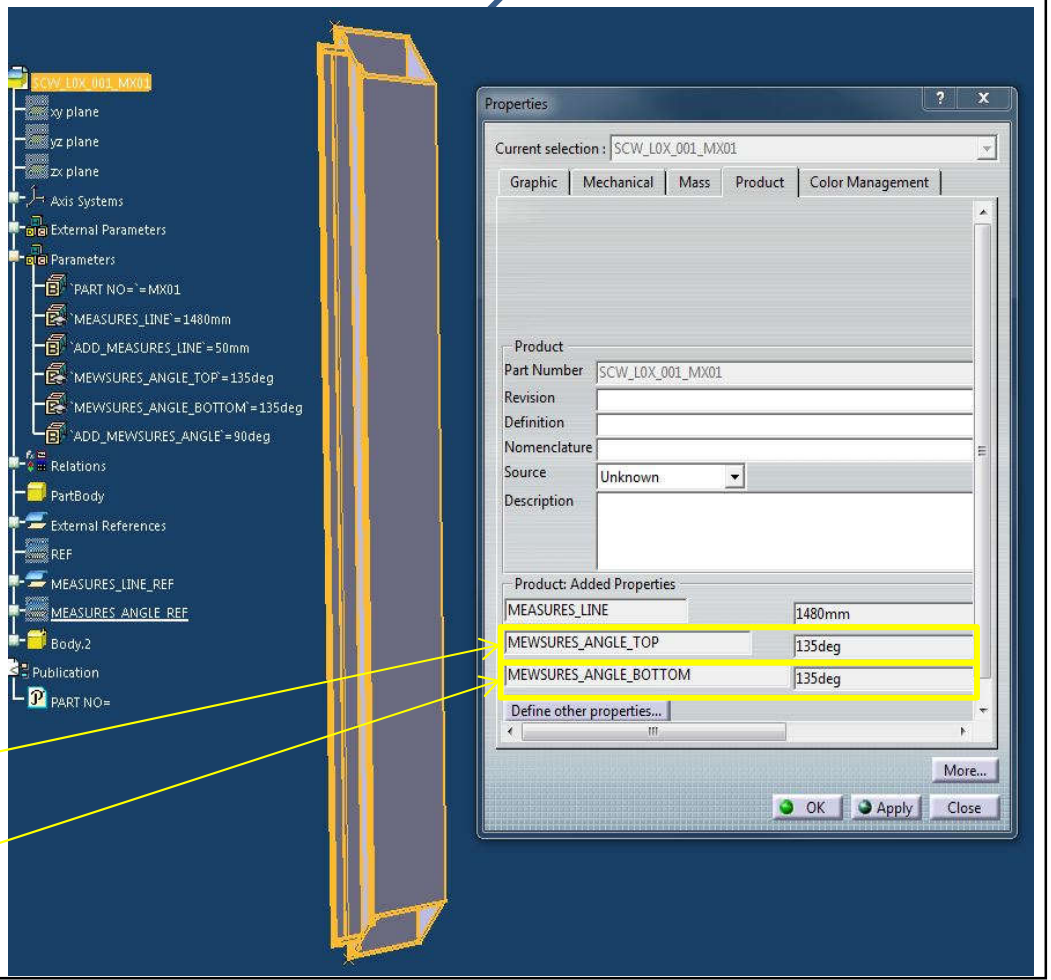
Extend length for fabricate fixing space = 100mm

Total length = 3135mm



Horizontal Cutting Case

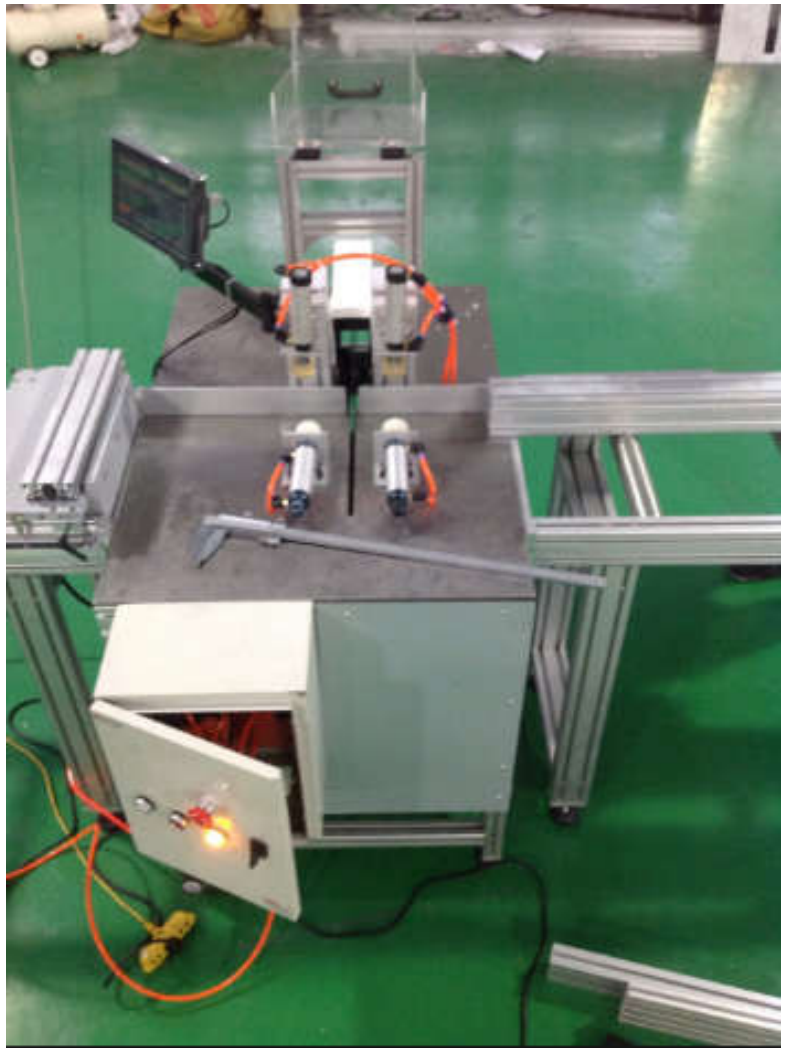
Angle Cutting Case



Extrusion Model measure cutting angle (Top) = 135deg

Extrusion Model measure cutting angle (Bottom) = 135deg

Component Fabrication



- Extrusion CNC

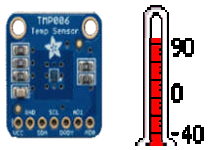
- Sheet Metal CNC

8D Developmect - i-Core

i-Core denotes an integrated circuit chip that could act as a “heart” of its carriers and make the construction resources “alive”.

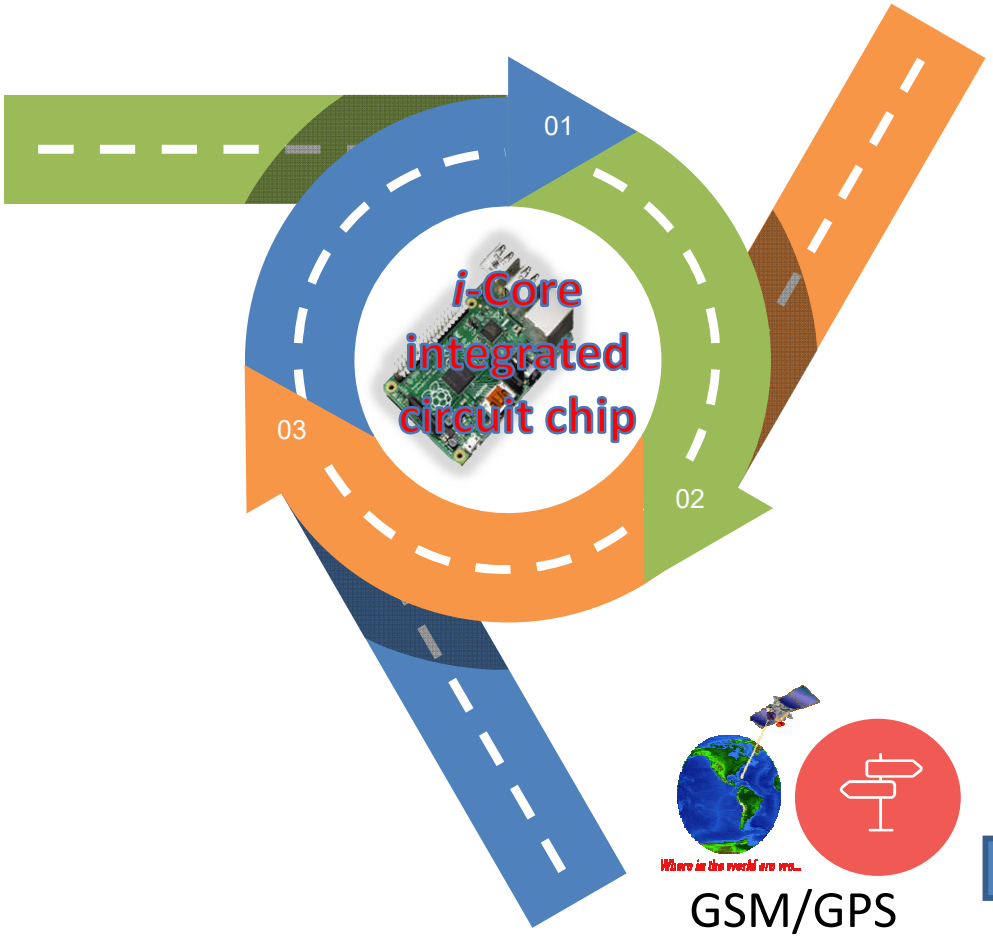
Bluetooth/WIFI
Data Exchange

On site operation management



Temperature Sensor
Safety Tracking

Health & Safety Management



GSM/GPS
Location Tracking

TIME MANAGEMENT
Logistic and Supply Chain

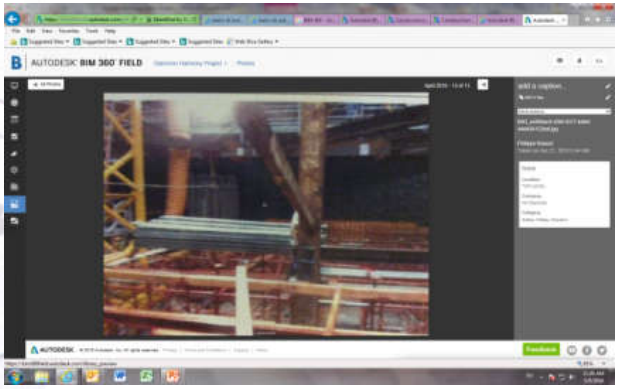
i-Core
Logistic
Management

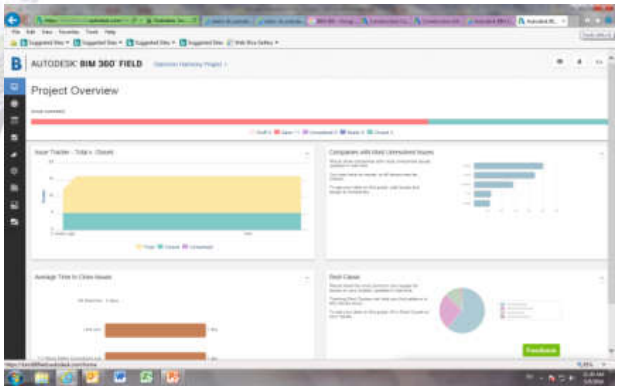
Link with BIM Model for precast concrete element production / arrival & site installation checking

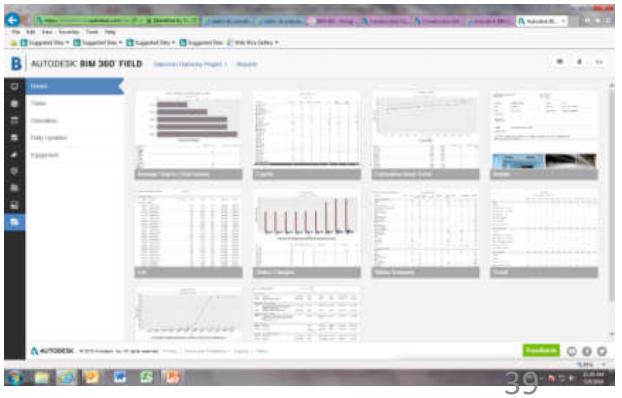
8D Development - Snagging

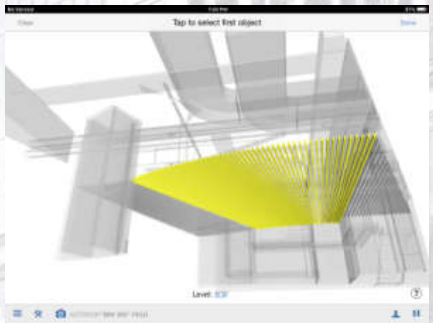
BIM 360

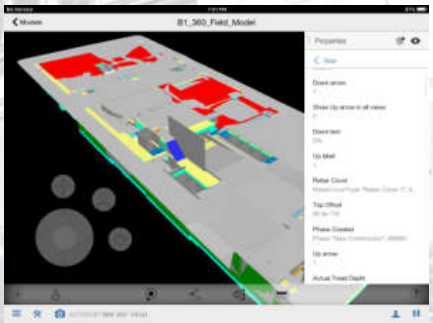
- Improve quality
- Promote safety
- Manage commissioning and handover
- Improve issue management workflows
- Monitor field performance

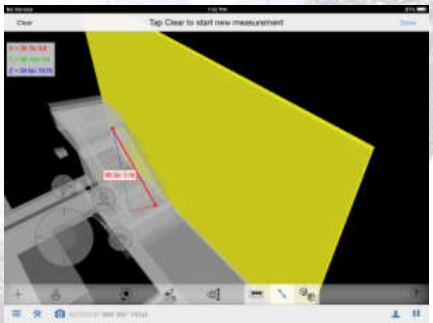


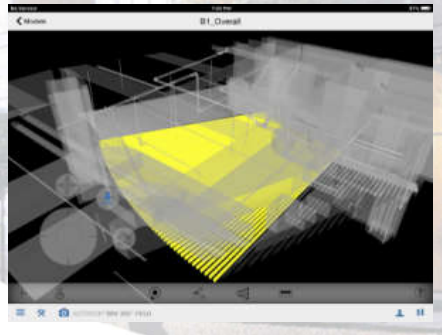


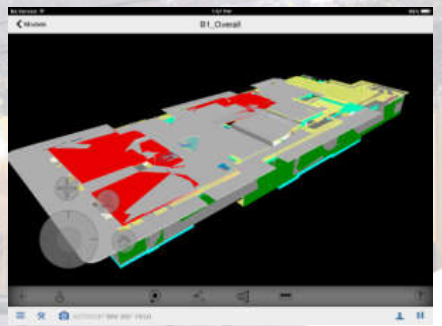


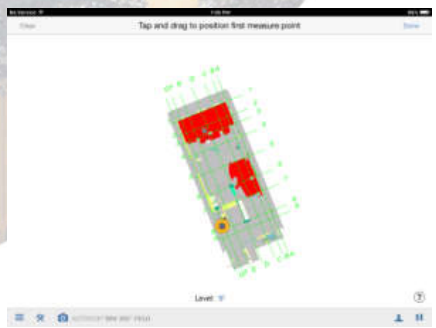






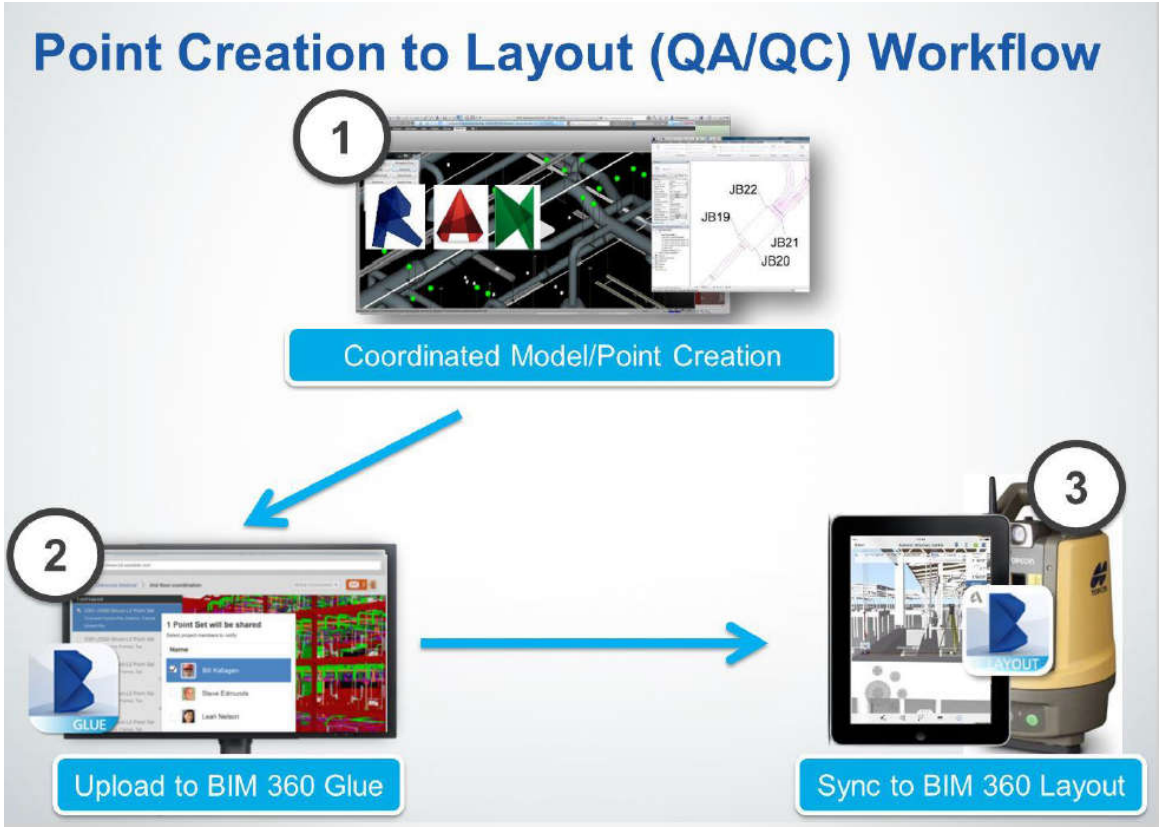






Looking forward

- BIM 360 Layout
- Cross check accuracy between BIM model and actual work.



BIM & Sustainability

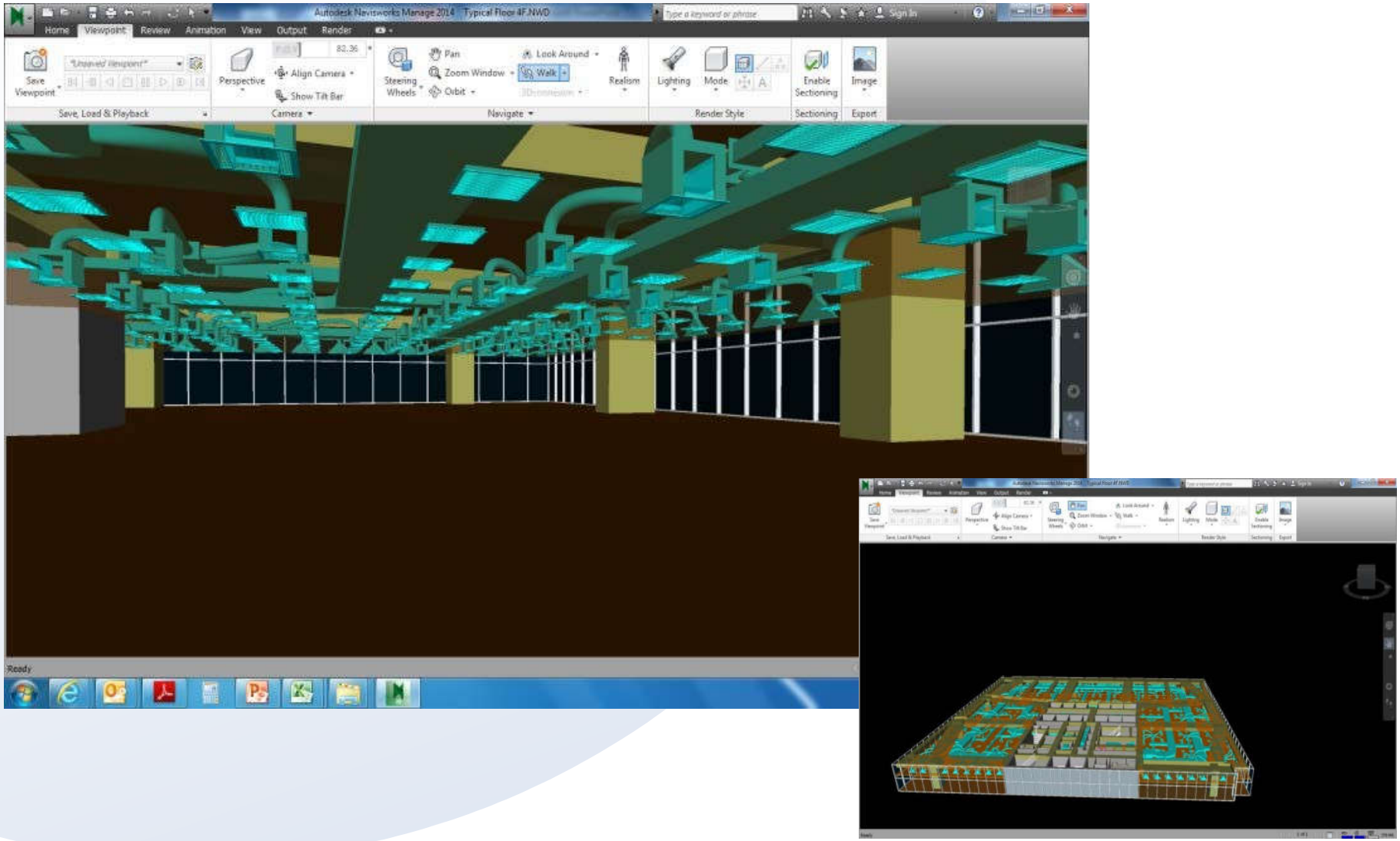
Task-Orientated/ Problem Driven

Adopt Supply Chain

Innovative Approaches

Work with Others

6D - Carbon Foot Print



6D - Carbon Foot Print

Example							
Type	Size			Type Name	Count	Weight (Kg)	CO2e (9.16CO2e/kg)
115X1200 SAG	1200	x	115	SAG	79	3.45	31.602
400X200 SAG	400	x	200	SAG	8	2	18.32

Example							
Duct Fitting Schedule							
Family	System Type	Free Size	Qty	Area (m2)	Total area (m2)	Weight (kg)	CO2e (1.38kgCO2e/kg)
HY-天圆地方	SAD	150 mmx600 mm-200 mmø	2	0.58	1.15	5.76	7.95
HY-矩形插管四通-中心对齐	SAD	835 mmx356 mm-835 mmx356 mm-345 mmx200 mm-345 mmx200 mm	1	0.81	0.81	6.55	9.04
Rectangular Tube-Align Left	SAD	150 mmx600 mm-150 mmx150 mm	16	0.29	4.61	23.04	31.80
天方地圆 - 角度 - 法兰	SAD	115 mmx1200 mm-200 mmø	38	0.46	17.48	142.46	196.60
矩形接头 - 45度接入 - 法兰1	SAD	1000 mmx400 mm-1000 mmx400 mm	1	1.28	1.28	10.43	14.40

Total Co2e used is = 2,281.662

6D - Carbon Foot Print

Concrete Volume and Grade for Outrigger Floor					
Item	Grade	Volume		Normal Emission Factor CO2e (Grade 30 = 370 kgCO2e/m3 Grade 45 = 362 kg CO2e/m3 Grade 80 = 613 kg CO2e/m3)	Green Concrete Emission Factor CO2e (Grade 30 = 240 kgCO2e/m3 Grade 45 = 282.4 kg CO2e/m3 Grade 80 = 246 kg CO2e/m3)
1	24/F C45	1,317.850	m^3	447061.7 kg	372160.84 kg
2	24/F C80	460.037	m^3	282002.681kg	113169.102kg
3	25/F C45	1,721.498	m^3	623182.276kg	486151.0352kg
4	25/F C80	659.781	m^3	404445.753kg	162306.126kg
5	26/F C45	982.013	m^3	355488.706kg	277320.4712kg
6	26/F C80	392.434	m^3	240562.042kg	96538.764kg
7	24/F C30	7.869	m^3	2911.53kg	1888.56kg
8	25/F C30	12.097	m^3	4475.89kg	2903.28kg
9	26/F C30	7.460	m^3	2760.2kg	1790.4kg
		Total		2362891kg	1514229kg

Total Co2e reduced is = 2,362,891-1,514,229= 848,662kg

= 42,433  **per year**

*Average carbon absorption by a tree assumed: 20 kg/ year

	On site Weld Length (mm)	Weld Weight(kg)	Additional Brackets (kg)	Additional Bolts(nos.)	Additional Off Site Weld(mm)	Usage of electricity (kWh)	CO2e (0.78kgCO2e/kWh)
Original Design (Weld Joint)	4000(40mm FW)	26.36	0	0	/	191.7	149.526
Revised Design (Bolt Joint)	0	0	182.9(Total in 4 no.)	16 nos. x M24x100 bolts 2 no. x M24x900 bolts with nuts (permanent use)	7600 (20mm FW)	107.16	83.5848

Total Co2e reduced is = 149.526-83.5848= kg

= 66  **per year**

*Average carbon absorption by a tree assumed: 20 kg/ year

BIM as the core technology
Integration & Collaboration

Task-Orientated/ Problem Driven

Adopt Supply Chain

Innovative Approaches

Work with Others

What *integrated , lean* means … what it have to do with *bim/vdc* …

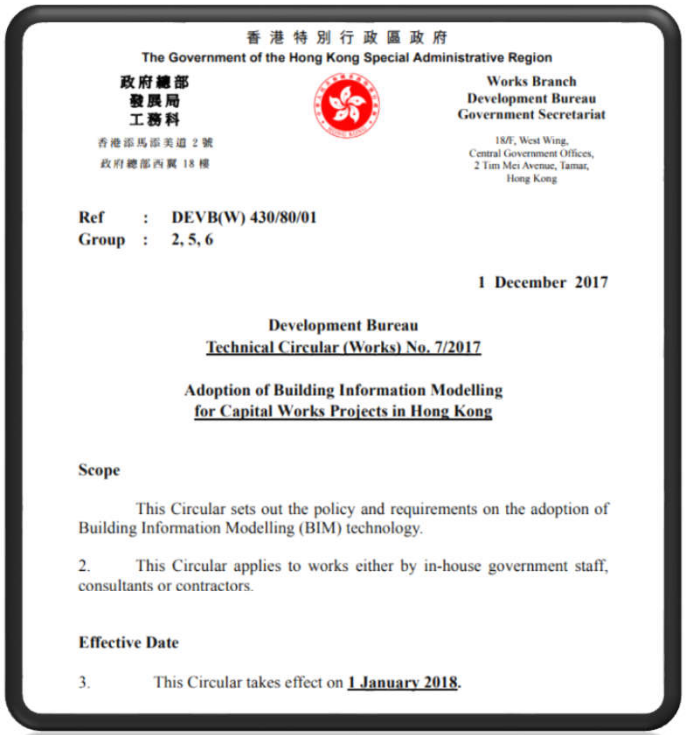
- A way of doing things
- Level of care
- A philosophy
- A culture

- Clay Goser: co-owner at BJC HealthCare, S. Louis

Can you do IPD without BIM?

Clay: You can't divorce Lean from BIM from IPD. Lean is a not a methodology, but a philosophy. BIM is a tool. You don't have to do BIM to be IPD. IPD is a means to an end. Lean is the end**. BIM is a way to get there.** You can do IPD without BIM and have great results. BIM is a tool that helps facilitate communication – understanding what it is you are trying to achieve.

By What means an integrated approach?



香 港 特 別 行 政 區 政 府
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政府總部西翼 18 樓

Works Branch
Development Bureau
Government Secretariat
18/F, West Wing,
Central Government Offices,
2 Tim Mei Avenue, Tamar,
Hong Kong

Ref : DEVB(W) 430/80/01
Group : 2, 5, 6

1 December 2017

Development Bureau
Technical Circular (Works) No. 7/2017

Adoption of Building Information Modelling
for Capital Works Projects in Hong Kong

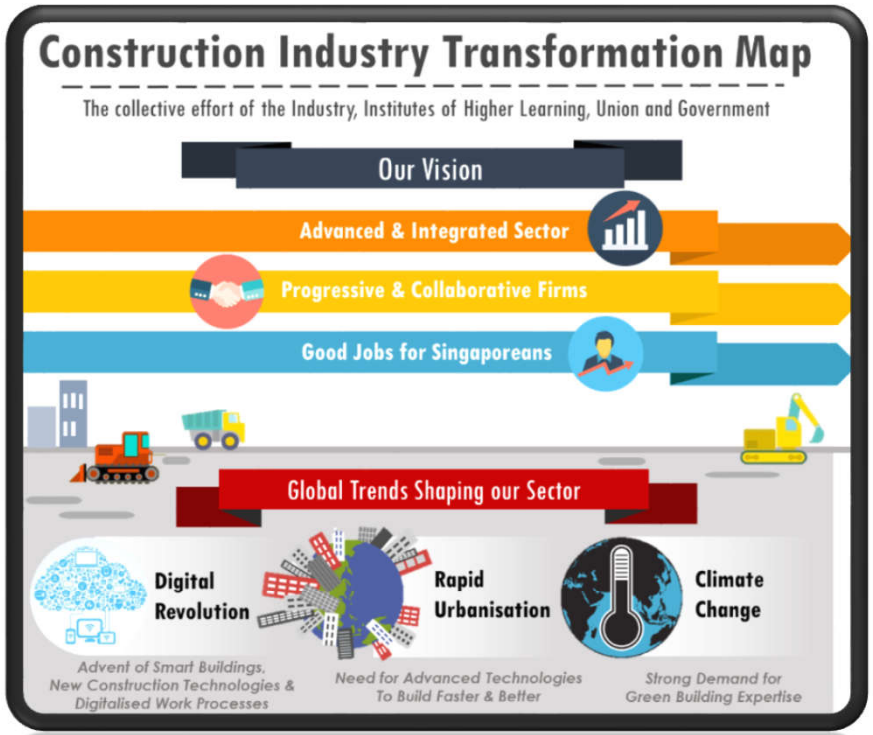
Scope

This Circular sets out the policy and requirements on the adoption of Building Information Modelling (BIM) technology.

2. This Circular applies to works either by in-house government staff, consultants or contractors.

Effective Date

3. This Circular takes effect on 1 January 2018.



- HKSAR Works Bureau
- Singapore BCA

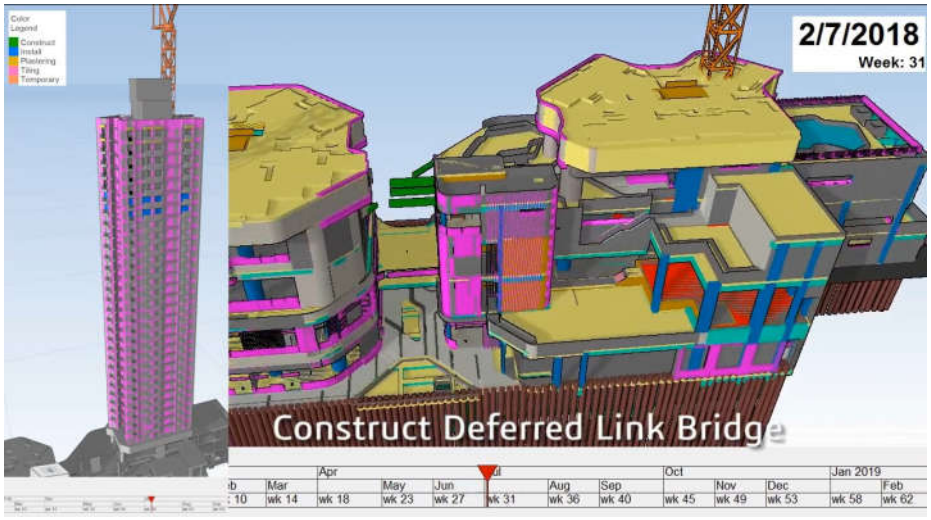
Being *integrated ,* can be very visible …

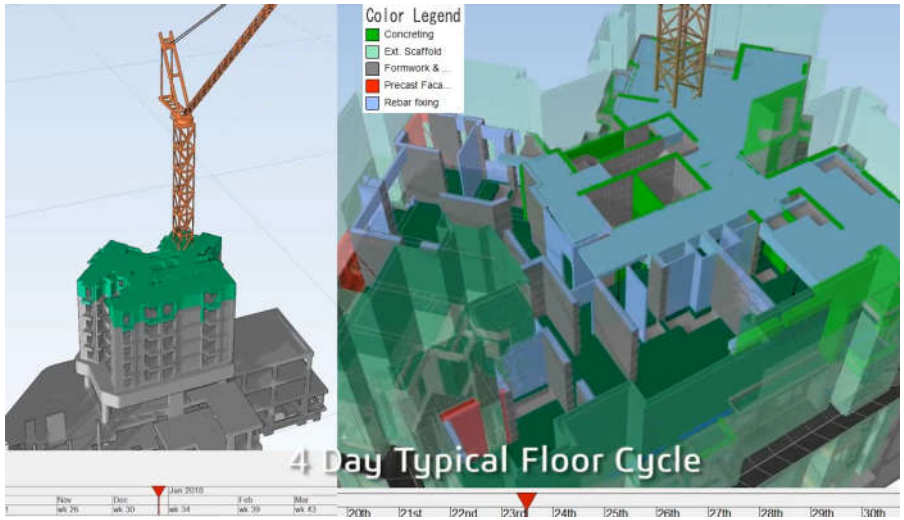
- A wrongly cut opening for an outdoor HR cabinet which leads raindrops in

Design & process integration …

- Integrated What, How and When in Single Visualization

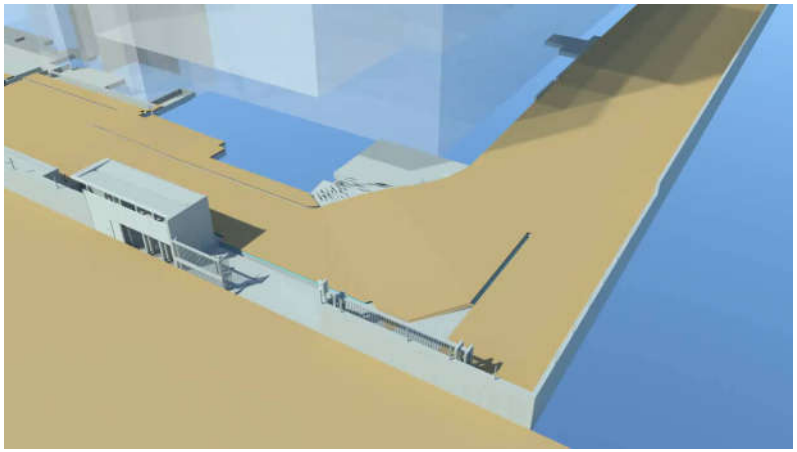
Design & Process integration …





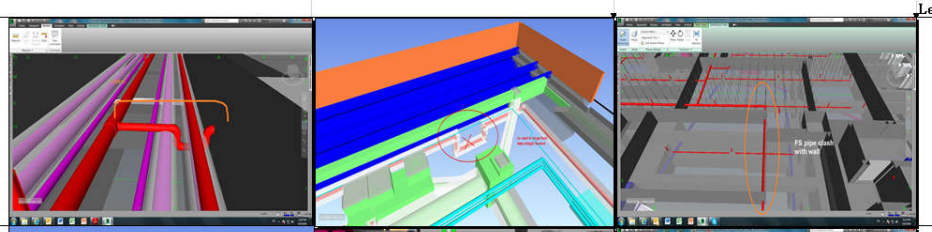
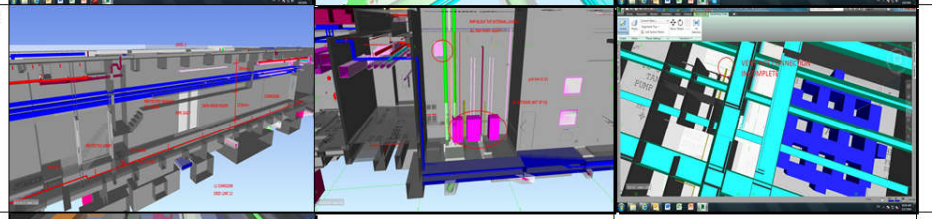
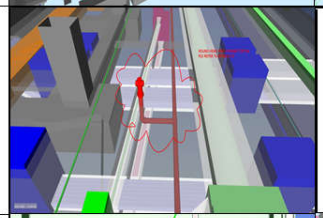
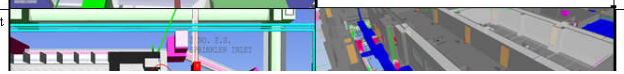
- Integrated What, How and When in Single Visualization

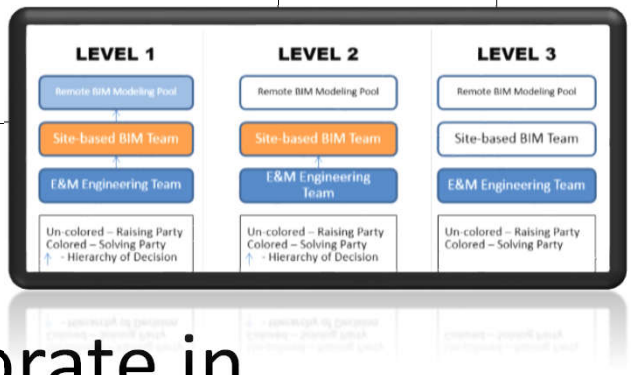
Integrating vertical and horizontal logistic …



- Logistic Planning of Plants and Traffic

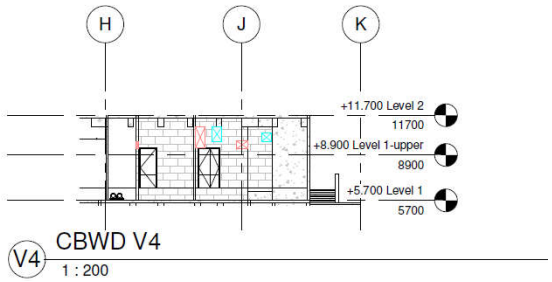
design processes Integration…

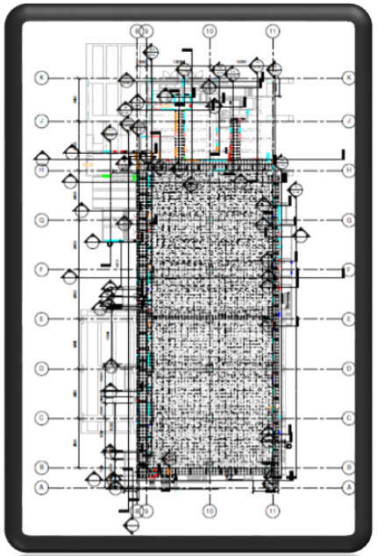
Type		Examples		Level of resolution
1.	Branch pipe routing to avoid **hard clashes**	1. simple cross-branch design 2. double-check federated model and rectify unreasonable issues arise from different design versions		**Level 1**
2.	Branch pipe routing to avoid **soft clashes**	1. simple headroom clash in cooridors and staircases 2. pipe work blocking door/louvres 3. unconnnected pipeworks		**Level 1**
3.	Discrepancy of 2D symbol and 3D object	1. Fire hydrant type and size		**Level 2**
4.	Simple modeling error	1. fixtures and equipment 3D to follow 2D settingout 2. downpipe/riser pipe/duct alignment		



- Multidiscipline Engineers Collaborate in Digital Environment

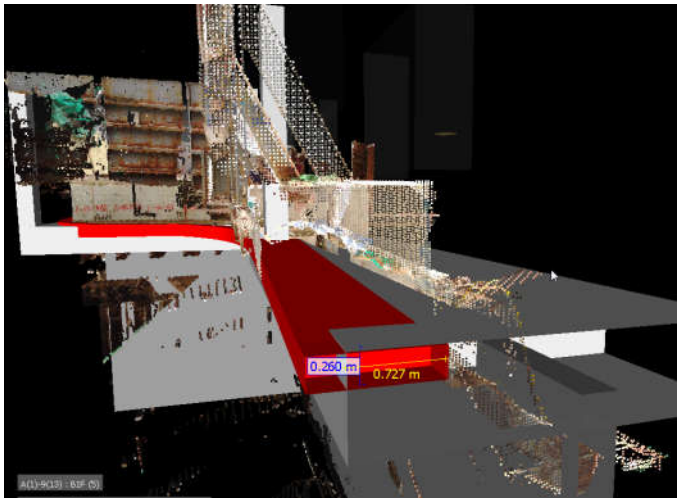
Assembly processes design integration …



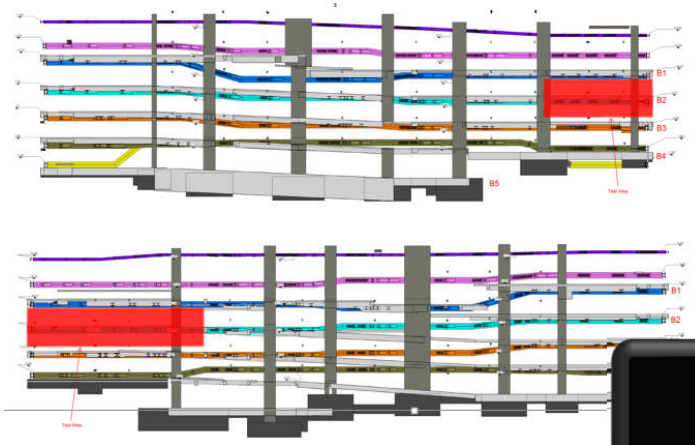


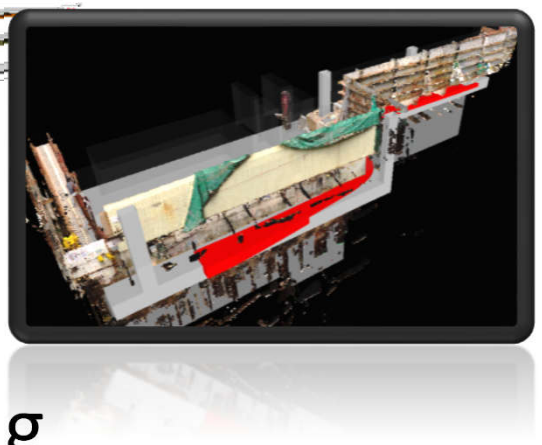
- System Partition Installation Process Integrated

Site context/constraint integration …



- Section views for record water proof status





- Site Context integrated with Building Processes Planning

Procurement processes integration …

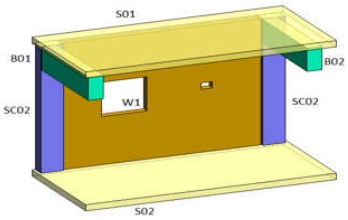
Readiness of BIM for Quantity Taking Off ?

…application of BIM in HK seems lagging behind other places … because HKSAR Gov't has not taken an active role…

Ref.	Tony's Question	Paul's Response
1.	Is BIM applied in all public works projects now ?	At present, the benefits of BIM are more apparent in complex building works projects (less in civils and simple works). A case in point is quantity taking-off. The **existing** off-the-shelf **BIM software cannot compute the quantity** of various construction materials according to the standard adopted in public works projects. Not require BIM to be adopted in all public works project.
2.	Has the Gov't included terms on the application of BIM in Gov't works contracts ?	5 public works contracts have incorporated provisions on using BIM, incl. Central-Wanchai Bypass. 3 are construction contracts and 2 are consultancy contracts.
3.	Will the Gov't make mandartory the application of BIM in all public works projects ?	The Gov't plans to select some complex projects, at the design and construction stage, as pilots in order to assess the cost-effectiveness of BIM in public works. To facilitate a better understanding, the selected projects to be selected would be designed and managed by in-house staff. The assessment includes merits of BIM in terms of design quality, works safety and coordination among project stakeholders (e.g. consultants and contractors).
4.	Has the Gov't conducted comprehensive assessment on the effectiveness of applying BIM ?	
5.	Have the authorities provided civil servants with training in applying BIM ?	In 2012, 200 civil servants (professional and technical staff) trained. The Gov't will provide more civil servants with appropriate BIM training.
6.	Will the authorities step up their efforts in promoting the development and application of BIM ?	The Gov't plans to share the experience in the pilot projects with industry stakeholders. **CIC** has set up a **working group** to discuss the strategies for promoting BIM in the industry.

- Digital Build-of-Material (BOM/BQ) Integrates Procurement from Design Models

Sample Model



Some of the HKSMM4 Rules

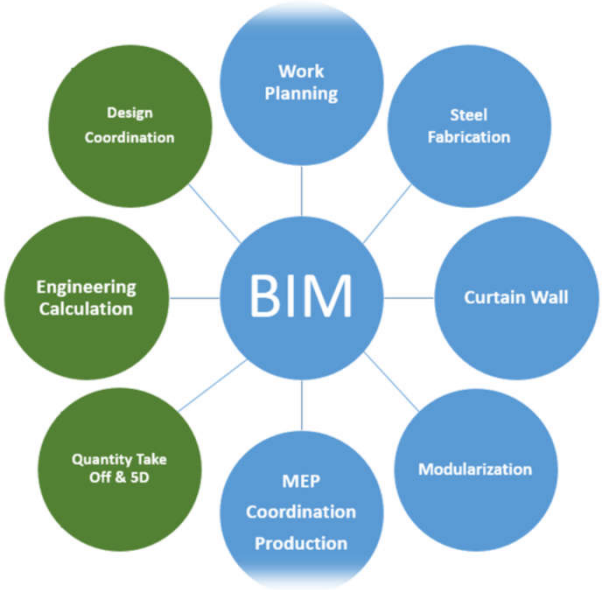
- Formwork deduction for overlapping area between the elements
- Concrete and formwork deduction for the openings (expect the area of opening is too small)
- Supporting height for slab and beam to be stated
- Edge and break in wall and slab to be stated

GQTO Result Summary

Concrete and formwork are measured at the same time

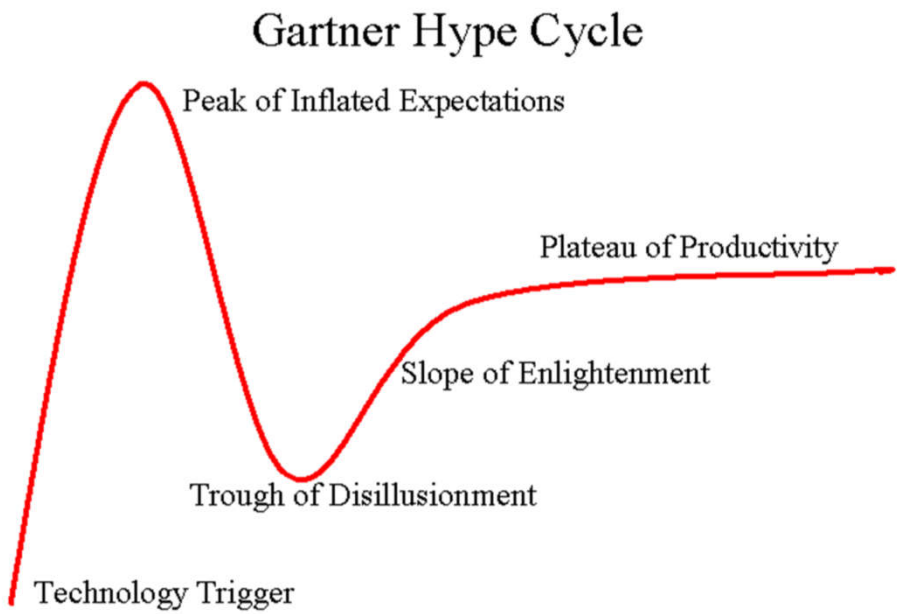
Instance Label	Length (m)	Width (m)	Height (m)	Supporting Height (m)	Adj for Conc(m3)	Adj for Fwk(m2)	Concrete (m3)	Formwork (m2)	E&B (m)
SC01	0.60	0.35	4.05	0	0	0	0.85	7.69	0
SC02	0.60	0.35	4.05	0	0	0	0.85	7.69	0
S01	6.66	3.24	0.200	4.05	0	-1.13	4.32	19.44	19.80
S02	6.66	3.24	0.200	0	0	0	4.32	21.58	19.80
W01	5.28	0.20	4.05	0	-0.26	-2.64	4.06	40.13	1.44
B01	2.81	0.40	0.95	3.30	0	0	0.84	5.95	0
B02	2.70	0.40	0.95	3.30	0	0	0.81	5.73	0

That We are heading to …



- Lean Practice
- Integrated Digital Delivery
- Integrated Design Delivery
- Integrated Project Team Collaboration

Like any new Paradigm, shall go thr' …



Thank You.