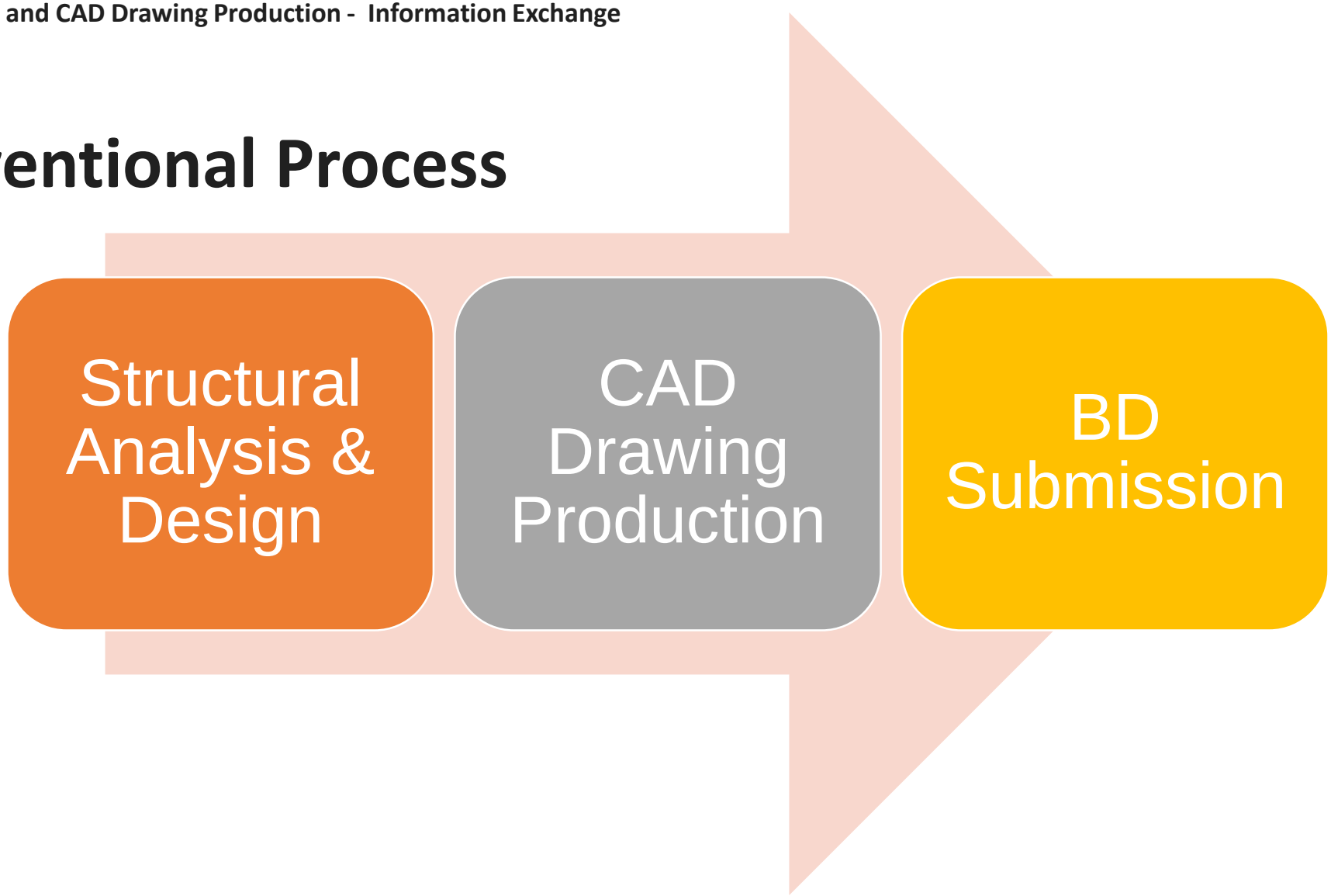
Arup – Structural BIM

BIM for Strcutural Design and BD Submission

Today's Topic

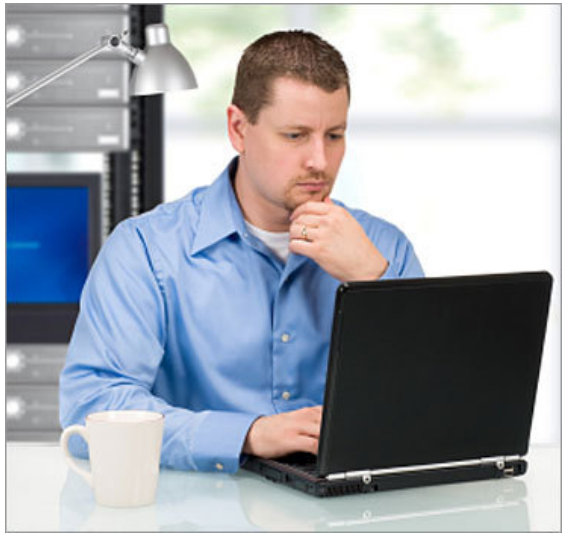
1. Structural Analysis / Design and CAD Drawing Production - Information Exchange
    1. Conventional Process
    2. BIM Adoption for Structural Engineers in BD Submission Process
2. Benefits of BIM for Structural Engineer
3. Example of using BIM for BD Submission
    1. Singapore's Government Reference Example (BCA)
    2. Hong Kong's Example – Some Pilot Projects

- **Conventional Process**



Work between Engineers and Draftsman

Drafter has to wait until the engineer has completed the structural analysis and design before starting the coordination and documentation tasks.

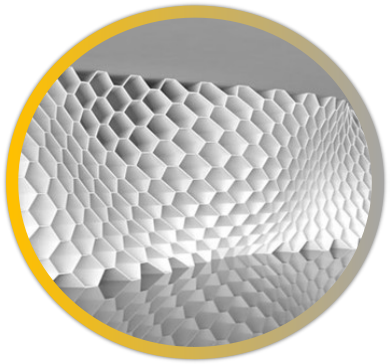


Engineer

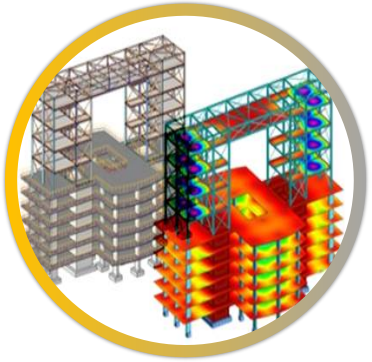
Draftsman

BIM Project Life Cycle

Structural BIM Process



Conceptual Design
in BIM



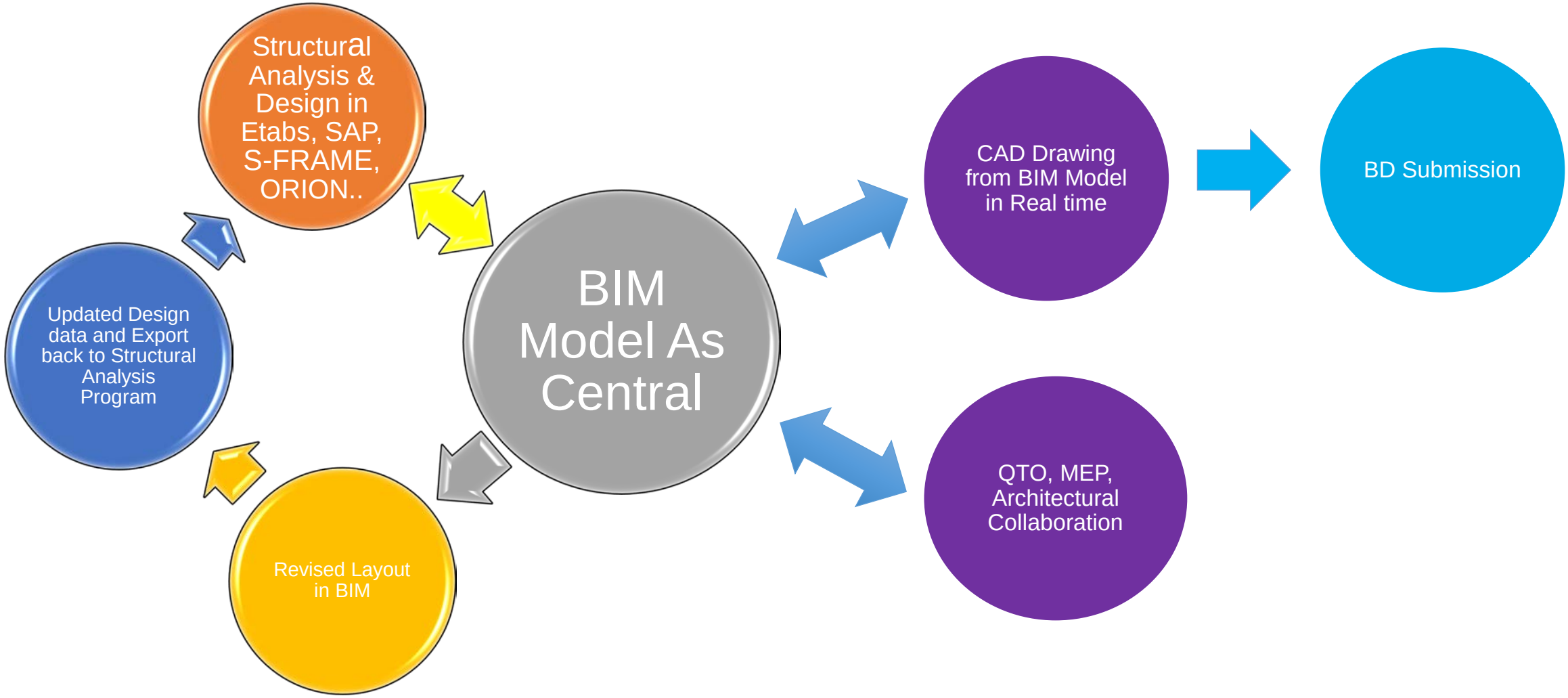
Structural Analysis
And Prepare Framing &
Foundation Plan, Site Formation

Architectural
Design
Prepare GBP
Drainage Plan

Distributed to the contractor
for Further On-Ste Collaboration

Construction

Structural BIM Process



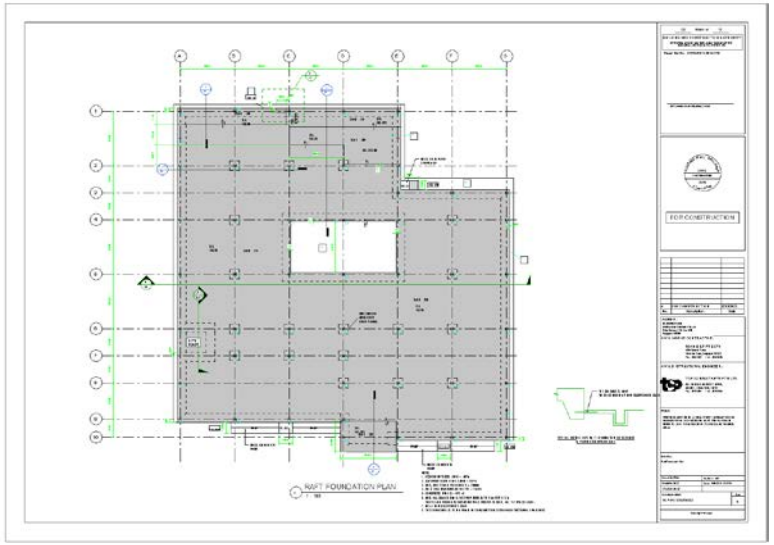
1. Improve Design Productivity

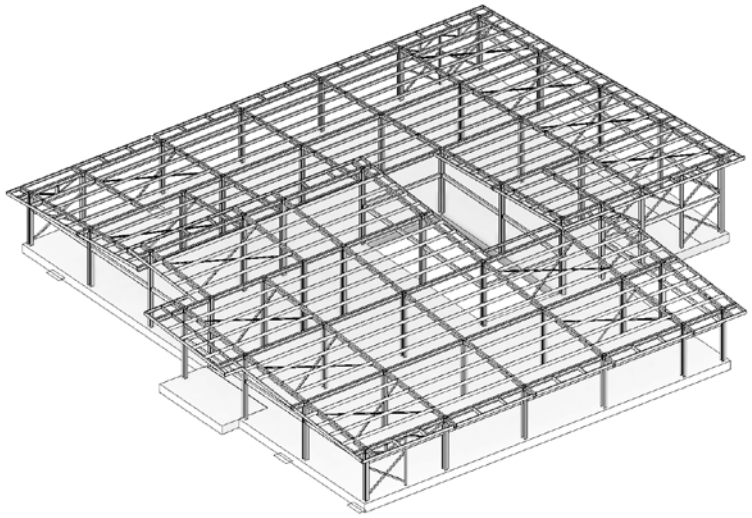
2. Deal with rapid changes in design and drawing updates

3. Collaborate with difference Disciplines before construction – save cost for client in project

- # Singapore Reference Example (BCA)

  - Proposed Addition of Single Storey Ancillary Office Building to the Existing Oil refinery Complex
  - Steel Frame Structure - Submission to BCA in Singapore
  - File: PC1313.rvt

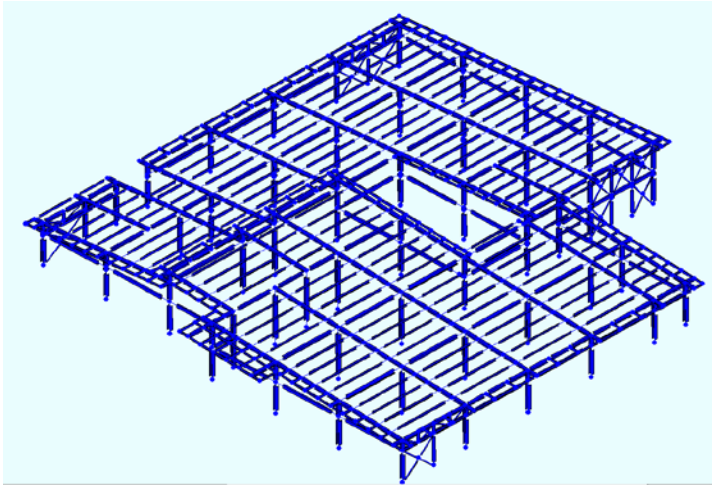




Client: Structural Consultant in Singapore

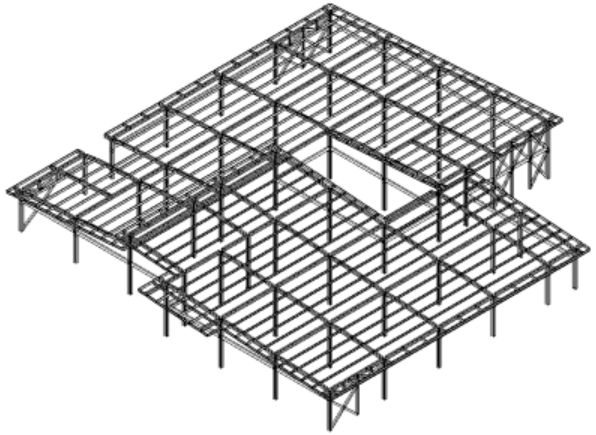
Proposed Addition of Single Storey Ancillary Office Building to the Existing Oil refinery Complex

Steel Frame Structure - Submission to BCA in Singapore



S-FRAM Model

Two way links with Revit and update the member size using S-STEEL Design Optimization.



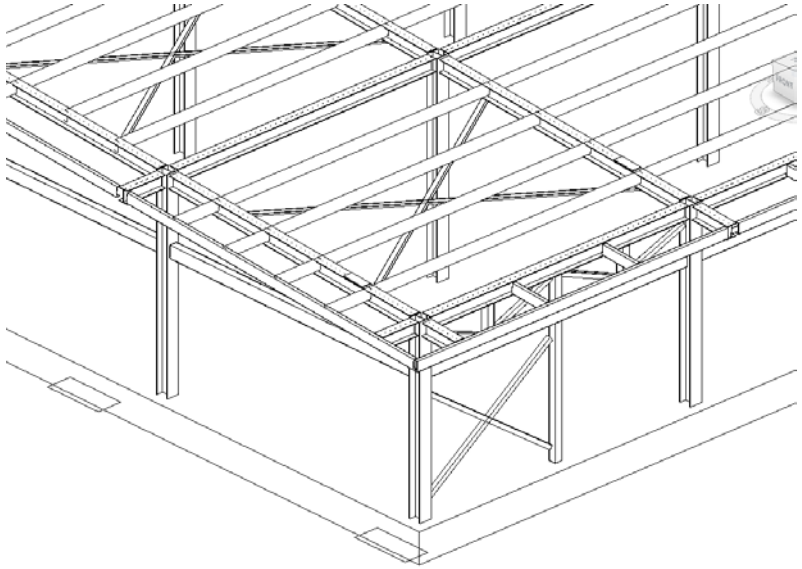
Revit Model

Client: Structural Consultants in Singapore

Proposed Addition of Single Storey Ancillary Office Building to the Existing Oil refinery Complex

Steel Frame Structure - Submission to BCA in Singapore

On Site



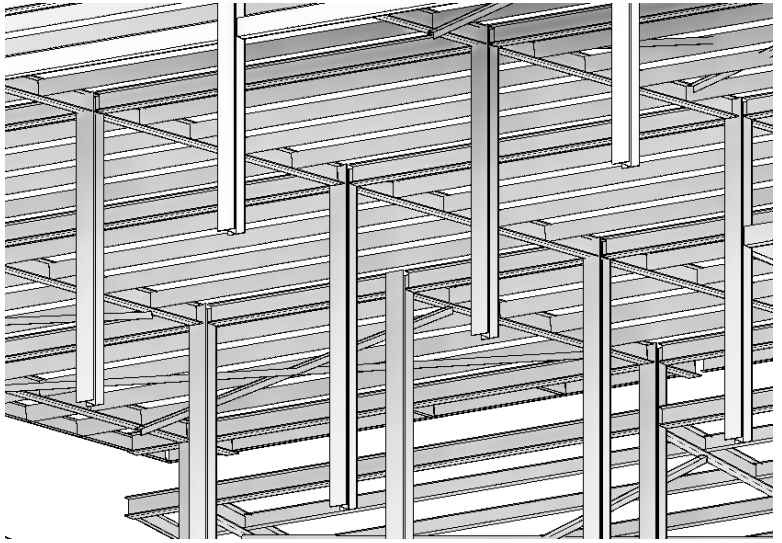
Revit Model

Client: Structural Consultants in Singapore

Proposed Addition of Single Storey Ancillary Office Building to the Existing Oil refinery Complex

Steel Frame Structure - Submission to BCA in Singapore

On Site

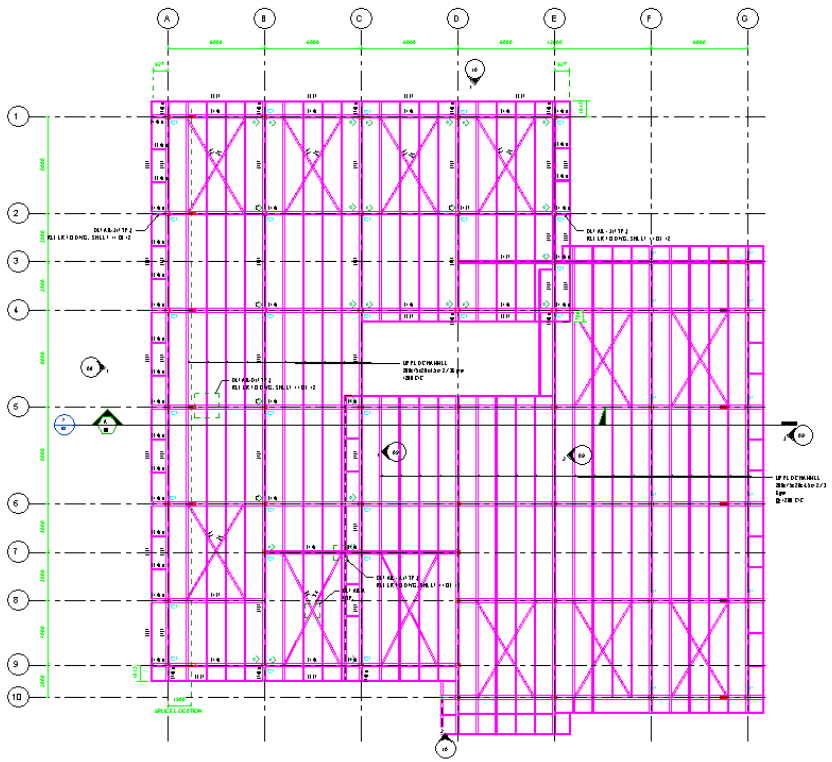


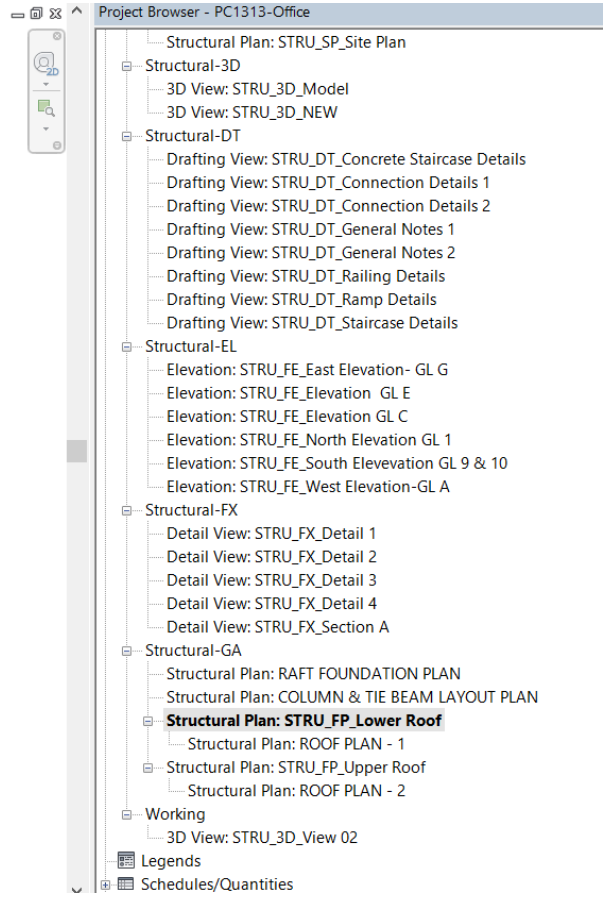
Revit Model

Client: Structural Consultant in Singapore

Proposed Addition of Single Storey Ancillary Office Building to the Existing Oil refinery Complex

Steel Frame Structure - Submission to BCA in Singapore



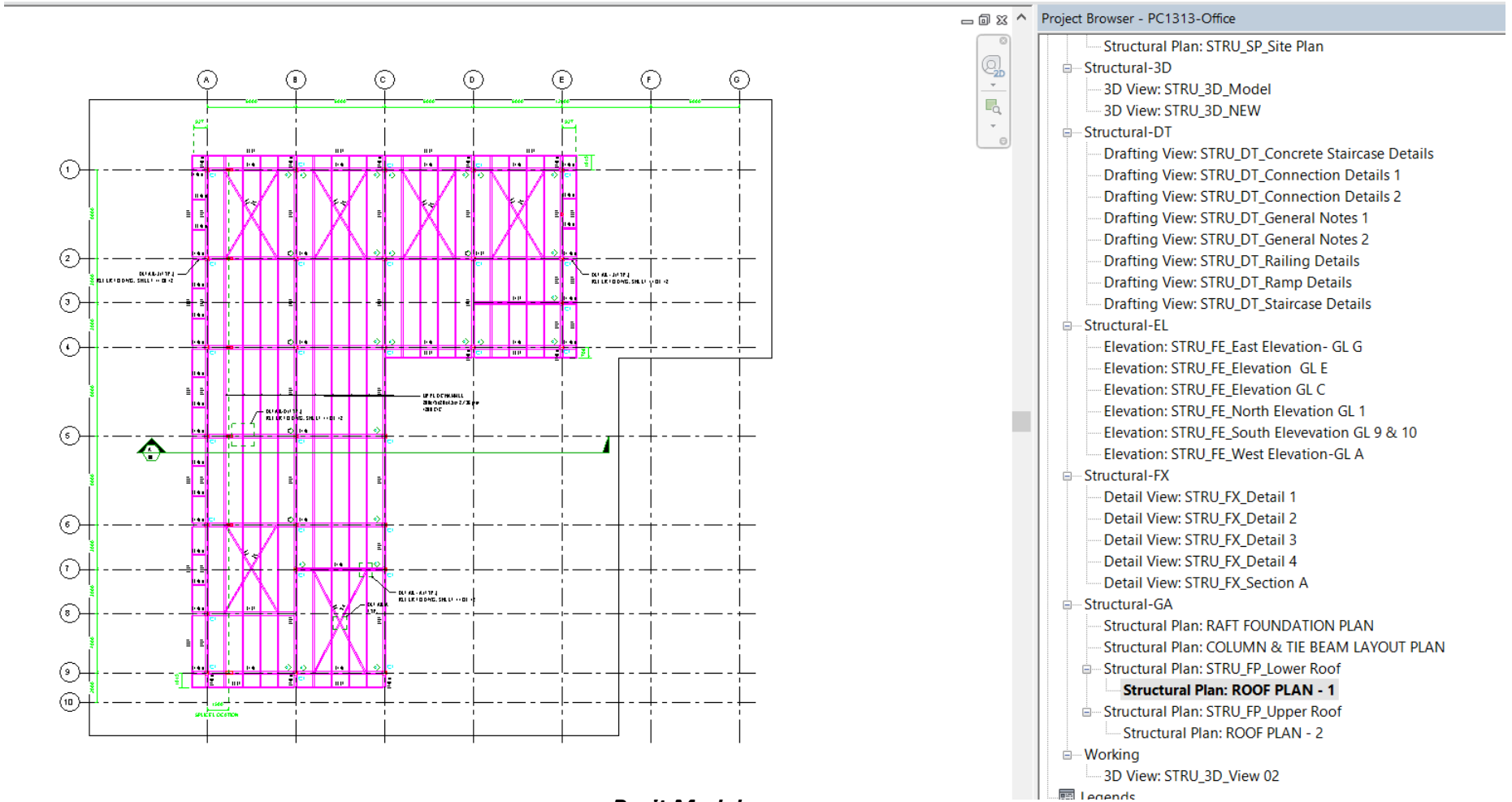


Revit Model

Client: Structural Consultant in Singapore

Proposed Addition of Single Storey Ancillary Office Building to the Existing Oil refinery Complex

Steel Frame Structure - Submission to BCA in Singapore

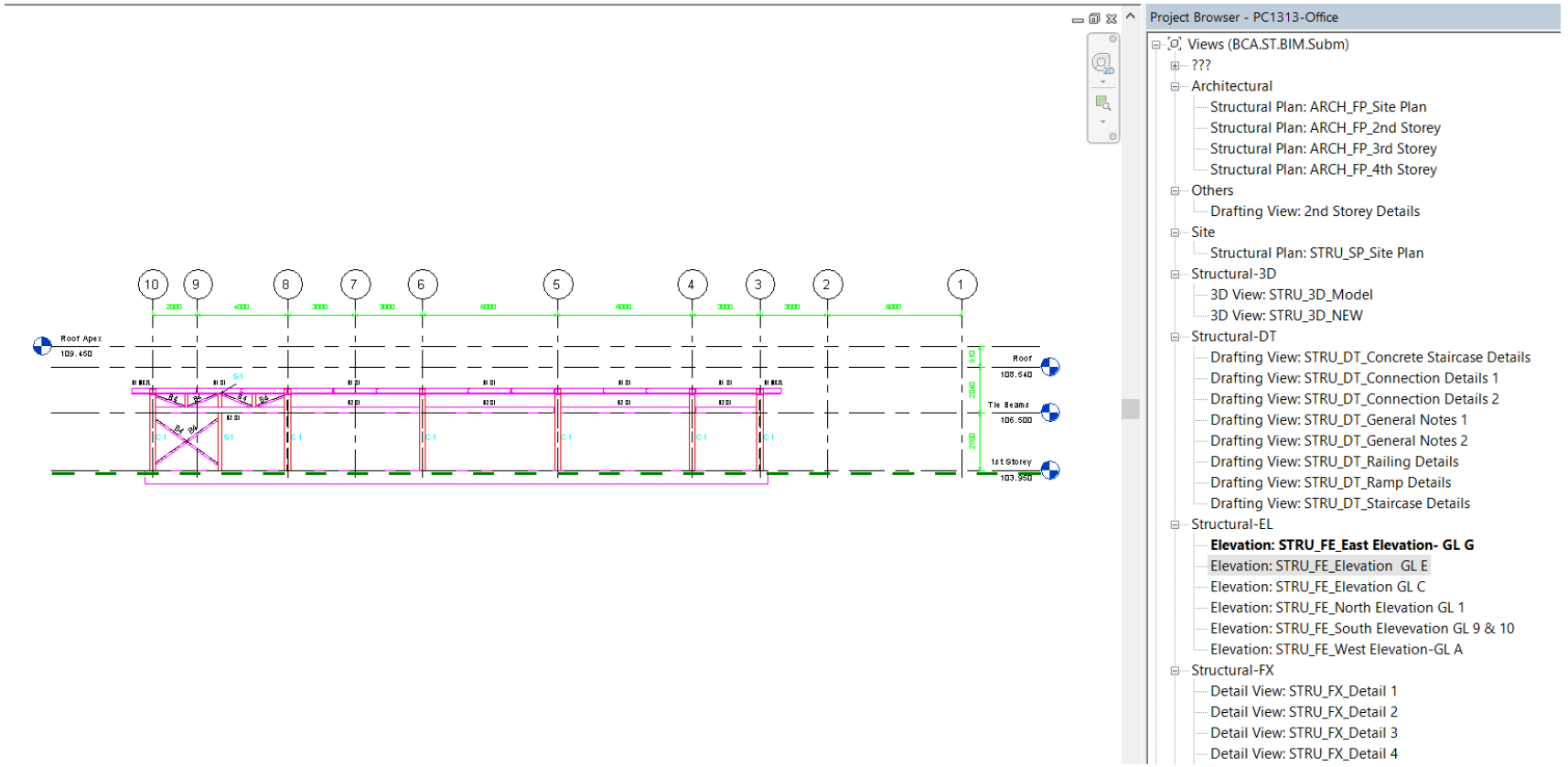


Revit Model

Client: Structural Consultant in Singapore

Proposed Addition of Single Storey Ancillary Office Building to the Existing Oil refinery Complex

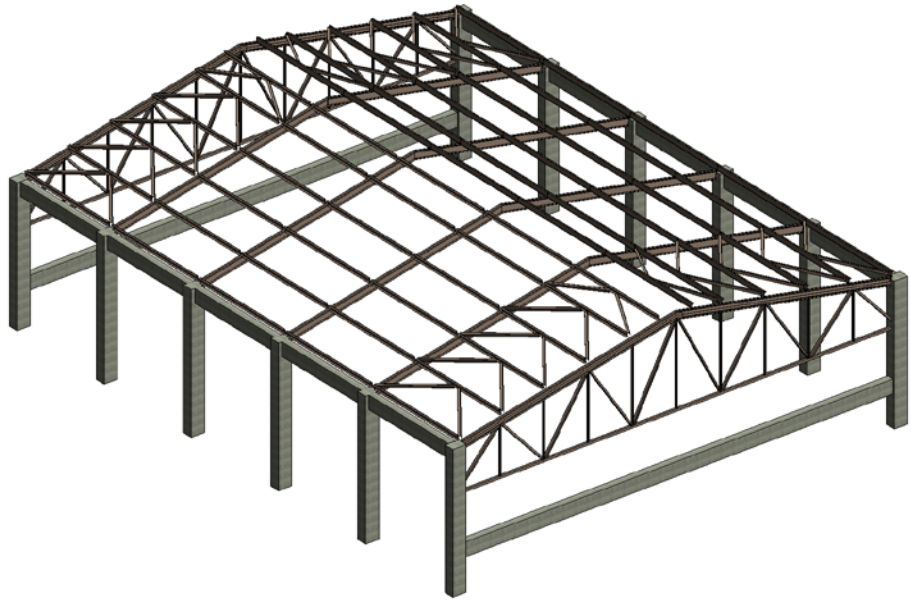
Steel Frame Structure - Submission to BCA in Singapore



Revit Model

Hong Kong Reference Examples

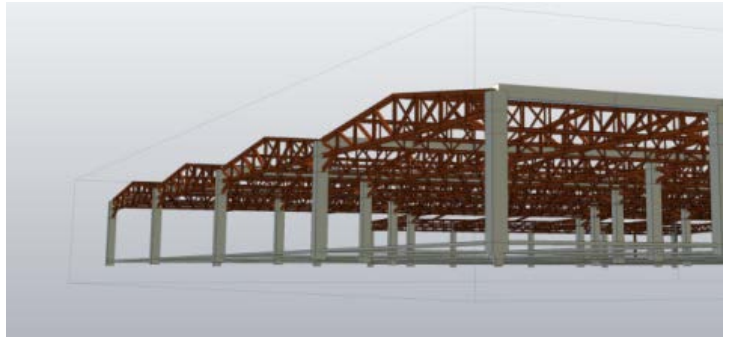
- Steel & Concrete Frame Structure at TKO designed by S-FRAME and S-STEEL
- Designed to The Hong Kong Code of Practice for the Structural Use of Steel 2011



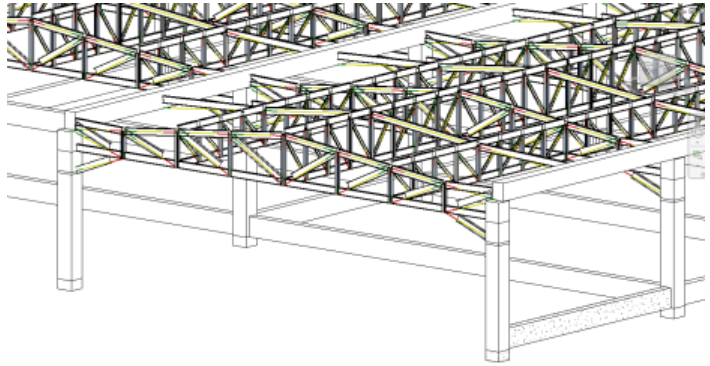
Client Example (Hong Kong)

Steel & Concrete Frame Structure
at TKO designed by S-FRAME and S-STEEL
Designed to The Hong Kong Code of Practice for the Structural Use of Steel

Real Structure on Site



S-FRAME Design Model



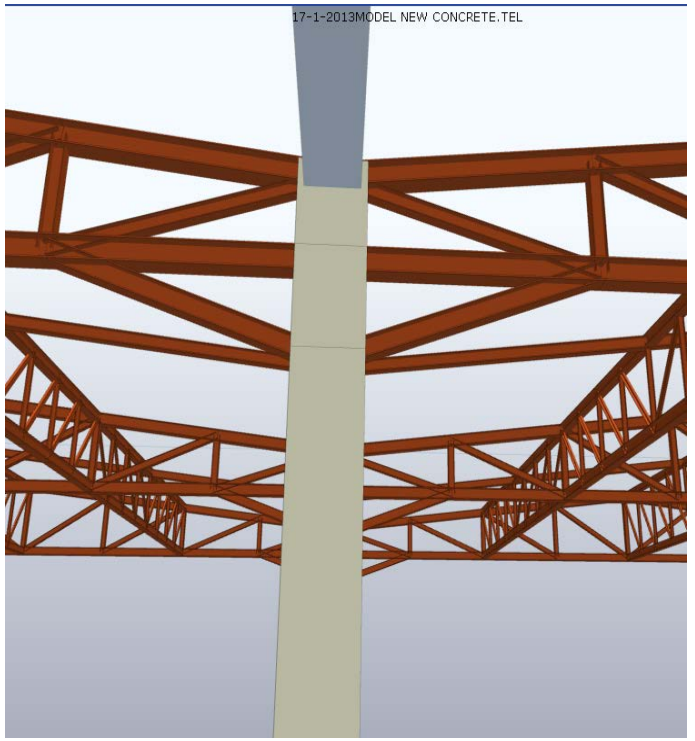
Revit Structure Model

Image courtesy by S.T. Wong & Partners Limited

Client: Client in Hong Kong

Steel & Concrete Frame Structure
at TKO designed by S-FRAME and S-STEEL
Designed to The Hong Kong Code of Practice for the Structural Use of Steel

Real Structure on Site



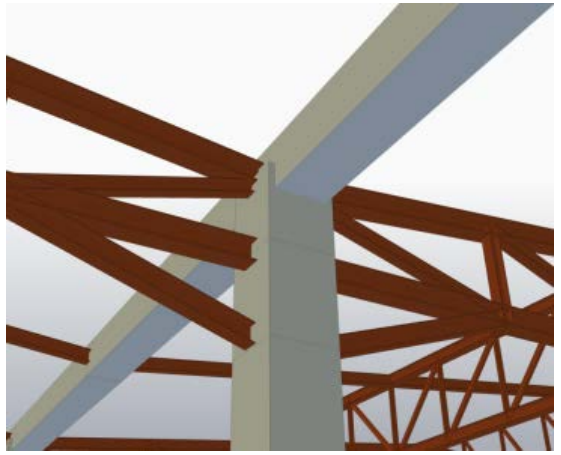
S-FRAME BIM Design Model

Image courtesy by S.T. Wong & Partners Limited

Client: Steel Frame Supported by Concrete Column Project in TKO

Steel & Concrete Frame Structure
at TKO designed by S-FRAME and S-STEEL
Designed to The Hong Kong Code of Practice for the Structural Use of Steel

Real Structure on Site

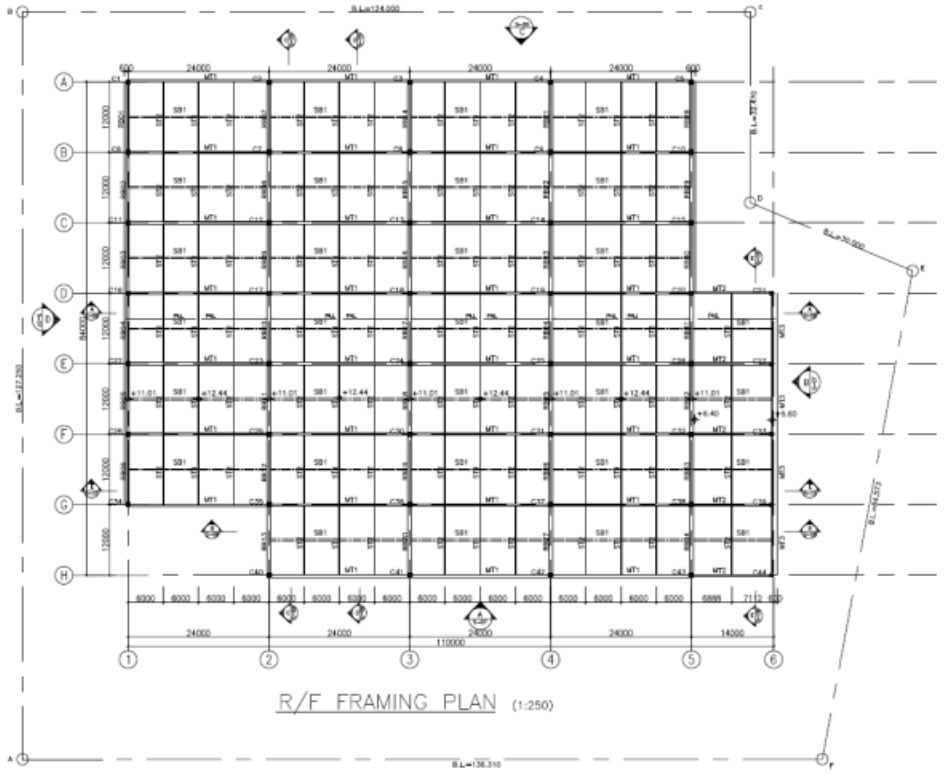


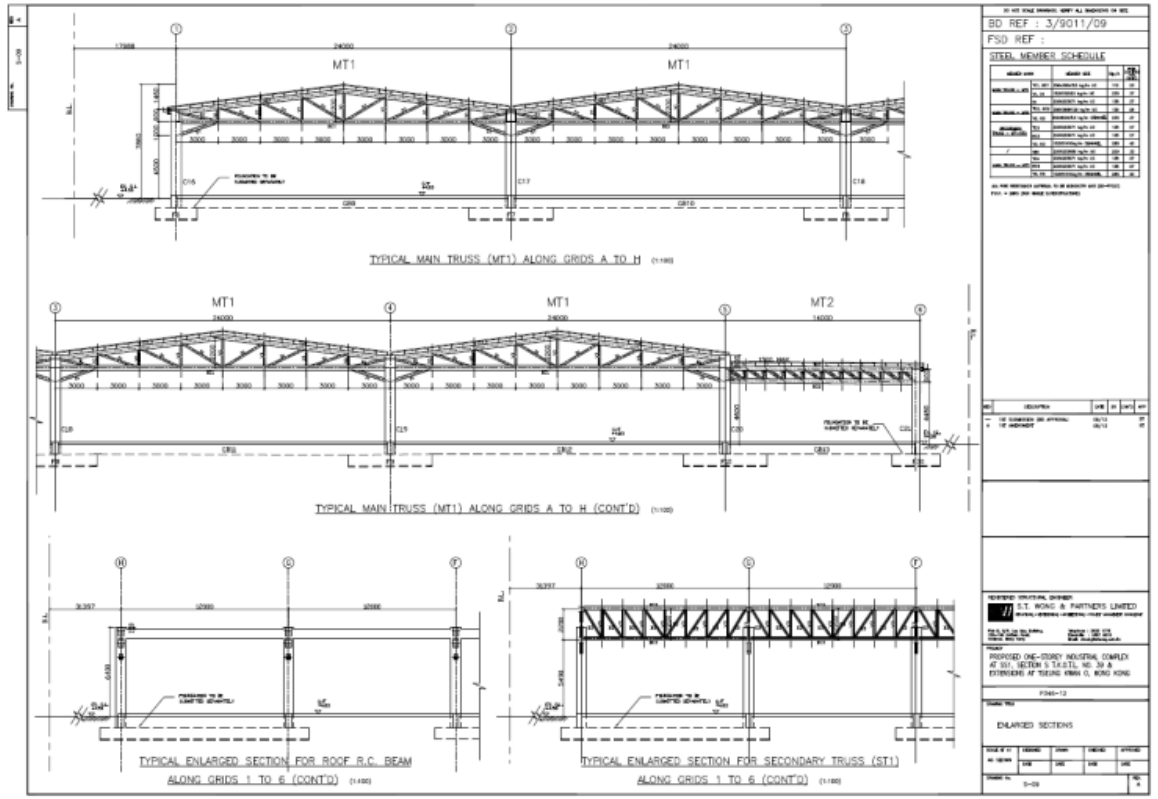
S-FRAME BIM Design Model

Image courtesy by S.T. Wong & Partners Limited

Client Example

Steel & Concrete Frame Structure
at TKO designed by S-FRAME and S-STEEL
Designed to The Hong Kong Code of Practice for the Structural Use of Steel



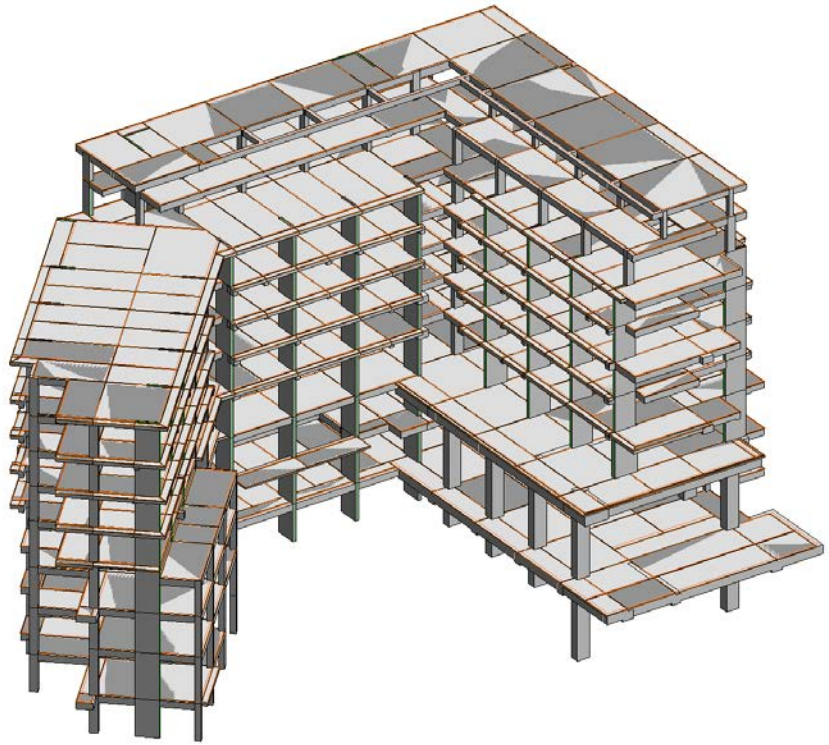


Drawing by Revit & AutoCAD

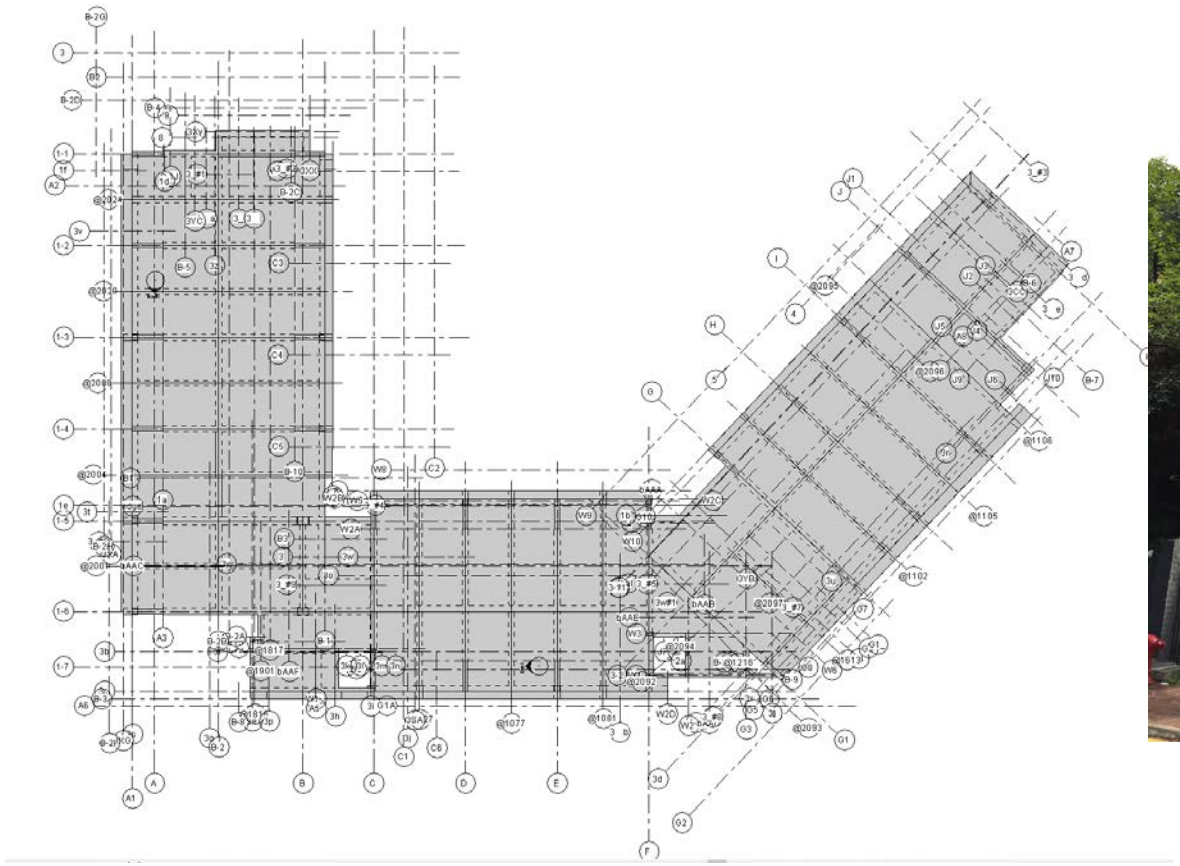
Image courtesy by S.T. Wong & Partners Limited

Hong Kong Reference Examples

- CUHK Student Dormitory Building
  - Already build and used BIM for collaborating with Architects



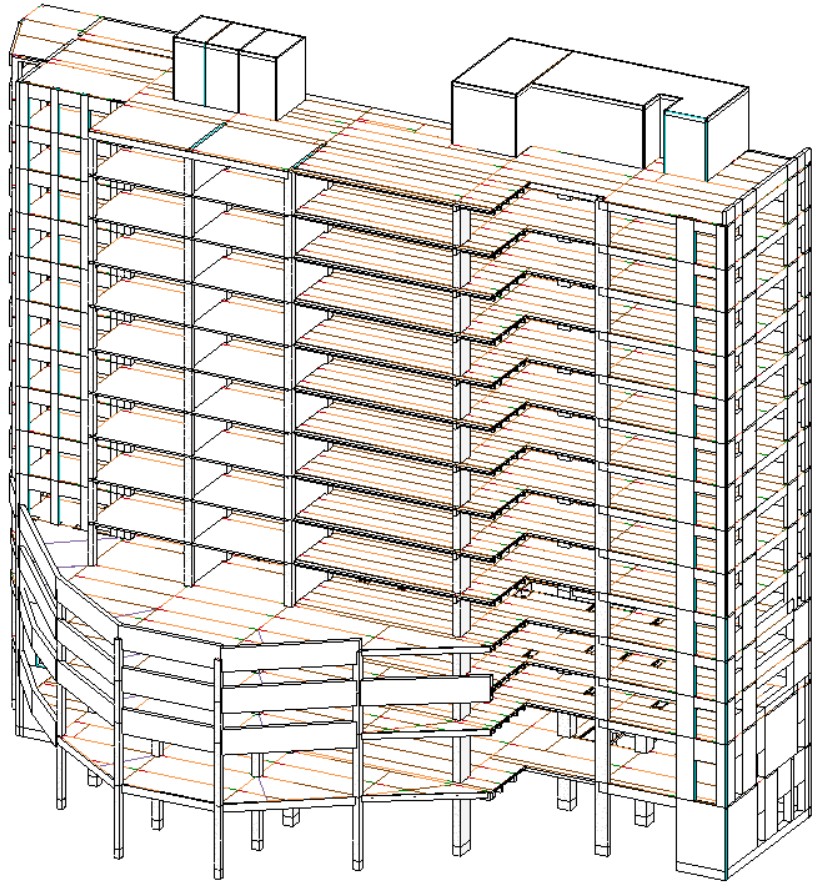
Hong Kong Reference Examples



Hong Kong Reference Examples

- # Hong Kong Reference Examples

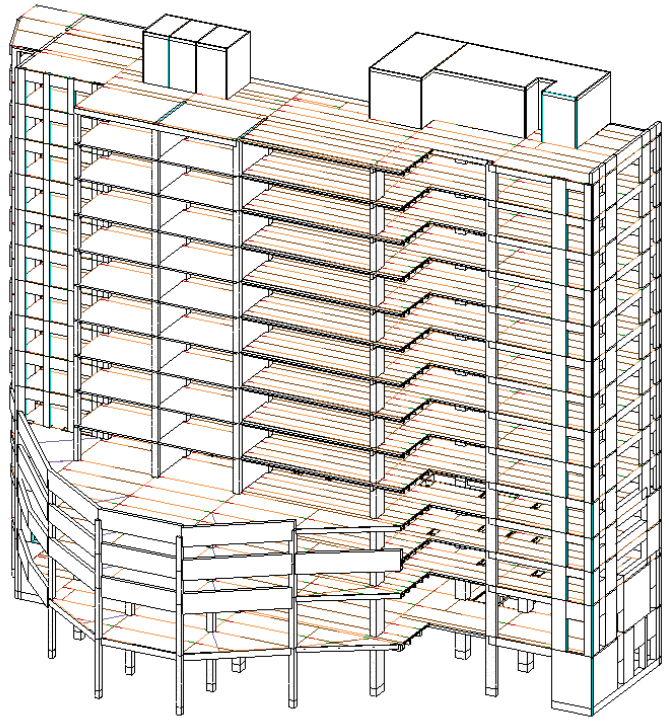
  - ## Wo Yi Hop Road Hotel Re-development from Industrial Building



Recommended Work Flow

- **A Project in HK and Client's requirements:**

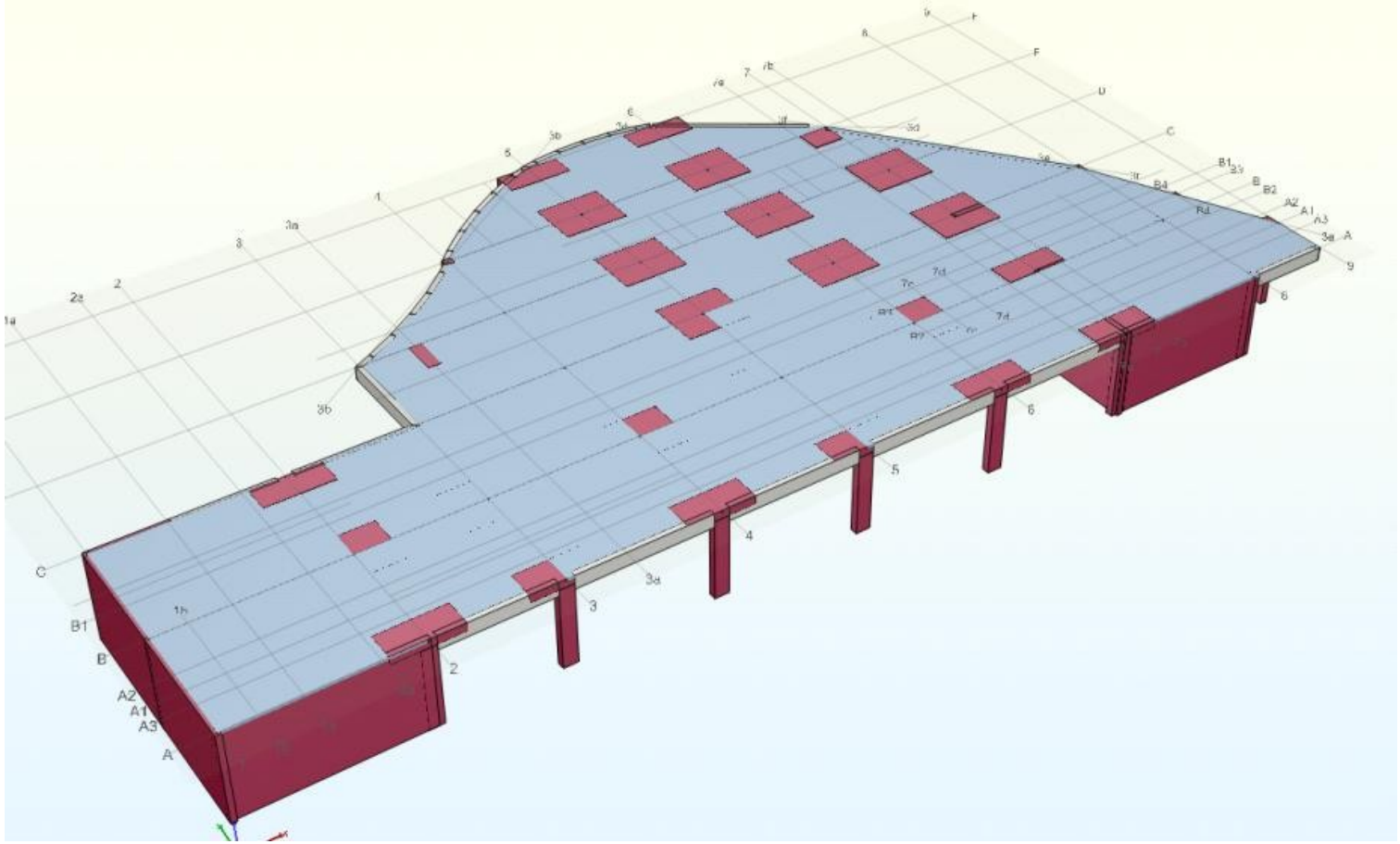
  - 1. An existing 7 storey industrial building will be modified for hotel usage.
  - 2. Client requested an Atrium at front door for hotel lobby which required a demolition of core wall entrances at first two floor .
  - 3. Transfer structure is therefore required to support the existing walls and provide rooms for Atrium.
  - 4. Loading for Hotel usage is less then the original industrial building.
  - 5. As Wind load is not controlled in this building as suggested, we expect the new columns and wall load due to transfer structure and wind would still be less then existing column / wall loads.
  - 6. Some wall are added in the building to improve the lateral stiffness due to the removal of structural core wall at center.
  - 7. Steel beams are added on the structure whenever required to strengthen the floor. They are all pinned joints to avoid duplication on lateral stiffness of overall stability.



Recommended Work Flows

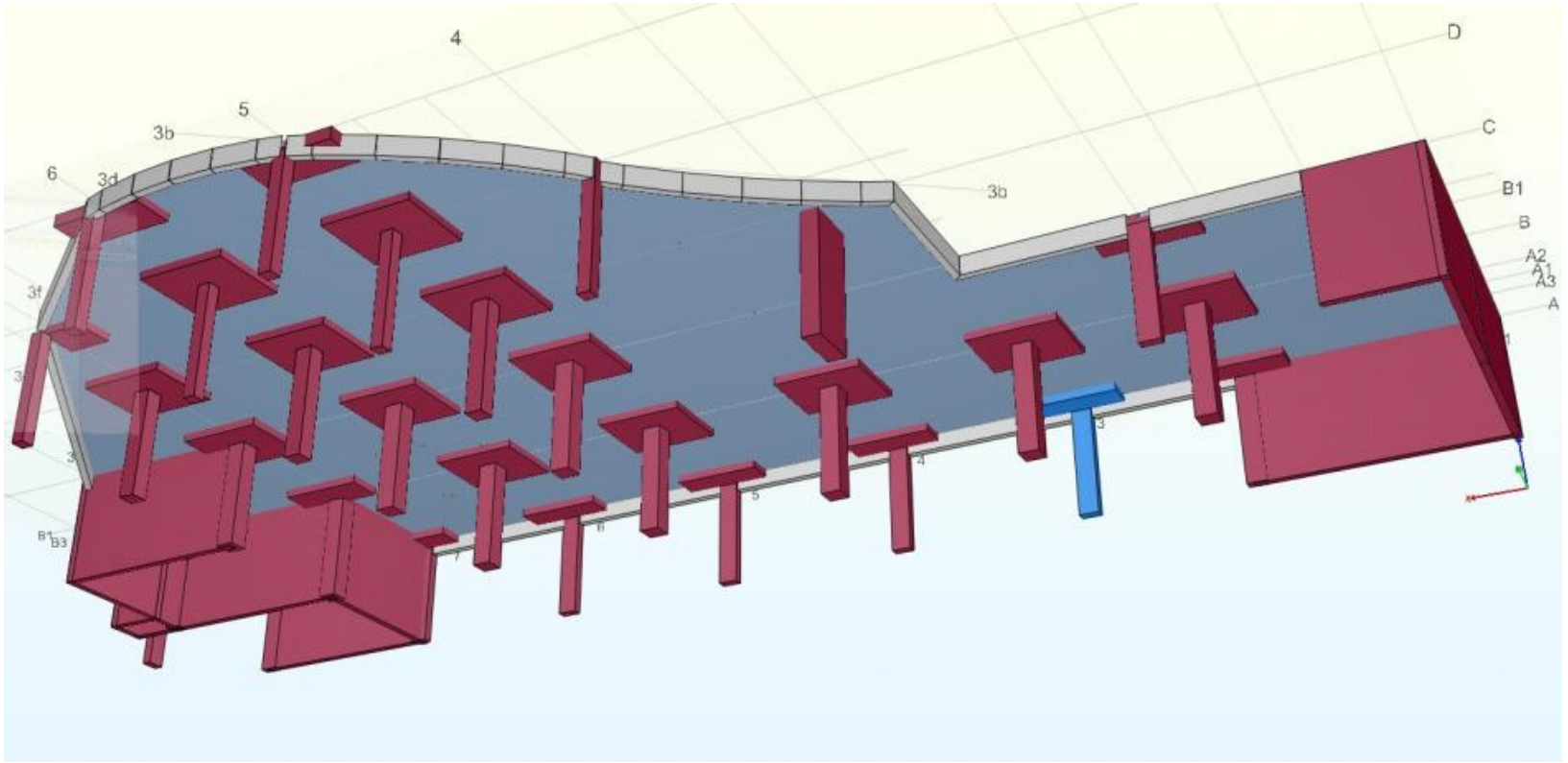
- Structural Analysis Linked with BIM Model
  - Concrete building model in ORION 3 years ago.
  - Exported model to S-FRAME
  - Proposed to Perform advance analysis in S-FRAME for Steel members for final results.
  - Add Steel members for performing design according to Hong Kong Structural Use Of Steel Code 2005 / 2011
  - Export to BIM Model for Discipline coordination

Recommended Work Flows



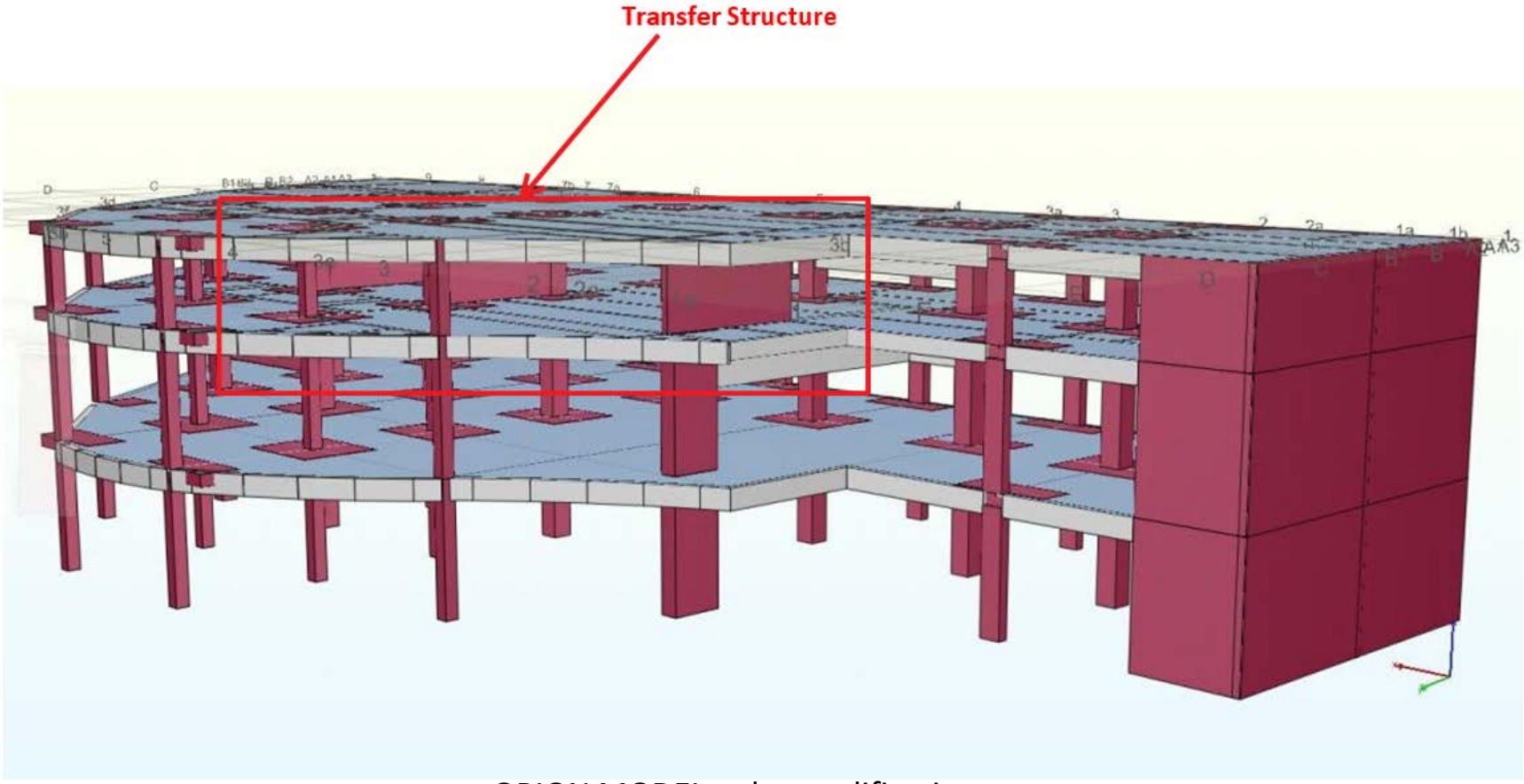
ORION MODEL – Existing Flat Slab

Recommended Work Flows



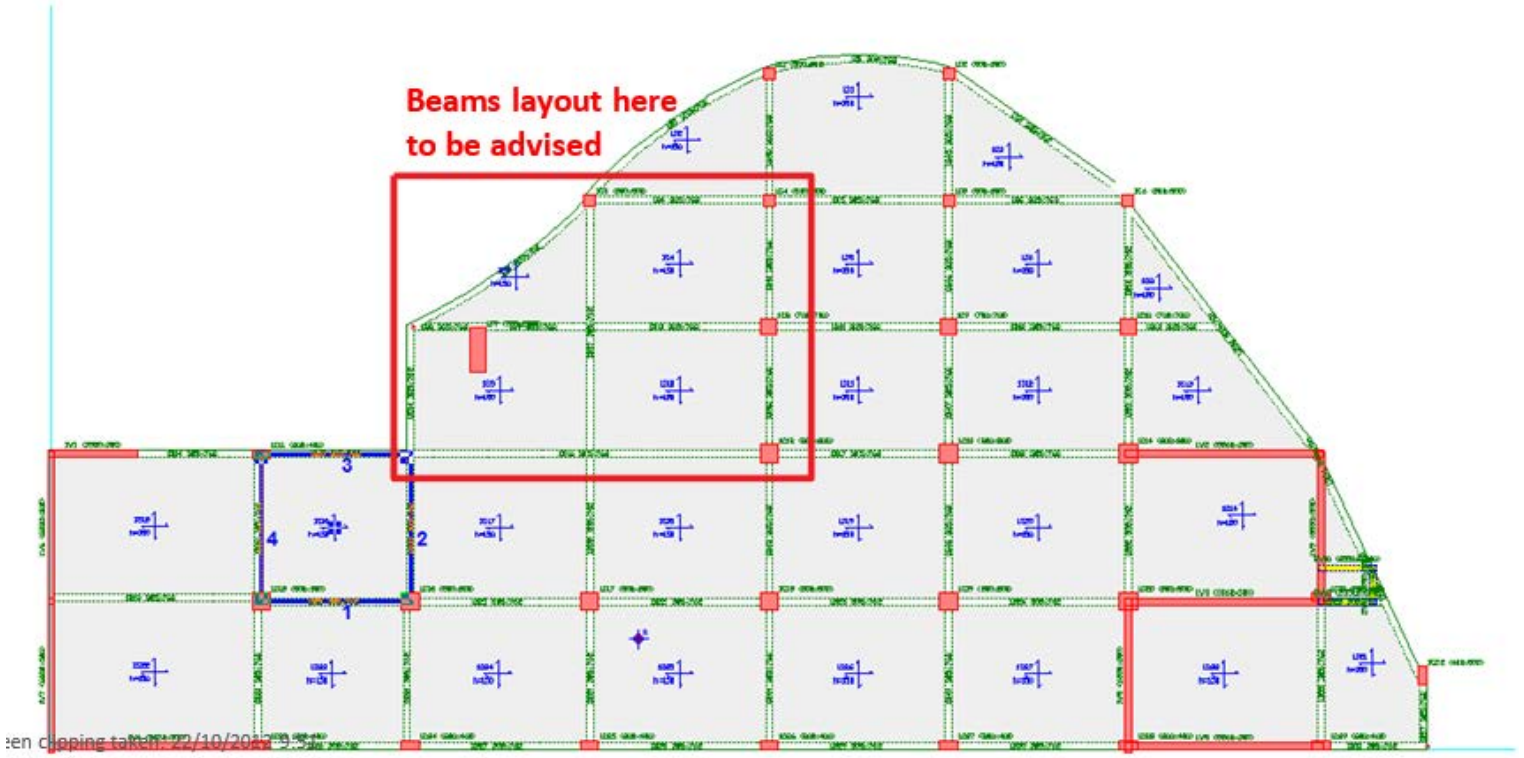
ORION MODEL –
Existing Column Drops

Recommended Work Flows



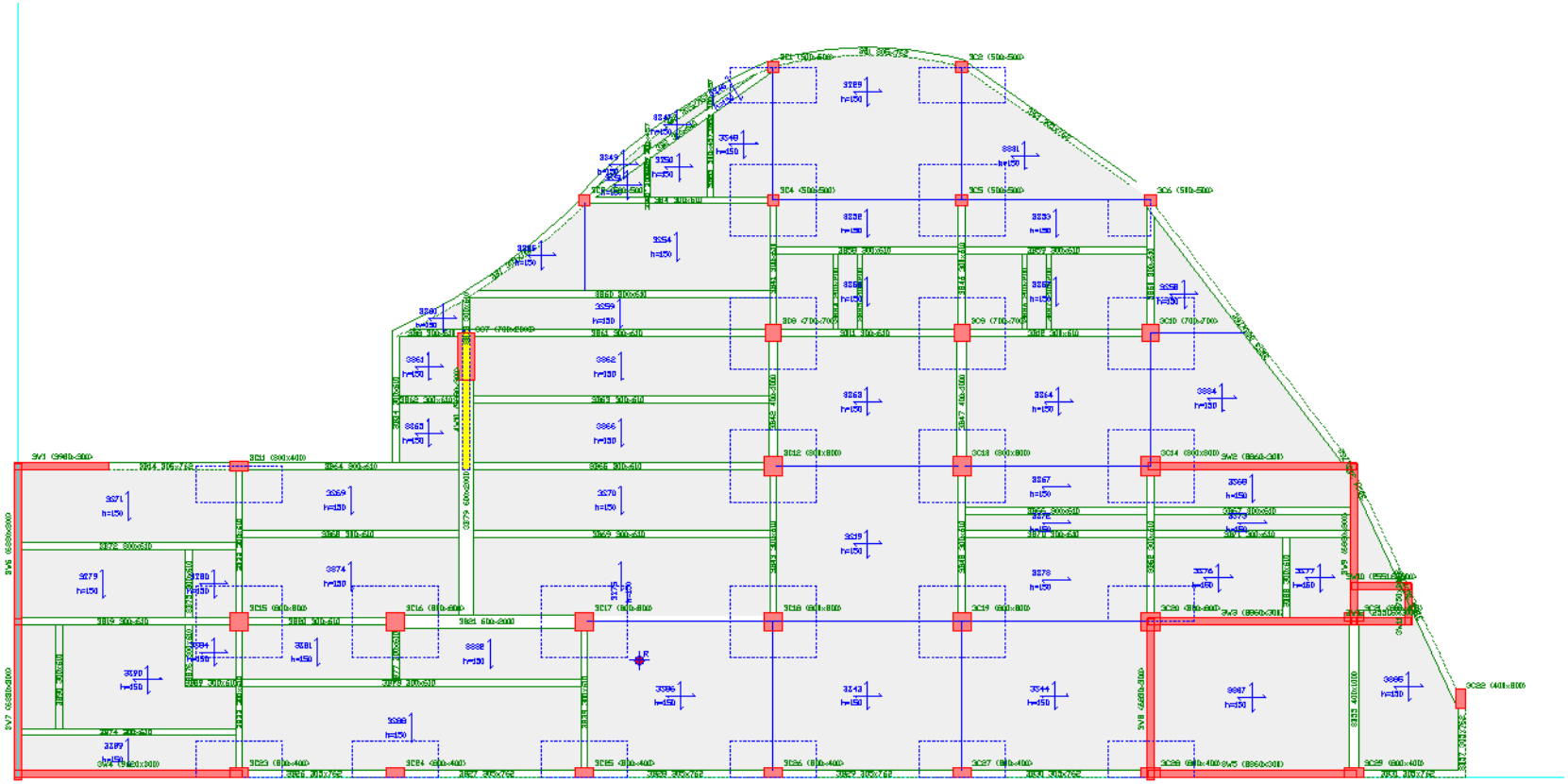
ORION MODEL – the modification works on existing building will required a new transfer structure

Recommended Work Flows



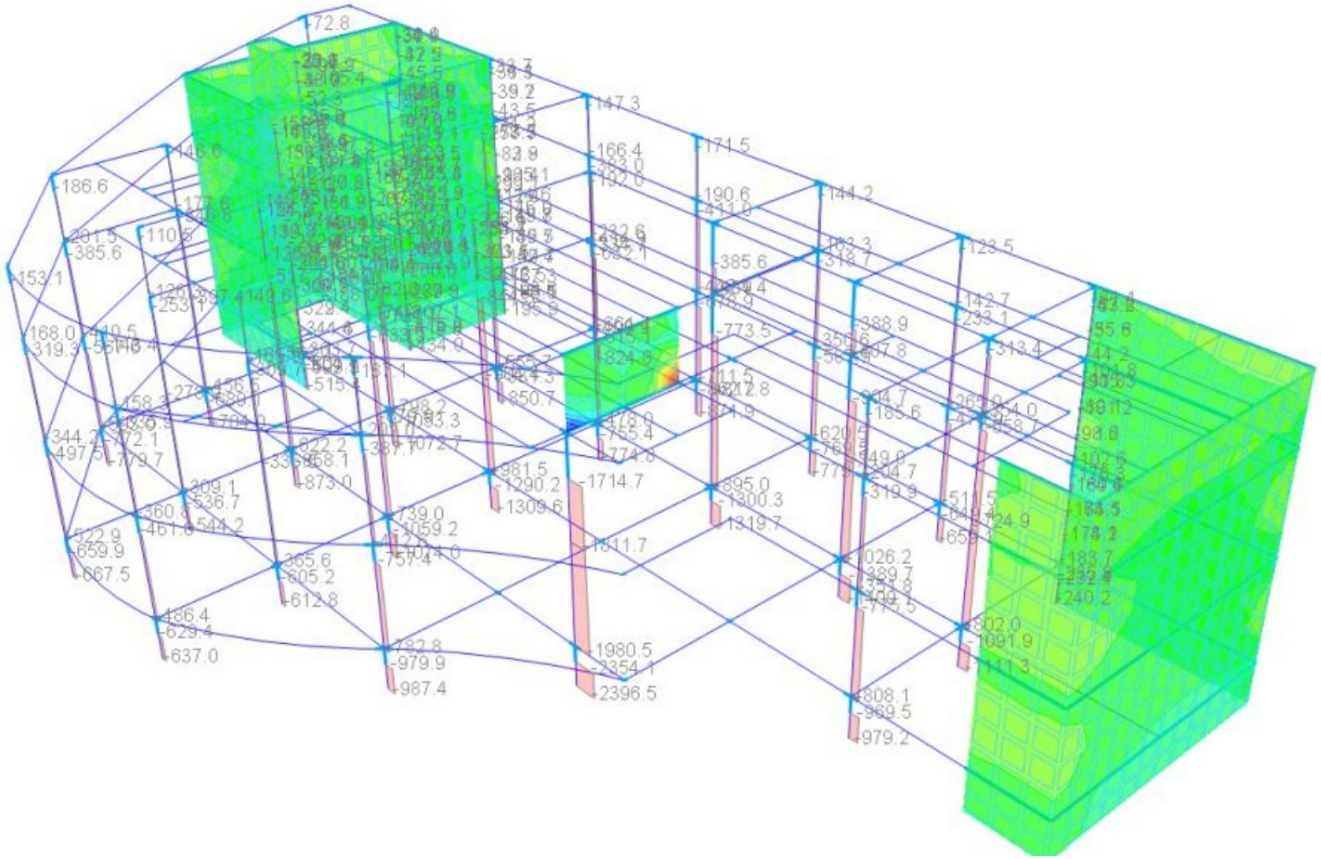
ORION MODEL – Transfer
Structures required steel beams
to support

Recommended Work Flows



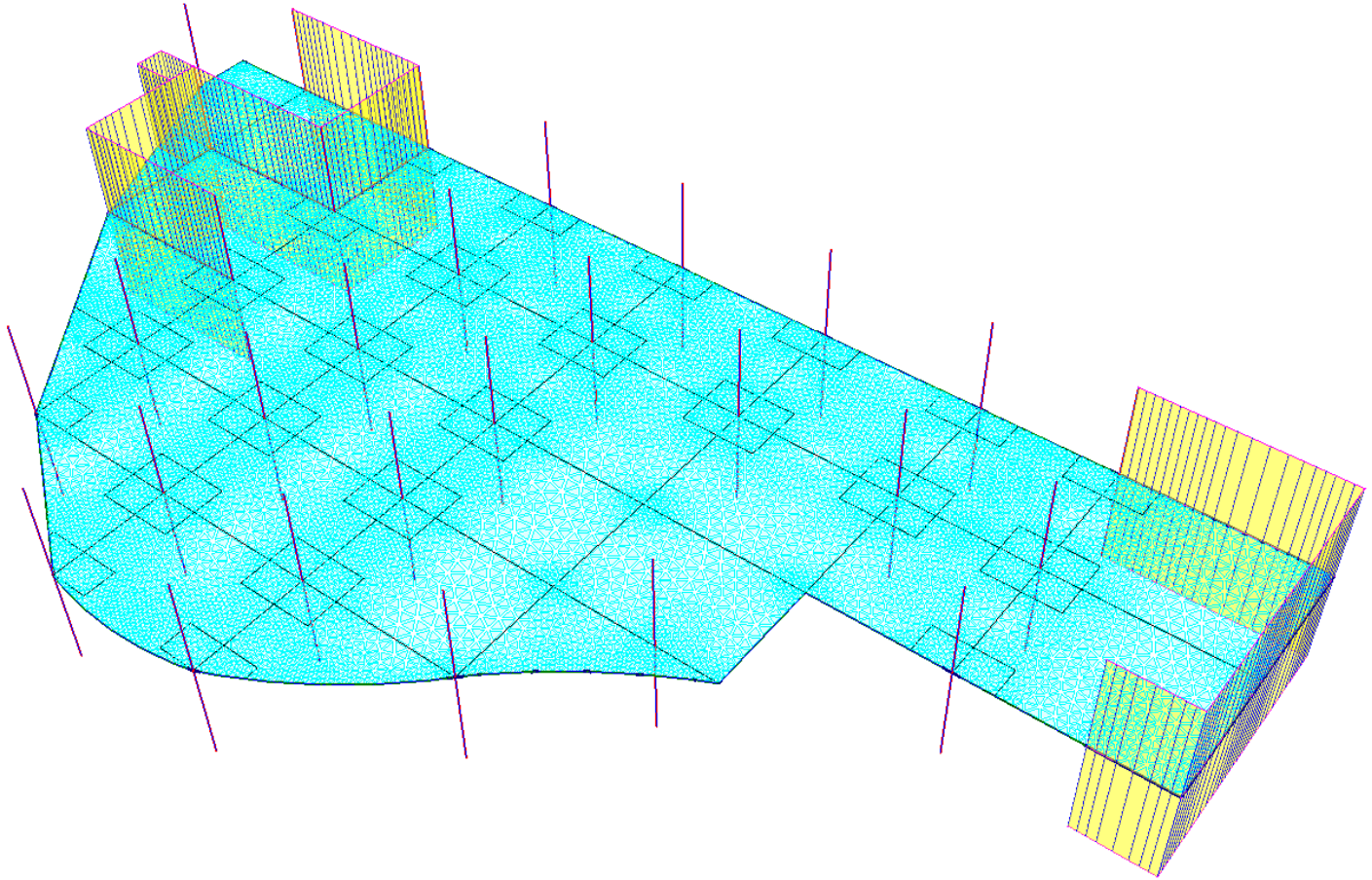
ORION MODEL – Plan Layout with
proposed Steel beams locations

Recommended Work Flows



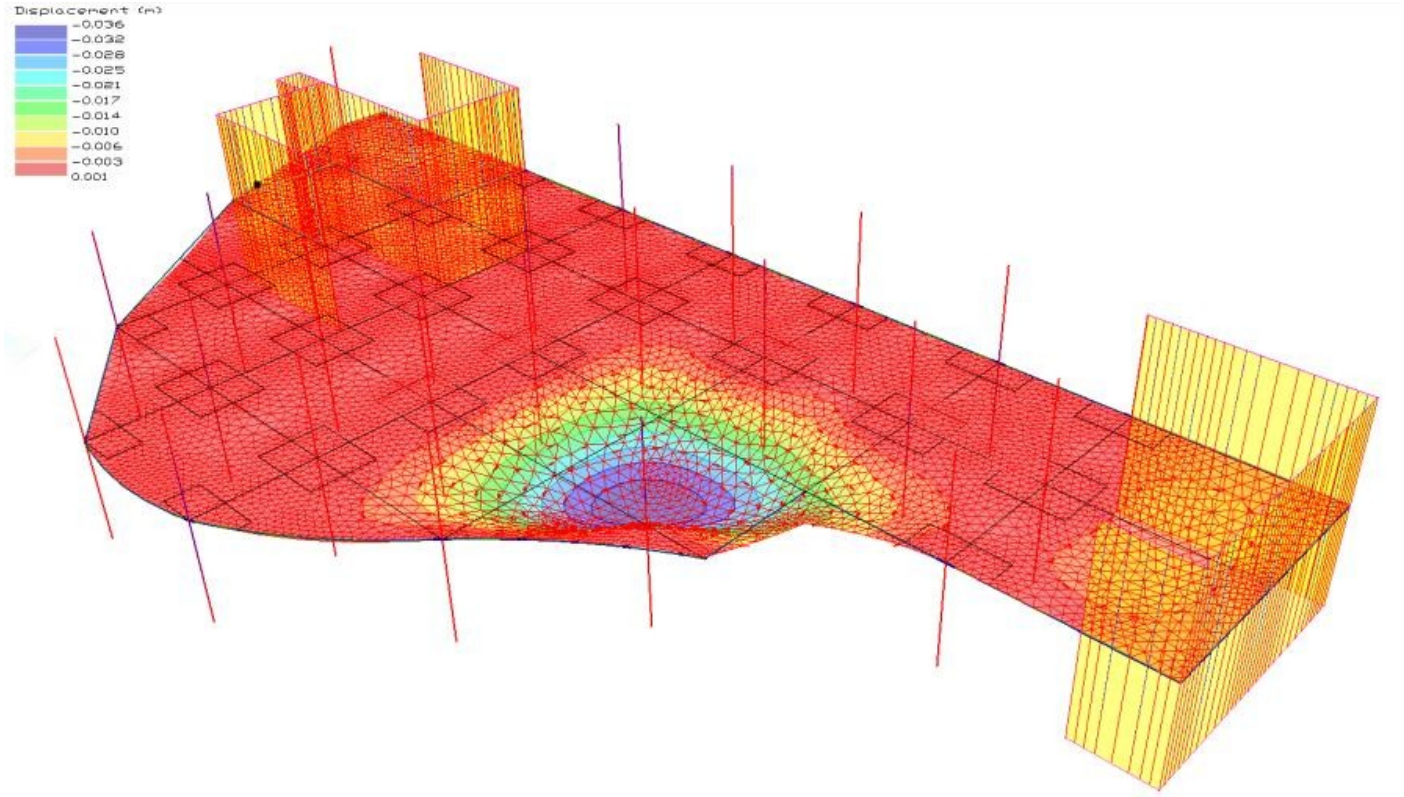
ORION MODEL – Carry out Structural Analysis to find out the loading.

Recommended Work Flows



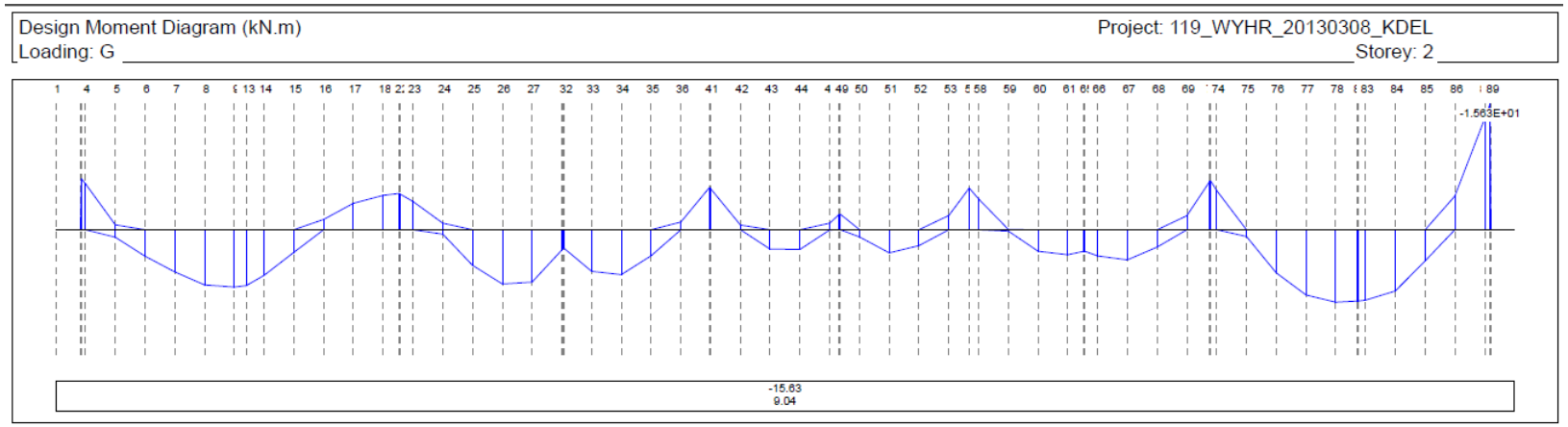
ORION MODEL – Meshing of floor

Recommended Work Flows



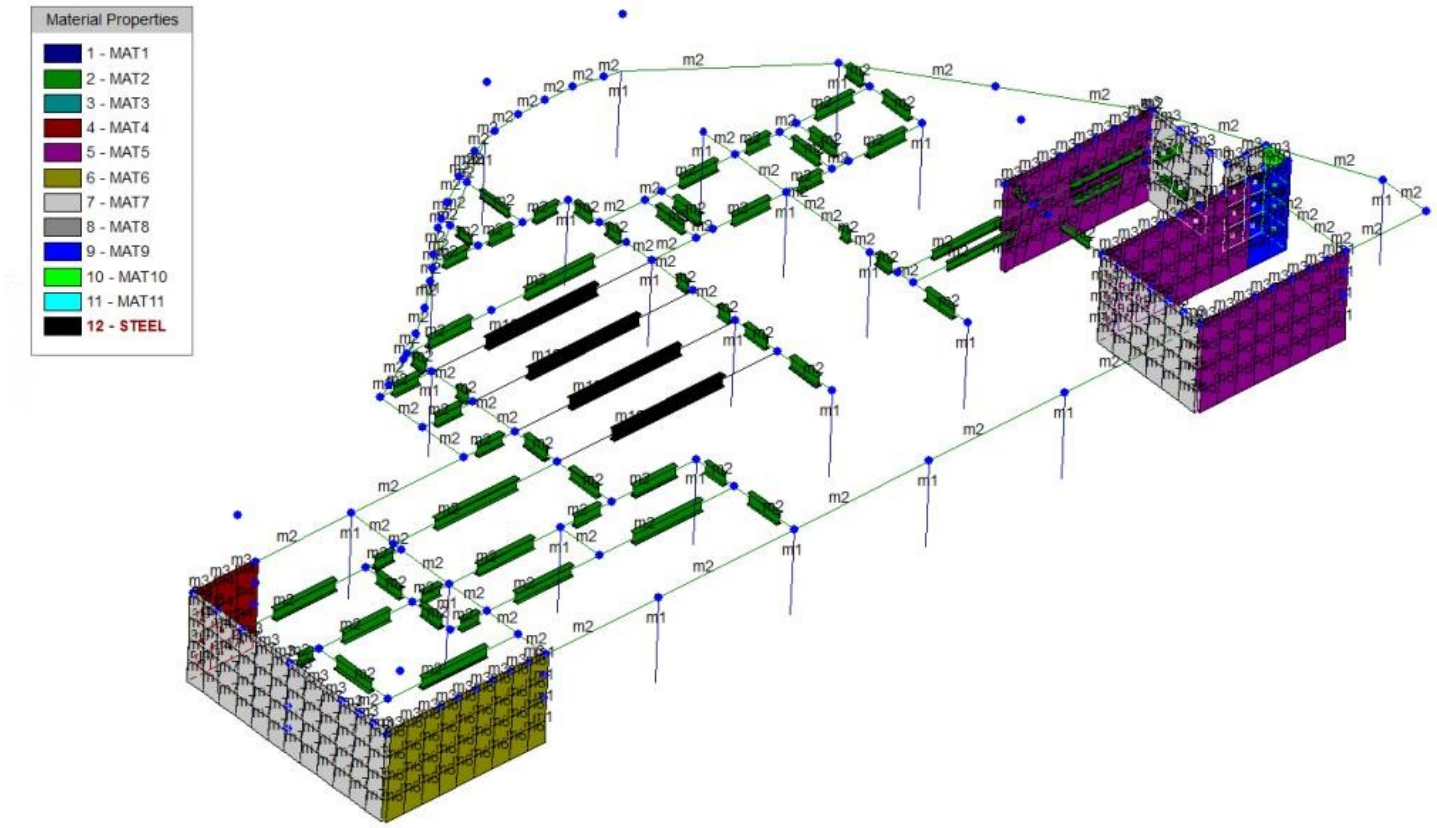
ORION MODEL **Limitation** – Cannot put steel members for model that integrated into the structures with pin joints and change of stiffness that simulating the real situation.

Recommended Work Flows



ORION MODEL **Limitation** – Slab can only show the concrete floor moment diagram integrated with beams support.

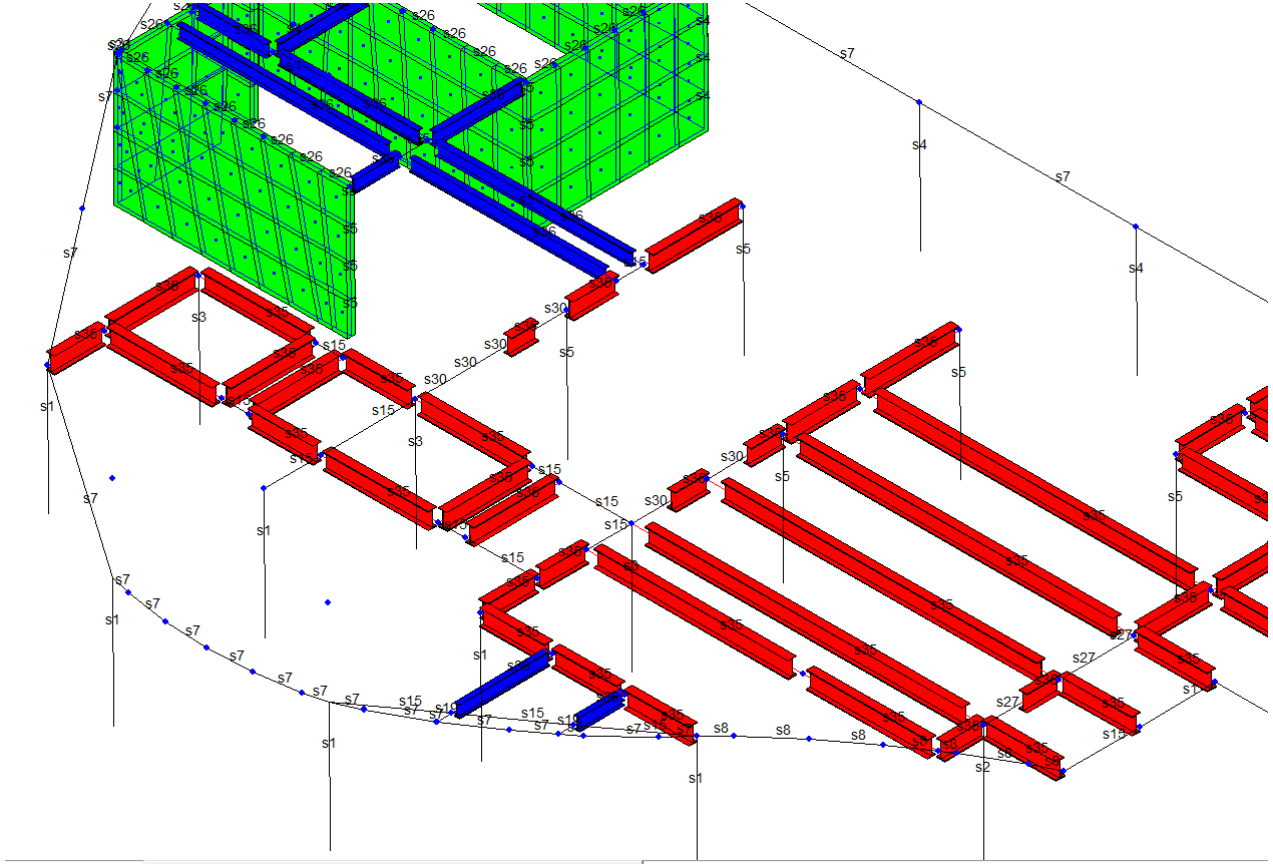
Recommended Work Flows



Export to S-FRAME for carrying out steel design.

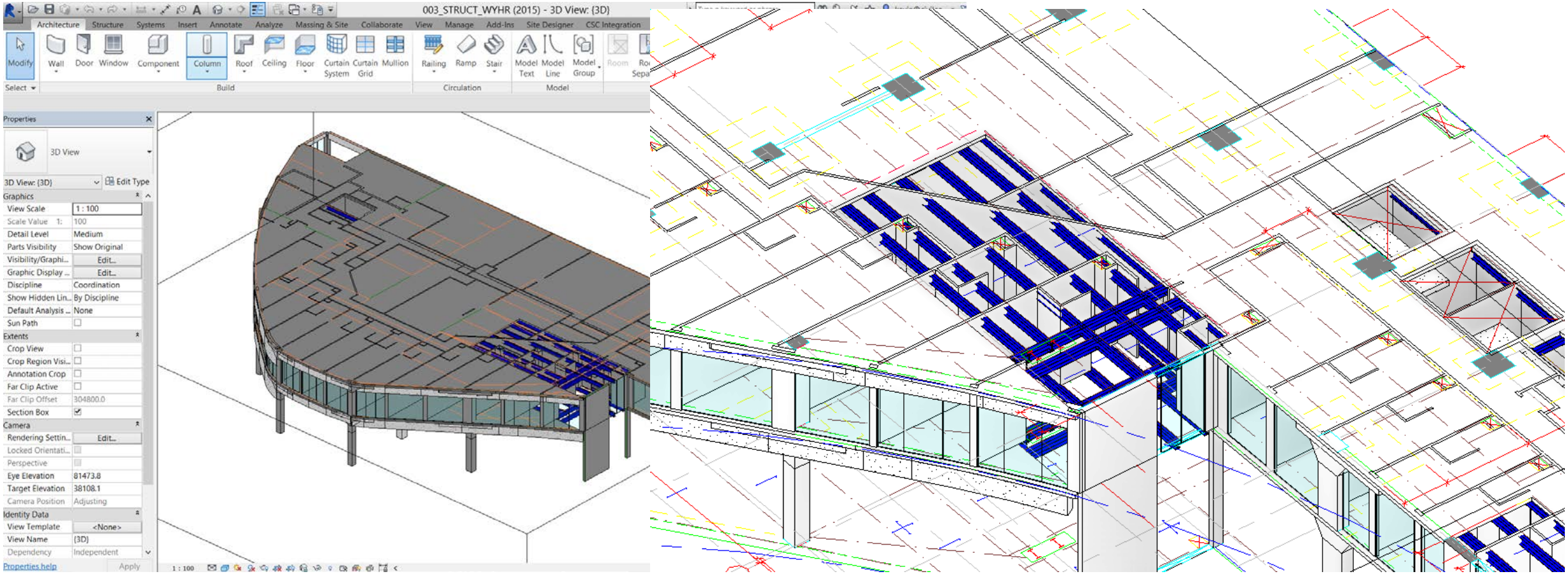
(Whole model with loading are 100% export)

Recommended Work Flows



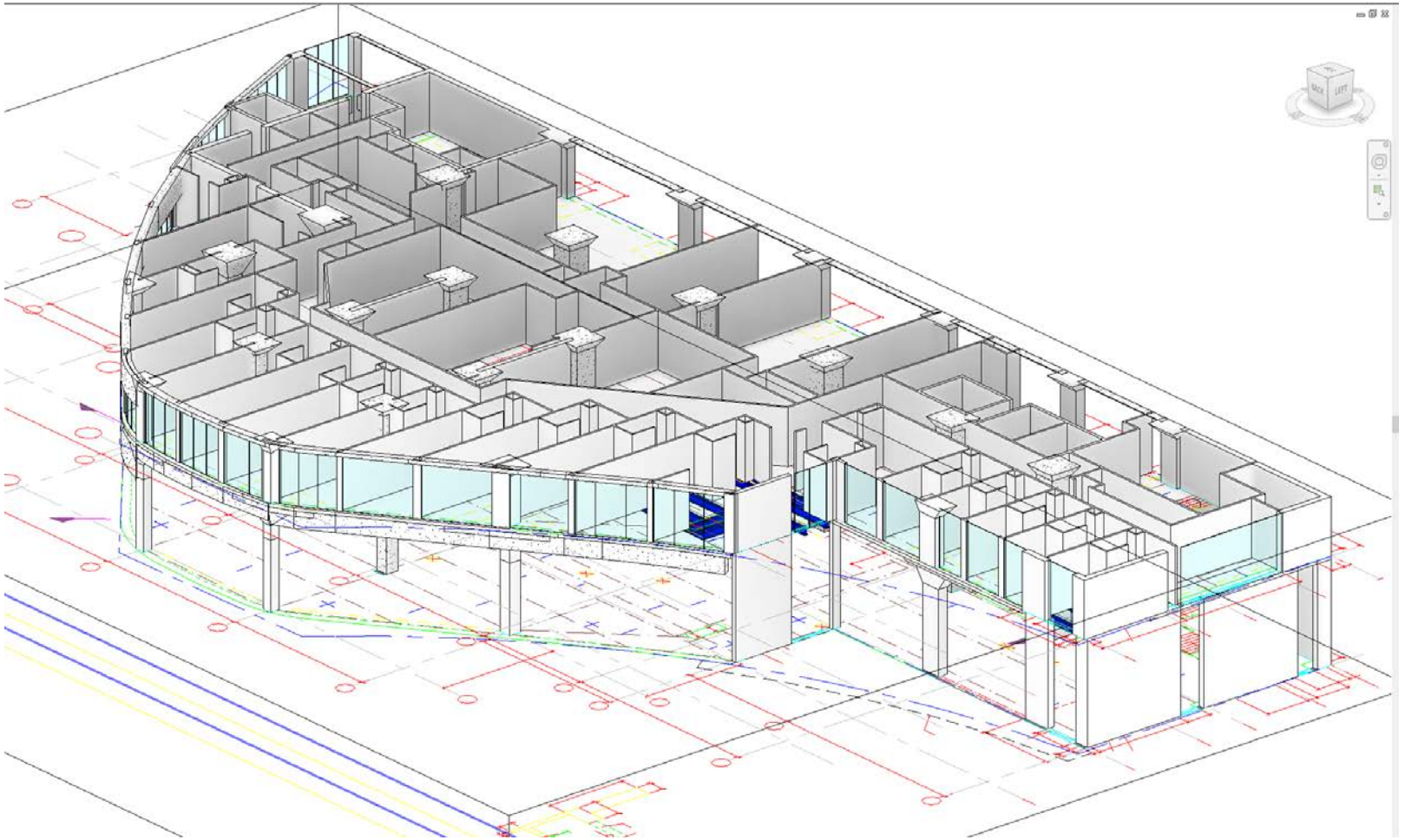
Define one whole floor with meshing, re-run again, then the steel members are designed according to the loading from the concrete models

Recommended Work Flows



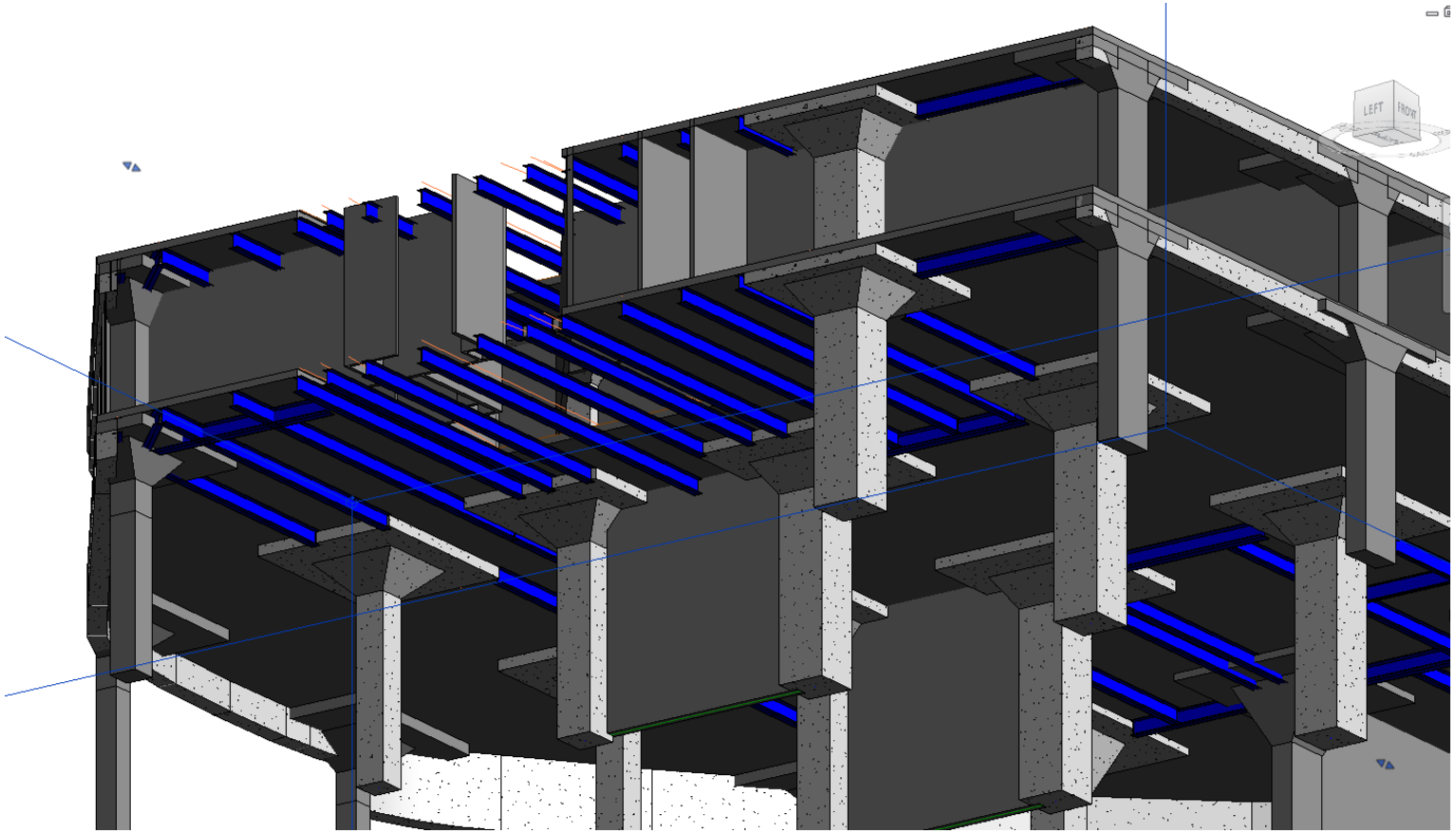
We realize that using Revit model for further coordination would be great benefits to client

Recommended Work Flows



We realize that using Revit model for further coordination would be great benefits to client

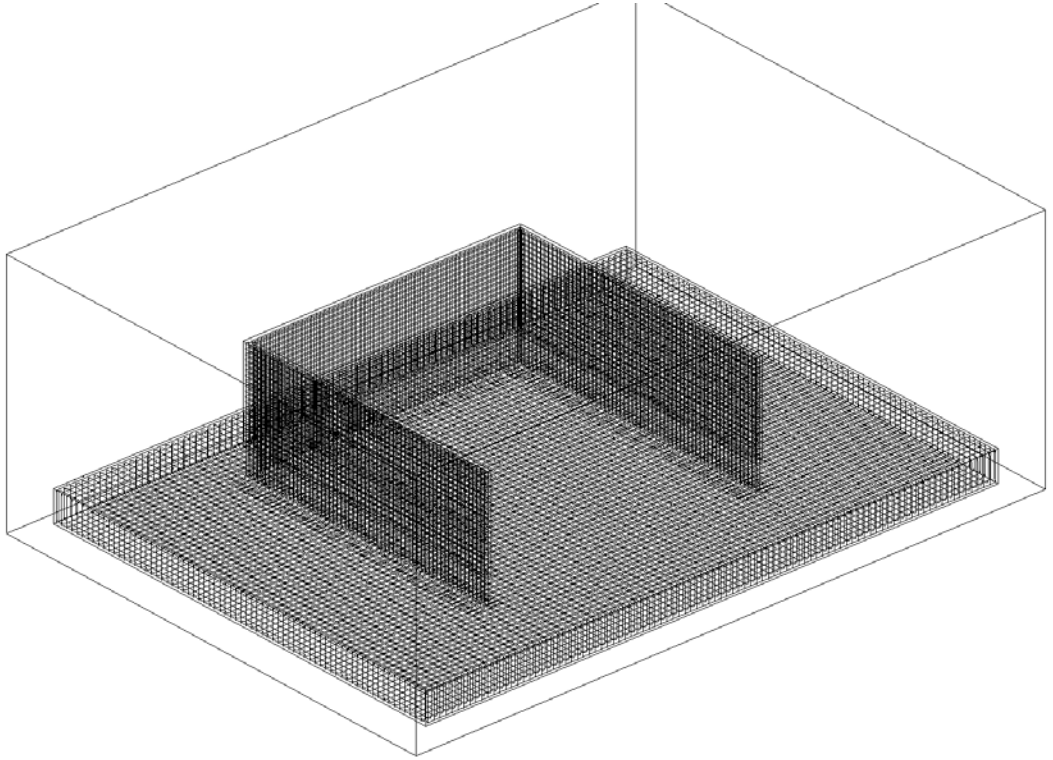
Recommended Work Flows

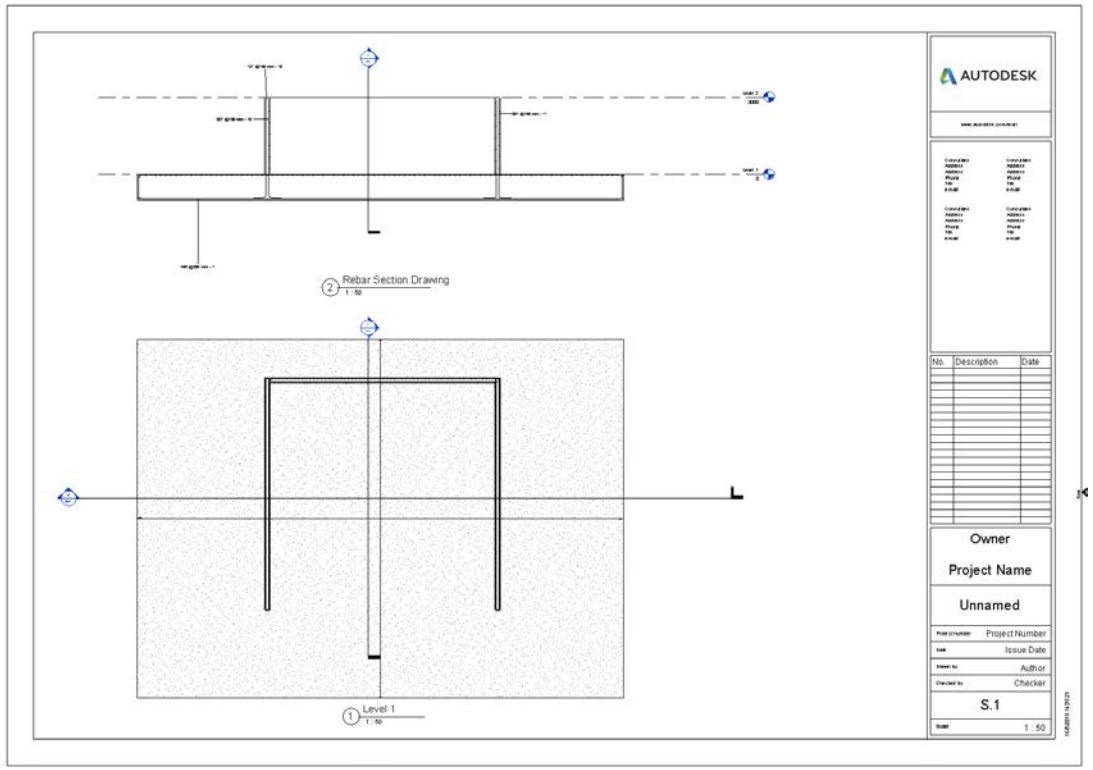


Use Revit model for easier coordination

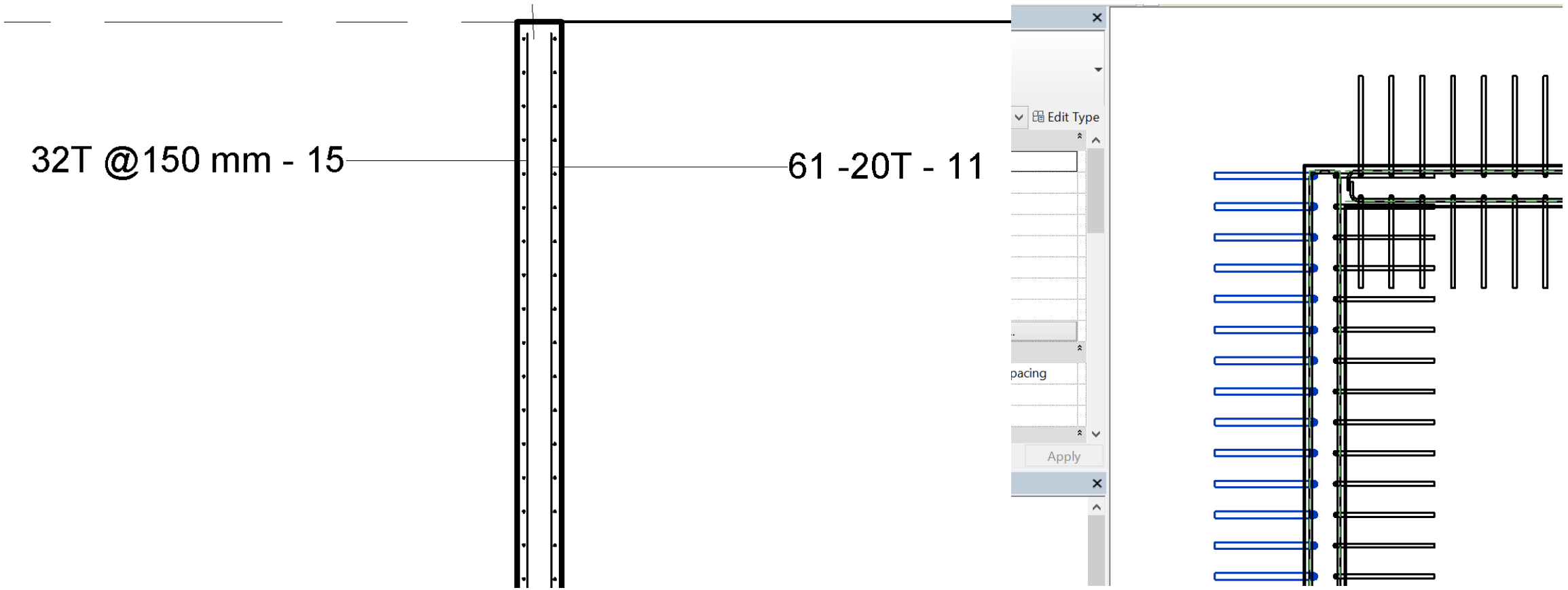
- Hong Kong Reference Examples
  - Rebar Drawing and Raft design for Private housing development in Shouson Hill Road.

Rebar Drawing and Raft design for Private housing development in Shouson Hill Road





Rebar Drawing and Raft design for Private housing development in Shouson Hill Road

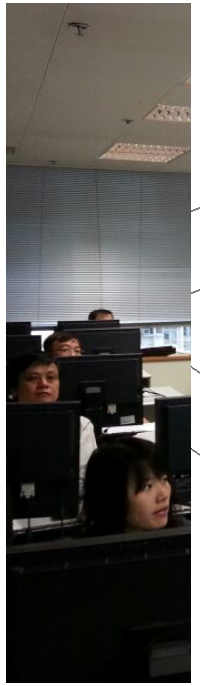


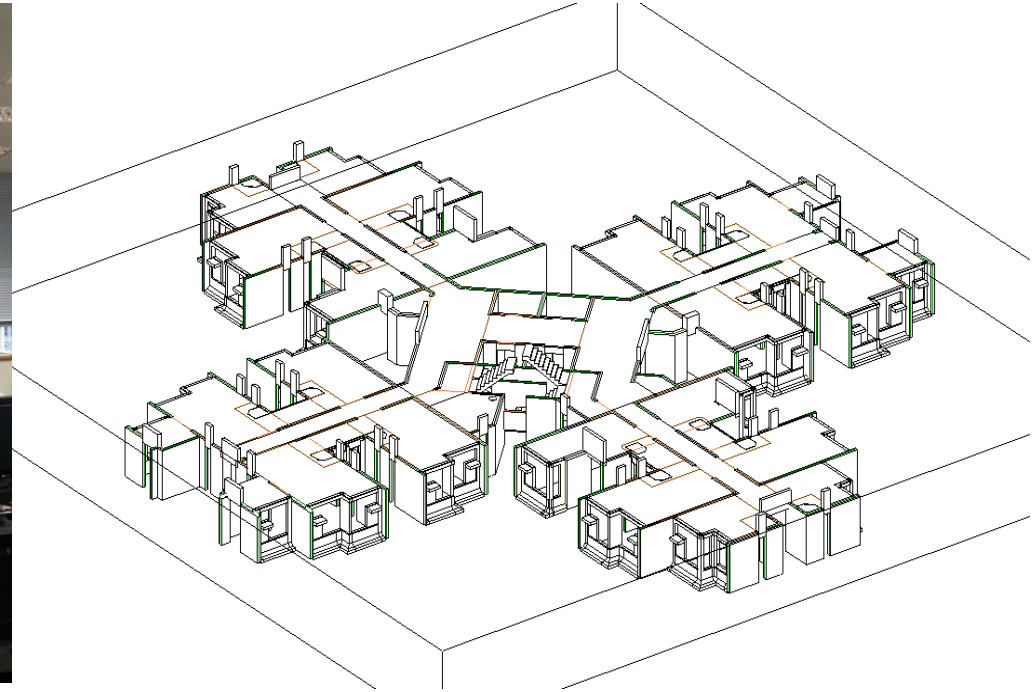
- Hong Kong Reference Examples
  - Hong Kong Housing Authority Structural Standard (SAM)

Project Portfolio

- Carried out **Professional Revit Structure and S-FRAME Training** for Government, Engineering Design Consultants, Contractors, and Educational Institutions across Asia Pacific Regions including Singapore and Malaysia.

Hong Kong Housing Authority
Nov – Dec 2013

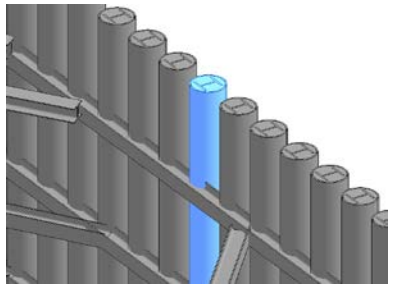


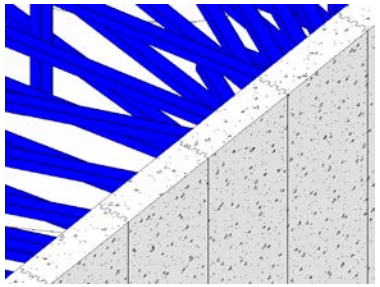


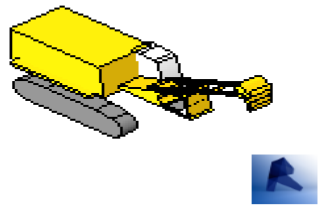
Project Portfolio

- Carried out **Professional Revit Structure and S-FRAME Training** for Government, Engineering Design Consultants, Contractors, and Educational Institutions across Asia Pacific Regions including Singapore and Malaysia.

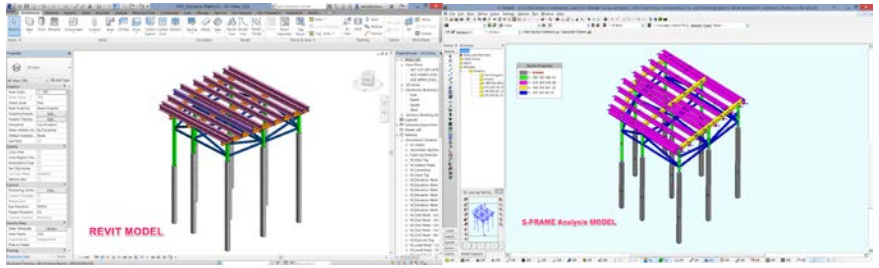
AECOM







協興建築
HIP HING CONSTRUCTION
新創建集團成員 Member of NWS Holdings



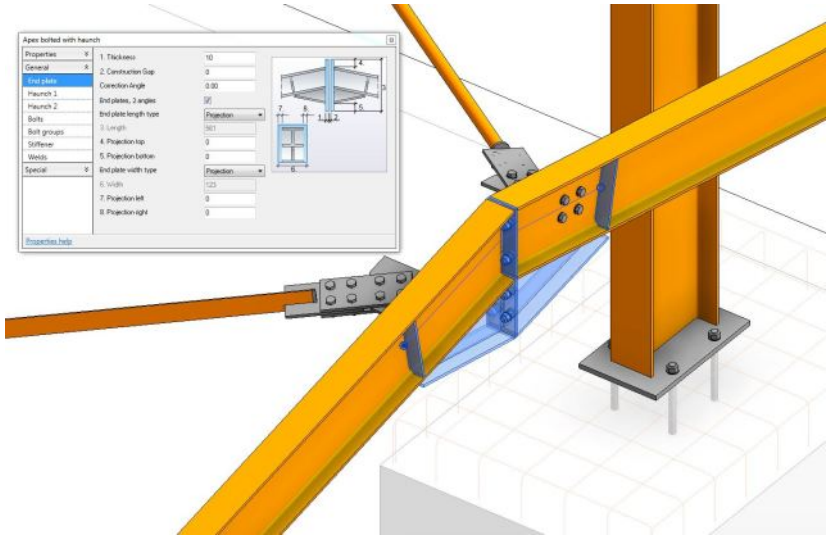
VICON Construction Co. Ltd.

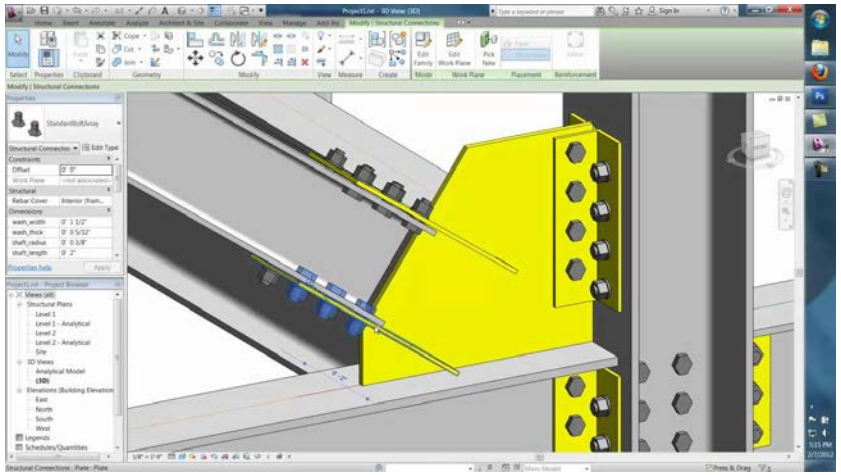
BD Submission Examples following ADV-34

Superstructure Plans

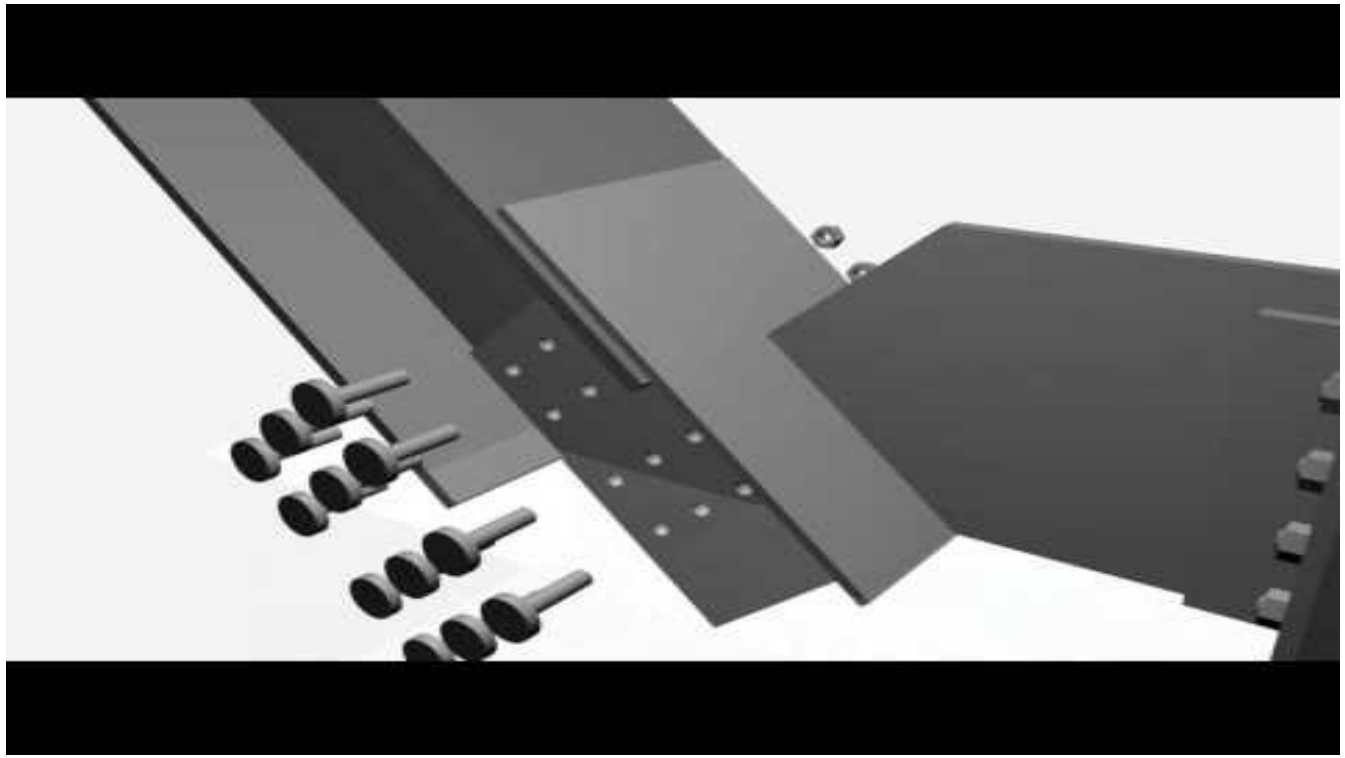
Complex steel structures and/or connections;

Building Information Model	Real-time Simulation





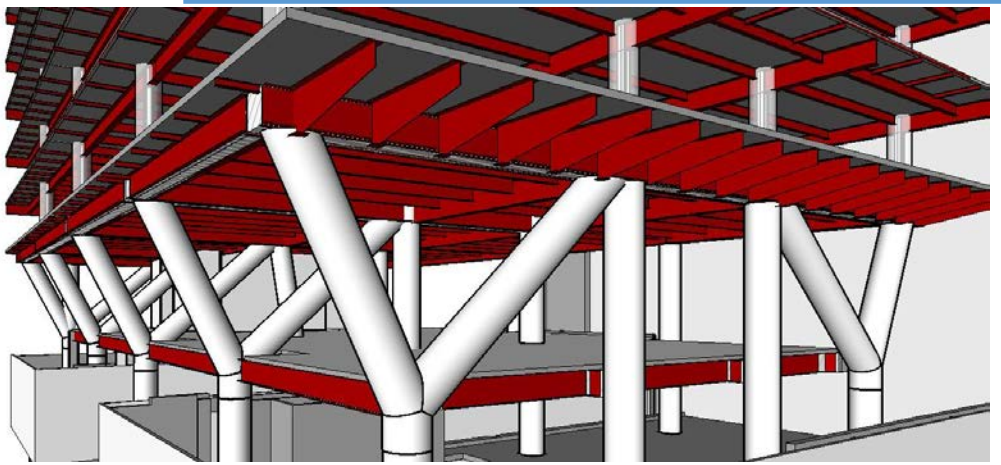
https://www.youtube.com/watch?v=4r-RW8ampdc

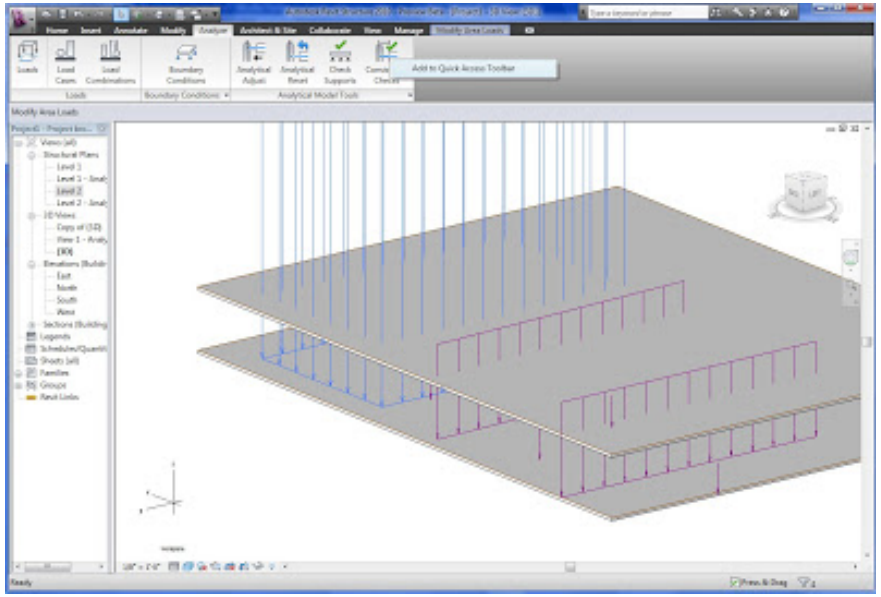


Superstructure Plans

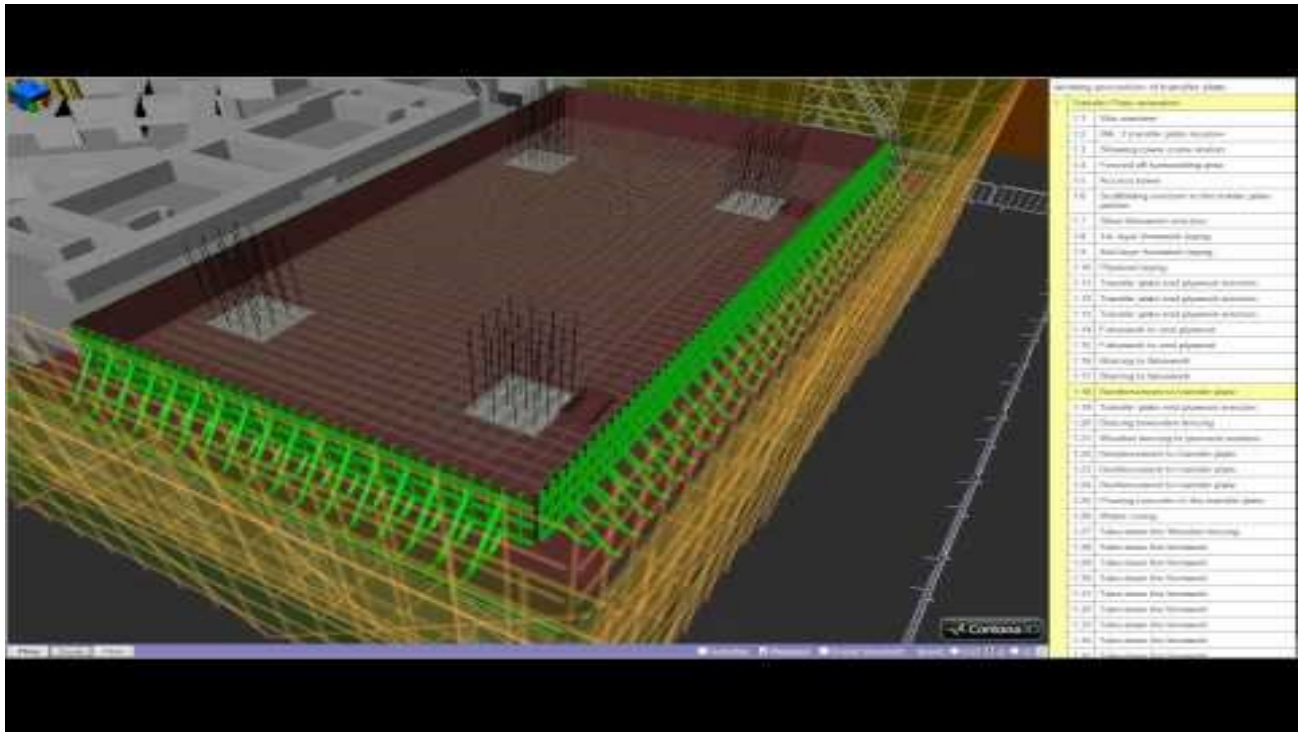
Arrangement of transfer structures and illustration of load path;

Building Information Model	Real-time Simulation





https://www.youtube.com/watch?v=lD1bcWRSKHA

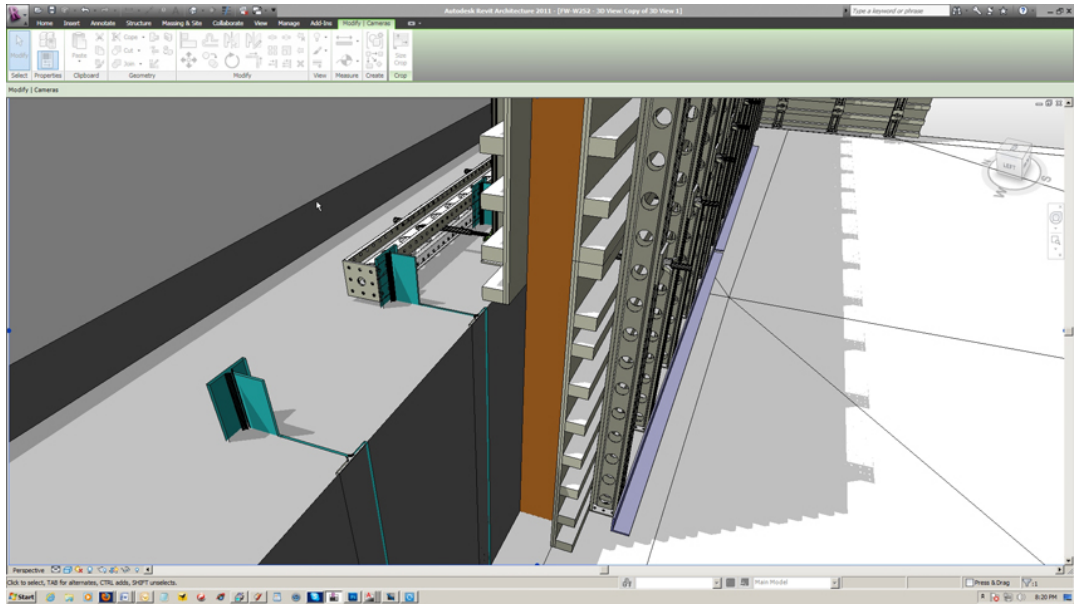


Superstructure Plans

basement structures supporting adjoining ground and/or existing geotechnical features;

Building Information Model	Real-time Simulation

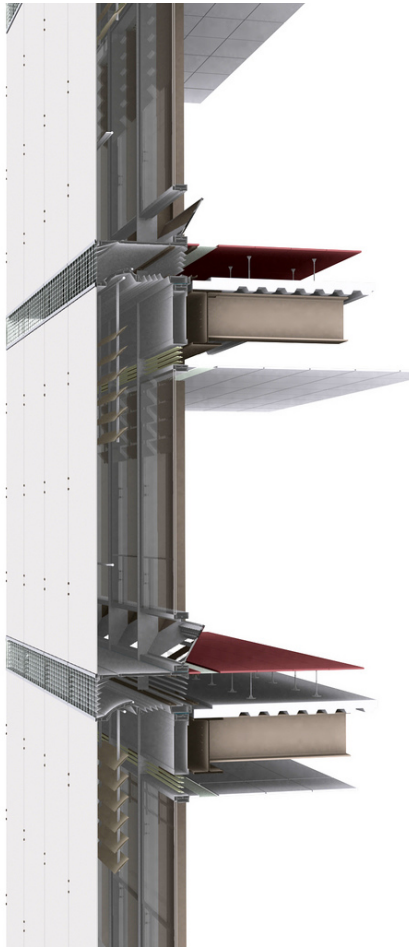
https://www.youtube.com/watch?v=eTGAGz_gSbU

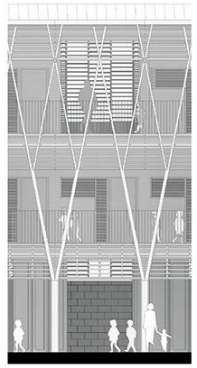


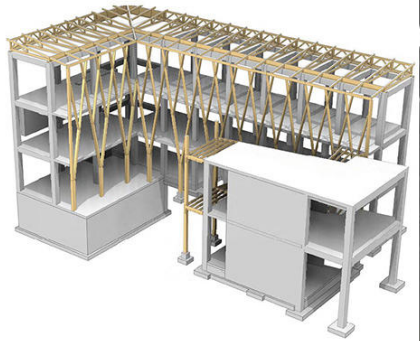
Superstructure Plans

assembly sequence, structural arrangement and/or connection of façade/glass wall/curtain wall/cladding works, etc.;

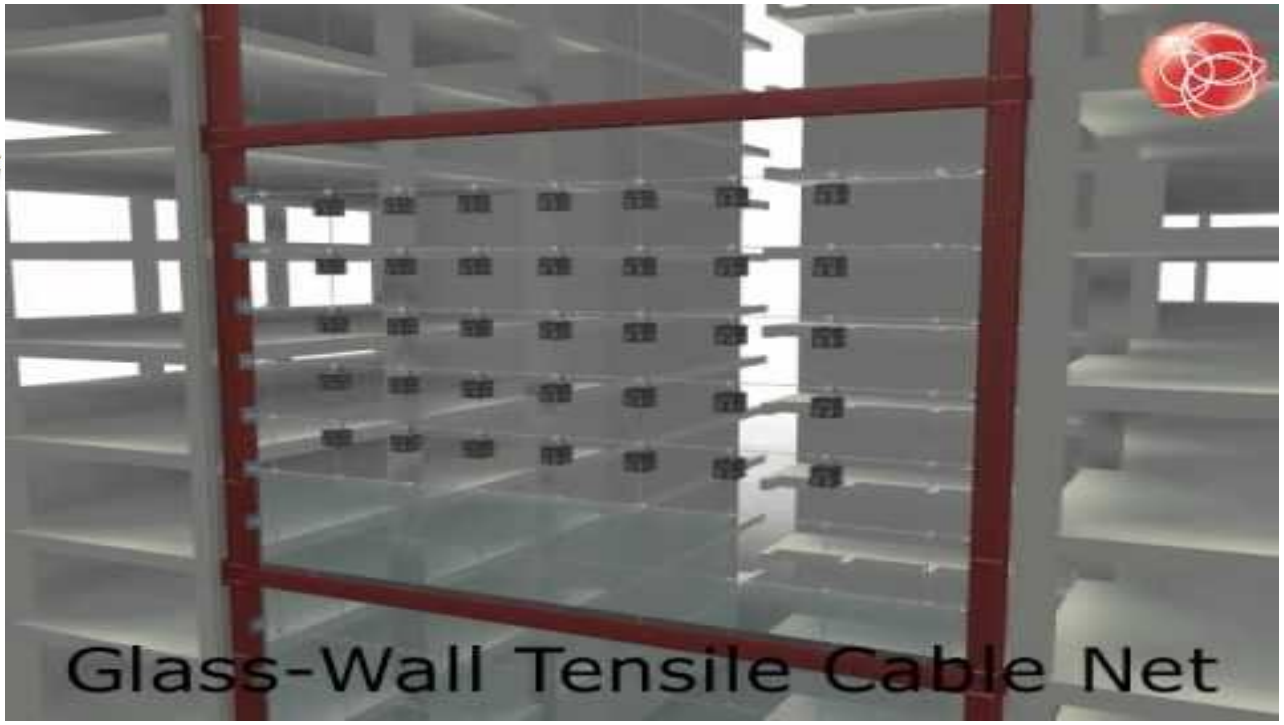
Building Information Model	Real-time Simulation







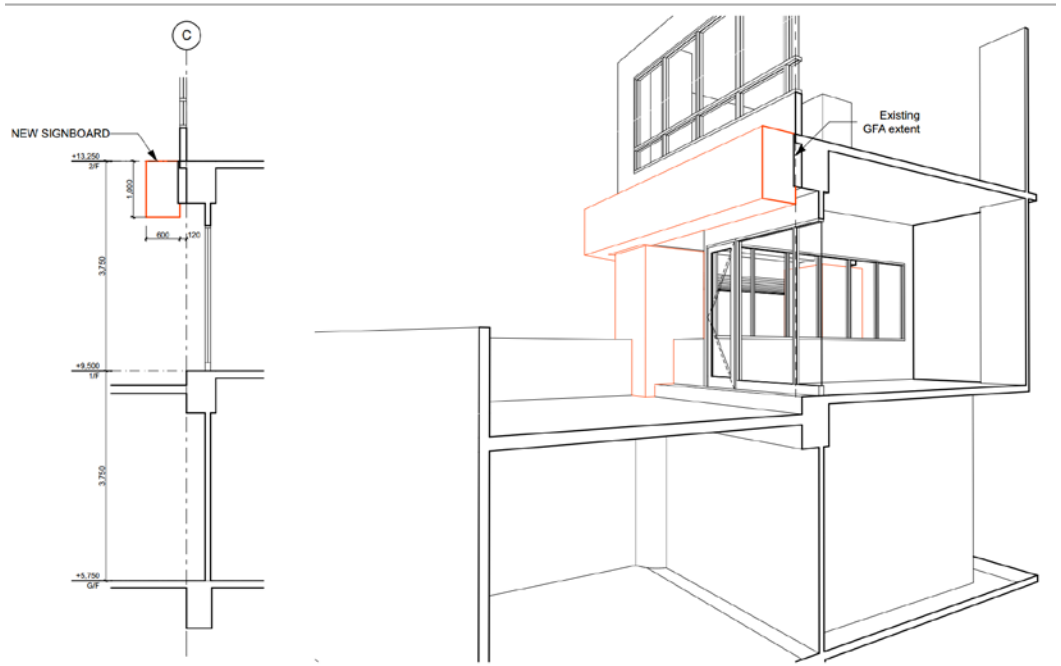
https://www.youtube.com/watch?v=PDXGs5dGxXE



Superstructure Plans

relationship between existing structures and proposed A&A works;

Building Information Model	Real-time Simulation

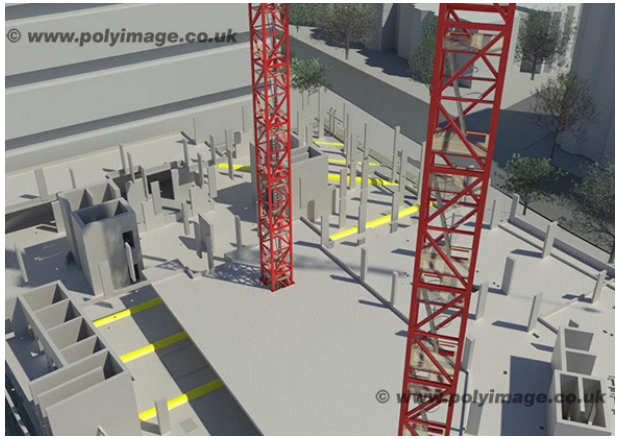


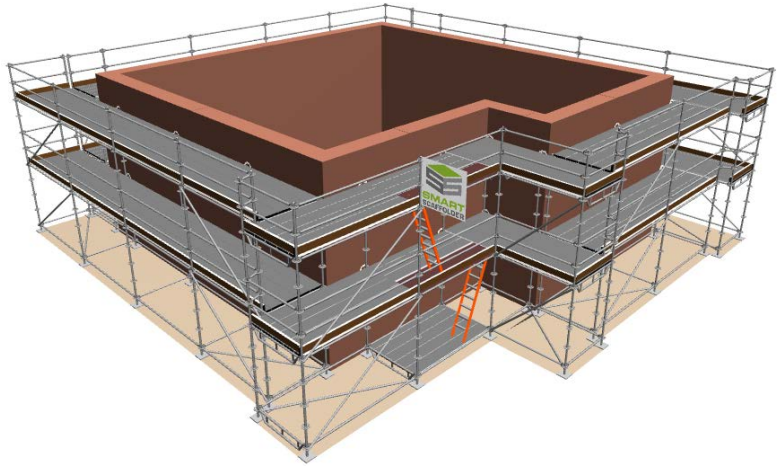
https://www.youtube.com/watch?v=SqpgFaFnwWk

Superstructure Plans

working space, temporary supports and strengthening in A&A works.

Building Information Model	Real-time Simulation



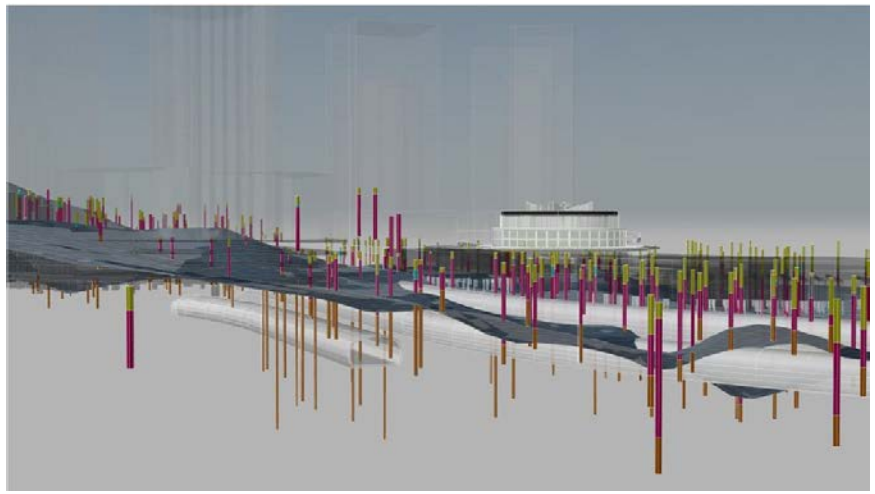


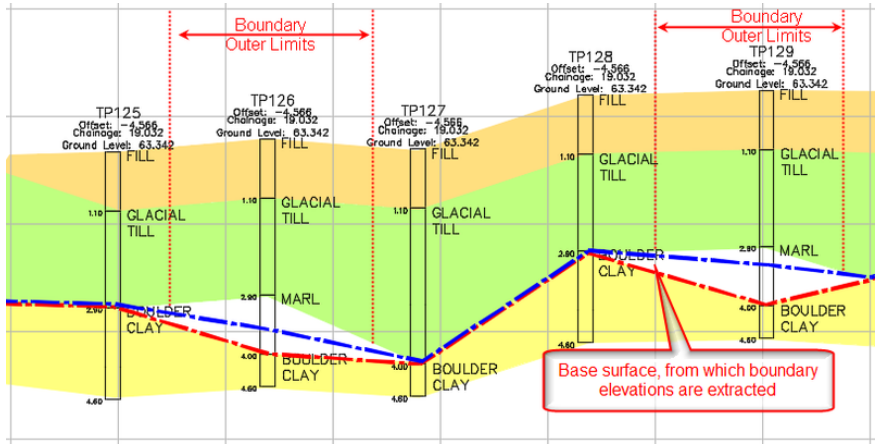
https://www.youtube.com/watch?v=5uHzLV3gf78

Foundation Plans, Excavation and Lateral Support (E&LS) Plans

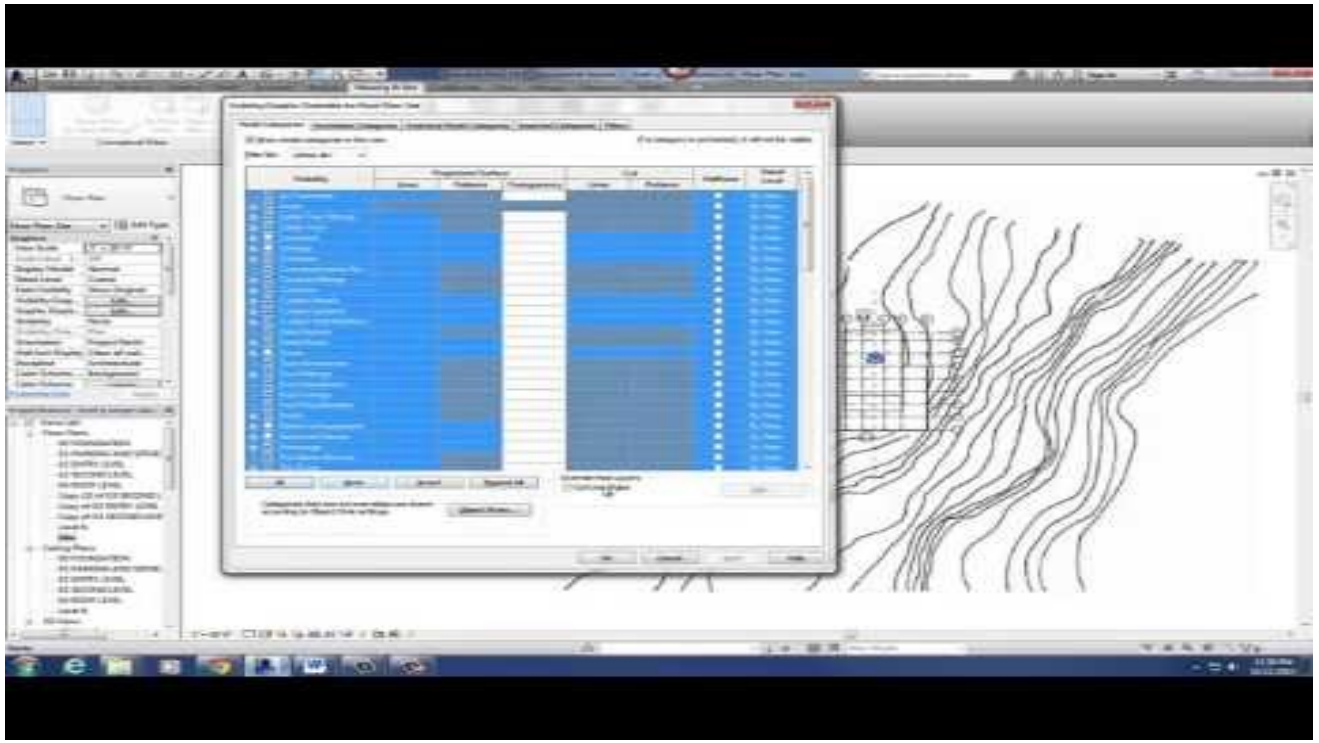
Relationship between proposed foundations, sub-structures, E&LS works and geological ground profiles, adjoining existing foundations, geotechnical features, sensitive structures, etc.

Building Information Model	Real-time Simulation





https://www.youtube.com/watch?v=NeK6AODwRVI

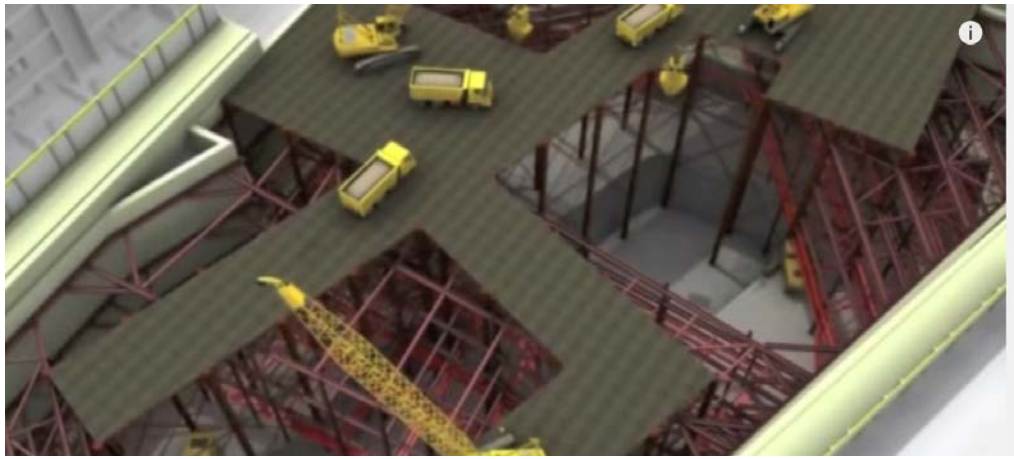


Site Formation Plans

relationship between site profiles, geological ground profiles and proposed works.

Building Information Model	Real-time Simulation

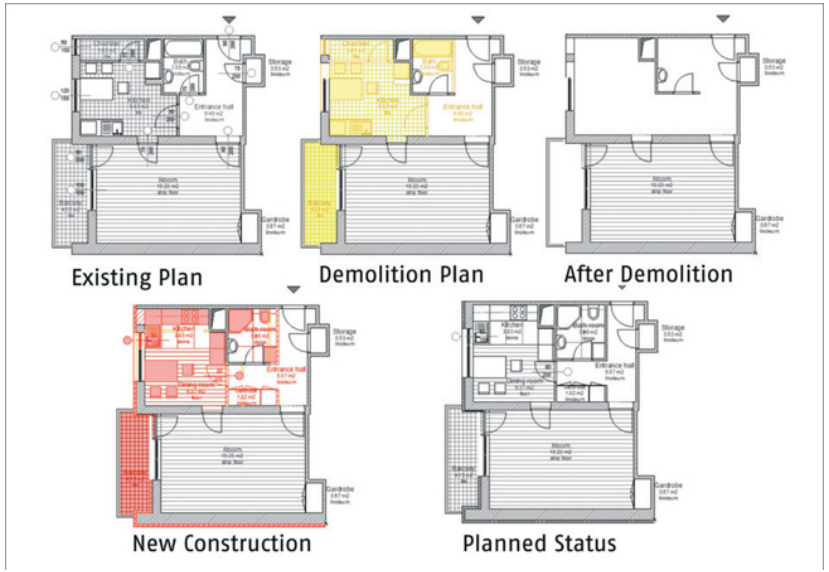
https://www.youtube.com/watch?v=SqpgFaFnwWk



Demolition Plans

Building Information Model	Real-time Simulation

final stage of partial demolished structures..



https://www.youtube.com/watch?v=QtVzRvqGXO4