



Building Information Modeling (BIM) Requirements for PT Projects – Today's Capabilities for a BIM-based Design

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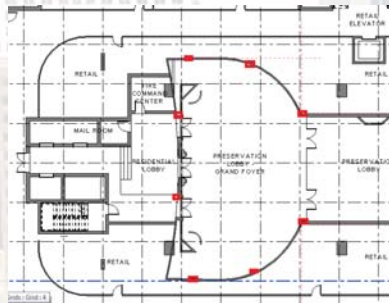
What is BIM?

The ability to model project information in a computer interpretable manner that can be used to support various collaboration, simulation, and documentation processes.

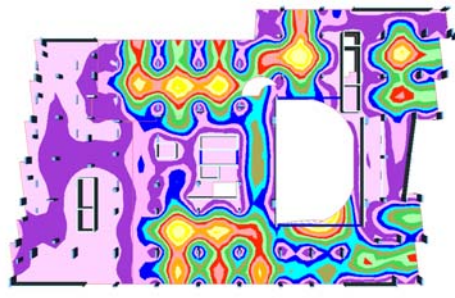
Key components of BIM data include:

- Explicit typology (what is it?)
- 3D location (where is it?)
- Context specific attributes (what are its details?)

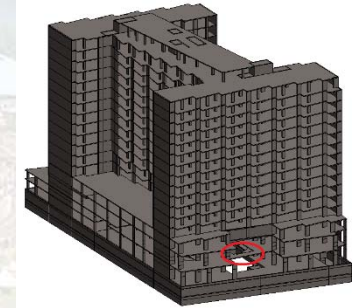
BIM to Streamline Production



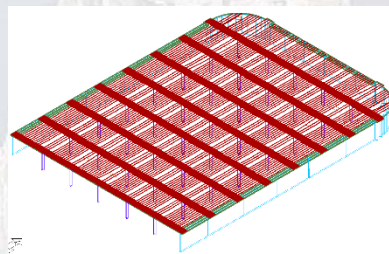
2D CAD



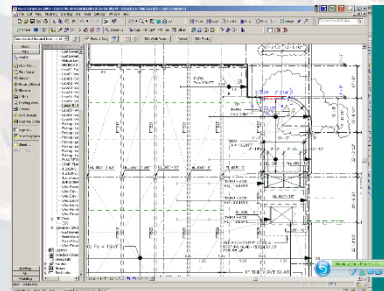
3D Analysis Model



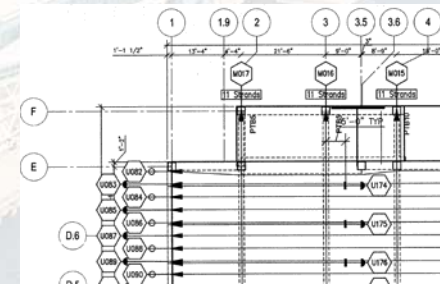
Coordinated Revit Model



3D Analysis Model
with Tendons



Revit Model with Tendons



Structural/Shop Drawings

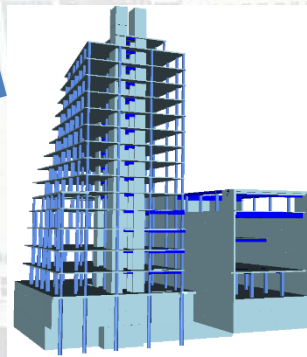
BIM to Support Coordination



Architect



MEP



Central 'Neutral'
Project Model

- Design integration
- Digital 3D clash detection
- Cloud-based collaboration



Structural Engineer



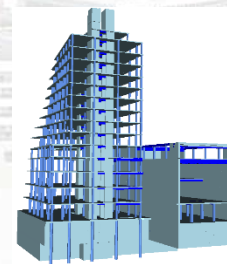
Contractor

Downstream Benefits of BIM

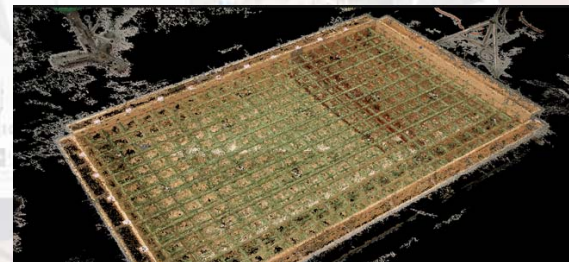
Submittal of electronic record of as-built-structure to support facility operation and maintenance



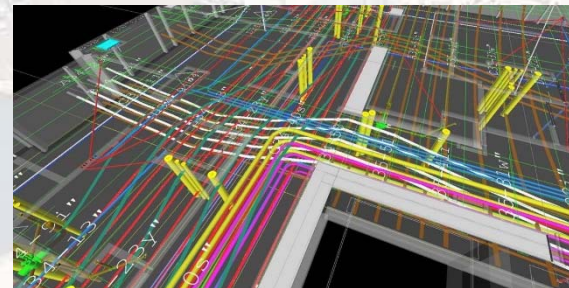
Design Team



Coordinated BIM Model



Digital Laser Scan of Construction Site



Integrated BIM Model Across Disciplines

Available BIM Tools

3D modeling platforms

- Revit
- Tekla
- ArchiCAD
- Microstation
- Vectorworks
- Catia

3D BIM viewers for collaboration

- Navisworks

Available BIM Tools

Database platforms

- Bentley Structural Synchronizer

Cloud-based platforms (geometry focused)

- Autodesk BIM 360 Glue

Cloud-based platforms (document and workflow)

- Newforma

Available BIM Tools

Structural analysis software

- Various products import/export model info from above tools
 - Geometry
 - Rebar
 - Tendons
 - Loading
 - Reactions
 - Design criteria

Main Challenge for PT Industry

None of the 3D modeling platforms support a native tendon object!

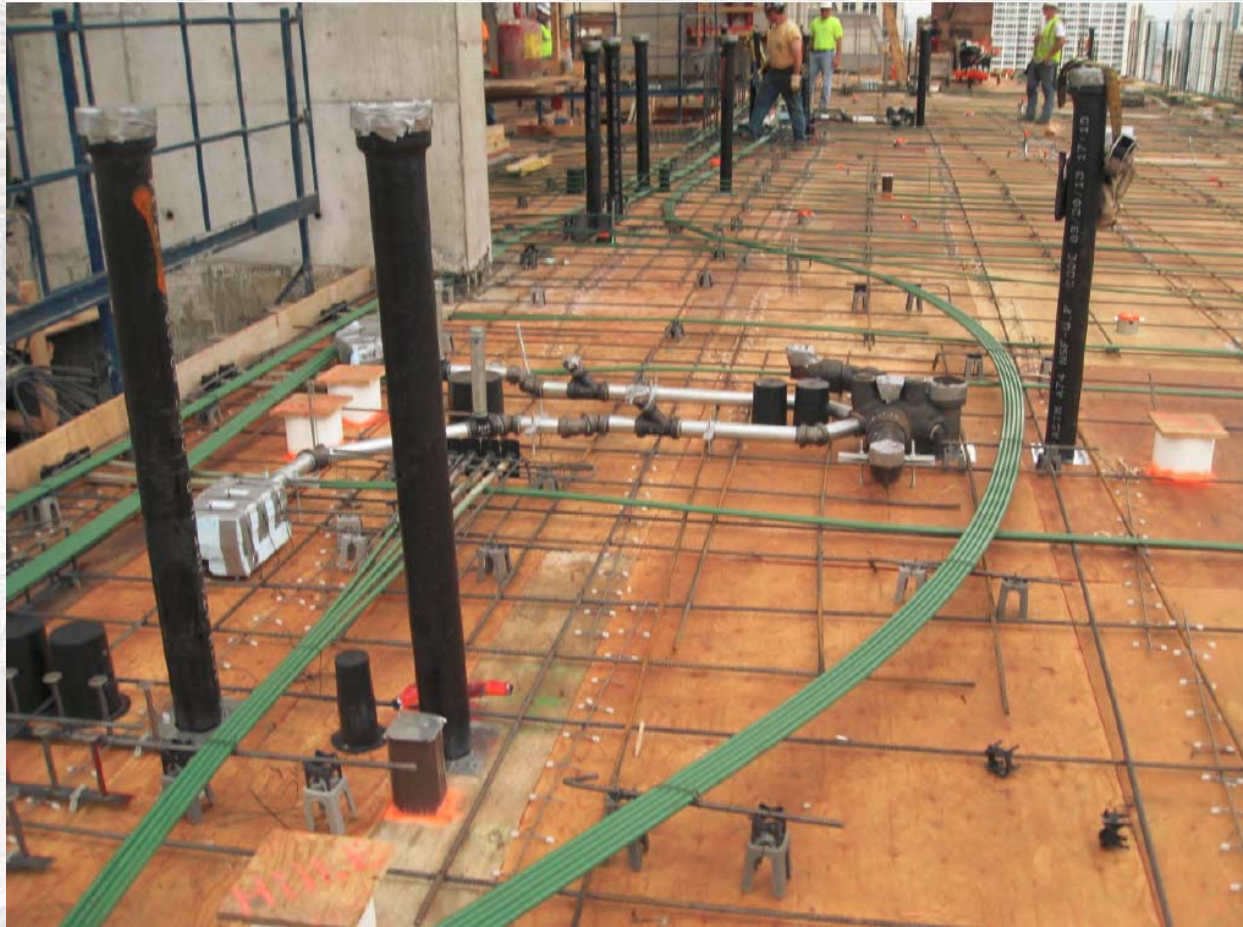
What are your options?

- Use 'dumb' 3D geometry objects
- Create custom families

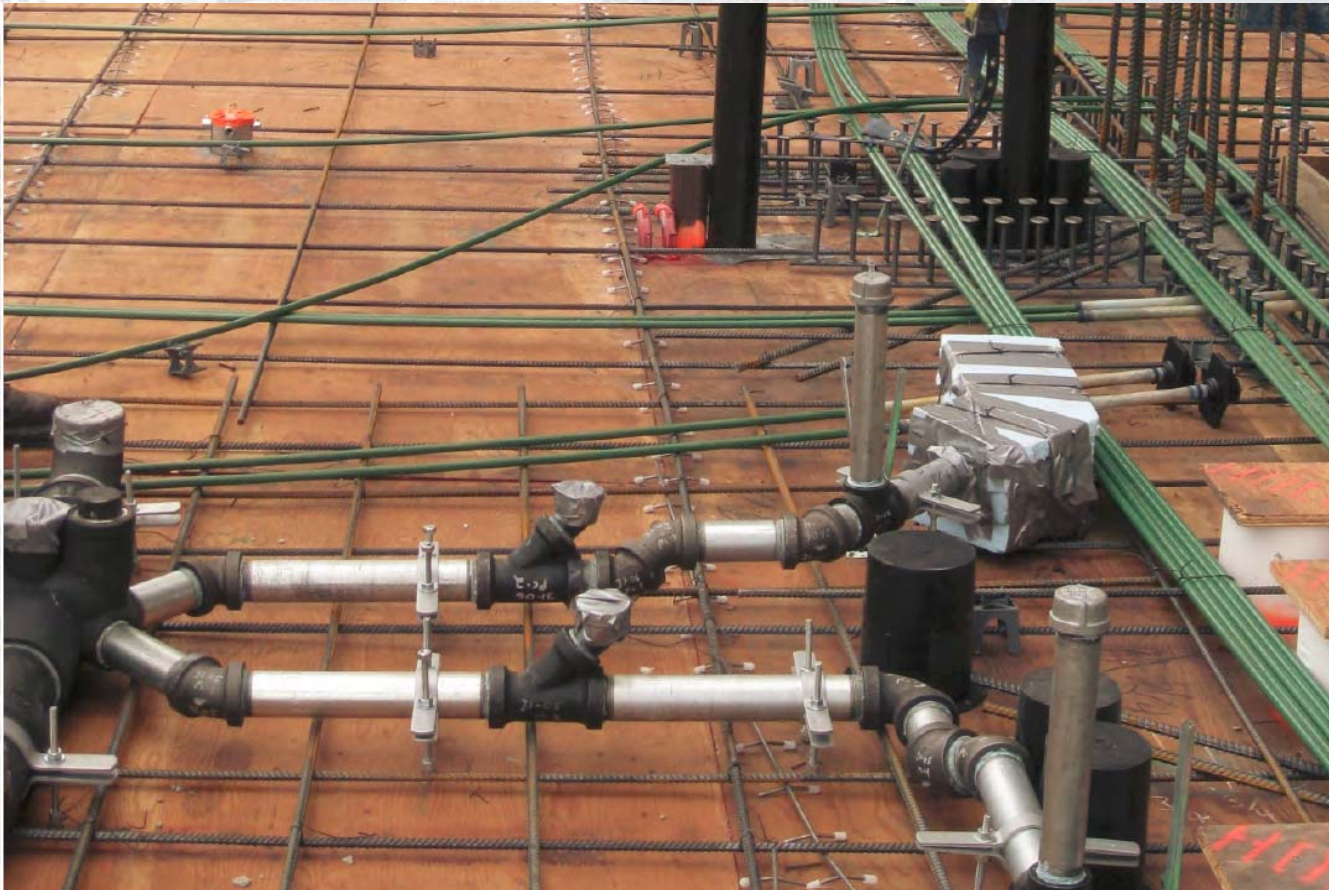
What's the downside?

- No commercially available integration

Case Study: 3D Clash Detection using Navisworks



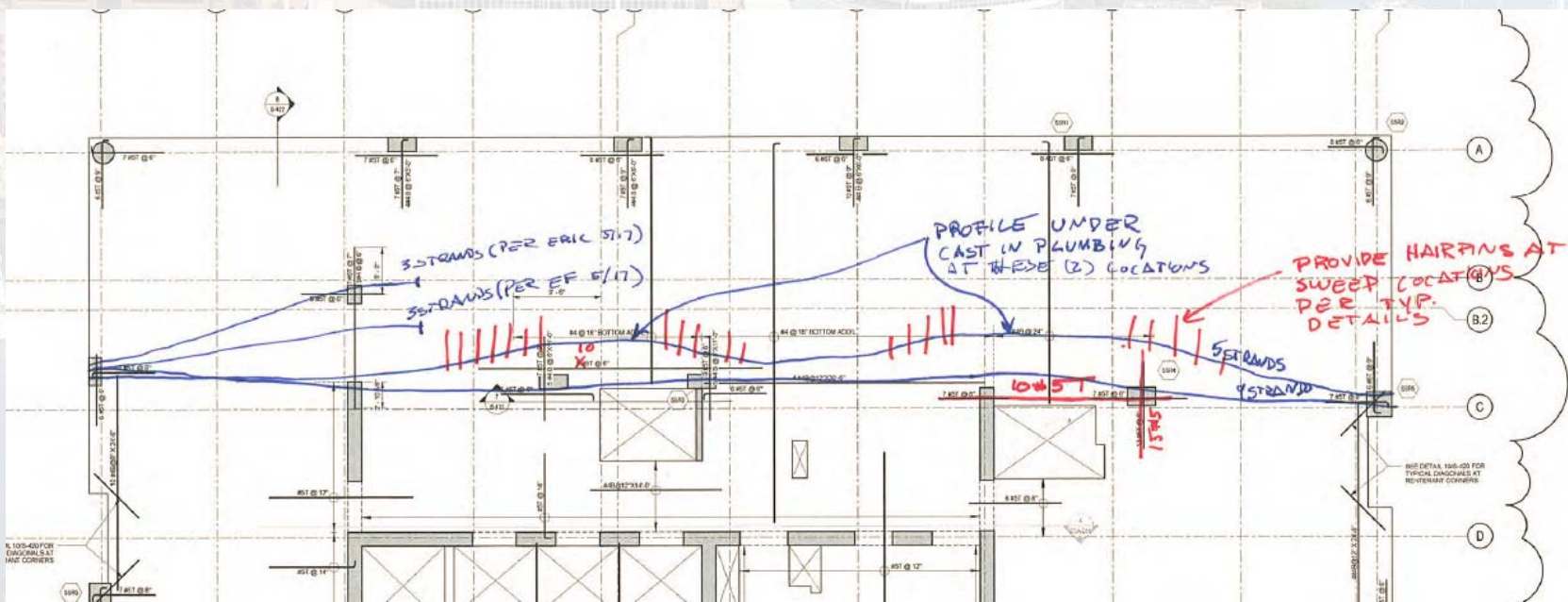
MEP / PT Site Coordination



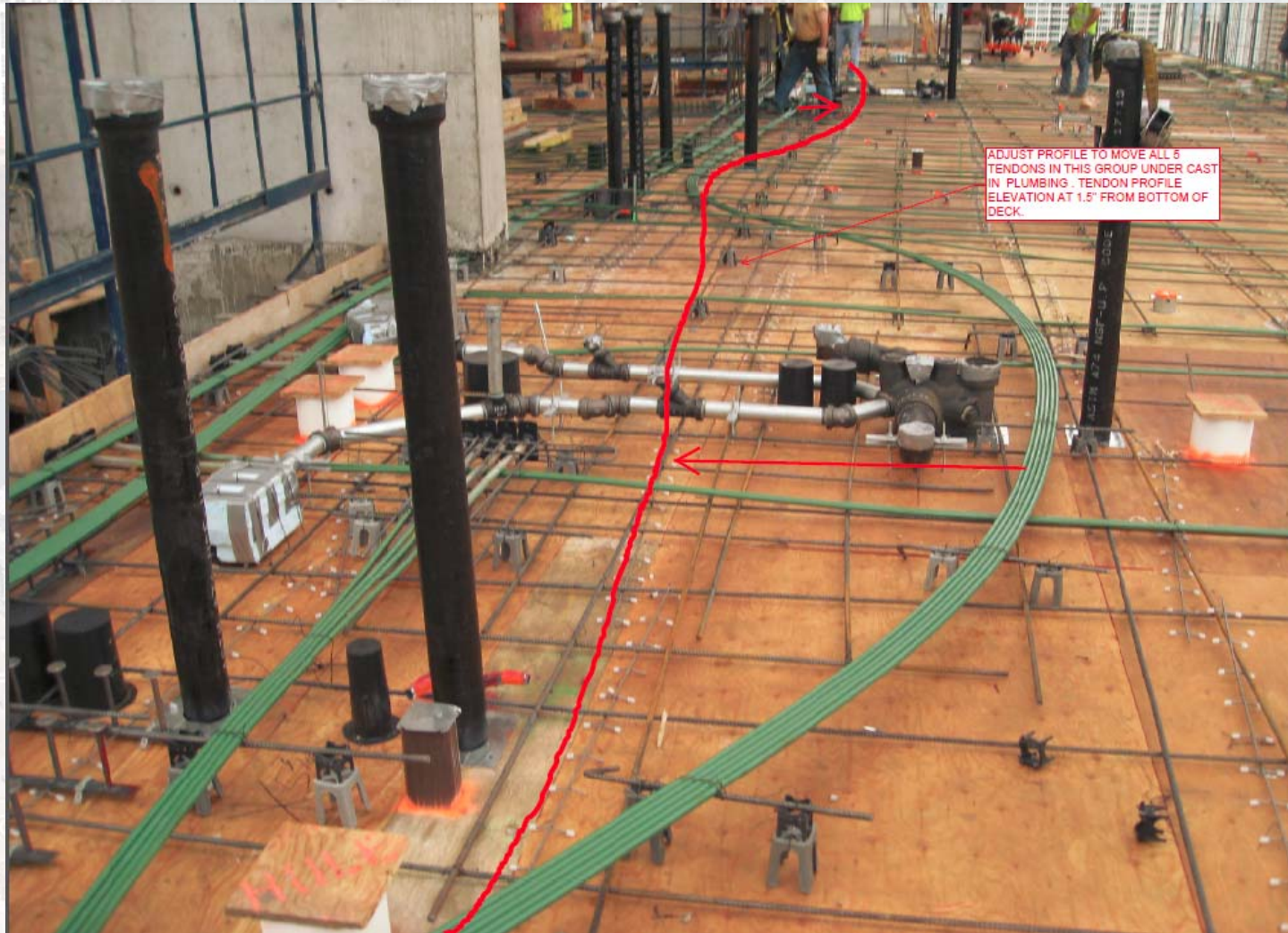
MEP / PT Site Coordination



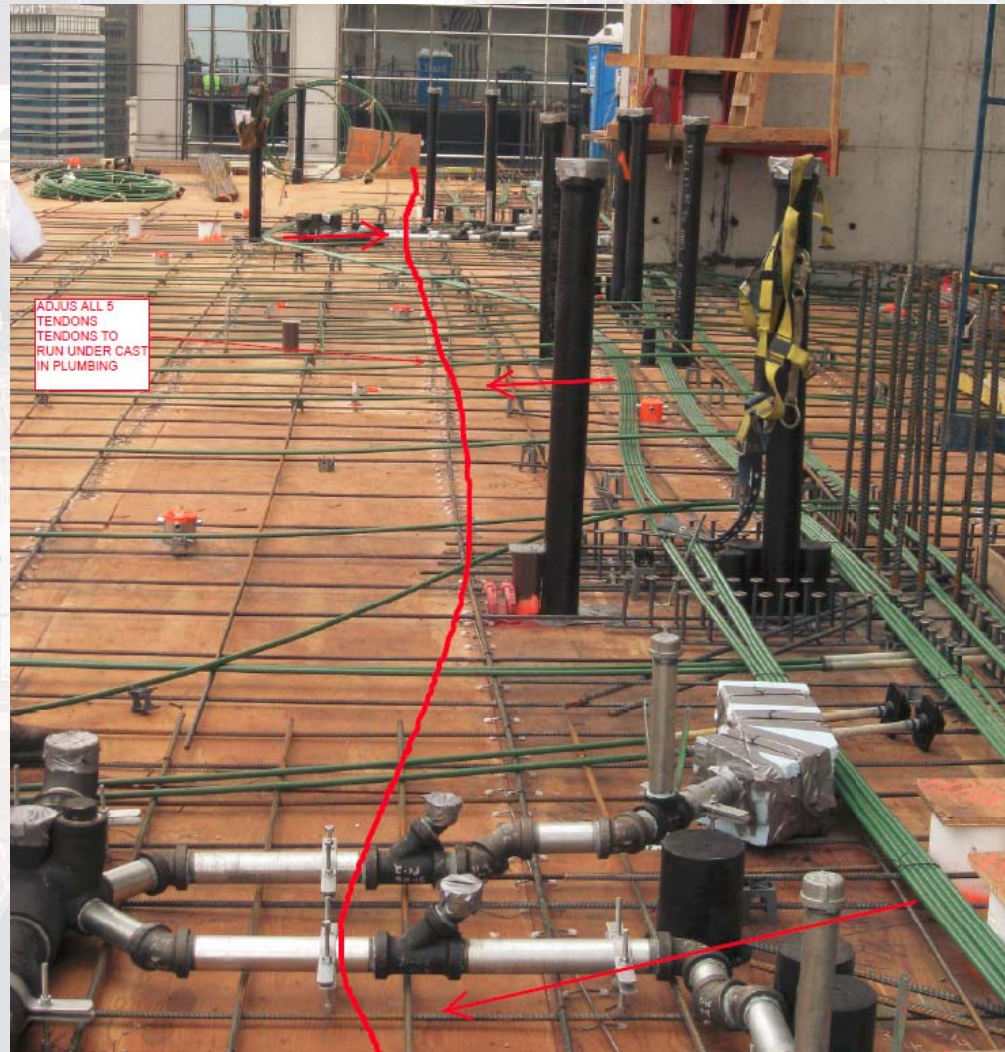
Traditional Resolution Approach



Traditional Resolution Approach

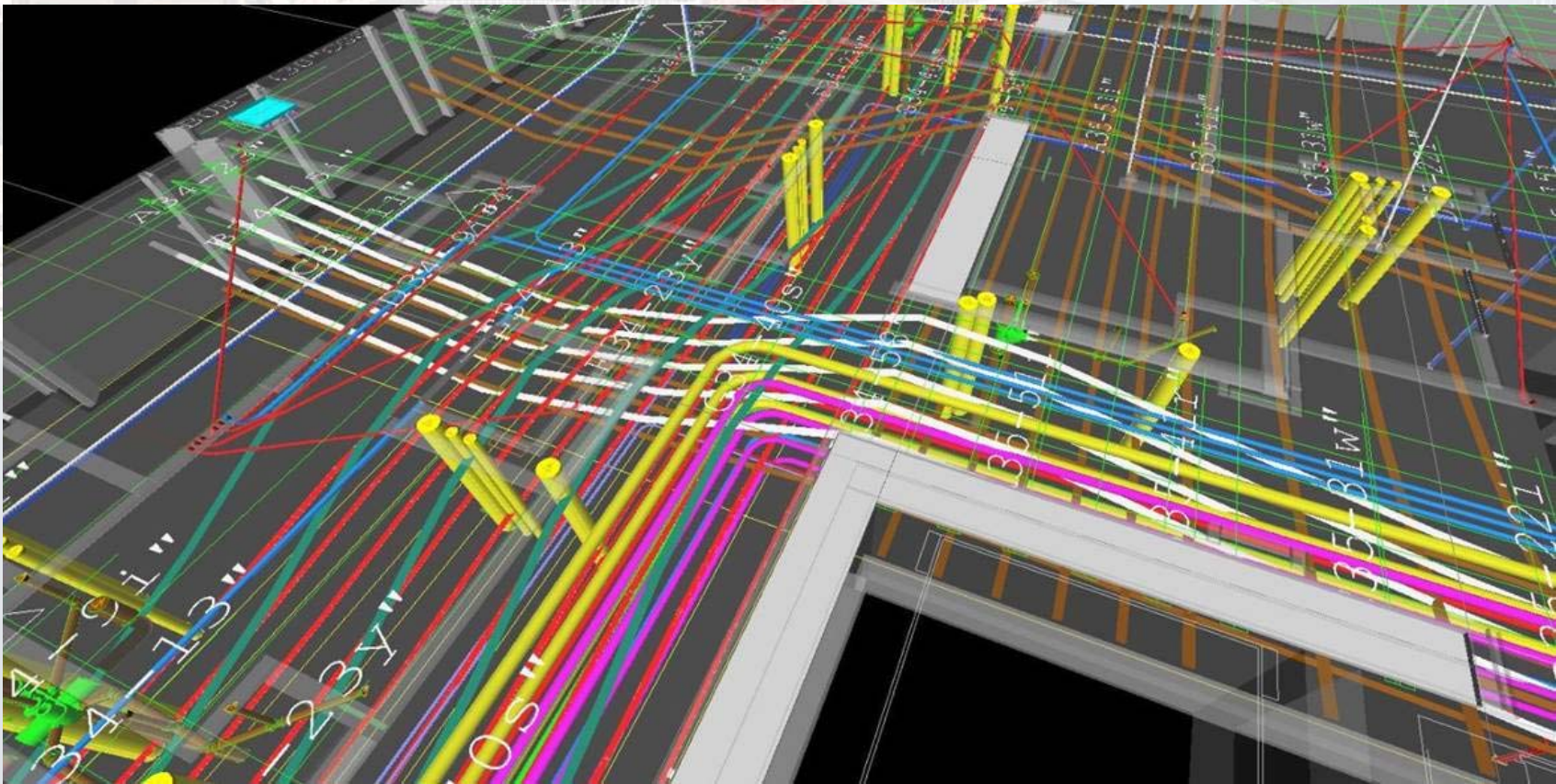


Traditional Resolution Approach



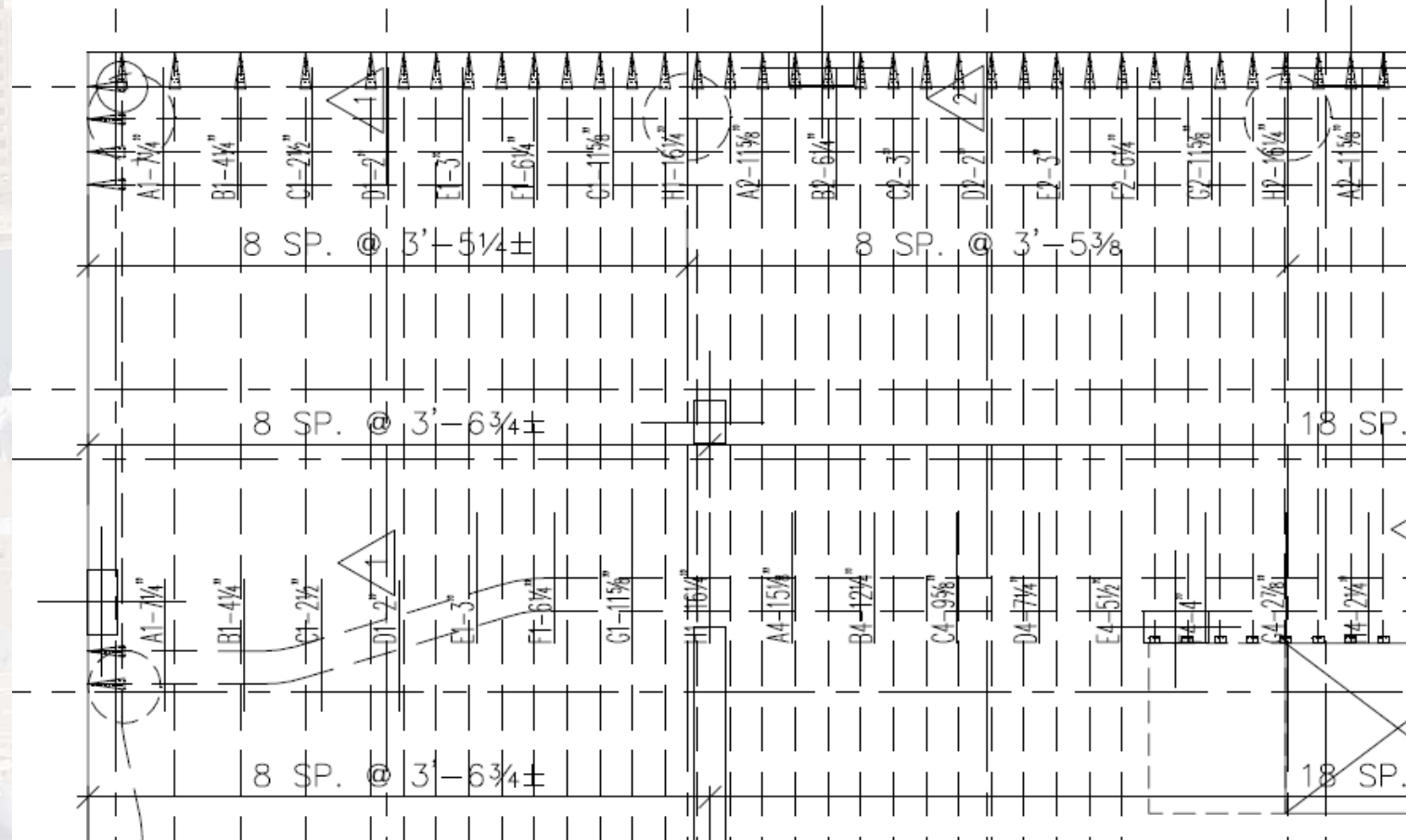
Navisworks Model of Slab

Contractor first tried to create tendons using manual modeling process – was not cost effective and could not keep up with changes

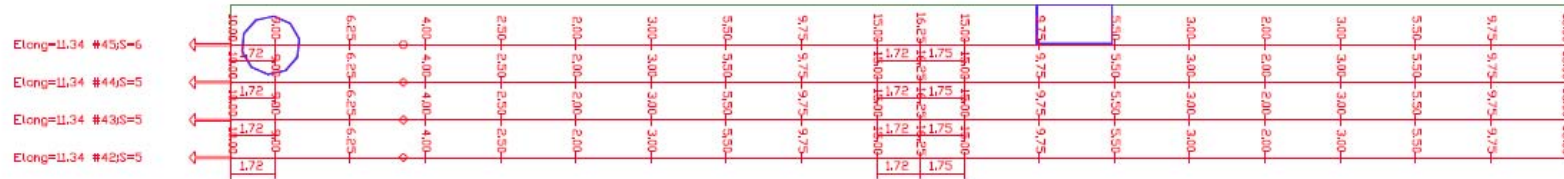


Created 3D Tendon Models using Design Software

Used traditionally generated PT shop drawings as basis of modeling.



Tendon Layout in Plan

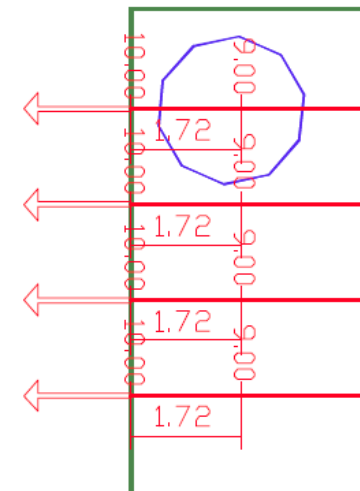


Elong=11.34 #45;S=6

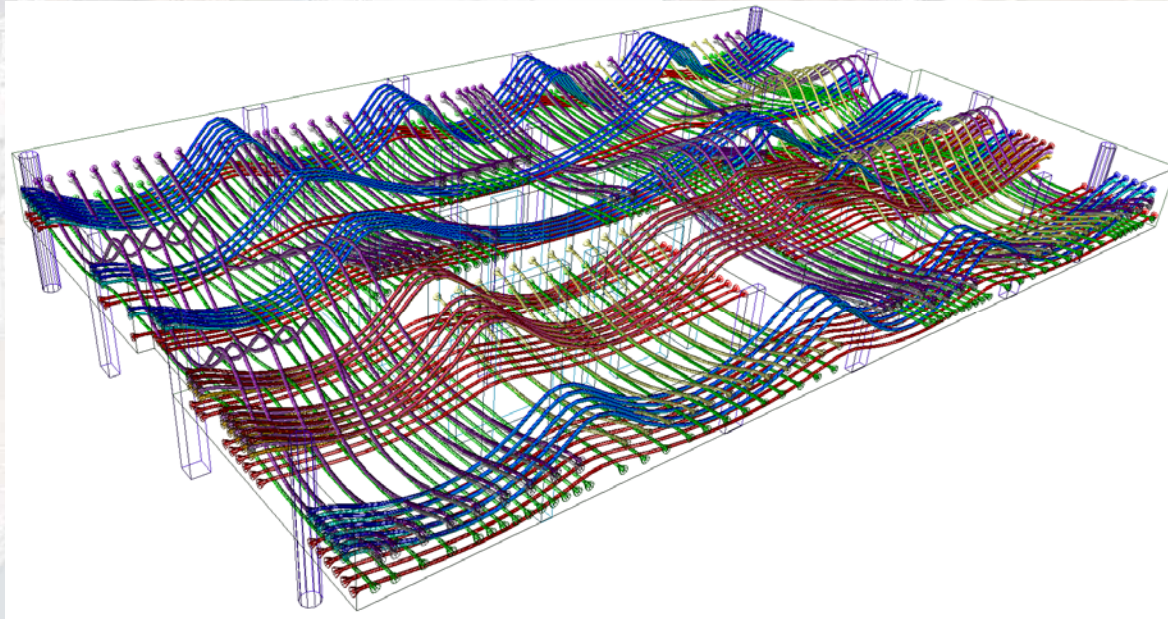
Elong=11.34 #44;S=5

Elong=11.34 #43;S=5

Elong=11.34 #42;S=5



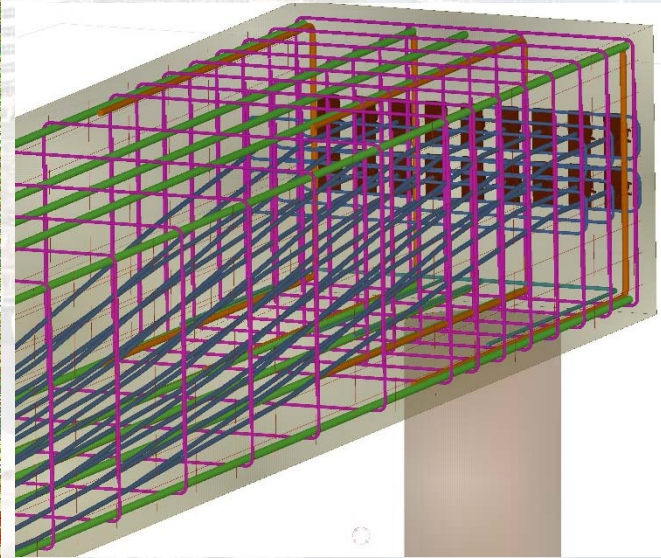
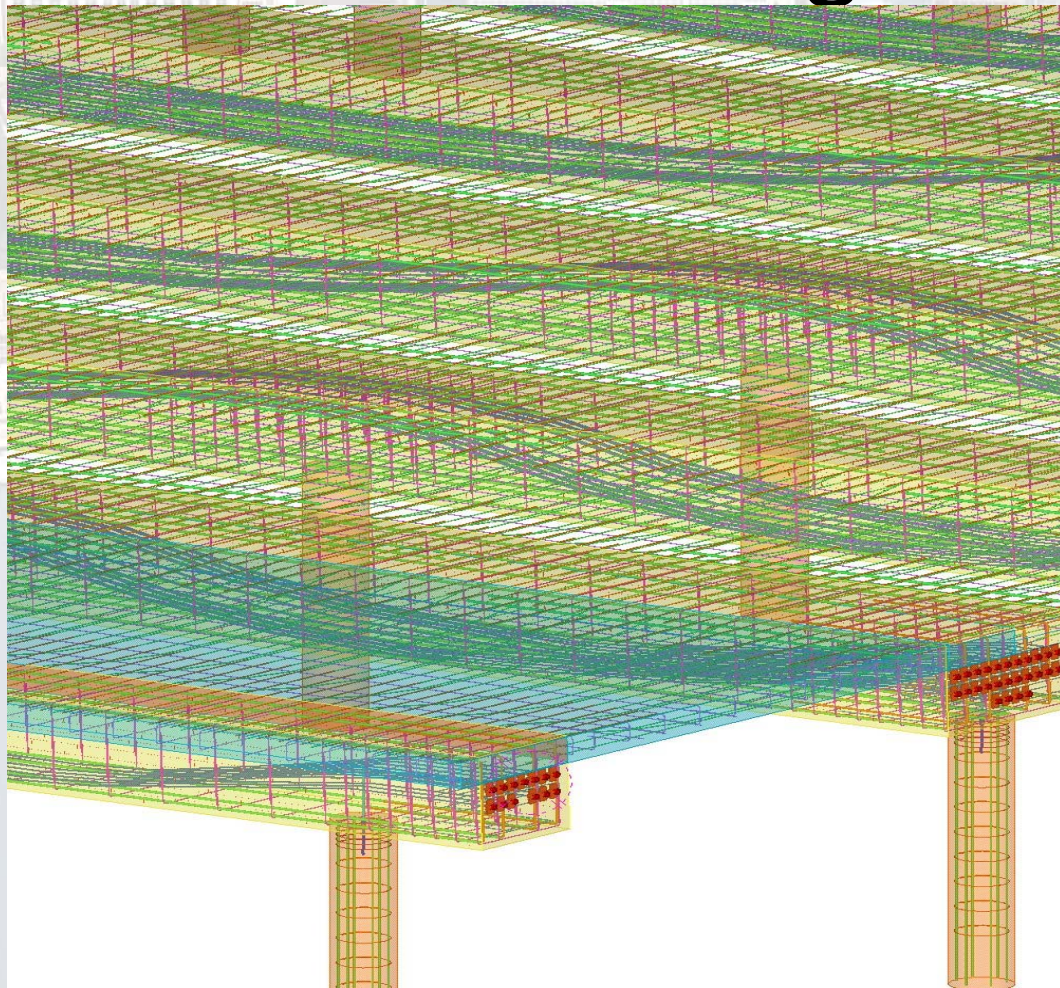
3D Model of Tendons Exported from Design Software



Observations

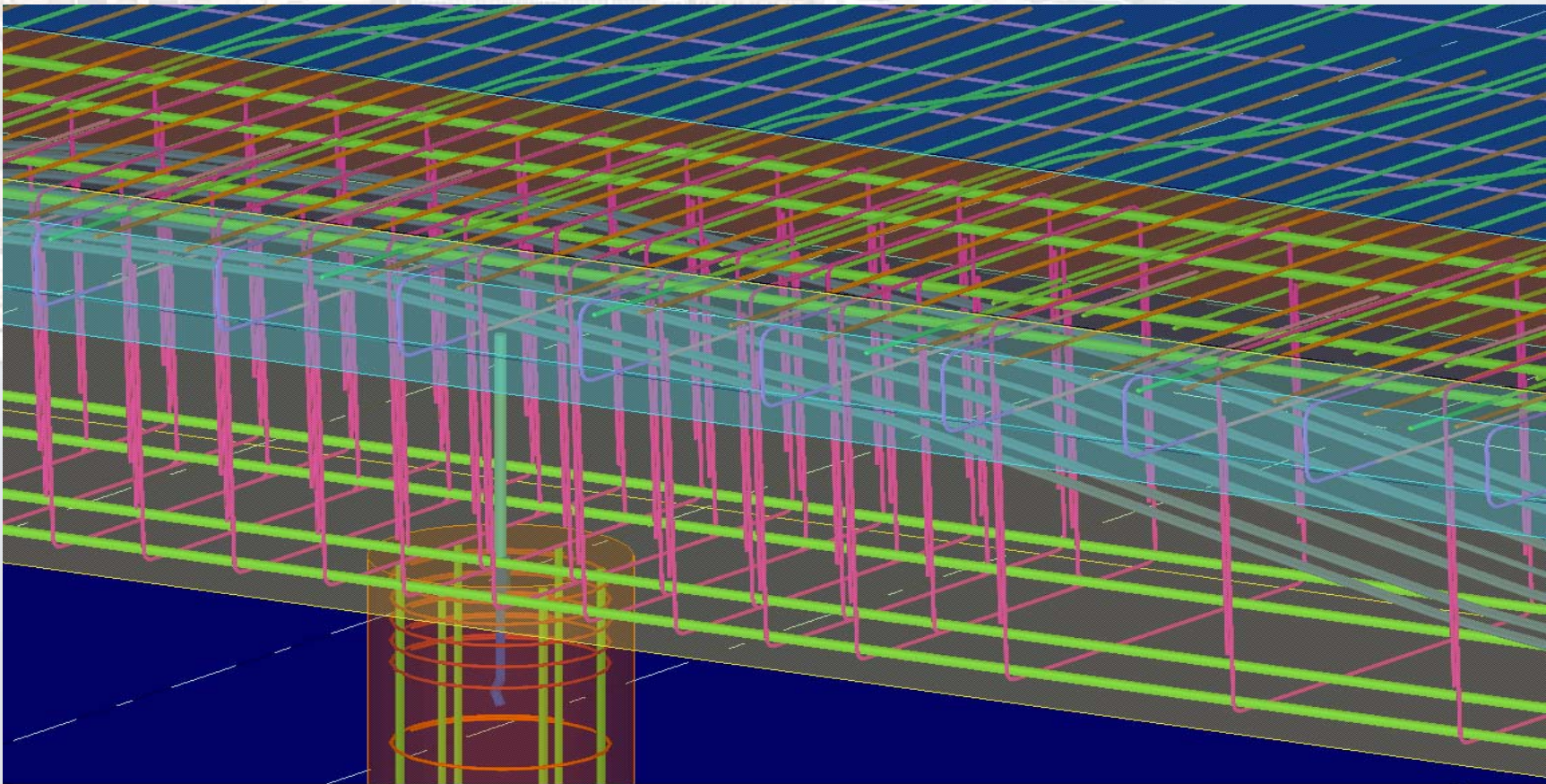
- Recreating 3D tendon models from PT shop drawings was fast – 4 hours total
- Had to go through Revit to transfer information to Navisworks
- Contractor not willing to pay for additional modeling

Case Study: 3D Shop Drawings using Tekla



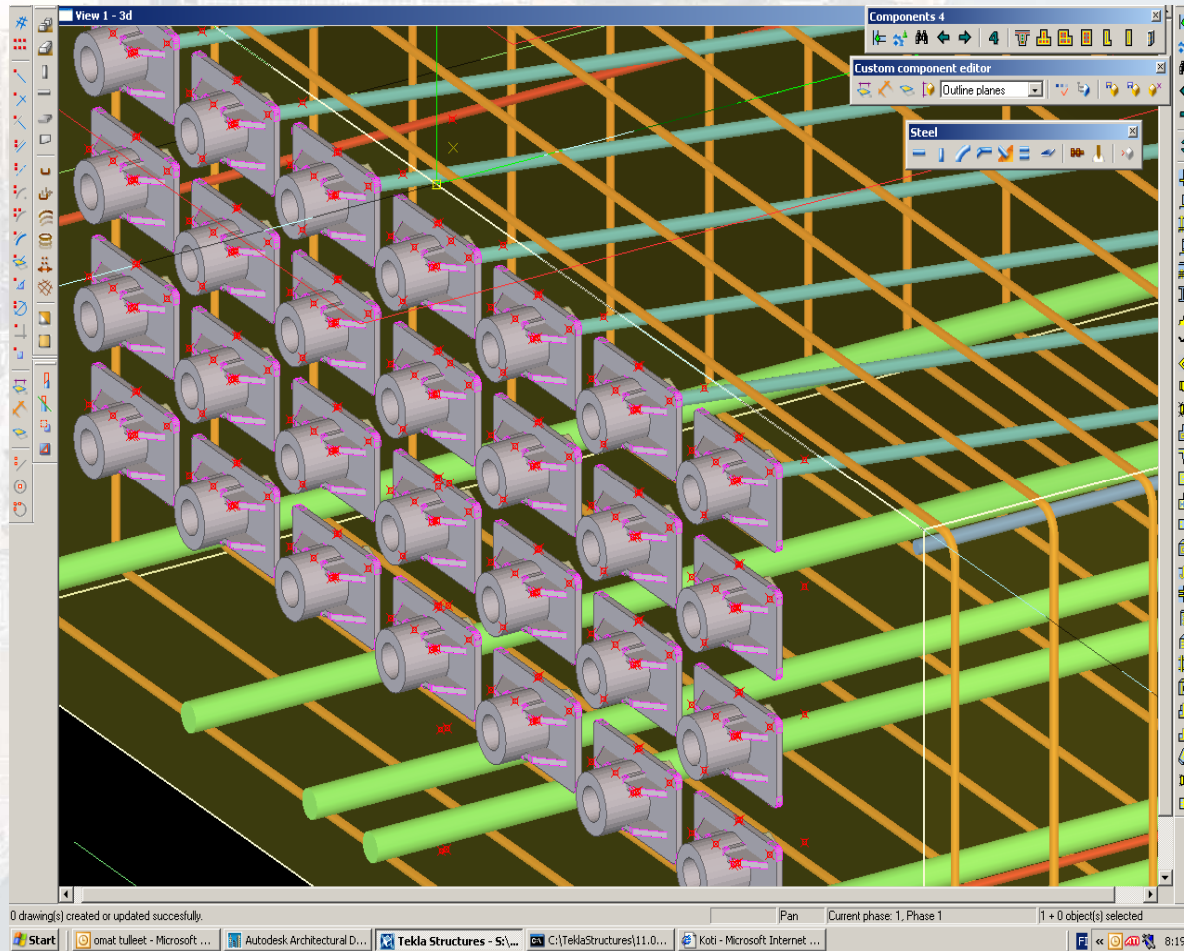
Tendons Modeled in Tekla

One of our Finnish clients models 3D tendons in Tekla using their own custom objects.

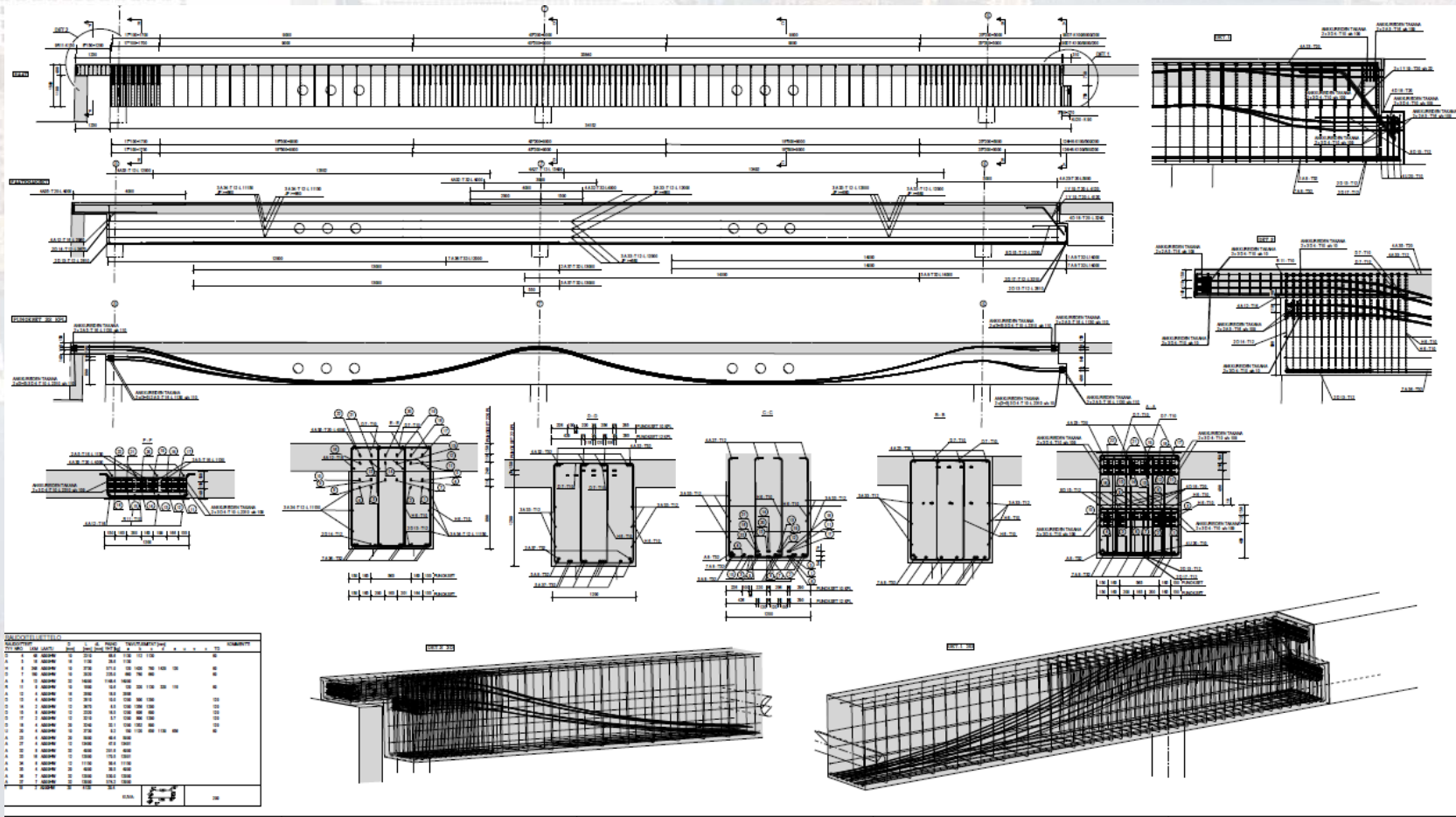


Tendons Modeled in Tekla

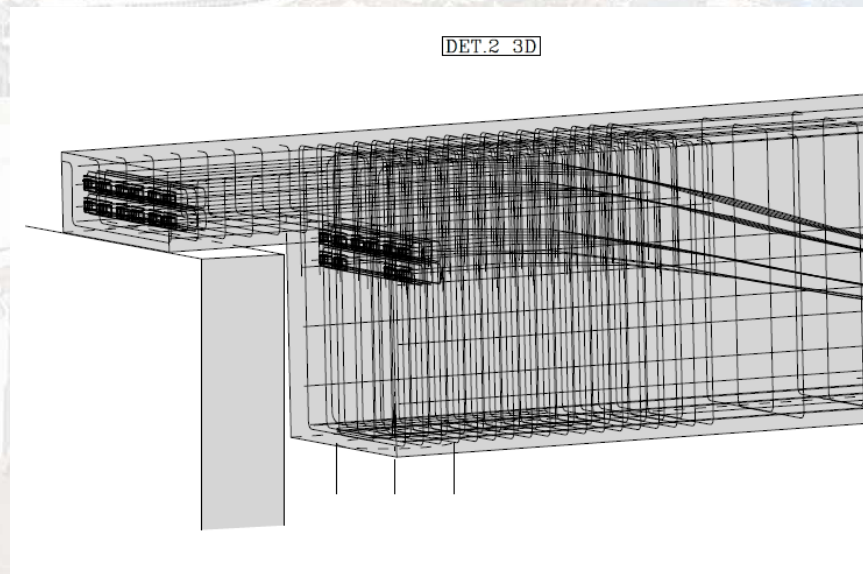
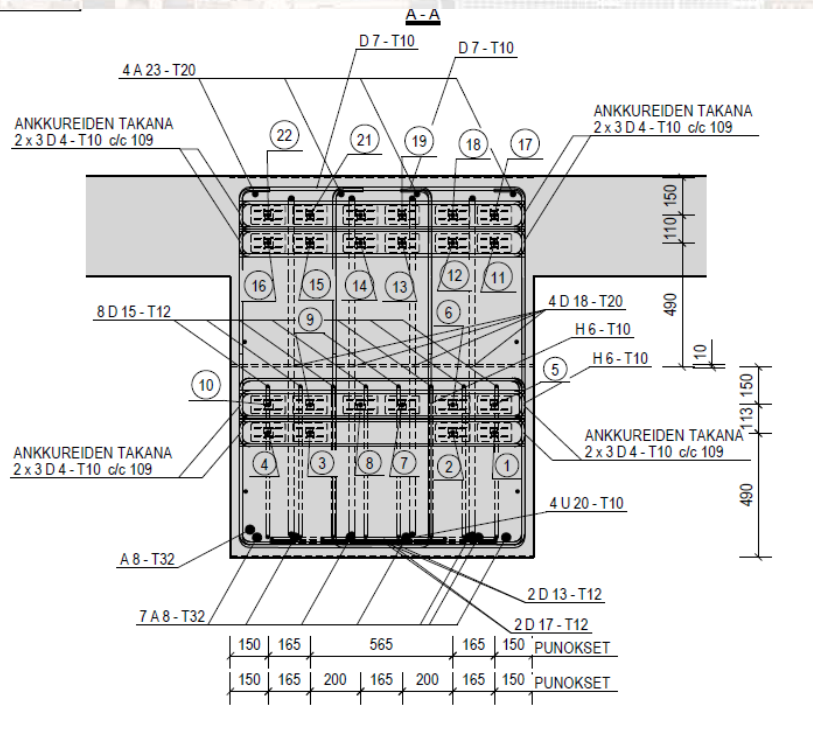
Tendon information is imported using their own Macro that reads ADAPT tendon database.



Automatically Generate 3D Shop Drawings from Tekla Model



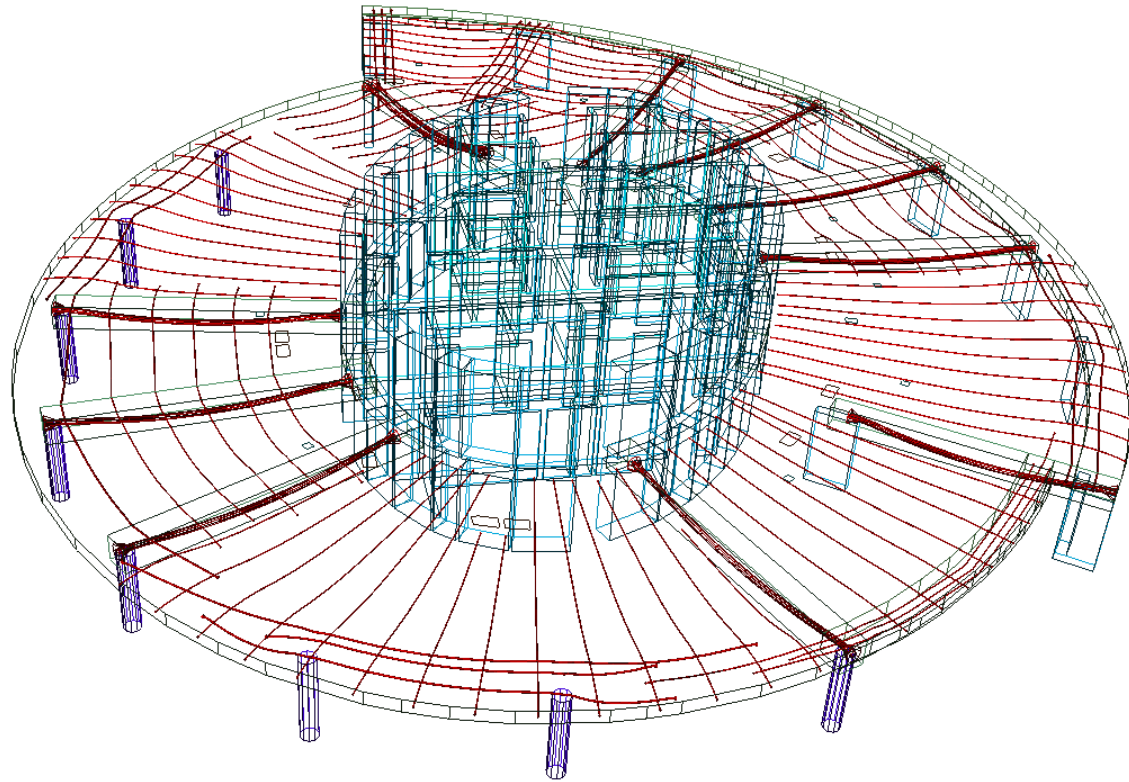
Automatically Generate 3D Shop Drawings from Tekla Model



Observations

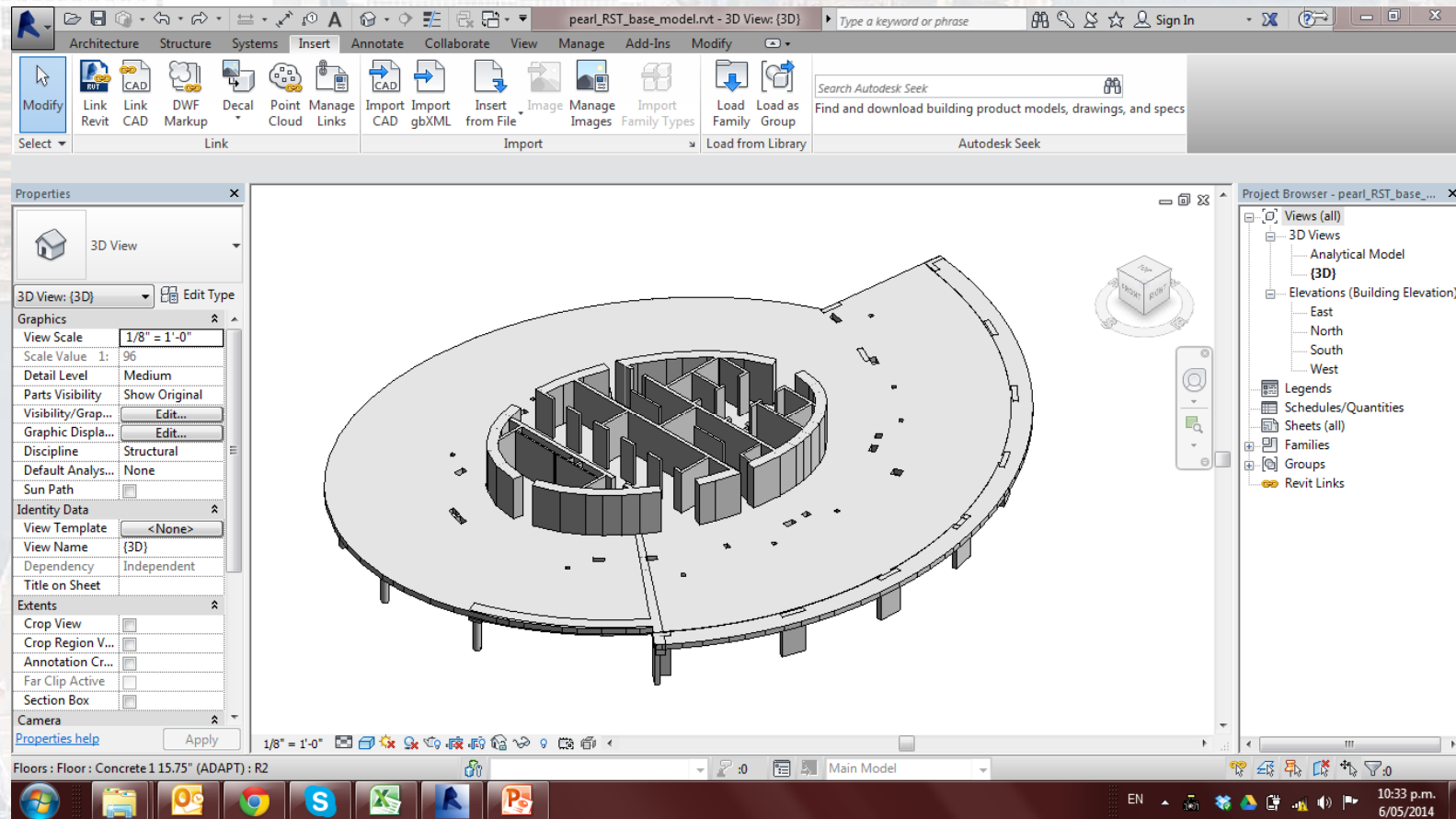
- Company needs to develop and maintain own integration software
- Tendons modeled in Tekla using “rebar” segments
- Link between design software and Tekla not dynamic
- Company added additional “placement logic” to their integration software to enable production of realistic tendon layouts

Case Study: Tendon Models in Revit using Custom Families



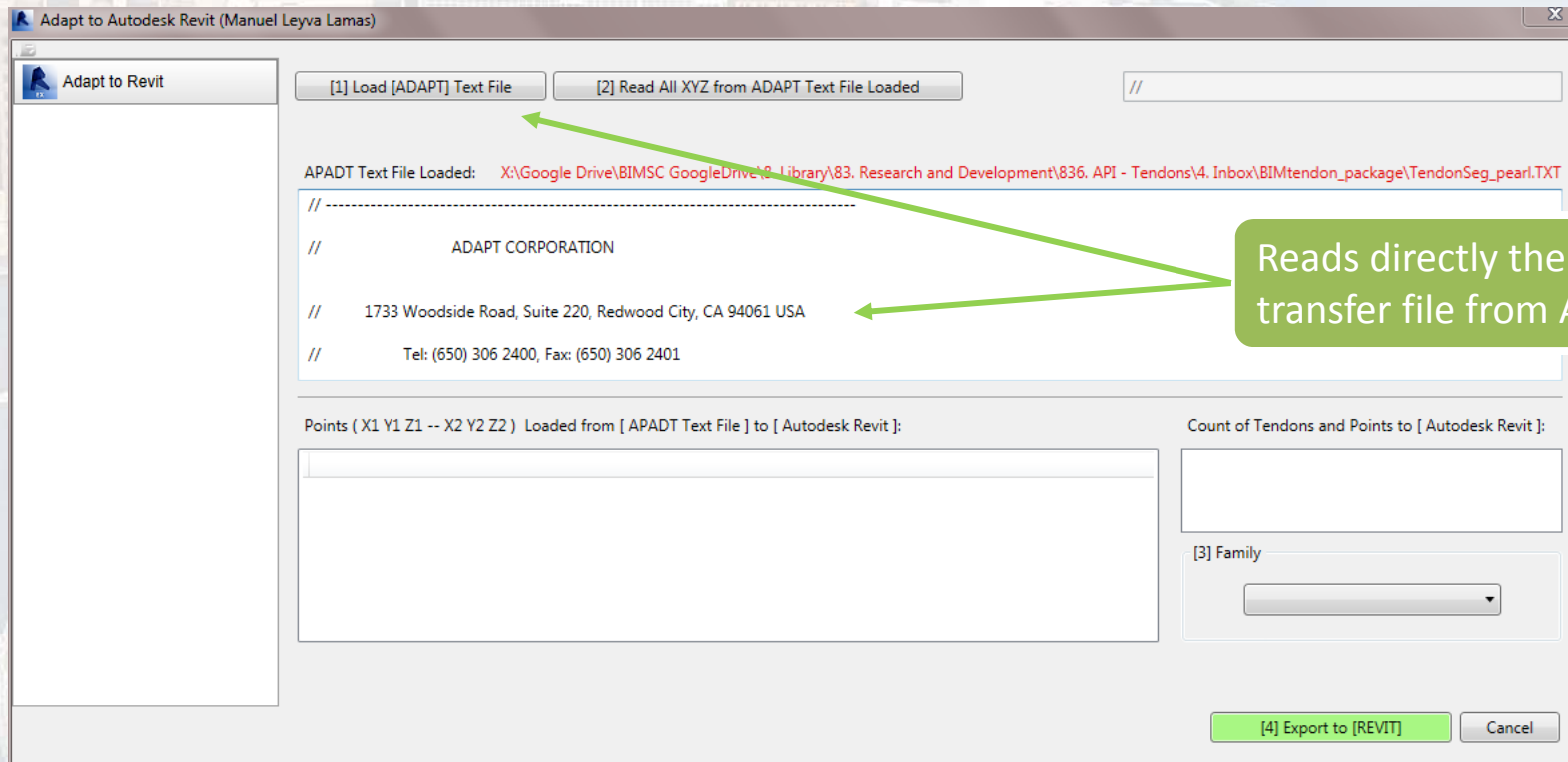
3D Tendons Modeled in ADAPT-Builder

Automated Tendon Modeling in Revit



Synchronized Revit model of floor system modeled in ADAPT

Tendon Data is Extracted from Design Software



Custom Revit Plugin developed in collaboration with BIM Solutions Centre

Tendon Data is Extracted from Design Software

Adapt to Revit

[1] Load [ADAPT] Text File [2] Read All XYZ from ADAPT Text File Loaded ~END_DATA SEGMENT_DATA

APADT Text File Loaded: X:\Google Drive\BIMSC GoogleDrive\8. Library\83. Research and Development\036 API - Tendons\4. Inbox\BIMtendon_package\TendonSeg_pearl.TXT

API 02 - Adapt to Autodesk Revit - Adapt to Autodesk R...
All Tendons Loaded OK
OK

Points (X1 Y1 Z1 -- X2 Y2 Z2) Loaded from [APADT Text File] to [Autodesk Revit]:

TENDON 1						
x1	y1	z1	x2	y2	z2	
-1.46404E+004	9.93762E+003	2.80000E+003	-1.43857E+004	9.77933E+003	2.86177E+003	
-1.43857E+004	9.77933E+003	2.86177E+003	-1.41310E+004	9.62104E+003	2.90650E+003	
-1.41310E+004	9.62104E+003	2.90650E+003	-1.38763E+004	9.46275E+003	2.93277E+003	

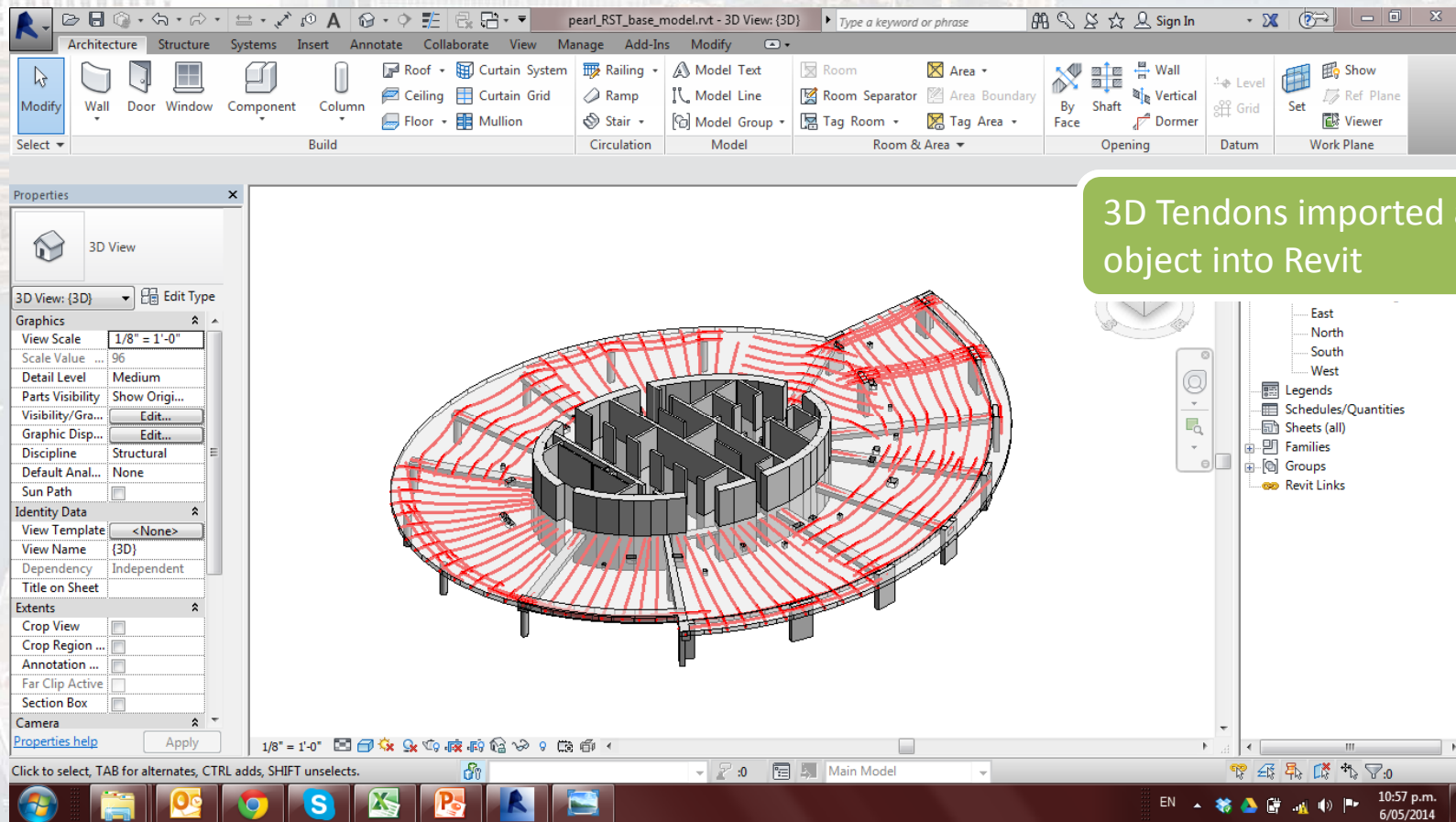
Count of Tendons and Points to [Autodesk Revit]:

[3] Family

[4] Export to [REVIT] Cancel

Compile the Tendons Info in a Revit Friendly Format

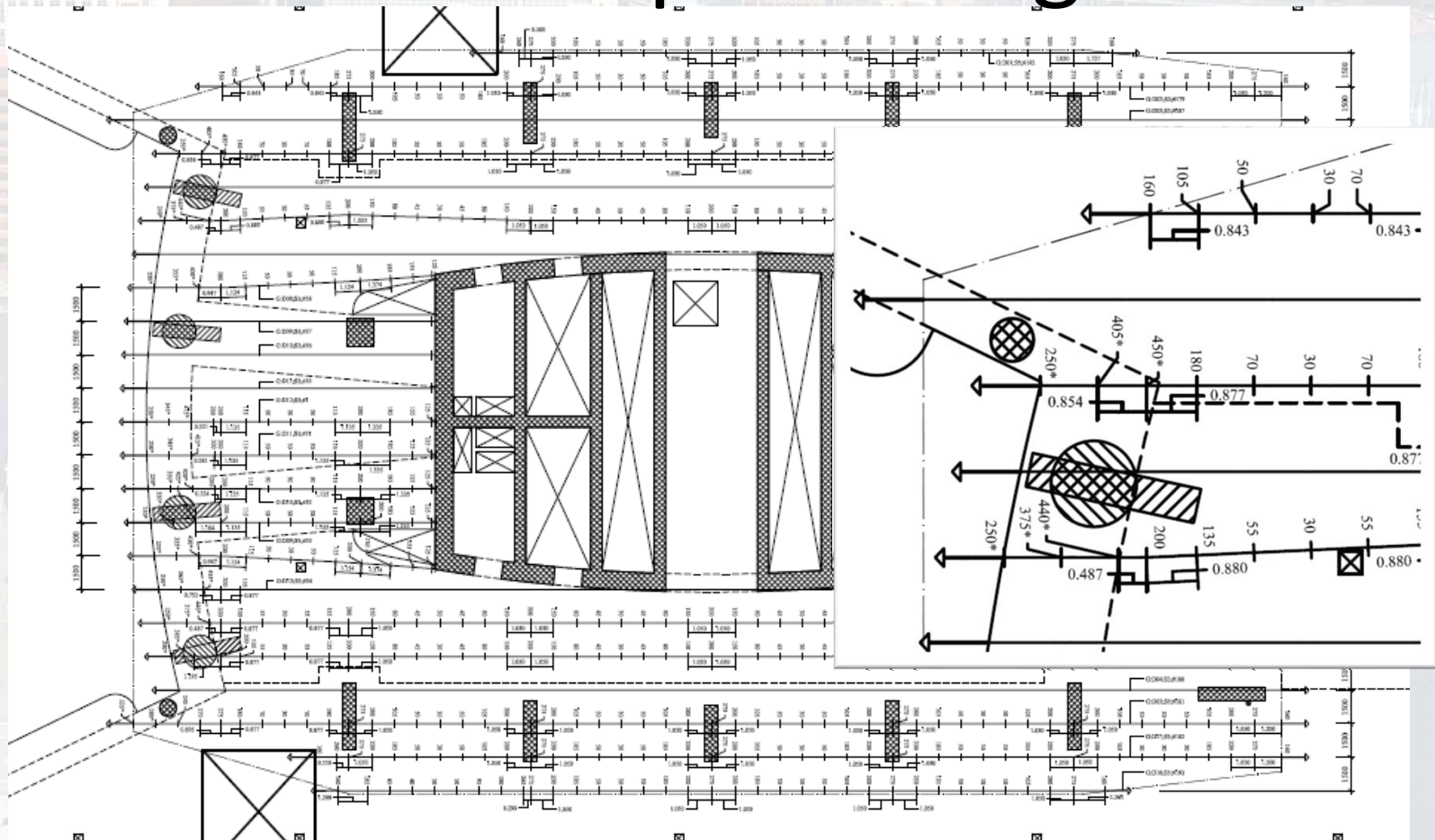
Tendon Data is Extracted from Design Software



Observations

- To produce usable 2D structural drawings need added representation views of tendon objects in Revit
- Imported information is usable for 3D clash detection

Case Study: Automated Generation of PT Shop Drawings



Post-tensioning shop drawing created from design software

Observations

- Used widely for bonded market where tendons are supported at specified distances
- Need additional information for US market
 - Options for different support types
 - Support accessory list
 - Support backup bars
 - Ability to specify pour boundary and adjust tendons

Concluding Remarks

BIM can take on many different forms and ultimately help your business improve quality, coordination and efficiency.

With regards to tendons, until the main BIM modeling platforms develop native tendon objects, you will have to build your own families or rely on those provided by third parties.