

Integrated Structural Analysis and Design for Concrete Buildings Modeled in Revit® Structure

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President & CEO, ADAPT Corporation

Class Summary

SE3106

This class is for structural engineers and architects that are either using or intending on using Revit Structure to model concrete buildings and are looking for opportunities to leverage information in their BIM models to run integrated structural analysis

Learning Objectives

At the end of this class, you will be able to:

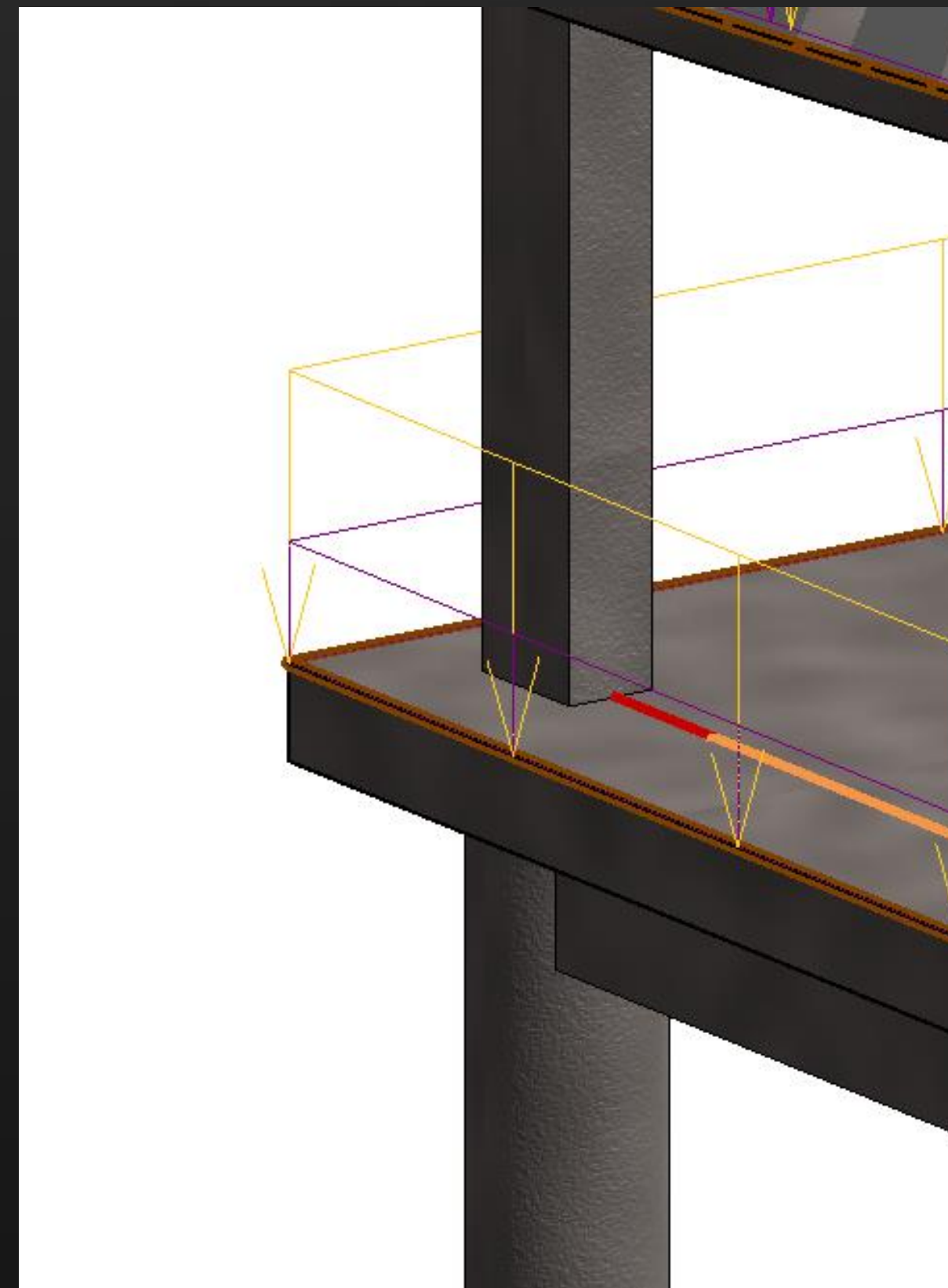
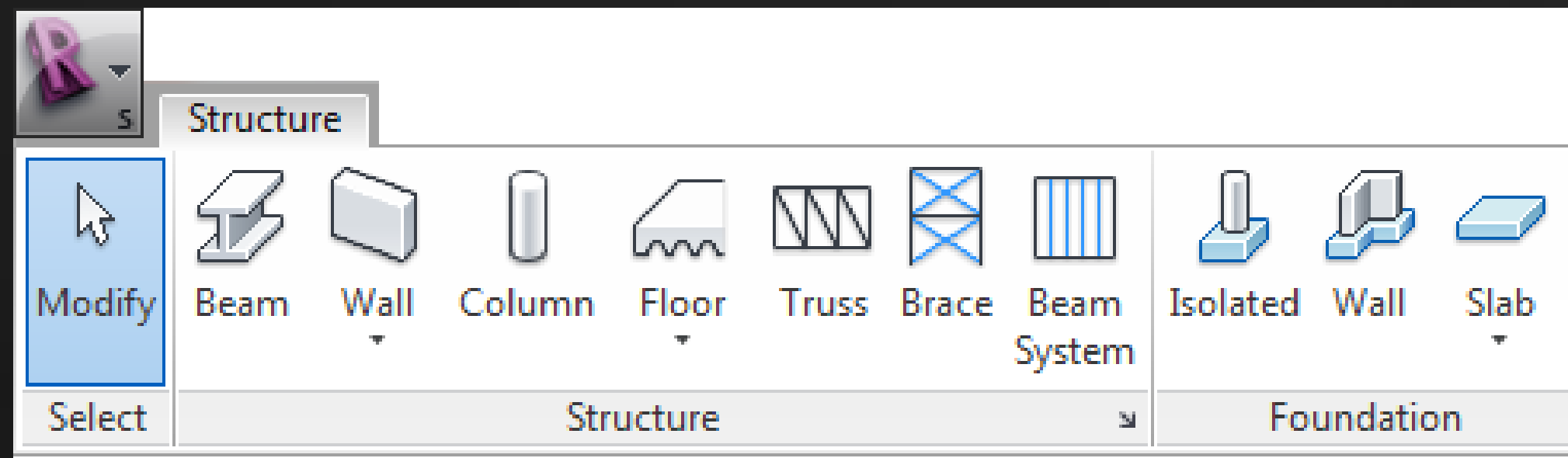
- Learn the options for integrated design of concrete floor and foundation systems for your Revit Structure models
- Know best practice for the rapid analysis of concrete building models created in Revit Structure
- Understand the steps to integrate ADAPT software with Revit Structure and generate analysis results
- Design concrete buildings in Revit Structure more effectively by getting early structural analysis feedback

Physical vs. Analytical Model

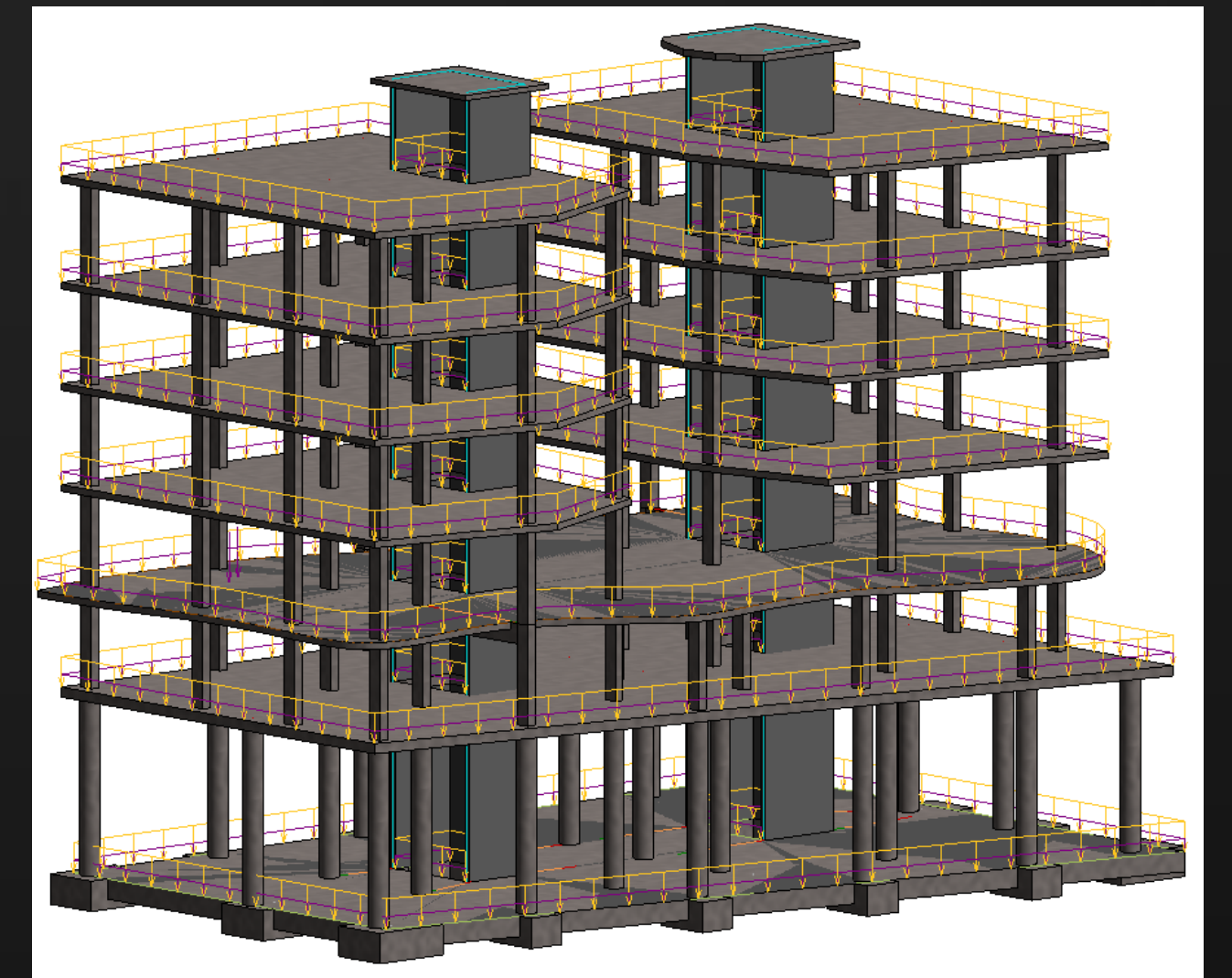
Physical Model Represents Real Structure

Modeling of a project typically starts with its physical representation:

- Structural Components



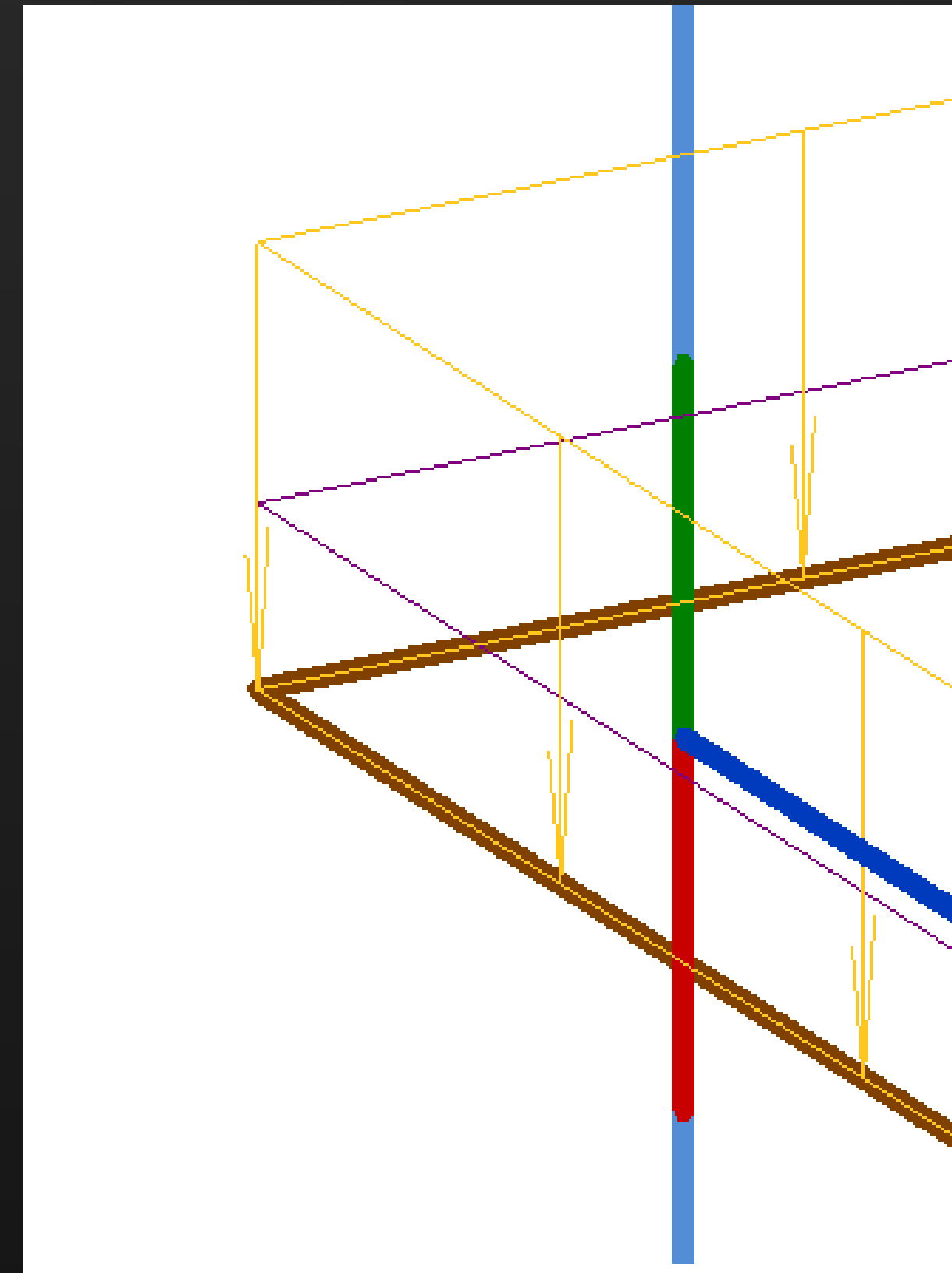
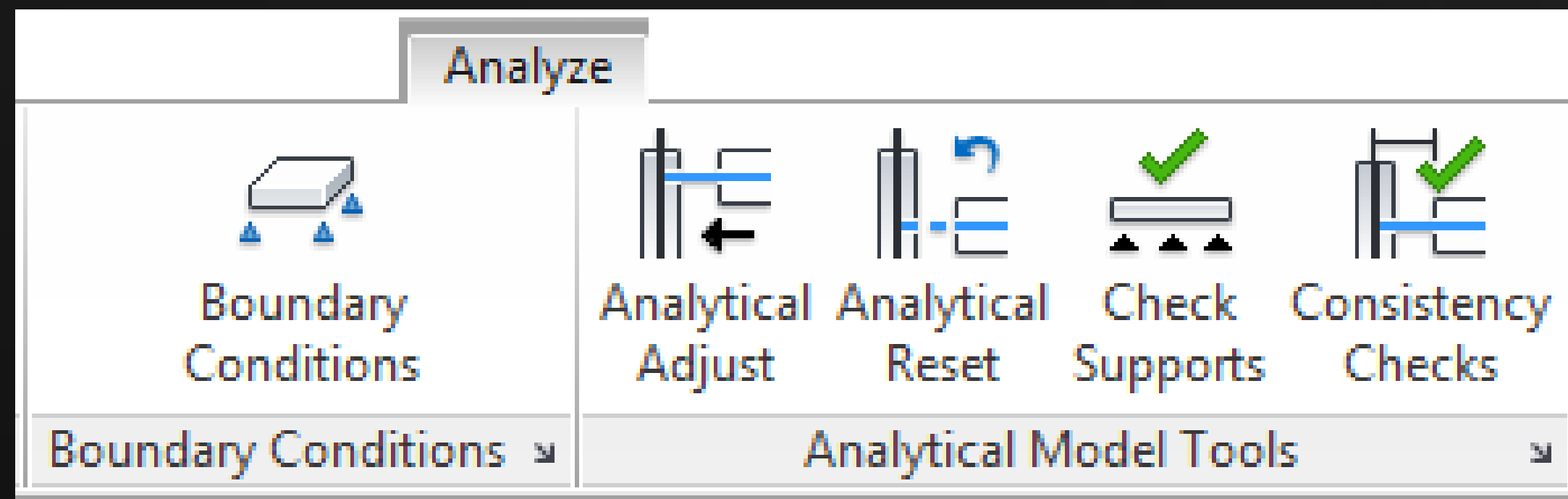
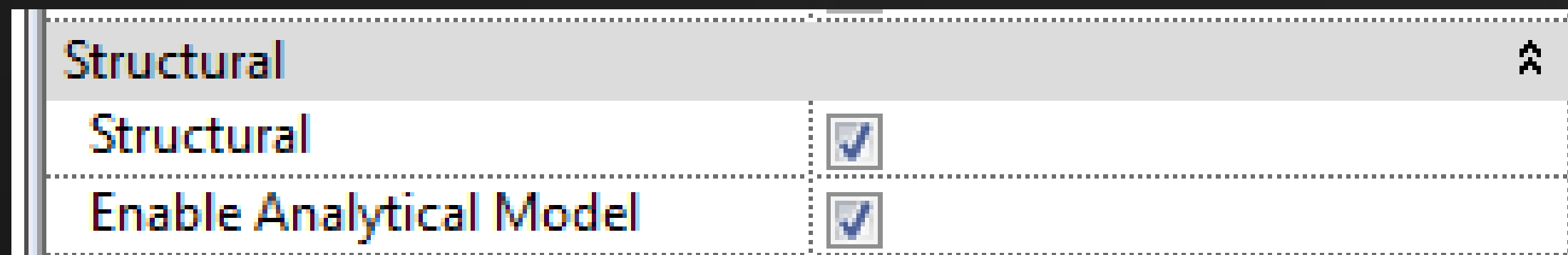
Detail



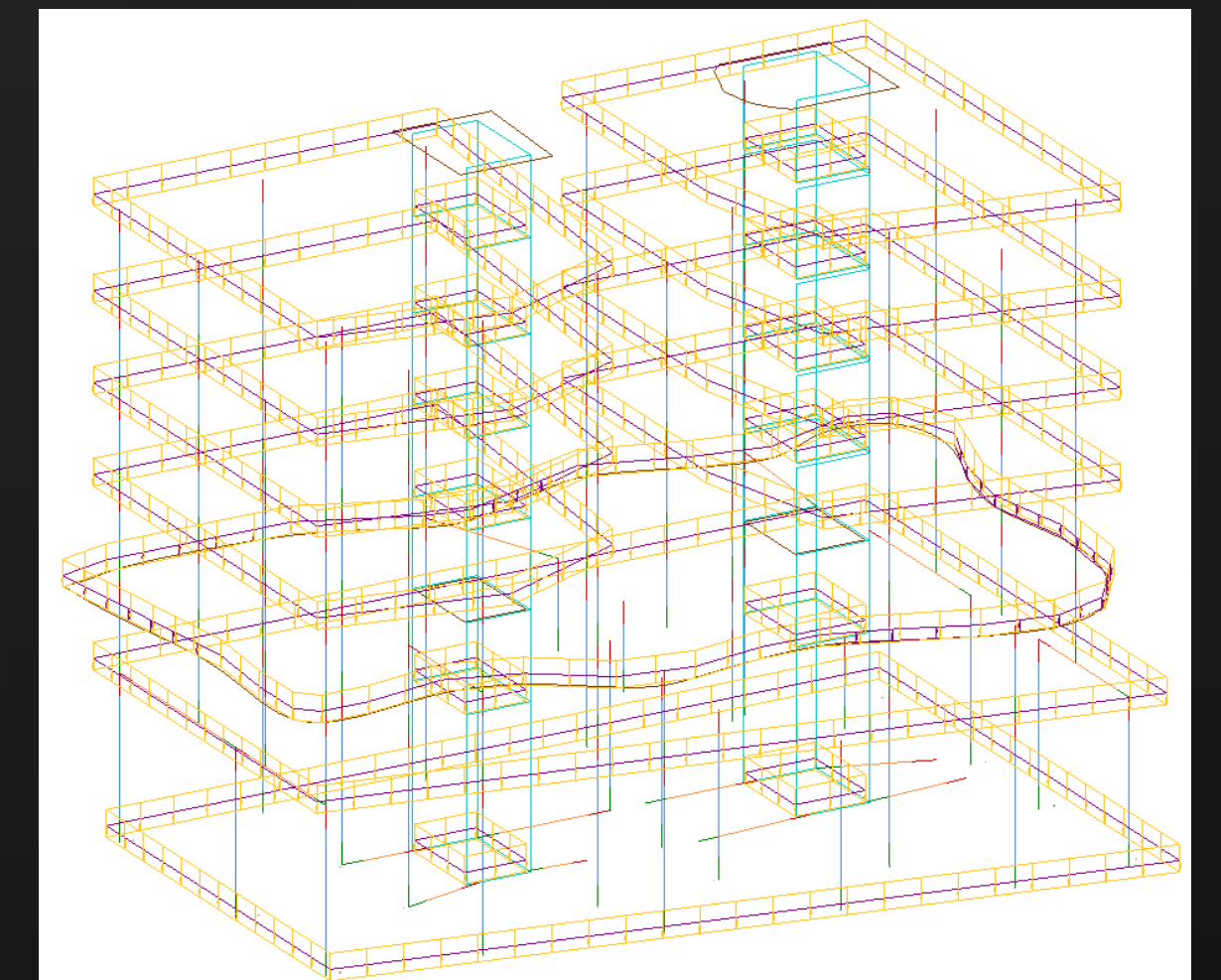
Analytical Model Represents Mathematical Model

Revit Structure creates an underlying analytical model for components :

- Discrete connection points
- Boundary conditions



Detail



Structural Analysis Information in Revit

Capture Structural Analysis Criteria in Revit

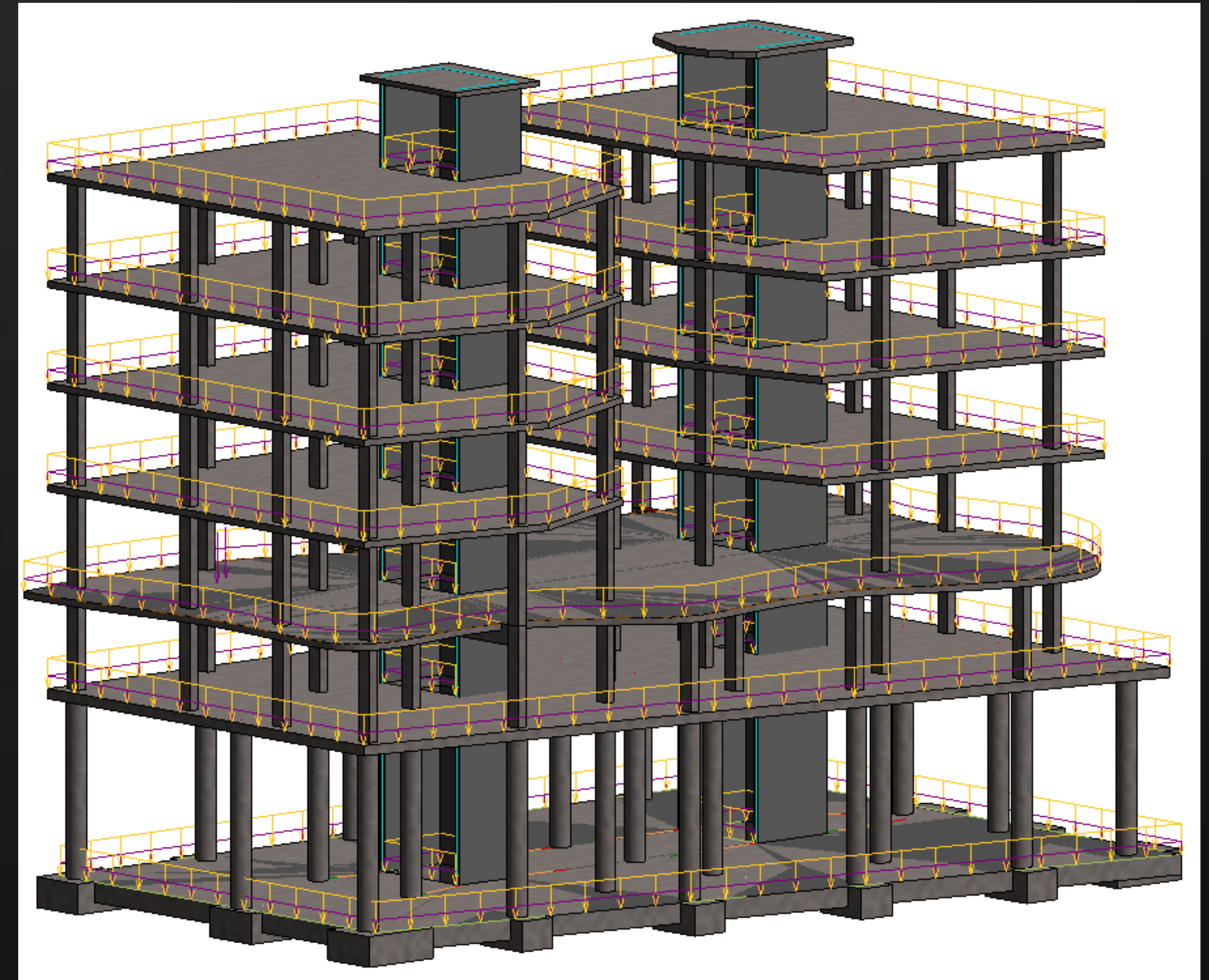
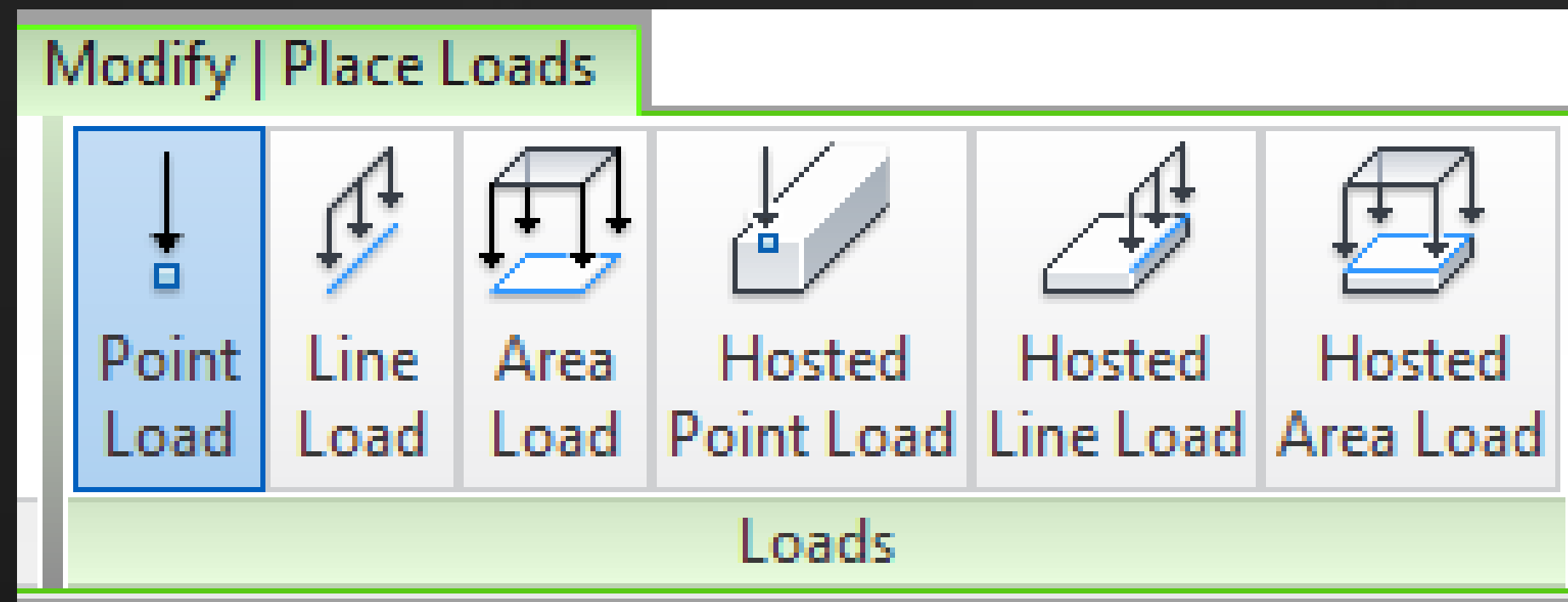
Revit Structure allows you to capture key structural analysis criteria:

- Applied loads
- Load combinations
- Material properties

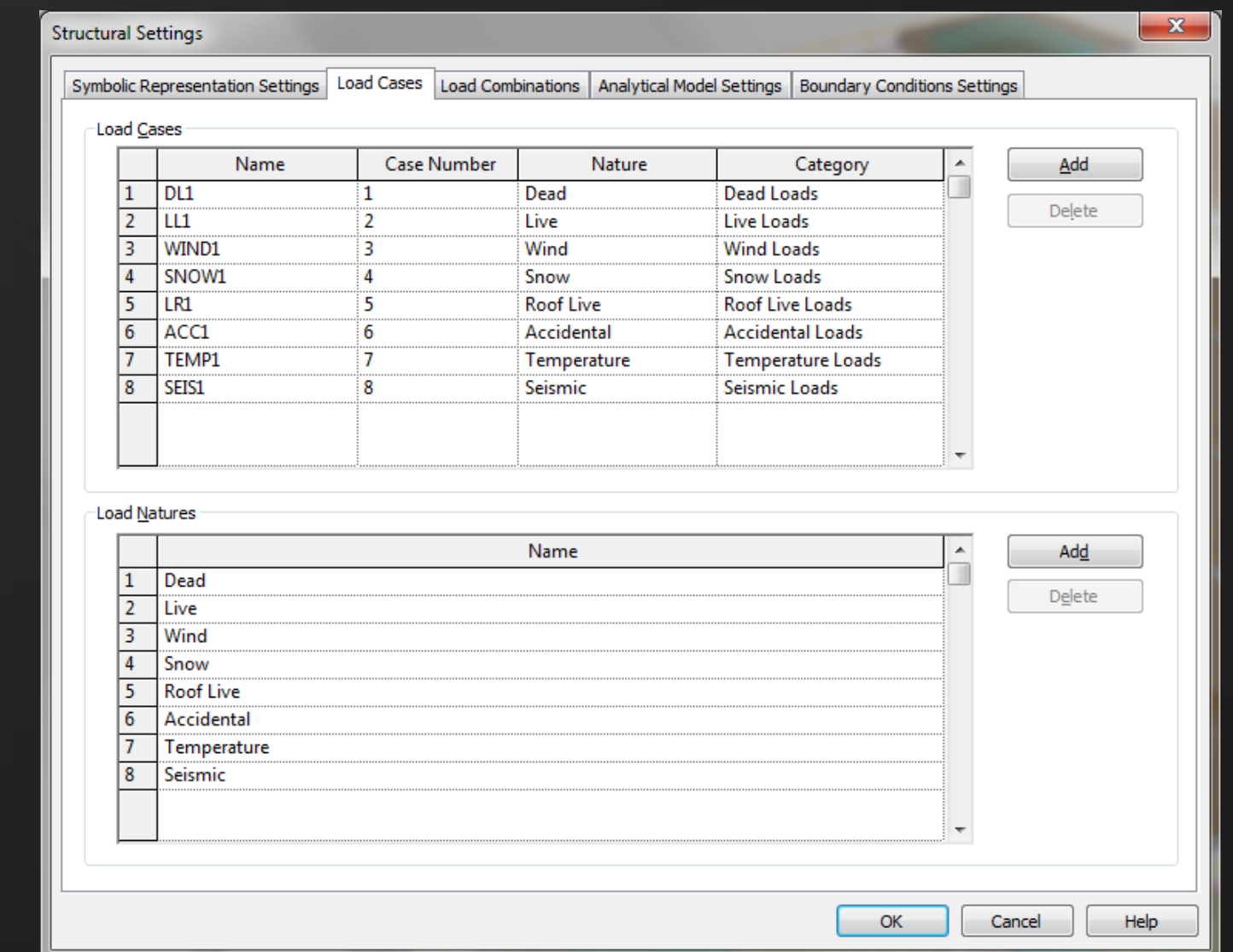
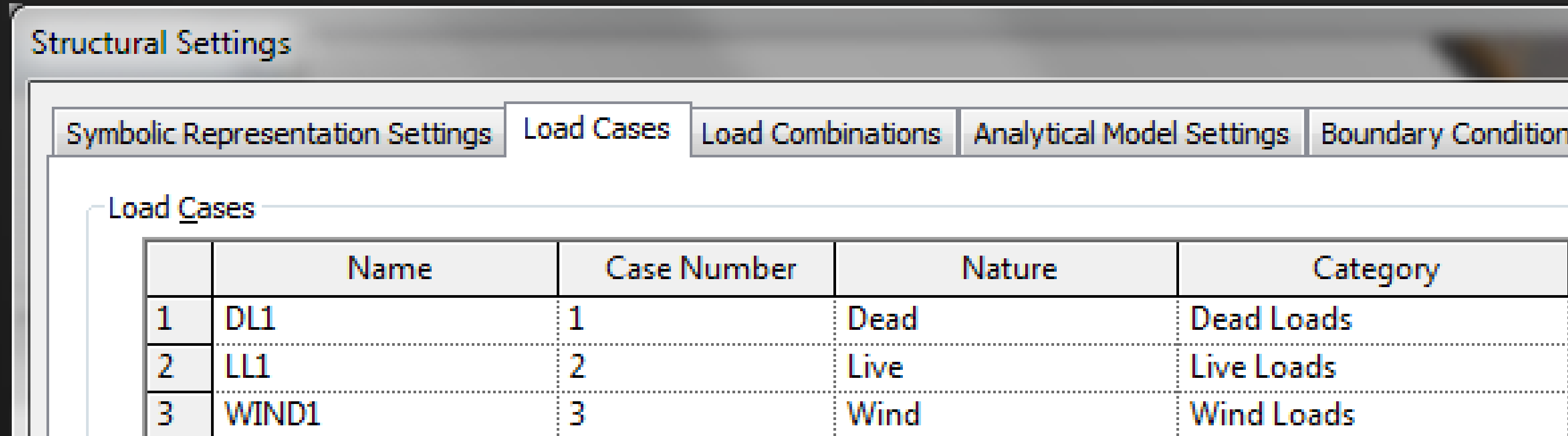
Loads Can Be Applied to Your Models

Revit Structure supports the modeling of typical load types:

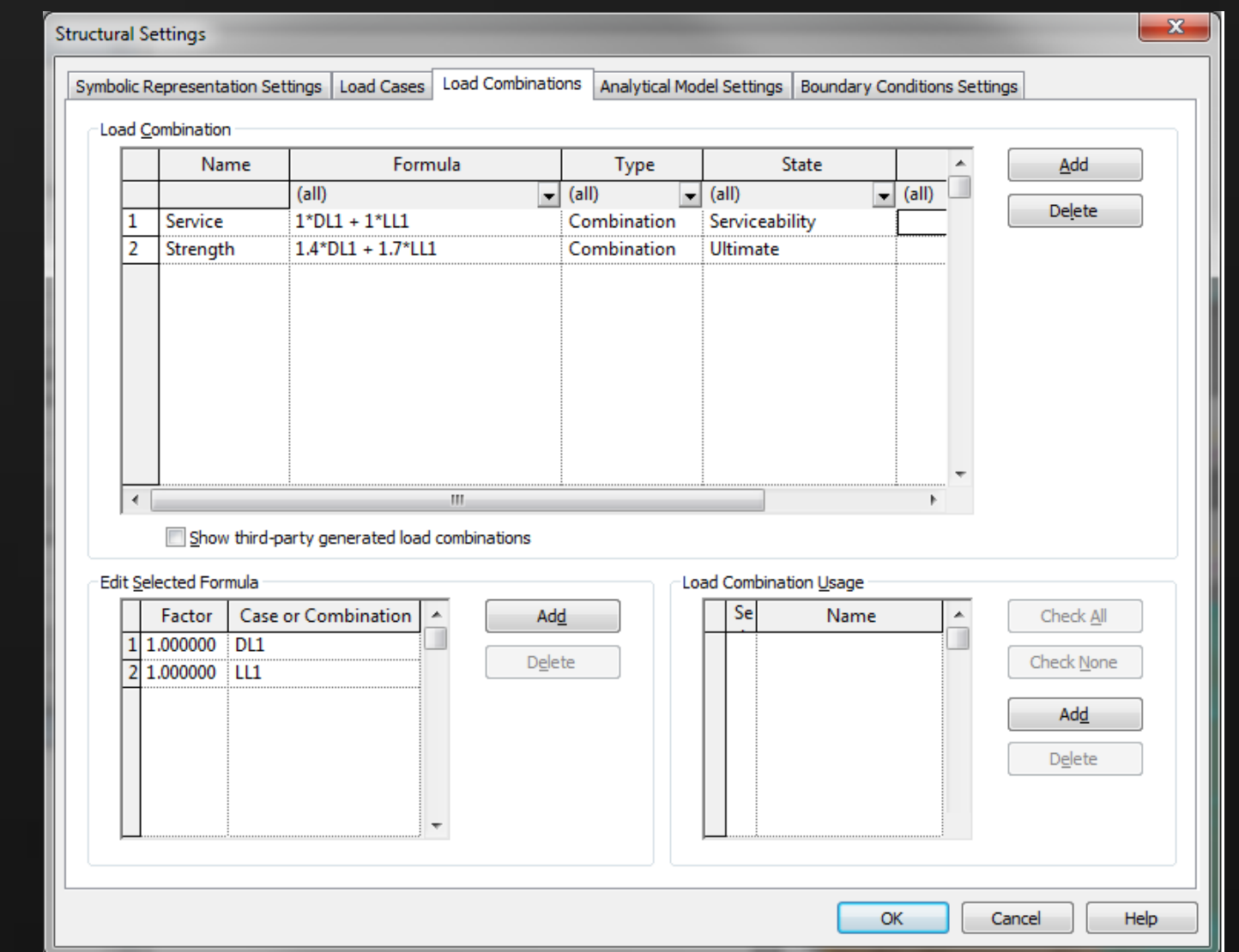
- Point
- Line
- Area



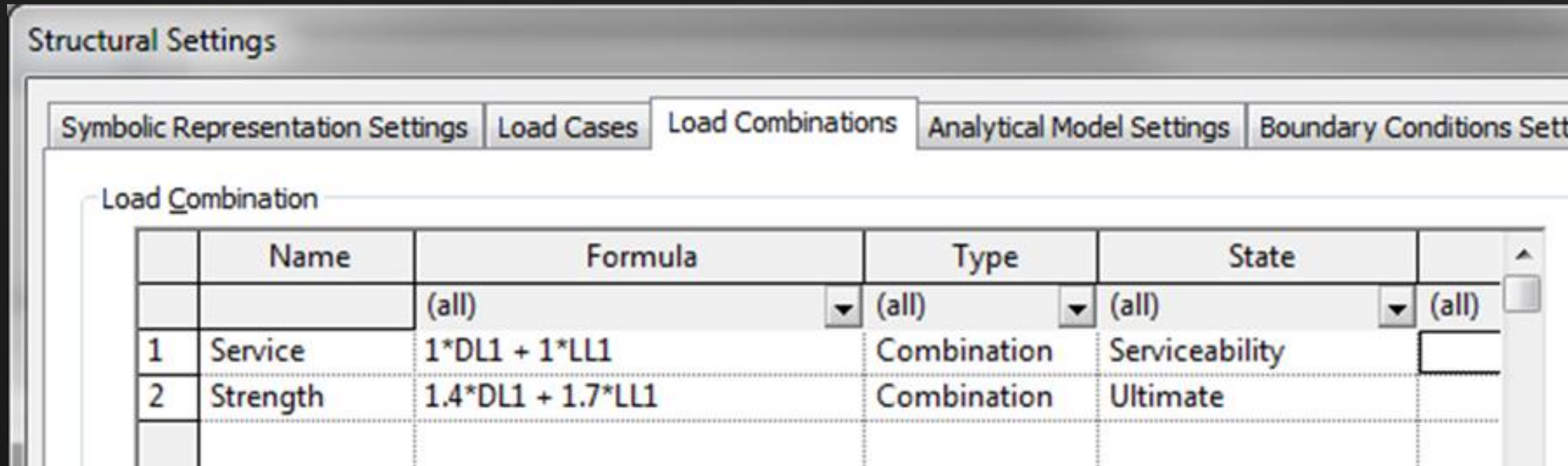
Define and Assign Load Cases



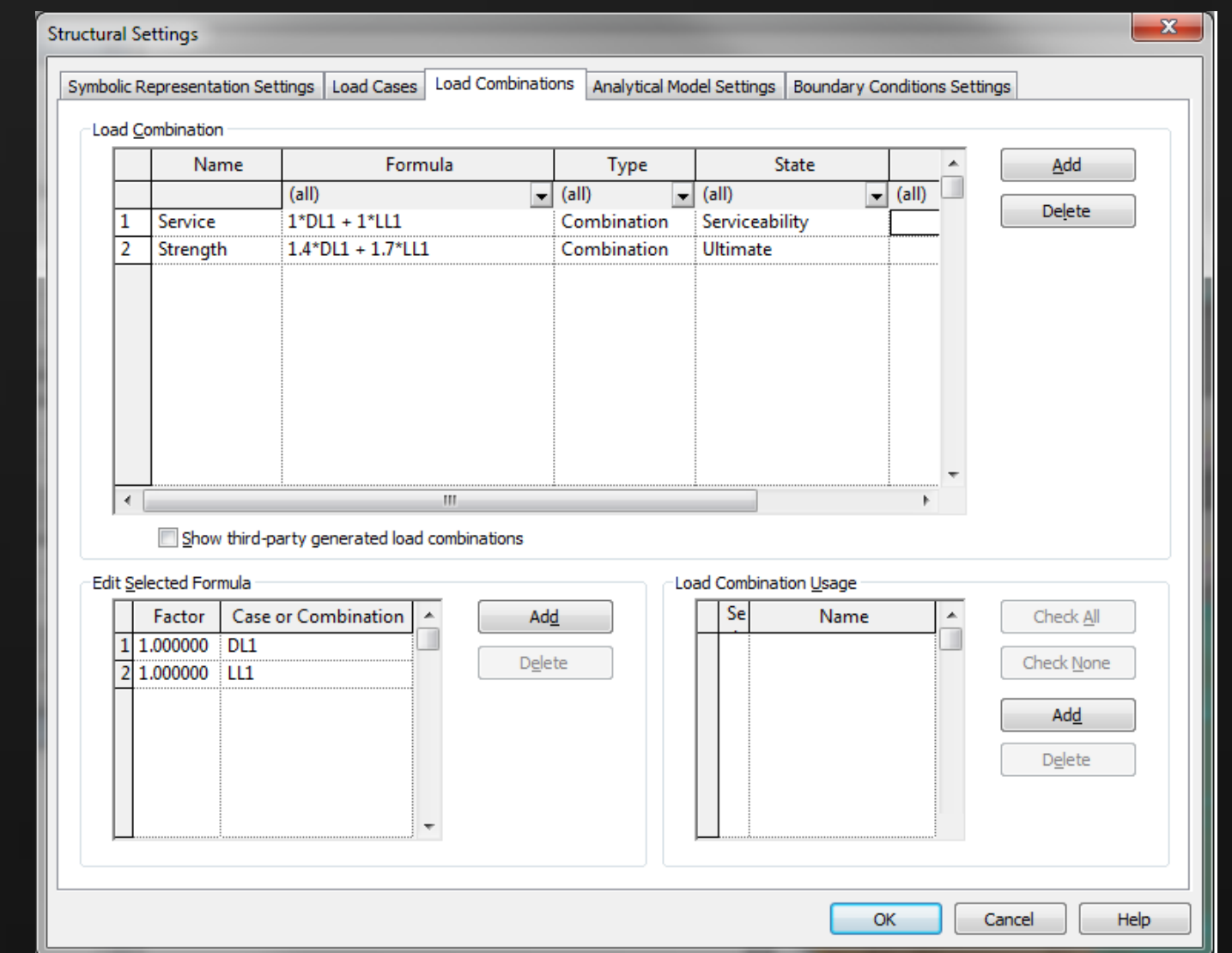
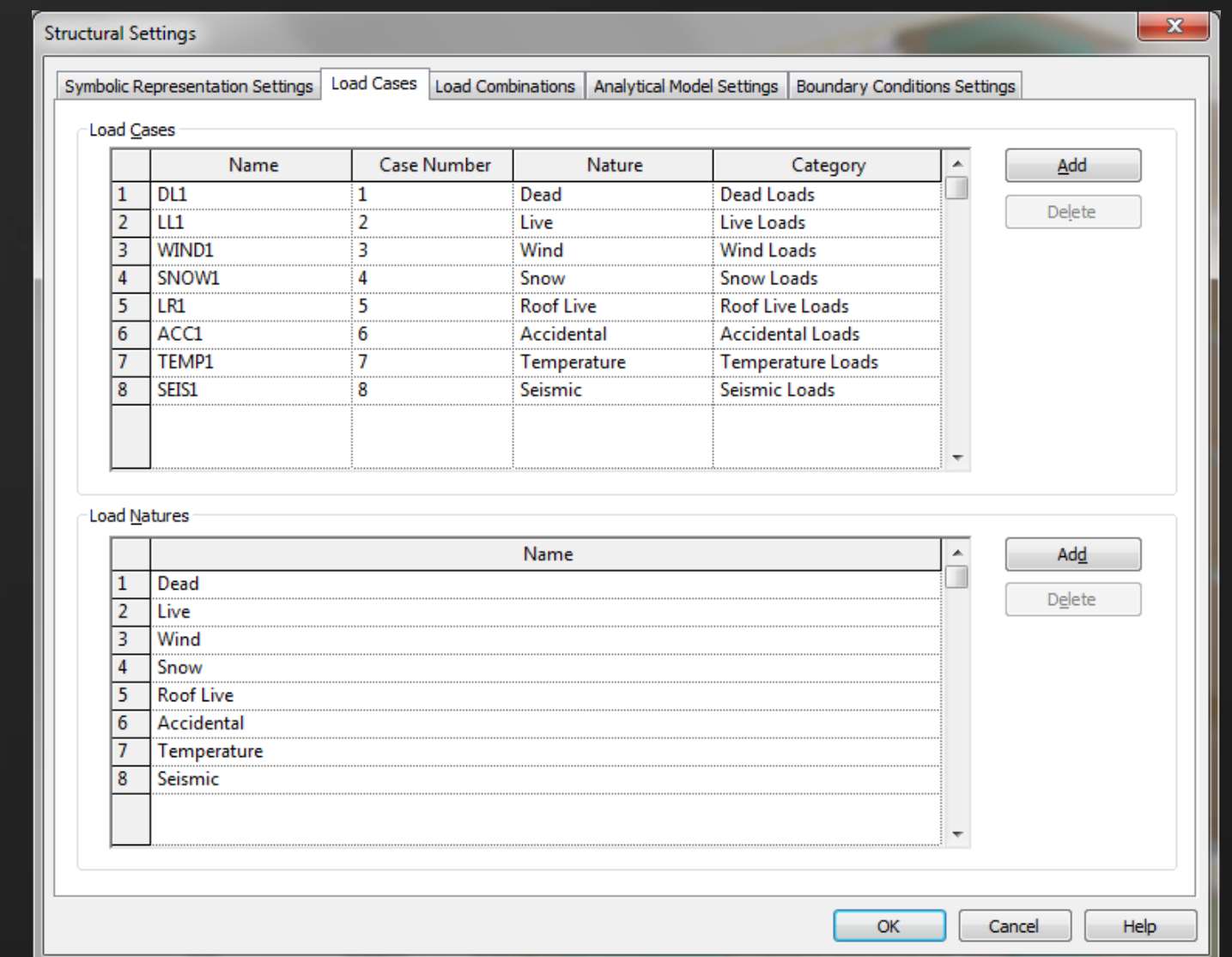
Defining loads, load cases, and combinations centrally in Revit, ensures project-wide consistency



Specify Load Combinations



Defining loads, load cases, and combinations centrally in Revit, ensures project-wide consistency



Comprehensive Material Editor

Material Editor records properties needed for analysis:

- Strength
- Density
- ...

▼ **Mechanical**

Behavior

Young's Modulus

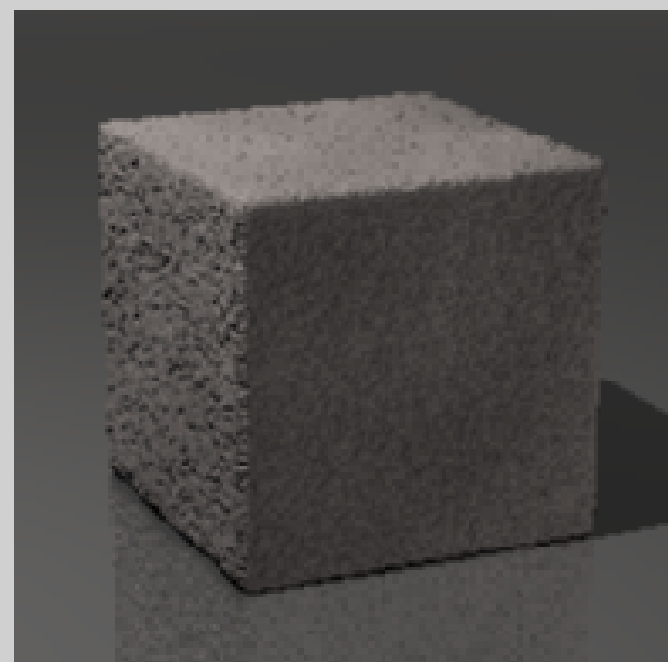
Poisson's Ratio

Shear Modulus

Density

Damping Ratio

Material Editor



► Concrete - Normal Weight - 5 ksi

Assets

Name	Aspect
Concrete - Normal Weight - 5 ksi	Graphics
Concrete - Normal Weight - 5 ksi	Appearance
Normal Weight Concrete - 5 ksi	Physical

Physical Properties

► Information

▼ Basic Thermal

Thermal Expansion Coefficient

▼ Mechanical

Behavior

Young's Modulus

Poisson's Ratio

Shear Modulus

Density

Damping Ratio

► Concrete

Custom Parameters Done

Structural Concrete Analysis Options

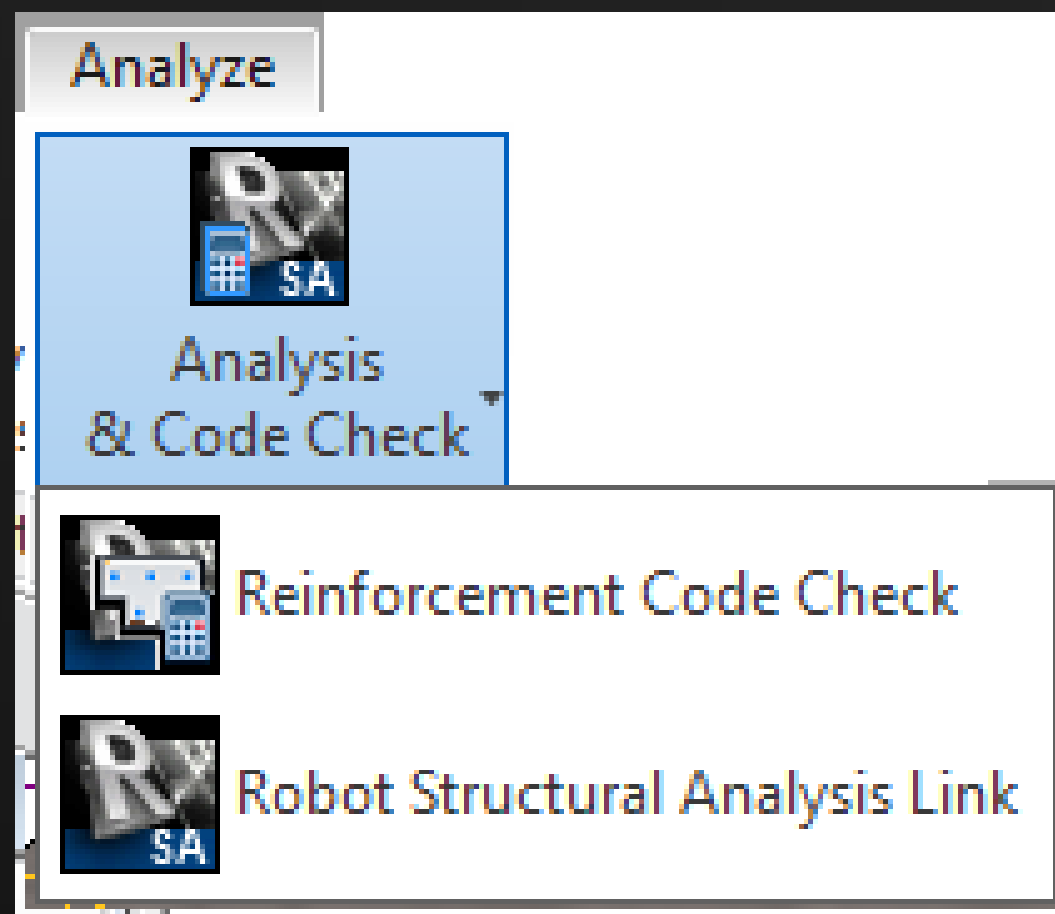
Revit Structure Offers Several Analysis Options

As an end-user, you have several choices to pick from:

- Robot Structural Analysis
 - General structural analysis and specific reinforced concrete design
- Analyze in Cloud with Autodesk 360
 - General structural analysis
- Revit extensions
 - Fully integrated analysis capabilities for beams, slabs and load takedown
- 3rd party analysis and design software
 - ADAPT-Builder Suite (Edge, Floor Pro & MAT)

Analysis Using Robot Structural Analysis

Autodesk maintains a tight bi-directional link between Revit Structure analytical models and Robot Structural Analysis:

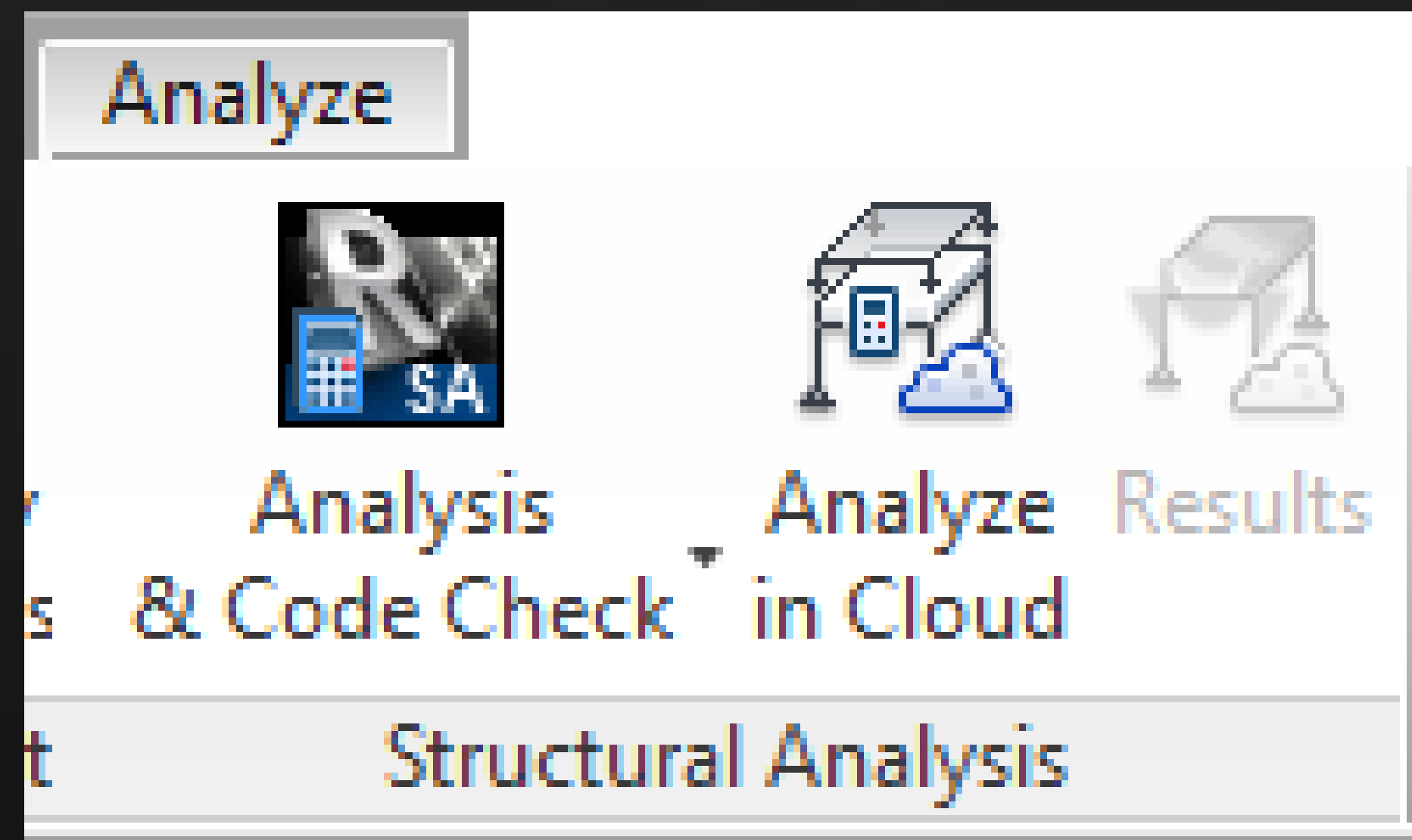


The integration link is embedded in each installation of RST

On-Demand Analysis Services in the Cloud

Autodesk 360 offers integrated, on-demand analysis services:

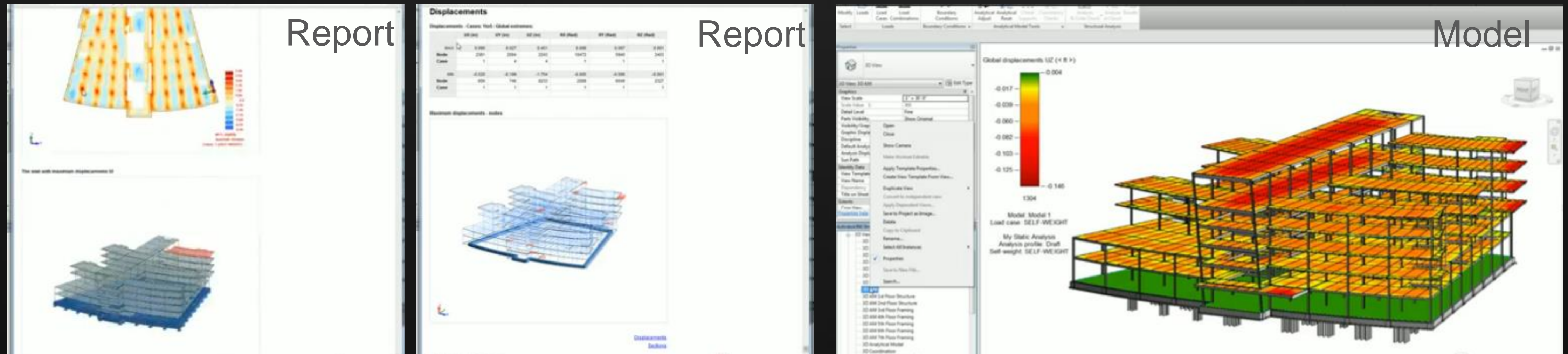
- Usage is measured in “cloud points”
- Certain point allocation comes with annual Subscription
- Then Pay-as-you-go



Structural Analysis using Autodesk 360

On-demand structural analysis options:

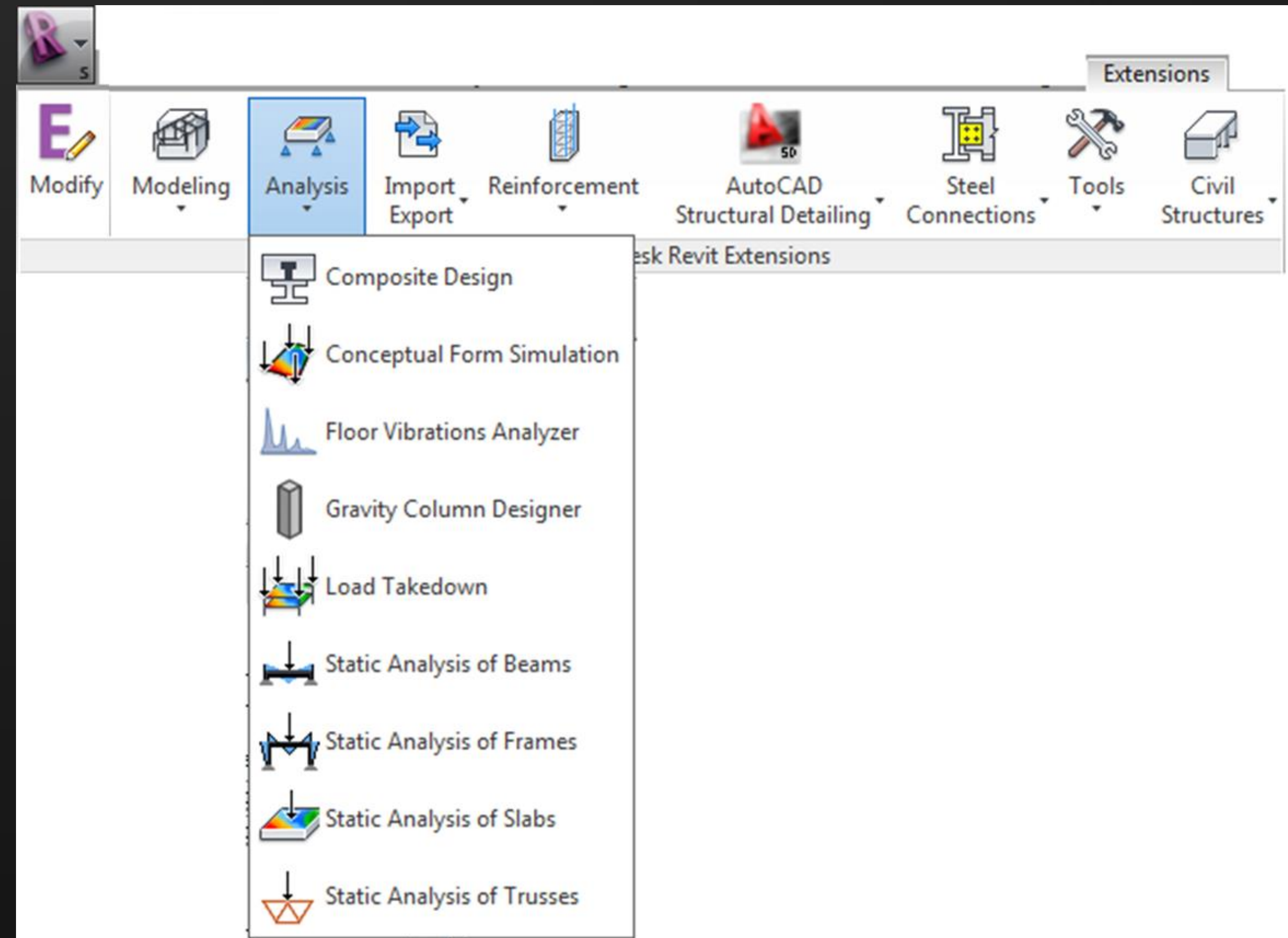
- Static structural analysis
- Results are presented in PDF graphical / tabular report
- Results can also be downloaded and displayed in model
- Analytic model uploaded and stored in cloud



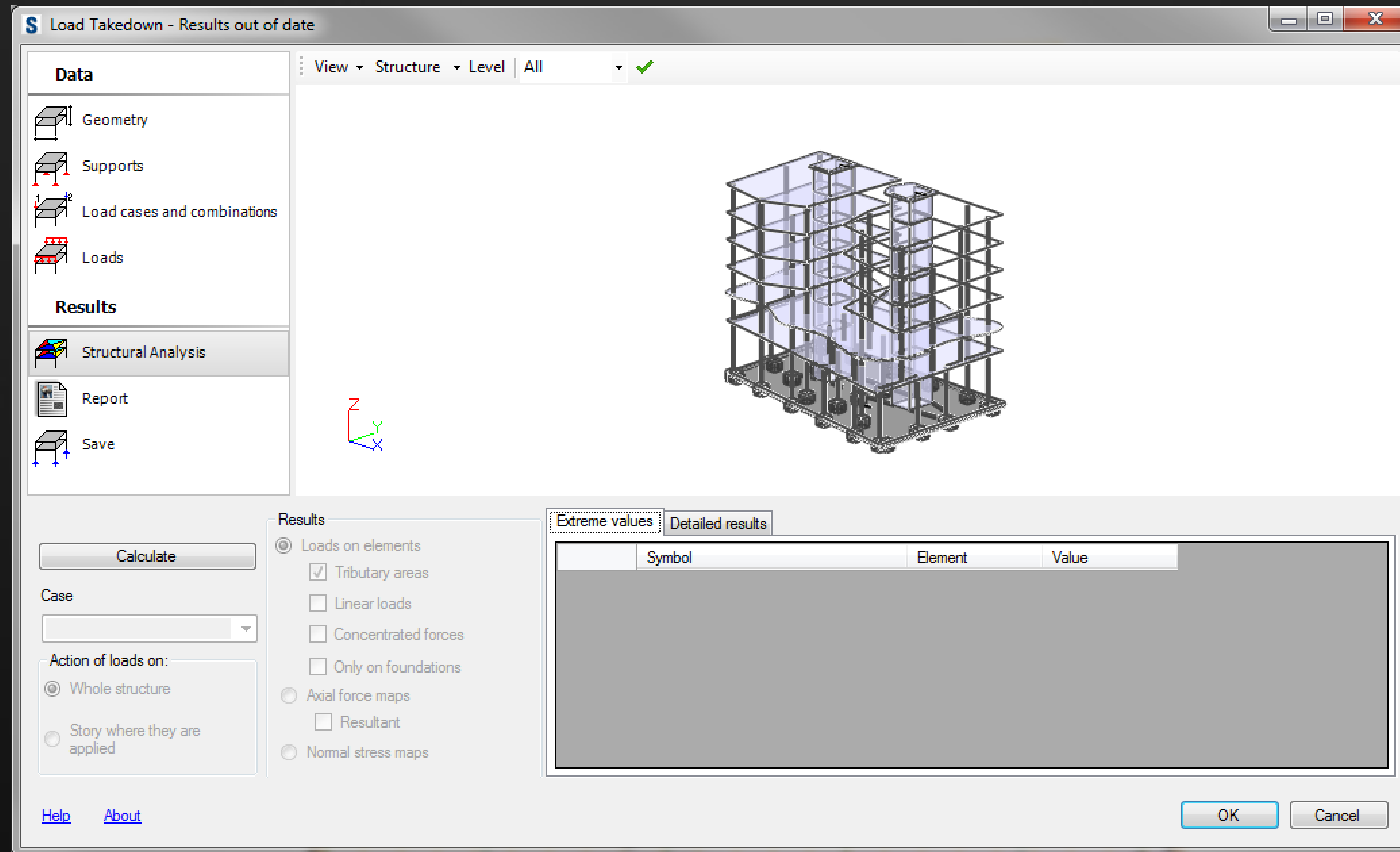
Leveraging Revit Extensions

Extensions offer some great value added tools:

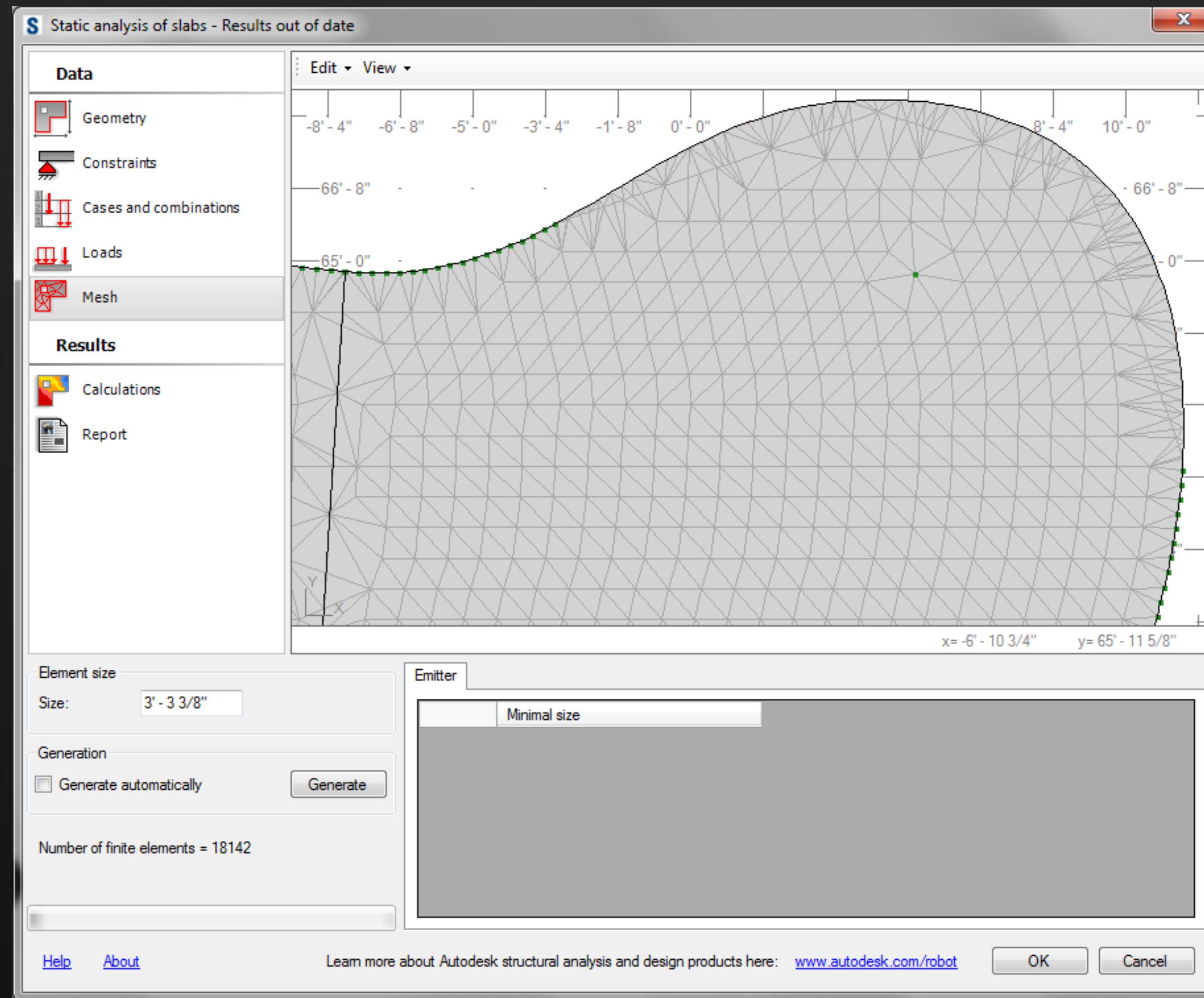
- Good rebar detailing
- Limited concrete analysis/design
 - Load takedown
 - Static analysis of
 - Beams
 - Frames
 - Slabs



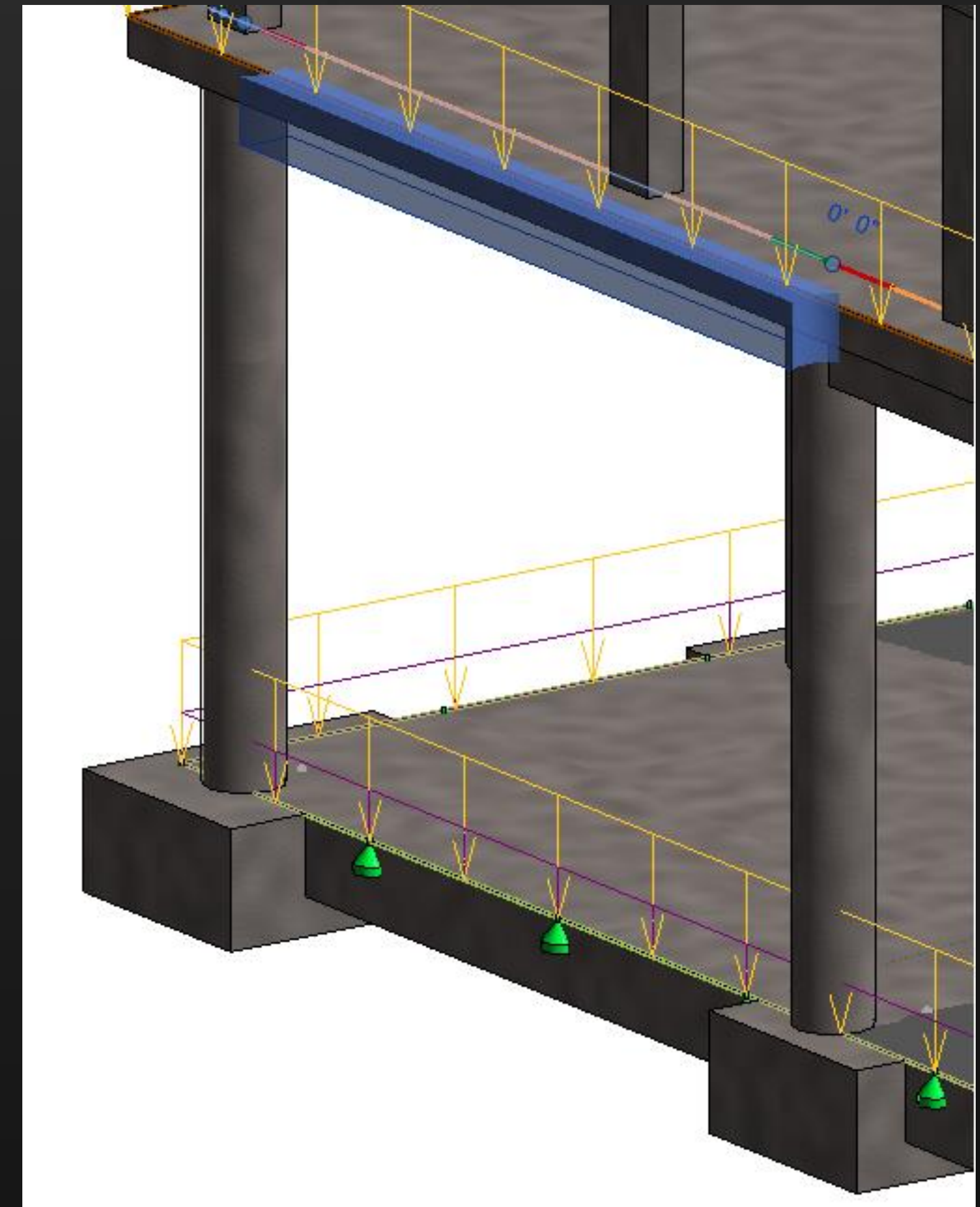
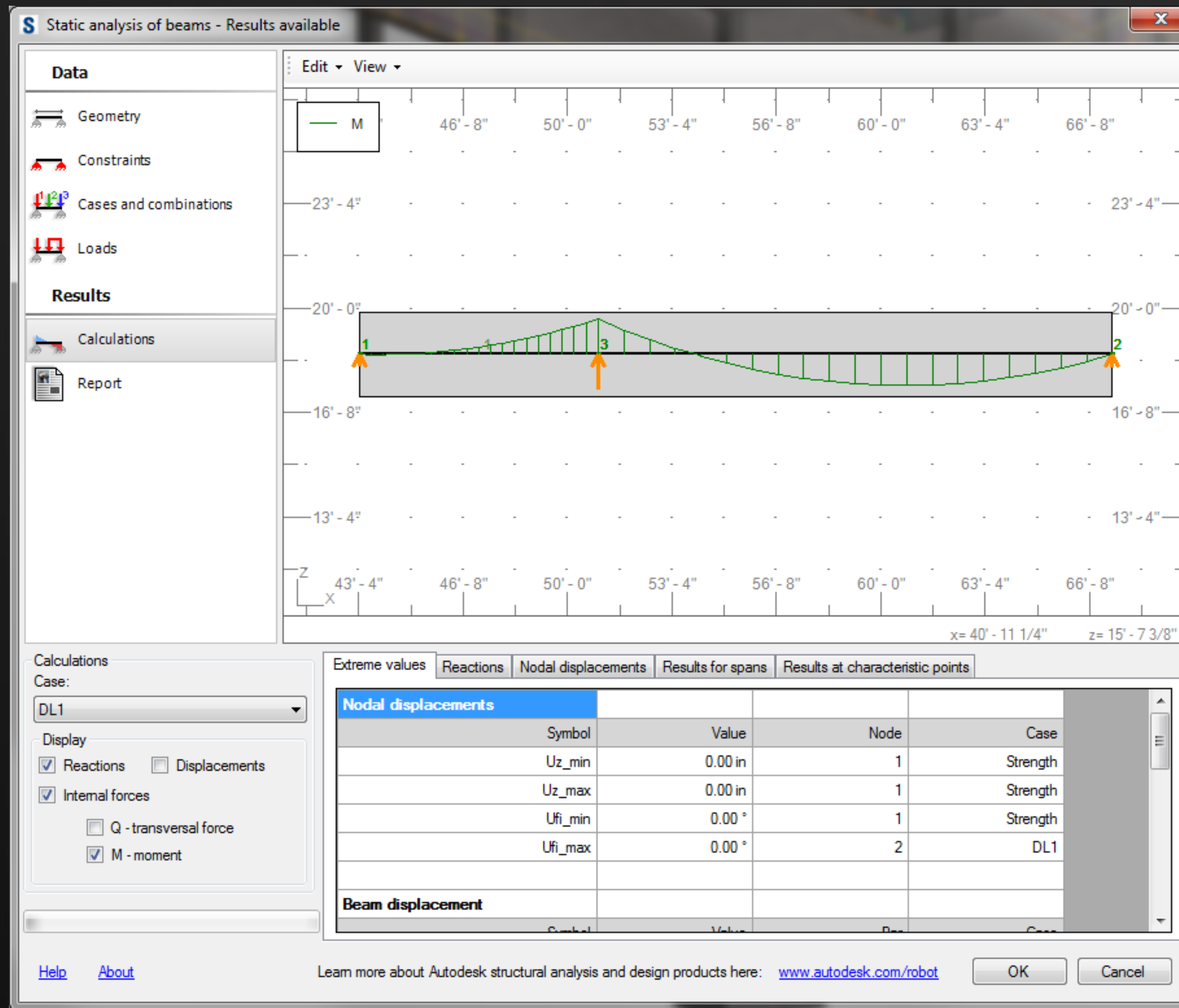
Load Takedown Using Revit Extension



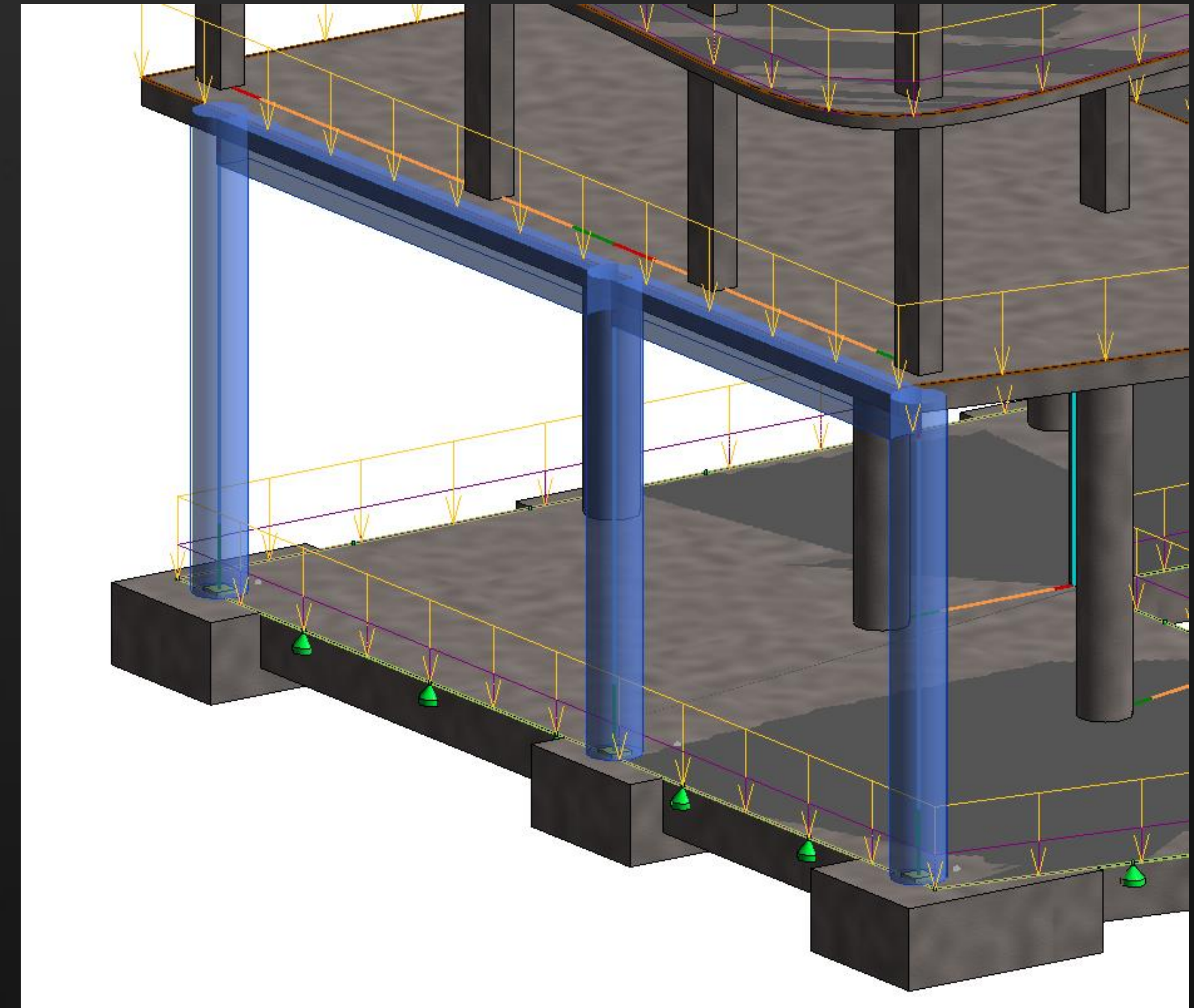
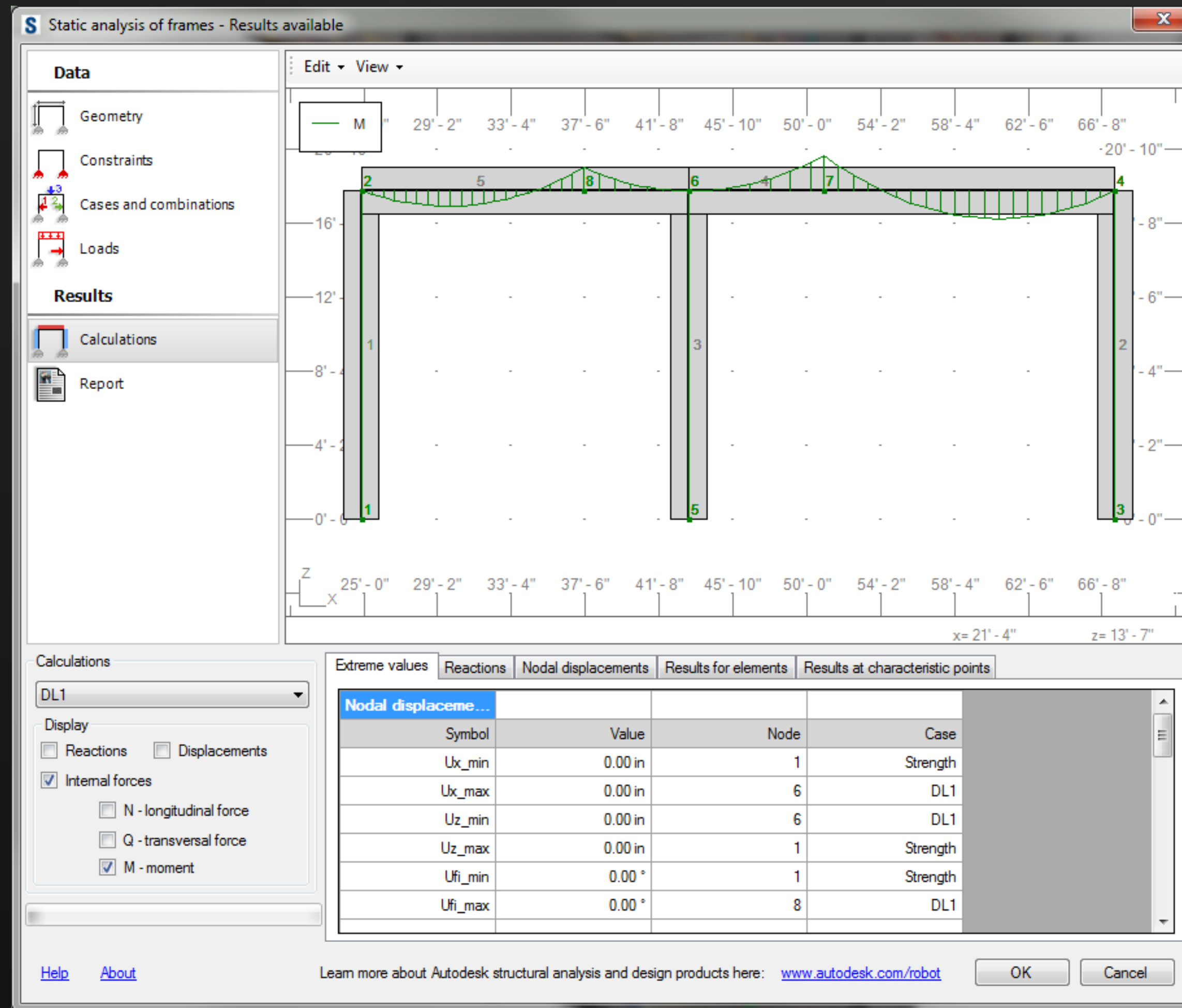
Automatic FEM Mesh Generated by Extension



Beam Analysis Using Revit Extension



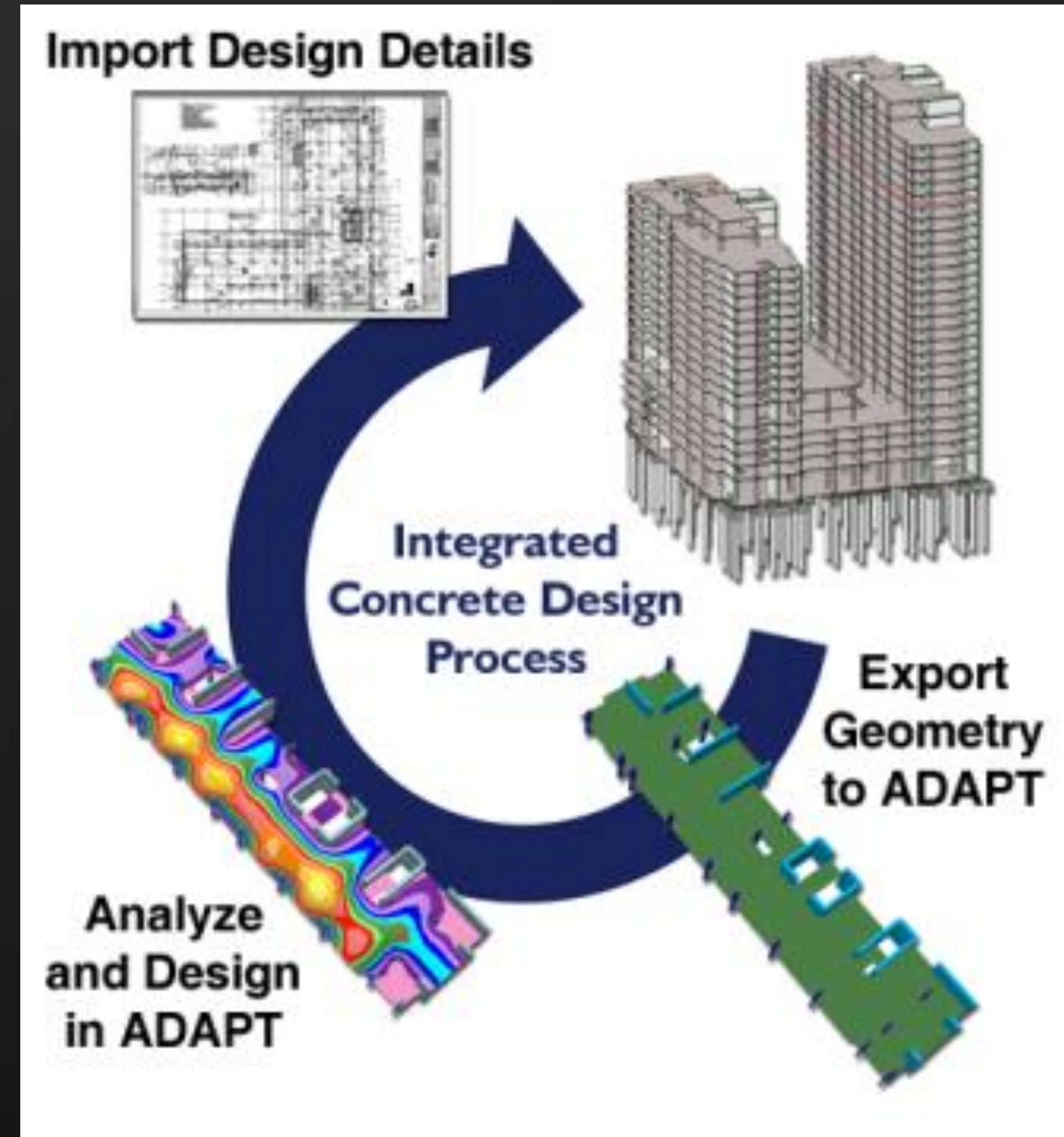
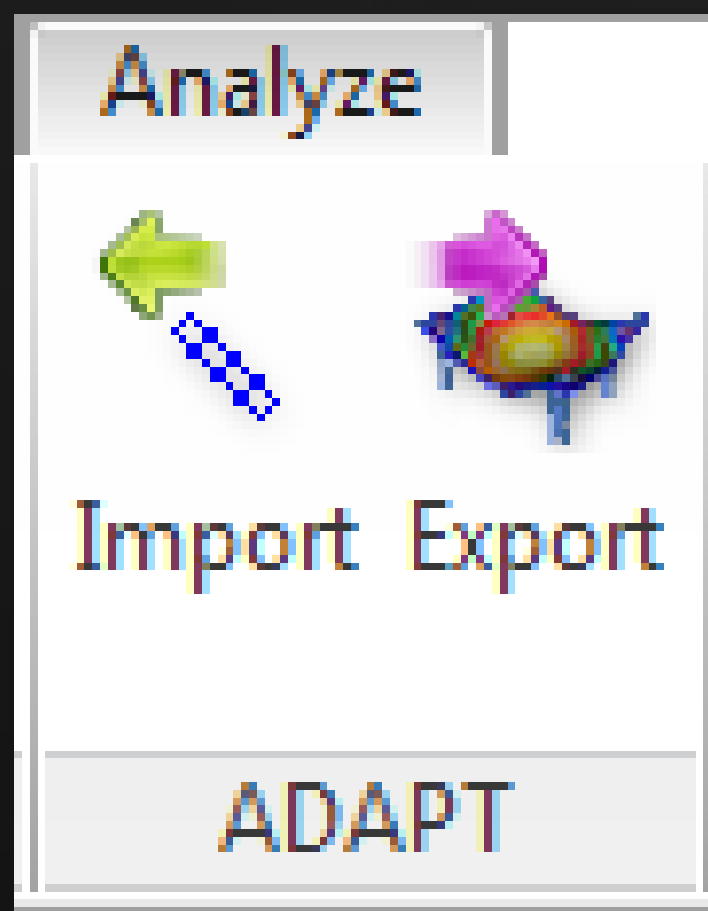
Frame Analysis Using Revit Extension



Rely on Specialized 3rd Party Integrated Solutions

ADAPT maintains Integration link:

- Export of **physical** model
- Detailed analysis & design of project
- Import of rebar and tendons

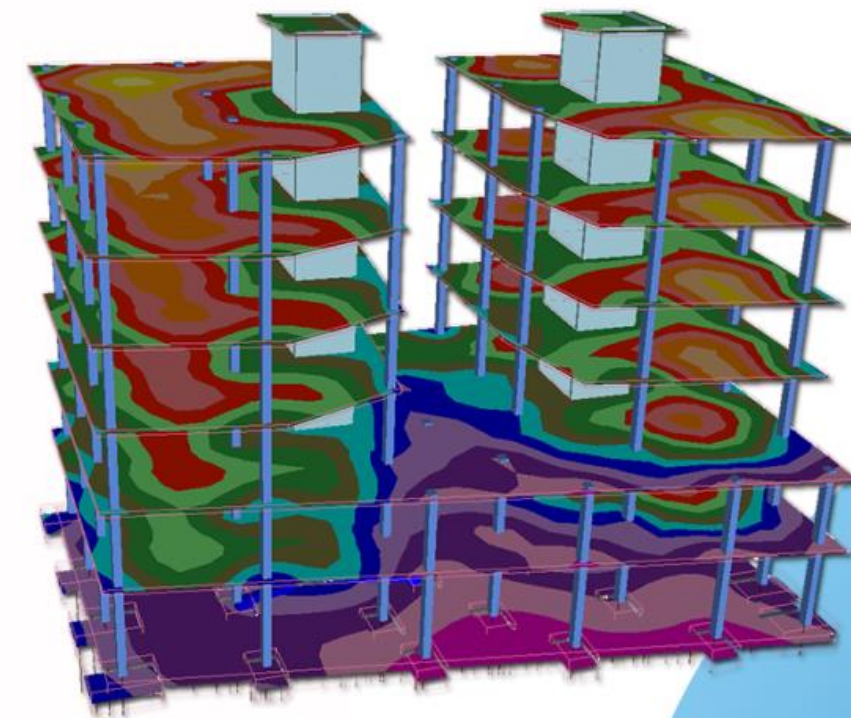


ADAPT-Builder Suite for Analysis/Design of Concrete Revit Models

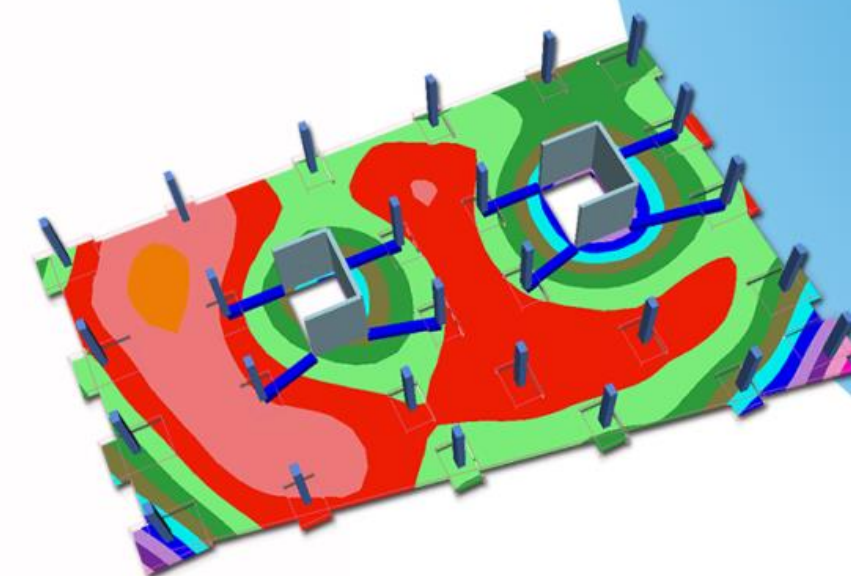
ADAPT Suite Offers Integrated Design Approach

Integrated approach:

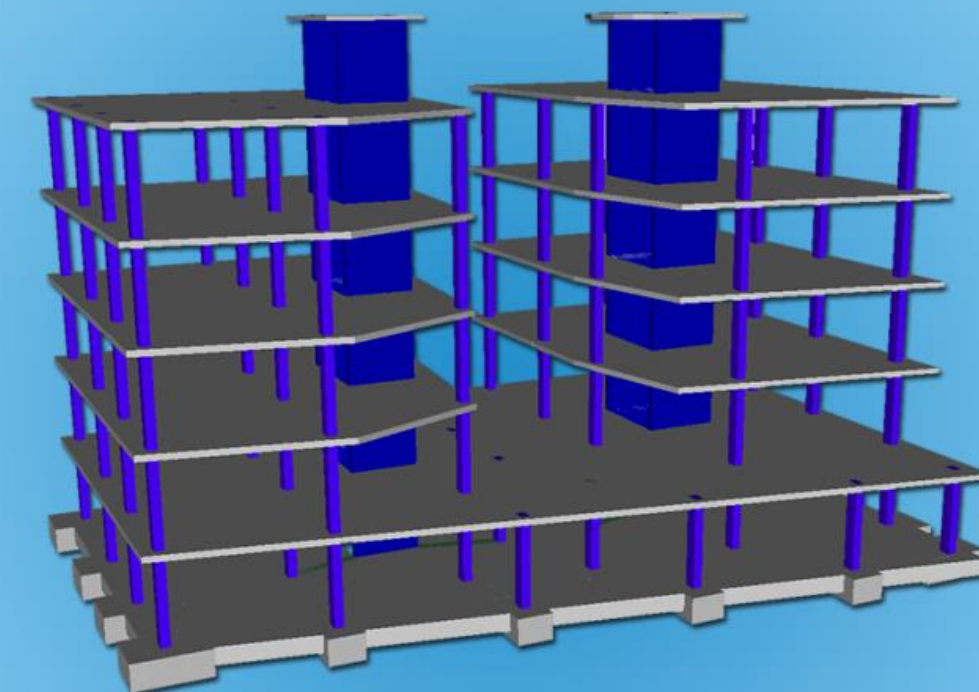
- Physical Model is extracted from Revit Structure and analyzed using Edge
- Slabs and beams are designed using Floor Pro
- Foundation systems are designed using MAT



ADAPT-Edge Analyzes Full Building Model for Lateral and Gravity Loads

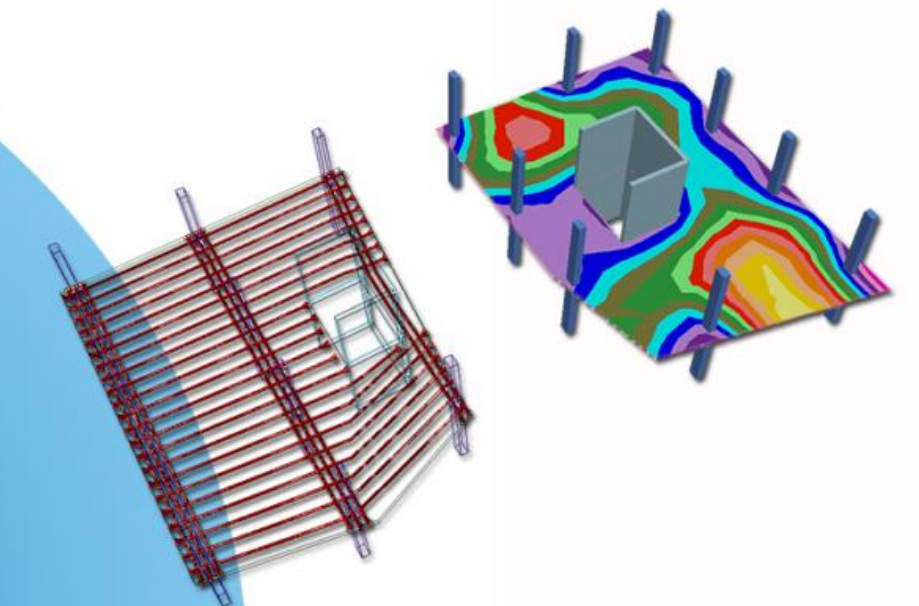


ADAPT-MAT® - Designs Mat Foundations Using Automatically Generated Load Take-down



ADAPT-Builder with Edge offers a Fully Integrated Modeling Approach for your RC/PT Building Projects

ADAPT-Floor Pro® - Designs Individual Levels and Automatically Combines Lateral and Gravity Analysis Results from the Building and Individual Slab Solutions



Project Name: General name
Date of execution: April 10, 2012
2012

Specific Data: Specific name
File Name: revit_model_no_mat_540912.dgn
FLOOR-PRO

60.20/40 LOWER/UPPER COLUMNS

COLUMN SECTION

Service	ID	Label	Location	Pz	Fz	Fs	Mx	My
1	Column 1	Top	-11.825	-0.000	-0.000	4.644	3.070	
		Bottom	-12.745	-0.000	-0.000	4.644	-3.070	
2	Column 2	Top	-21.587	-0.000	-0.000	8.469	6.148	
		Bottom	-22.713	-0.000	-0.000	8.469	-6.148	
3	Column 3	Top	-12.744	-0.000	-0.000	4.304	-3.182	
		Bottom	-13.873	-0.000	-0.000	4.304	3.182	
4	Column 4	Top	-12.802	-0.000	-0.000	4.176	3.329	
		Bottom	-13.867	-0.000	-0.000	4.176	-3.329	
5	Column 5	Top	-18.515	-0.000	-0.000	5.527	-1.233	
		Bottom	-19.642	-0.000	-0.000	5.527	1.233	
6	Column 6	Top	-11.762	-0.000	-0.000	2.050	-1.678	
		Bottom	-12.890	-0.000	-0.000	2.050	1.678	
7	Column 7	Top	-12.740	-0.000	-0.000	1.680	4.654	
		Bottom	-13.865	-0.000	-0.000	1.680	-4.654	
8	Column 8	Top	-15.163	-0.000	-0.000	5.544	3.108	
		Bottom	-16.288	-0.000	-0.000	5.544	-3.108	
9	Column 9	Top	-15.860	-0.000	-0.000	2.214	-3.185	
		Bottom	-16.885	-0.000	-0.000	2.214	3.185	
10	Column 10	Top	-15.832	-0.000	-0.000	5.655	-6.105	
		Bottom	-16.957	-0.000	-0.000	5.655	6.105	
11	Column 11	Top	-15.430	-0.000	-0.000	2.257	-5.842	
		Bottom	-16.545	-0.000	-0.000	2.257	5.842	
12	Column 12	Top	-15.961	-0.000	-0.000	1.963	-3.193	
		Bottom	-17.026	-0.000	-0.000	1.963	3.193	
13	Column 13	Top	-14.255	-0.000	-0.000	0.930	-2.186	
		Bottom	-15.380	-0.000	-0.000	0.930	2.186	
14	Column 14	Top	-26.805	-0.000	-0.000	2.722	-1.909	
		Bottom	-27.924	-0.000	-0.000	2.722	1.909	
15	Column 15	Top	-26.838	-0.000	-0.000	2.296	-1.514	
		Bottom	-27.962	-0.000	-0.000	2.296	1.514	
16	Column 16	Top	-13.876	-0.000	-0.000	2.088	-1.030	
		Bottom	-14.999	-0.000	-0.000	2.088	1.030	

Autodesk Support@Autodesk.com website: <http://www.autodesk.com>

1732 Woodside Road, Suite 220, Redwood City, California, 94061, USA, Tel: (650) 205-2400 Fax: (650) 205-2401

Easily Extract all Column and Shear Wall Design Loads

Key Capabilities of ADAPT-Builder Suite

For your Revit Structure concrete building models, ADAPT can:

- Accurately analyze concrete structures
- Detailed design of slabs and beams
- Generate and analyze wind and earthquake loads
- Carry out load takedown
- Analyze soil supported structures
- Vibration analysis for concrete floor systems
- Model, analyze and design post-tensioning
- Report all member forces
- Automatically generate rebar layout in slabs

The Benefit of Using ADAPT for Concrete Design

ADAPT continues to add value:

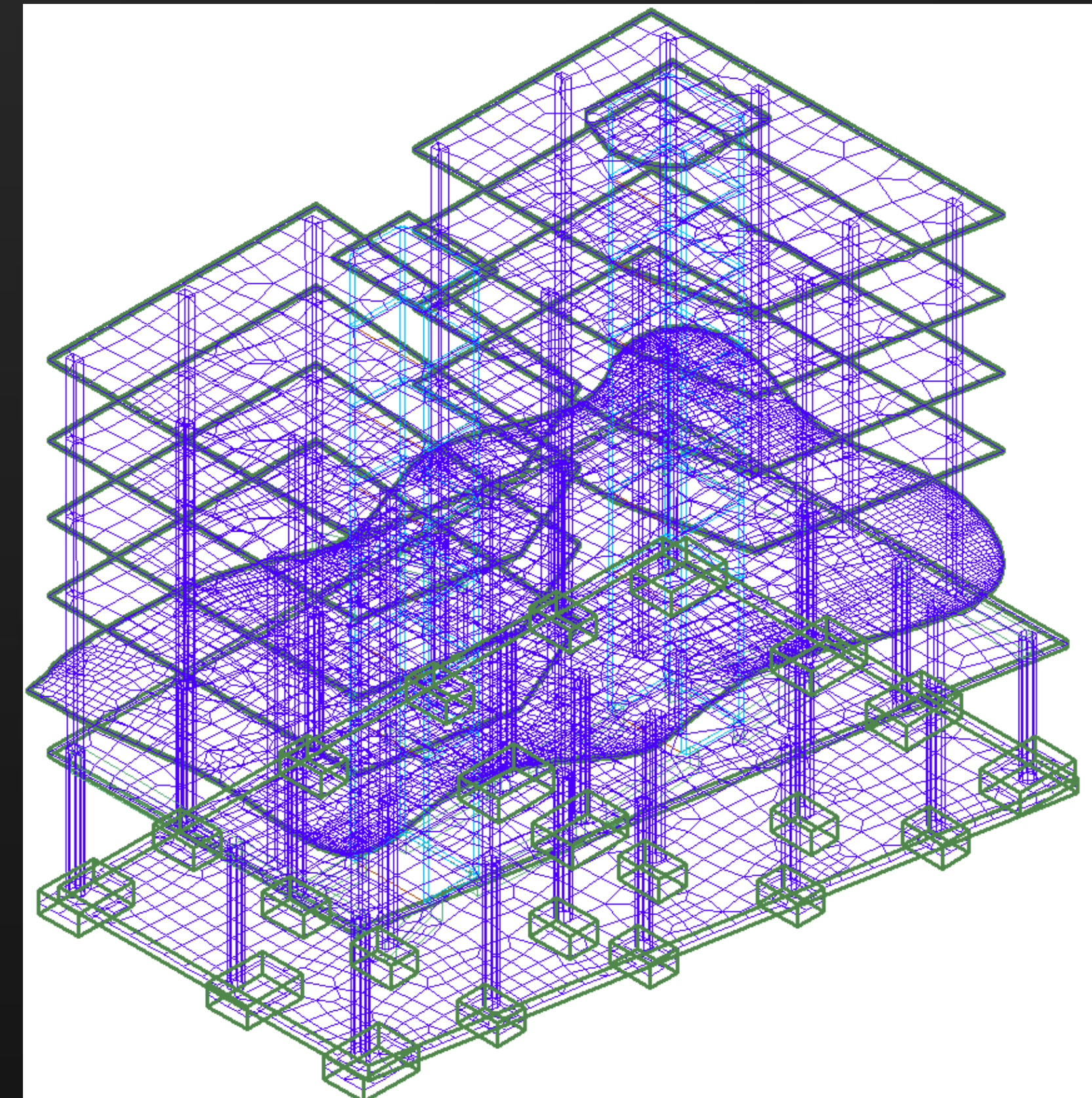
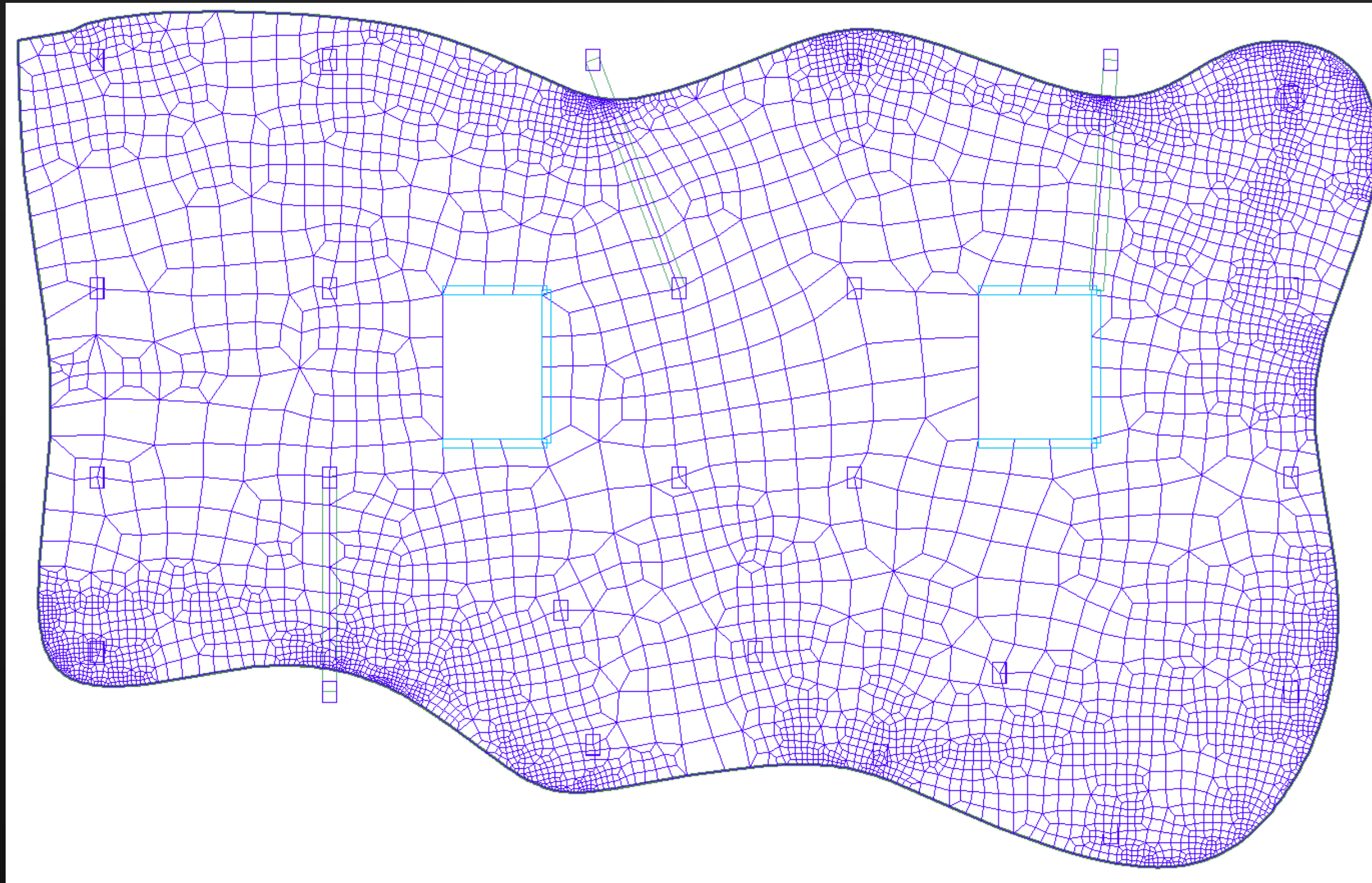
- Save time by avoiding the RST analytical model
- Regional code check and complete design
- Design process the way you want it
- Deep domain expertise
 - Accessible and knowledgeable support team
 - Incorporation of domain specific code requirements
- Maintain more control of your analytical model and results
- Analysis accuracy for complex geometries

We Know The Options You Have are Changing

... Our goal is to continue improving our products and services to ensure your modeling, design and documentation workflow is as efficient as possible

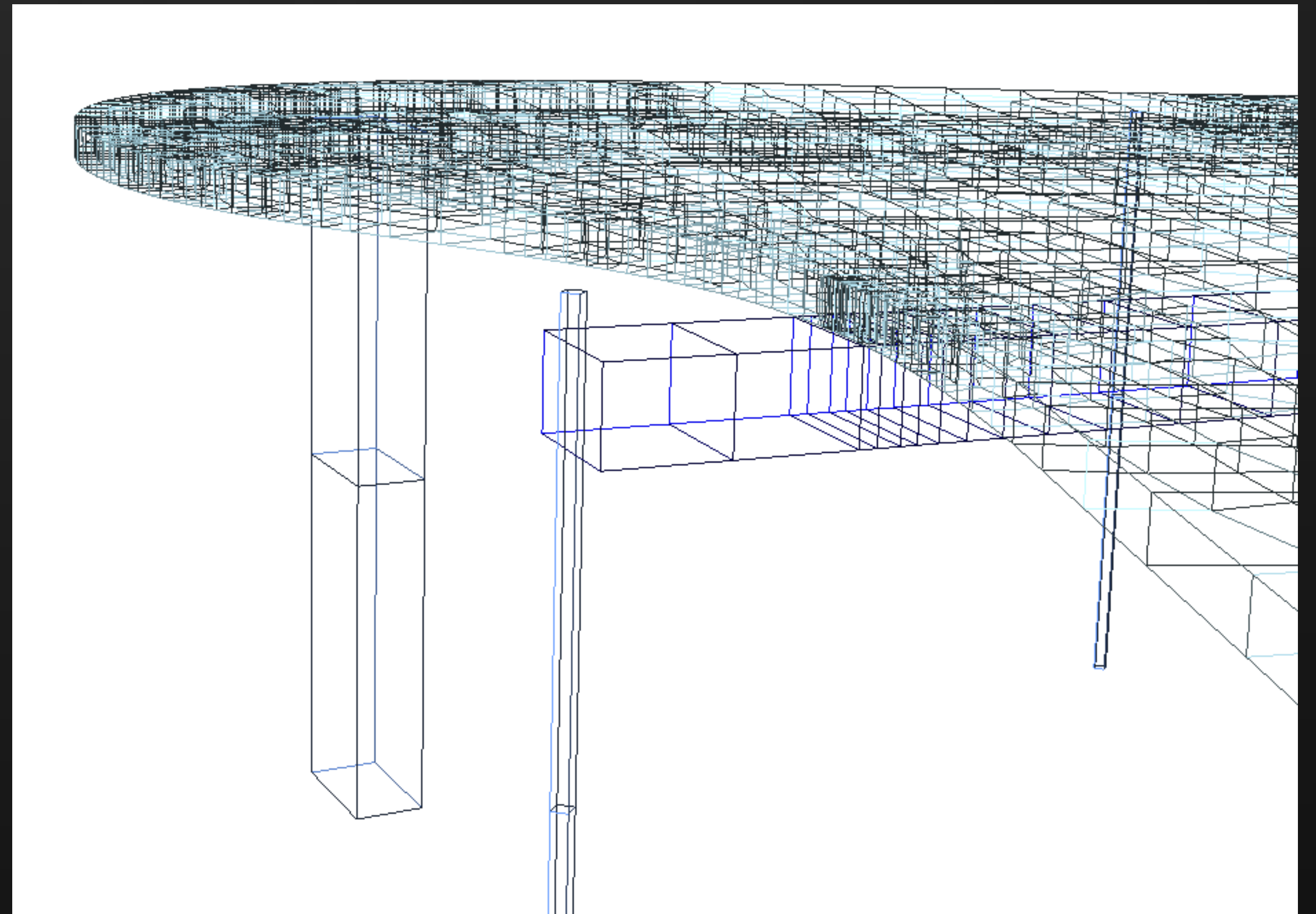
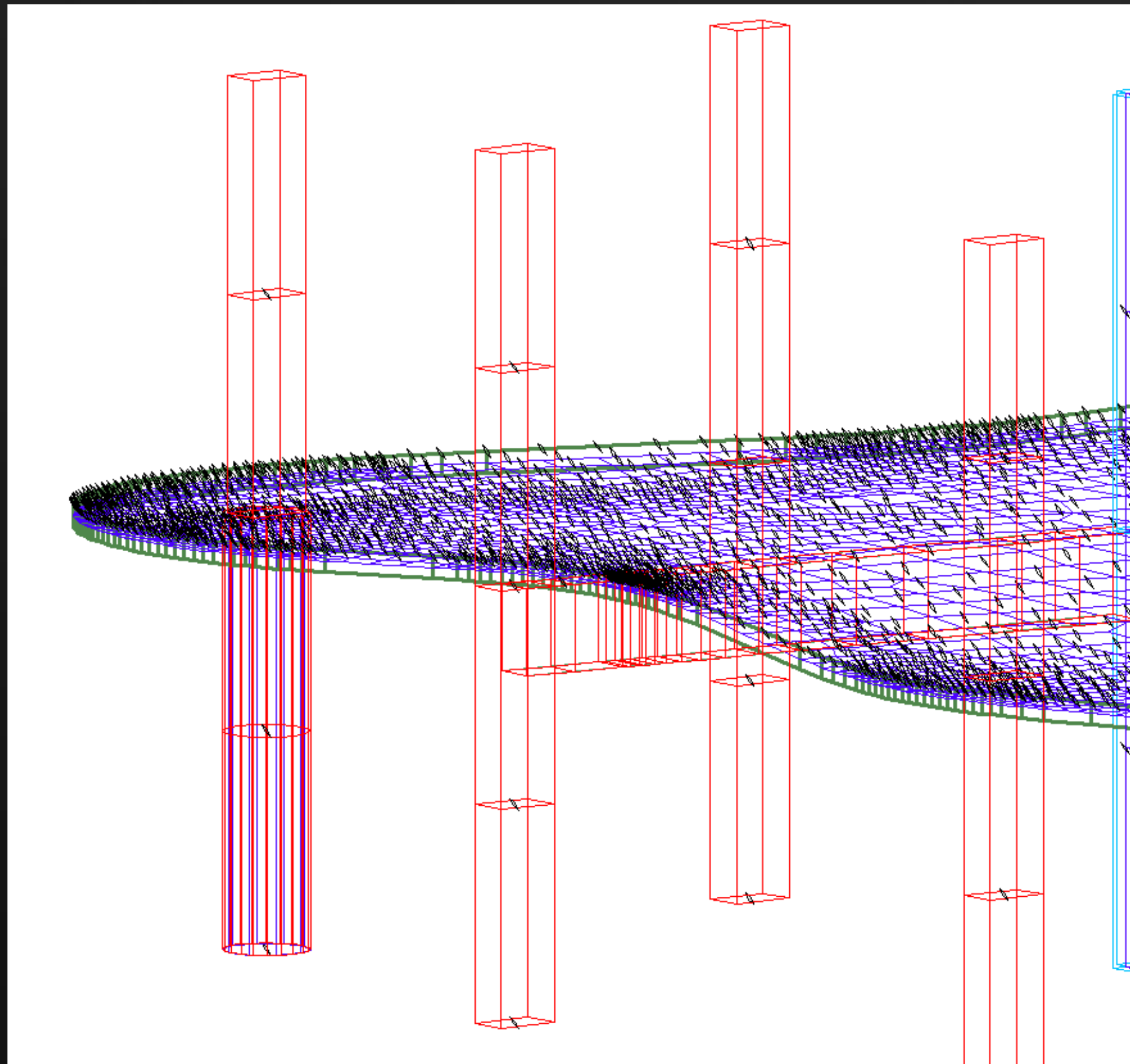
ADAPT Automatically Generates Analytical Model

ADAPT generates a detailed 3D Finite Element analytical model from the Revit Physical model:



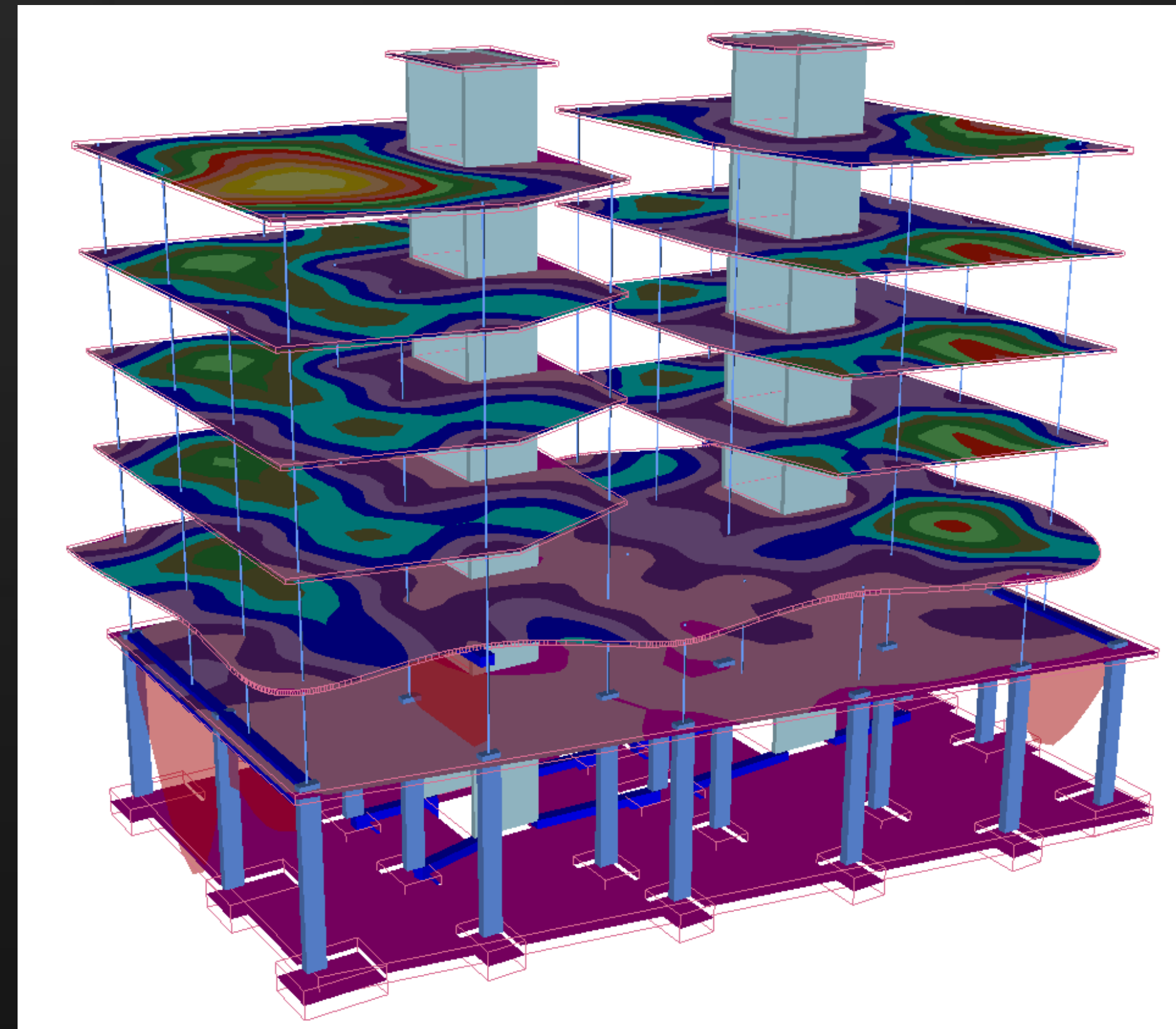
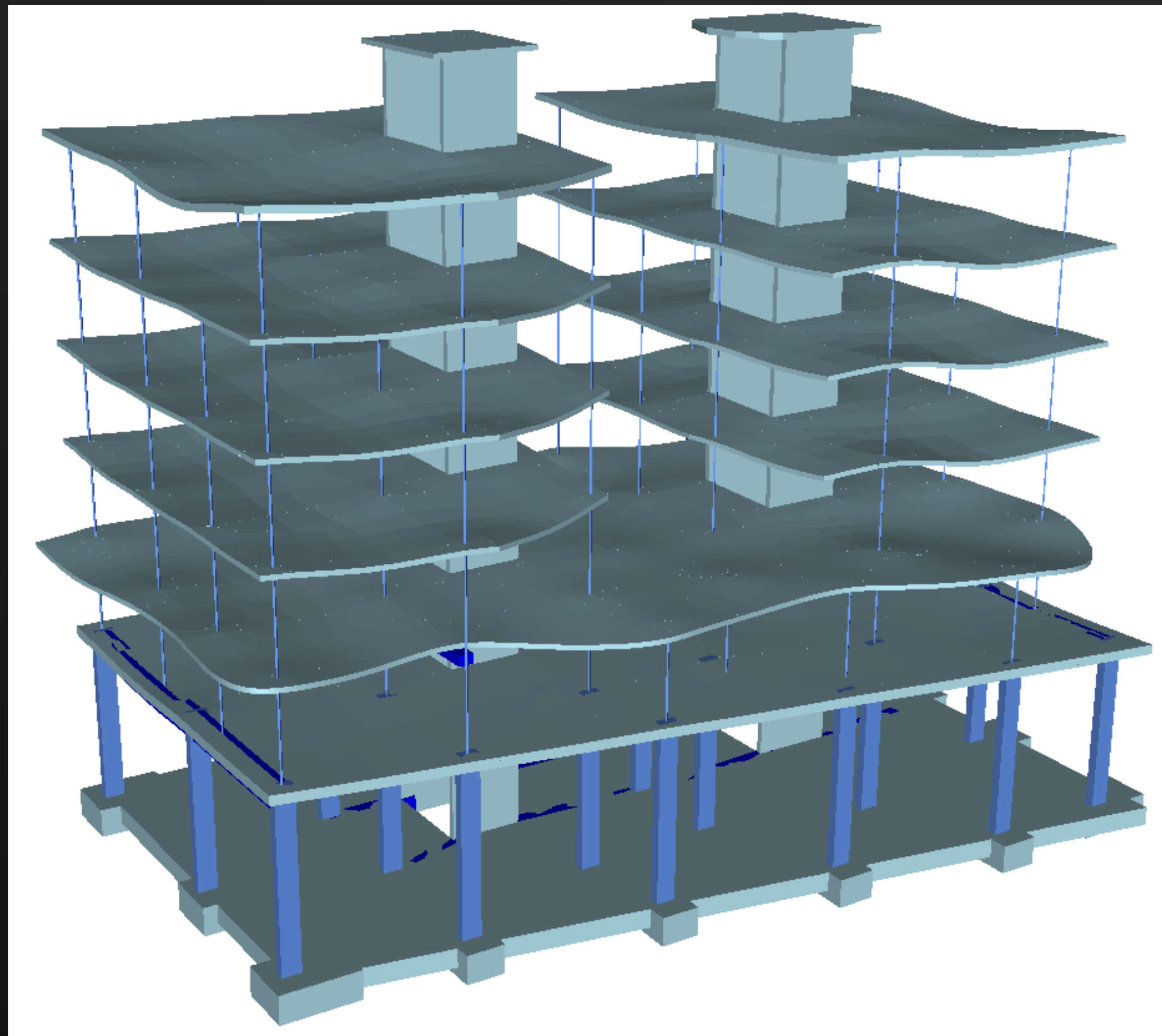
ADAPT Maintains True Offsets in Analytical Model

View of beam under slab framing into free-standing column:



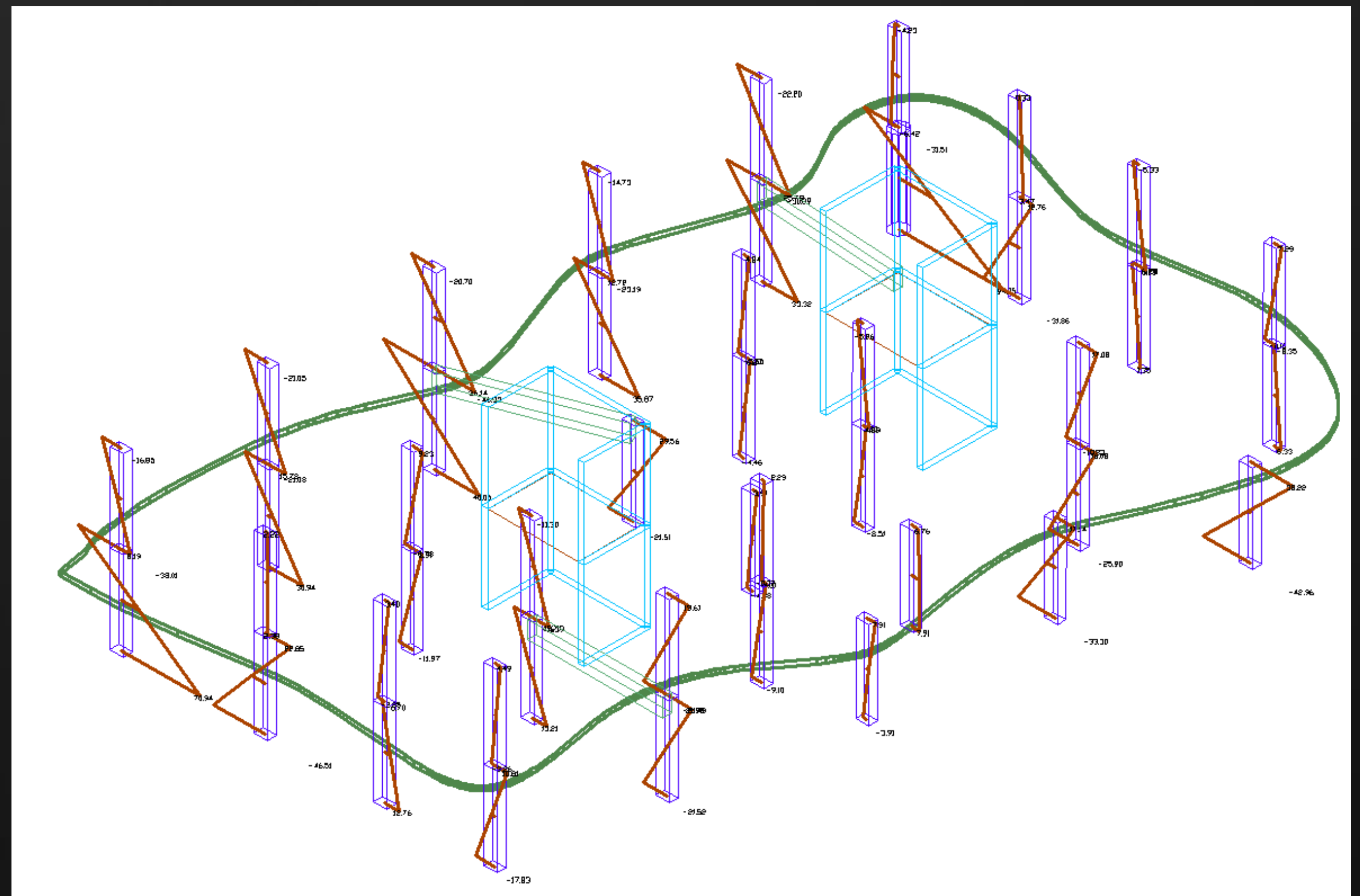
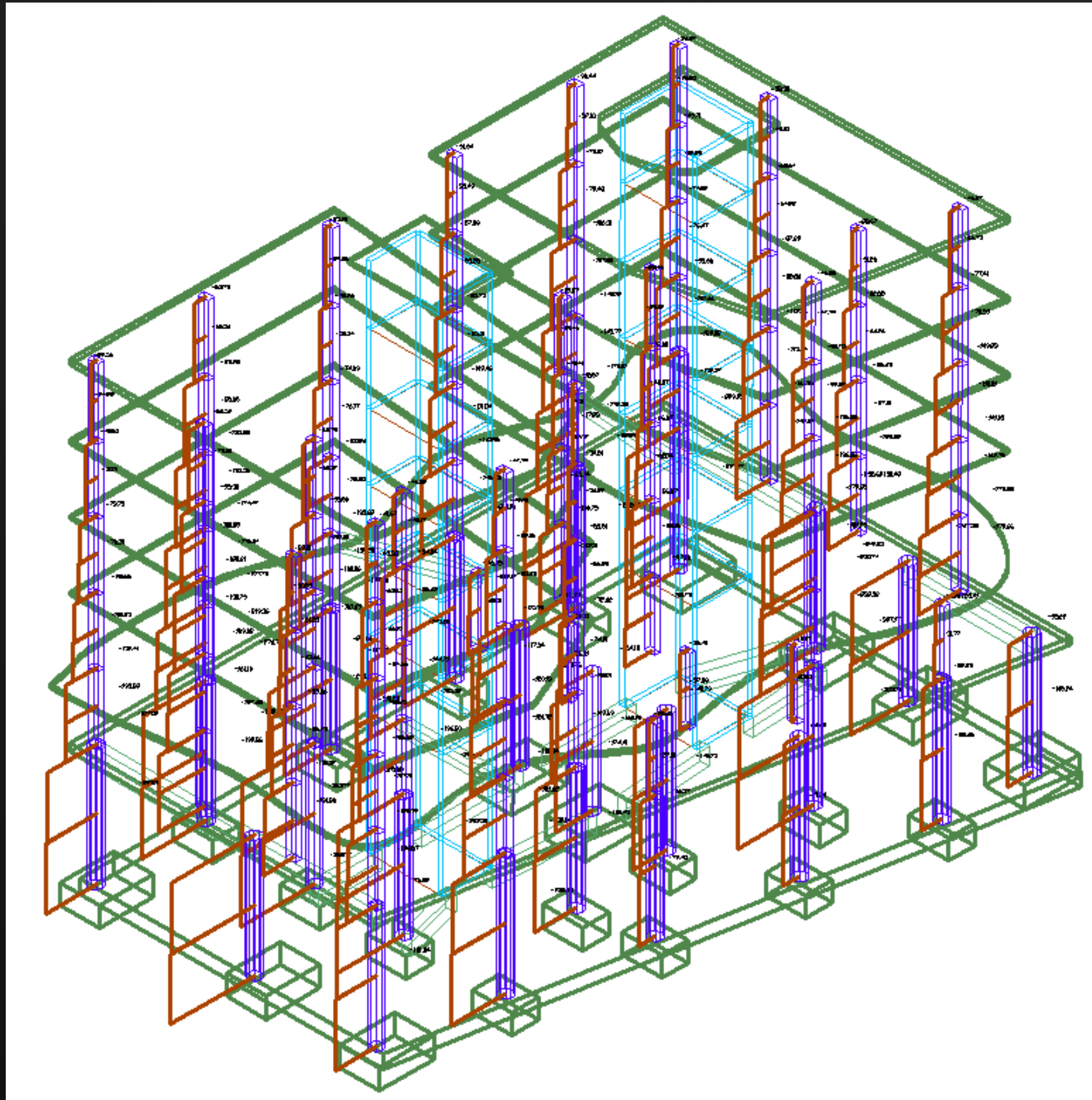
3D FEM Analysis Results in ADAPT

Analysis results can be viewed in the model or as calculation reports:



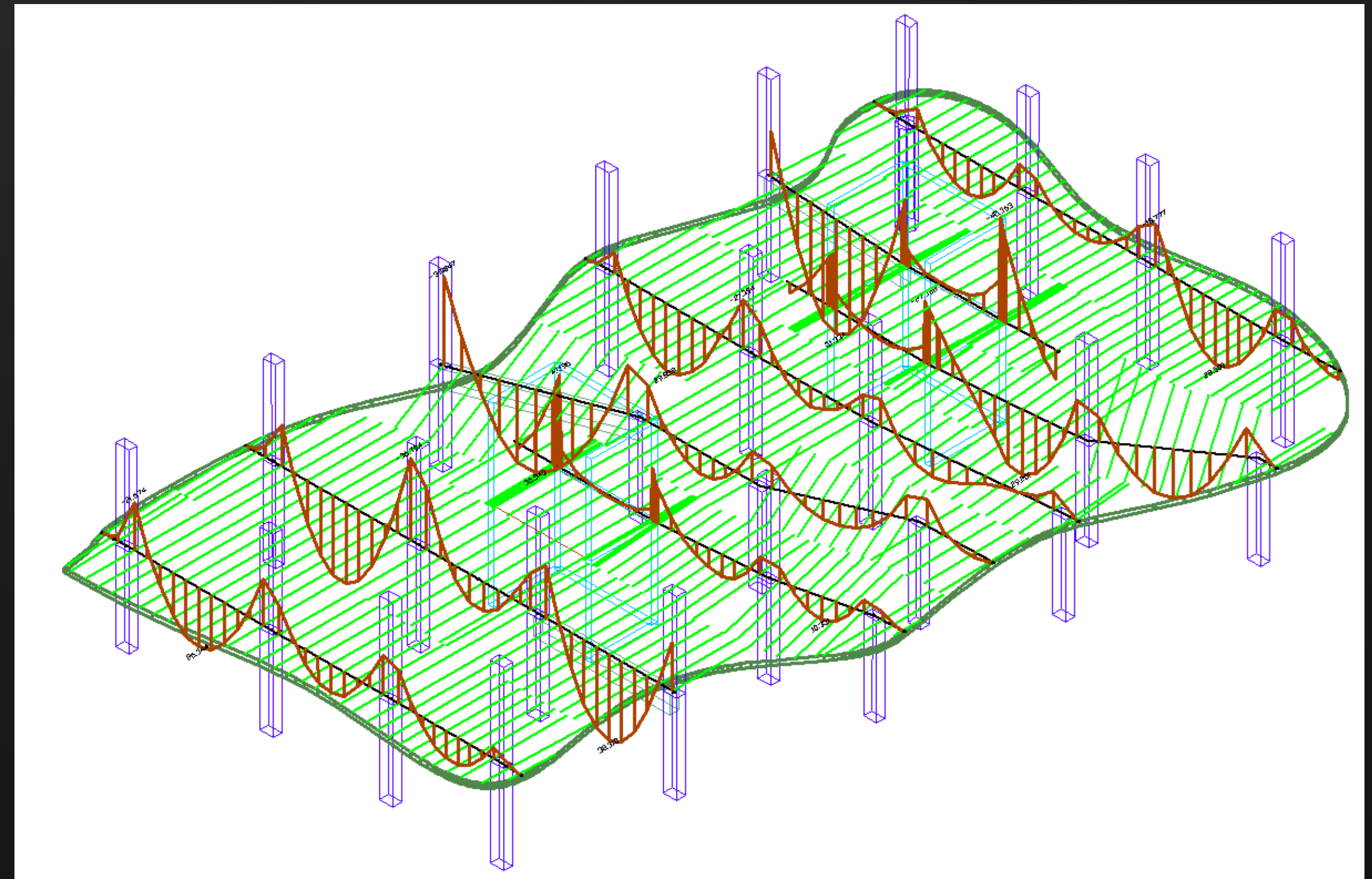
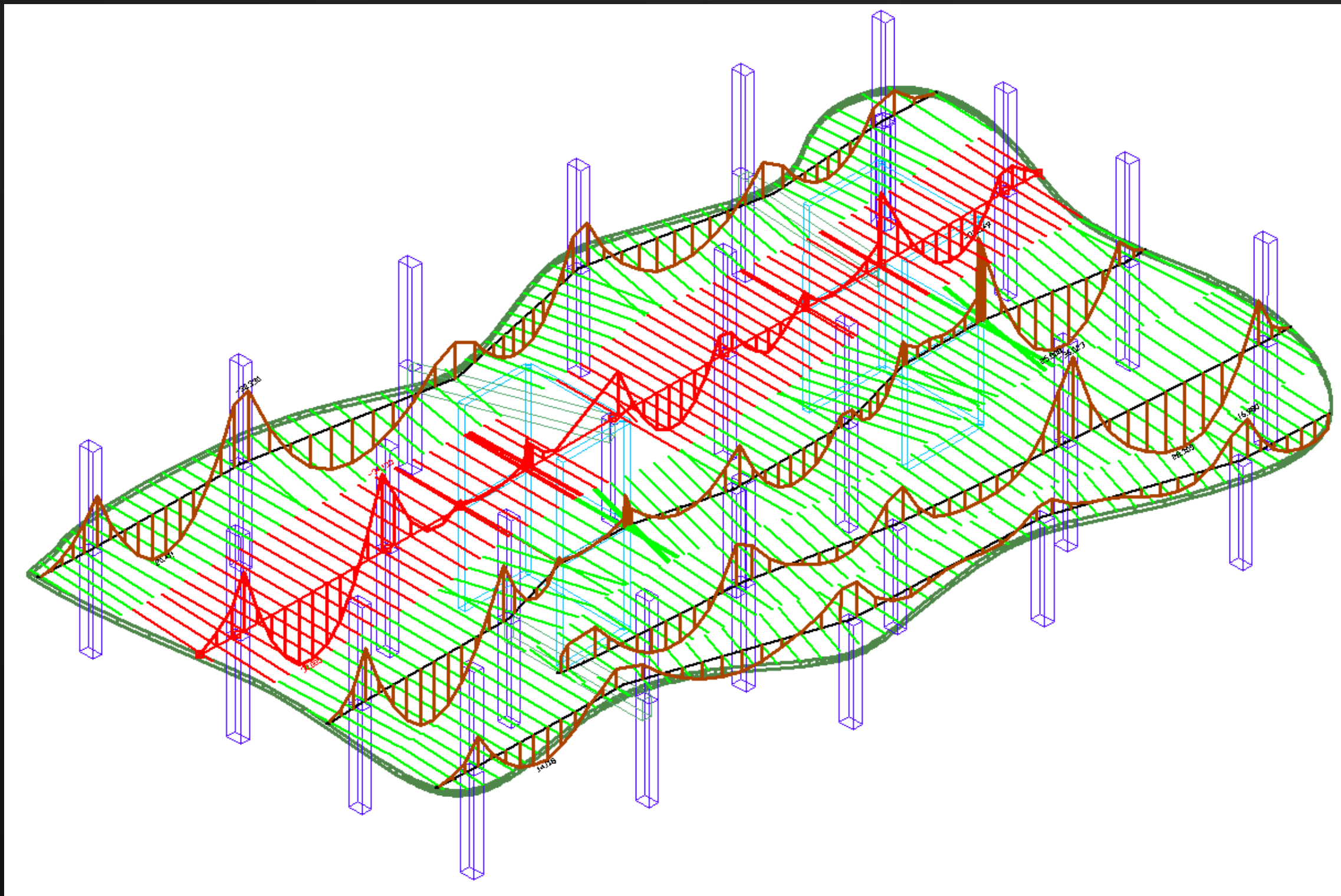
3D FEM Analysis Results in ADAPT

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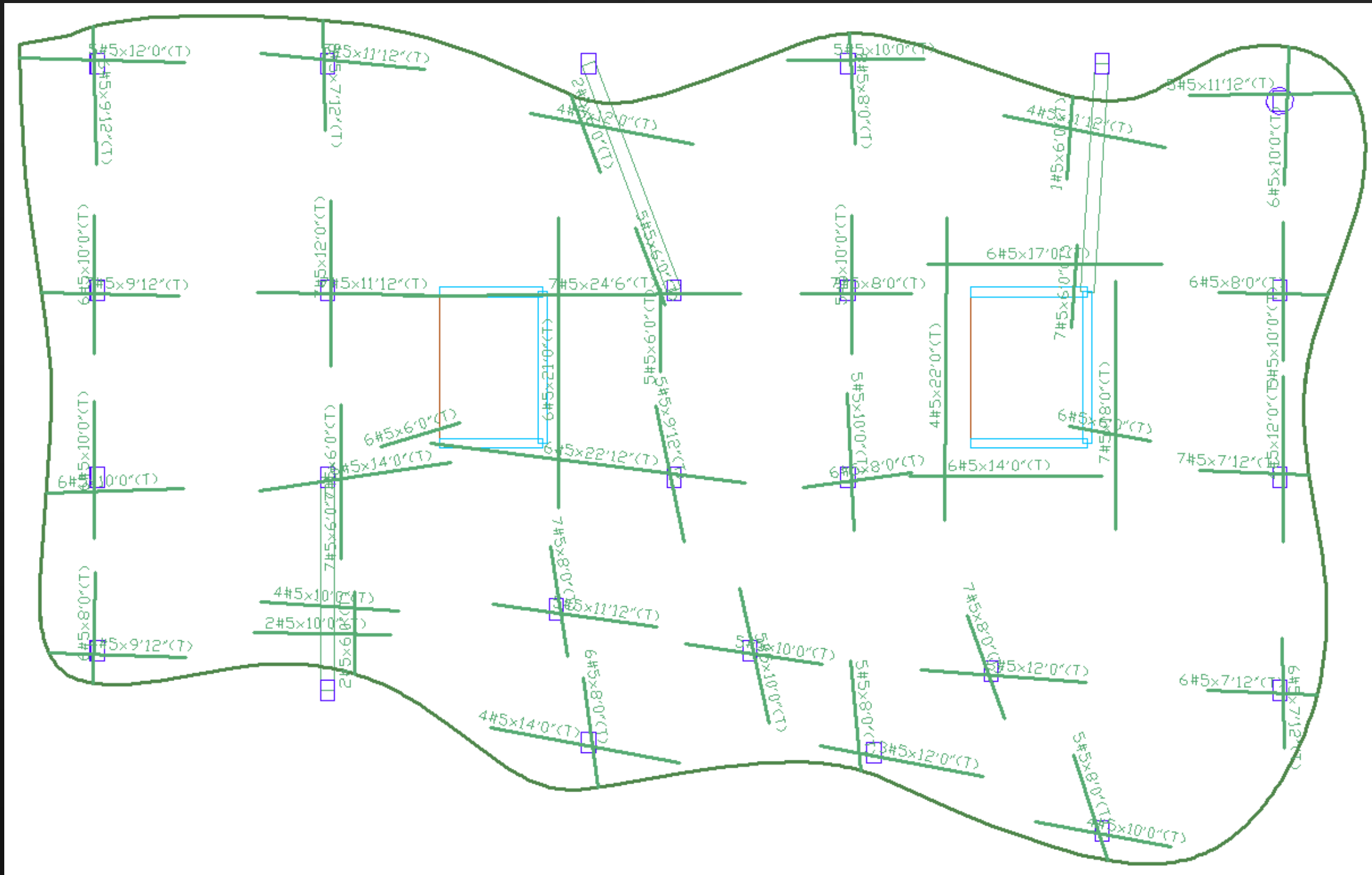
Detailed Slab and Beam Design

Floor system design is carried out using design strips:

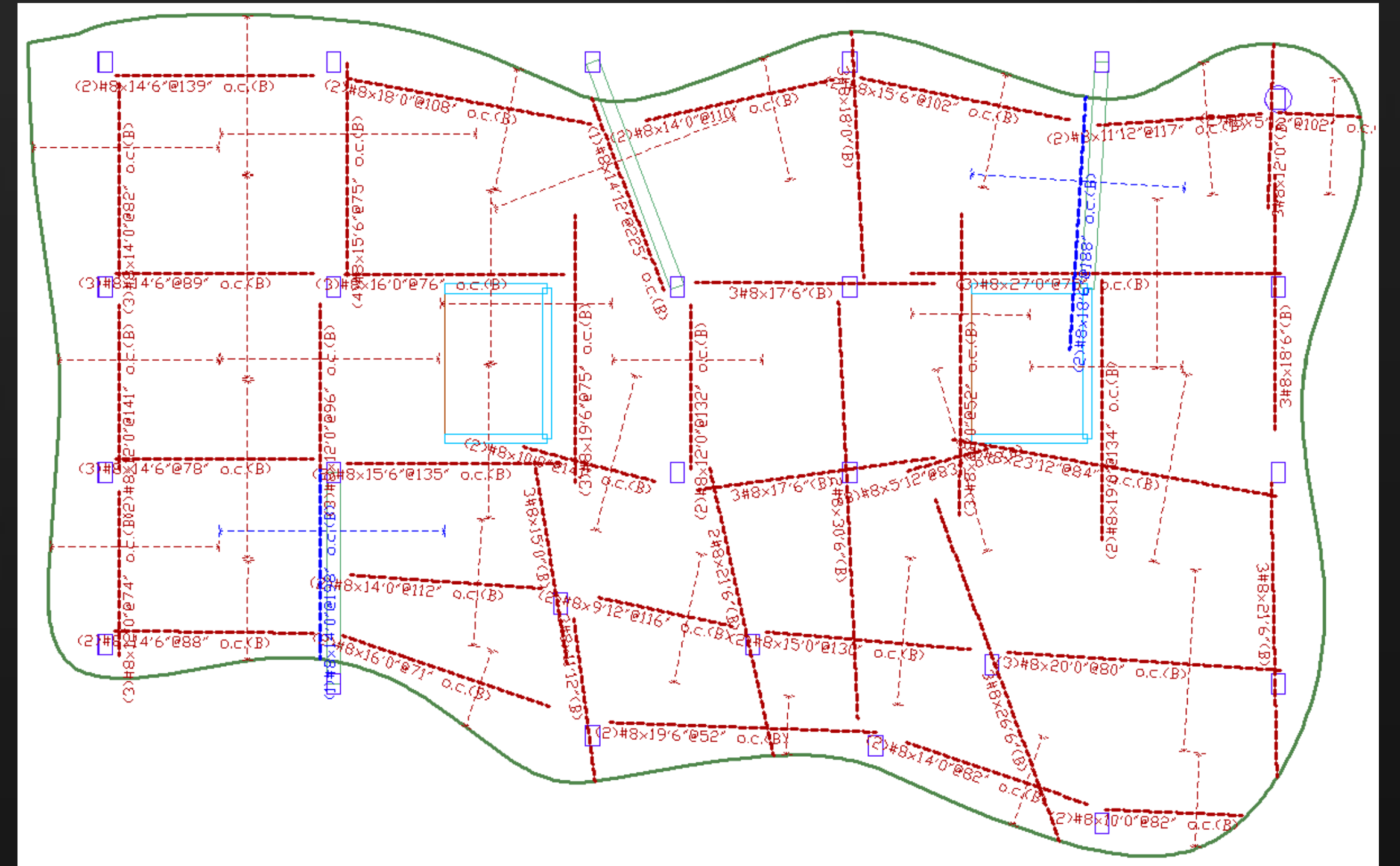


Detailed Slab and Beam Design

Calculated reinforcement is place in the slab and beams:



Top bars



Bottom bars

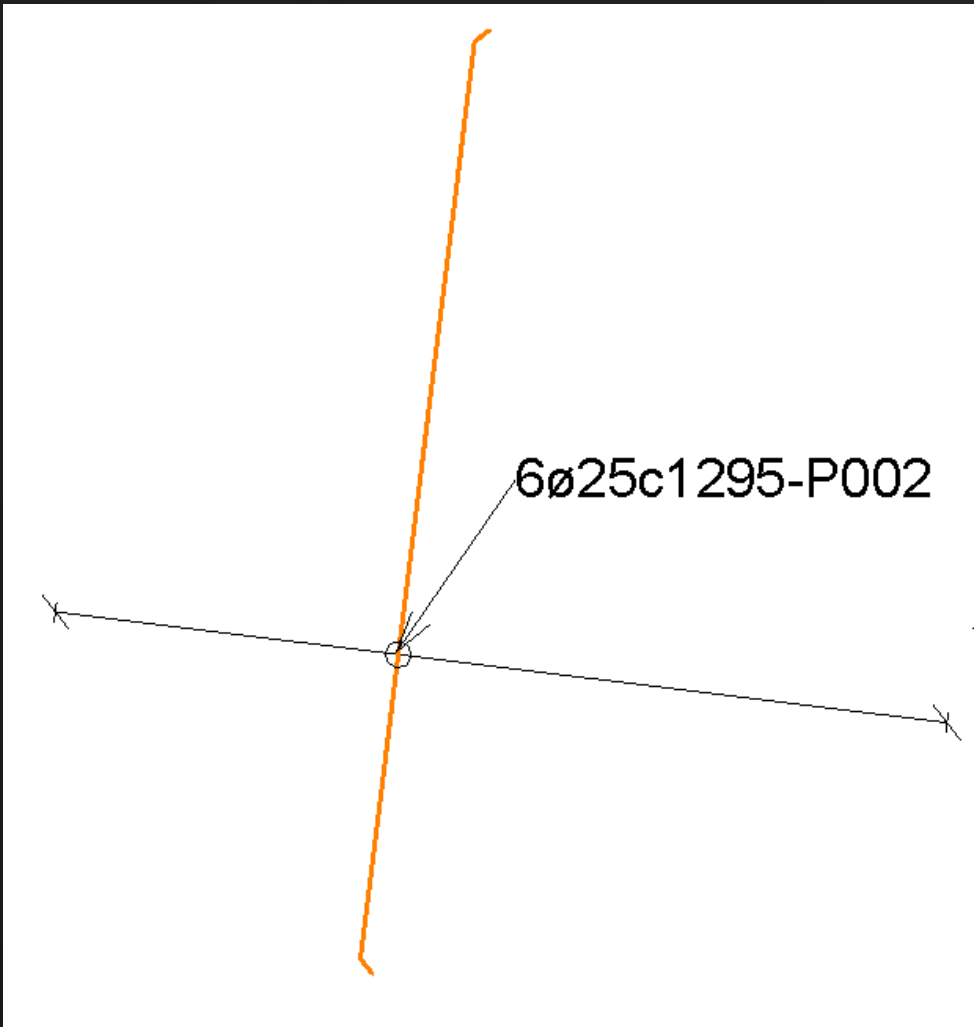
Rebar Imported into Revit

Calculated reinforcement can be imported back into your RST model for final detailing:



Post-Processing of Rebar for Documentation

Tools like ISY CAD Rebar for Revit exist that can help you manage individual rebar and produce practical documentation (symbolic representation) and schedule your bars:



	P001	P002	P003	P004	P005	P006	P007	P008	P009										
	← 6553,2 →	← 6858 →	← 5638,8 →	← 1828,8 →	← 3657,6 →	← 1828,8 →	← 8839,2 →	← 3657,6 →	← 4724,4 →										
Bøyelisten stemmer overens med: NS-EN ISO3766:2004																			
Posnr.	Stålkval.	Diam (mm)	Lengde av hver stang (mm)	Ant. konstr. deler	Stenger pr. del	Totalt antall	Total Lengde (mm)	Formkode	Bøydimensjoner										
									A B C D E F G R / V Dor(mm) Korr (mm) Revisjon										
P001	Rebar, ASTM	25	6553	1	8	8	52424	00	6553,2								152	0	
P002	Rebar, ASTM	25	6858	1	6	6	41148	00	6858								152	0	
P003	Rebar, ASTM	25	5639	1	3	3	16917	00	5638,8								152	0	
P004	Rebar, ASTM	25	1829	1	3	3	5487	00	1828,8								152	0	
P005	Rebar, ASTM	25	3658	1	6	6	21948	00	3657,6								152	0	
P006	Rebar, ASTM	25	1829	1	5	5	9145	00	1828,8								152	0	
P007	Rebar, ASTM	25	8839	1	15	15	132585	00	8839,2								152	0	
P008	Rebar, ASTM	16	3658	1	15	15	54870	00	3657,6								95	0	
P009	Rebar, ASTM	16	4724	1	14	14	66136	00	4724,4								95	0	
Sum denne siden		ø6	ø8	ø10	ø12	ø14	ø16	ø20	ø25	ø28	ø32	ø40	Hylser	Gjenger	T-Hoder				
Total lengde (mm)										121006					279654				
Total vekt (kg)										0,00					0,00				
Total vekt inkluderer IKKE vekt av eventuelle T-hoder eller hylser, kun vekt av stang																			
Konstruktør	Oppdragsnavn			Utarbeidet dato			Revidert dato			Tegningsnummer			Dokumentnummer						
Norconsult	Project Name			Issue Date															
Bøyeliste	Oppdragsgiver			Utarbeidet av			Oppdragsnummer			Bøyeliste side			Rev. Indeks						
	Owner						Project Number			P00									

A detailed rebar layout diagram for a structural element. It shows a grid of rebar with various labels: 23ø16c38-P019, 3ø25c2743-P004, 3ø25c3175-P003, 14ø16c38-P014, 14ø16c38-P015, 6ø25c38-P016, 6ø25c38-P017, 17ø16c38-P018, 26ø16c38-P013, and 25ø787-P007. The diagram includes dimensions and bend symbols for each bar.

Demonstration Using ADAPT-Builder Suite to Analyze/Design a Revit Model

Workflow Followed in Demonstration

For your Revit Structure concrete building models, ADAPT can:

- Export Physical Model from Revit Structure
- Generate 3D FEM mesh in ADAPT
- Analyze structure
- Place post-tensioning tendons
- Design slabs & beams
- Determine member forces
- Generate slab rebar
- Export rebar and tendons back to Revit for documentation

Limitations of ADAPT-Revit Link

The current 2013 integration has the following limitations:

- Orthogonal geometry
 - Vertical columns
 - Horizontal slabs
- Geometry changes only propagated from RST to ADAPT
- Tendons imported to RST as basic rebar objects only, not intelligent editable family

Upcoming Capabilities of ADAPT-Revit Link

The following features are under development:

- Support for slanted columns
- Beam rebar detailing and scheduling from ADAPT model
- Round tripping of geometry changes RST – ADAPT - RST
- Transfer of tendons from ADAPT to RST as intelligent family



Thank You for Listening

Additional resources:

- For more information about the topics covered, go to www.adaptsoft.com
- To watch videos showing Revit Structure and ADAPT integration, go to www.youtube.com/ADAPTSupport
- To contact Florian, send an email to florian@adaptsoft.com

