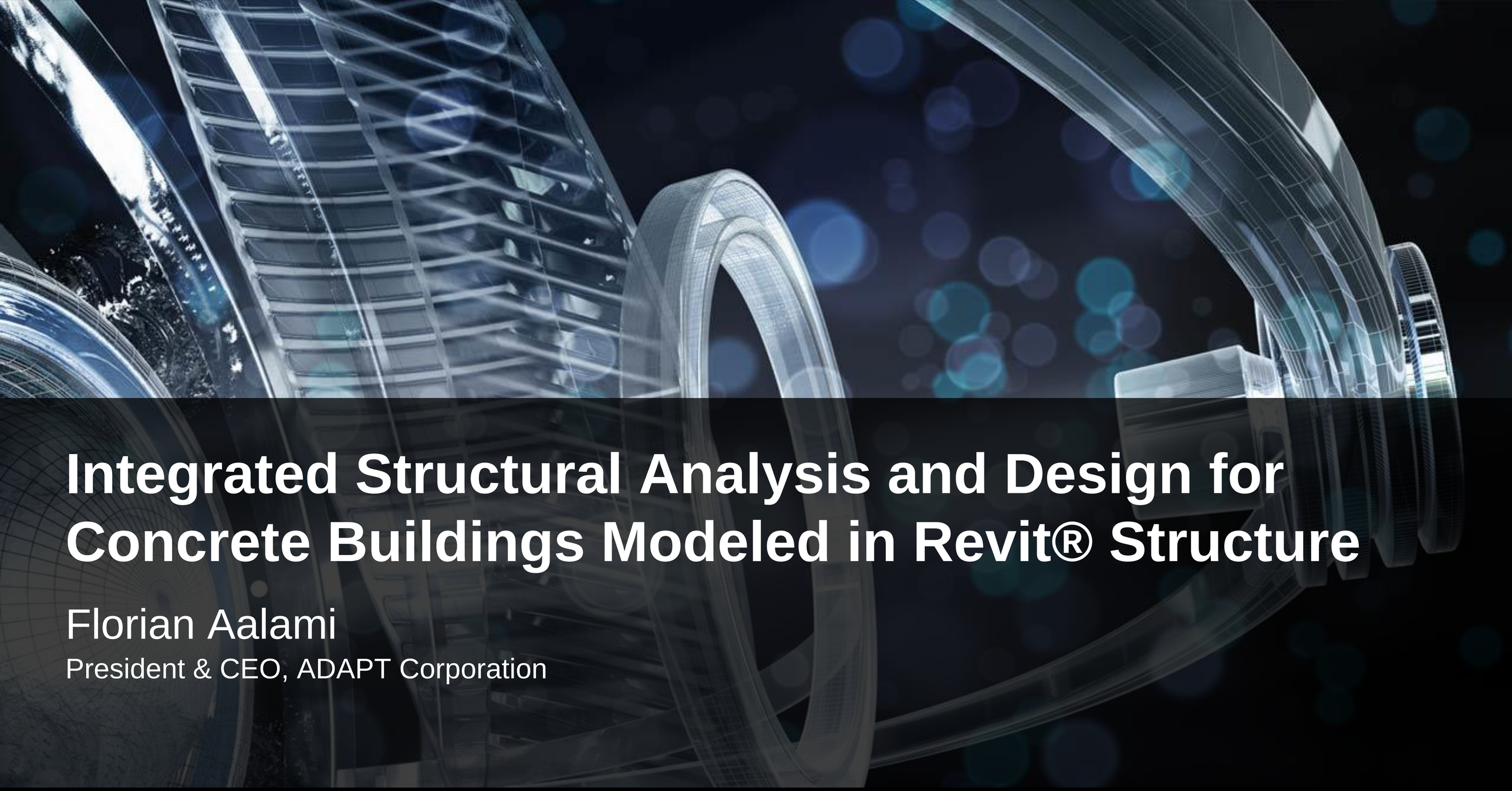


Integrated Structural Analysis and Design for Concrete Buildings Modeled in Revit® Structure

Florian Aalami

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:

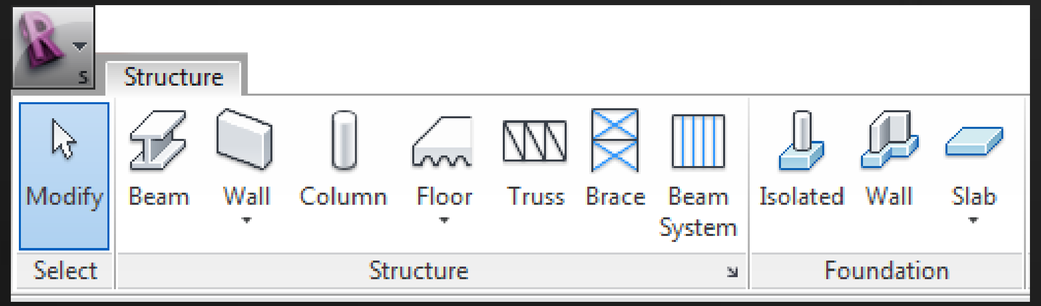
- Learn the options for integrated design of concrete floor and foundation systems for your Revit Structure models
- Know best practice for the rapid analysis of concrete building models created in Revit Structure
- Understand the steps to integrate ADAPT software with Revit Structure and generate analysis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

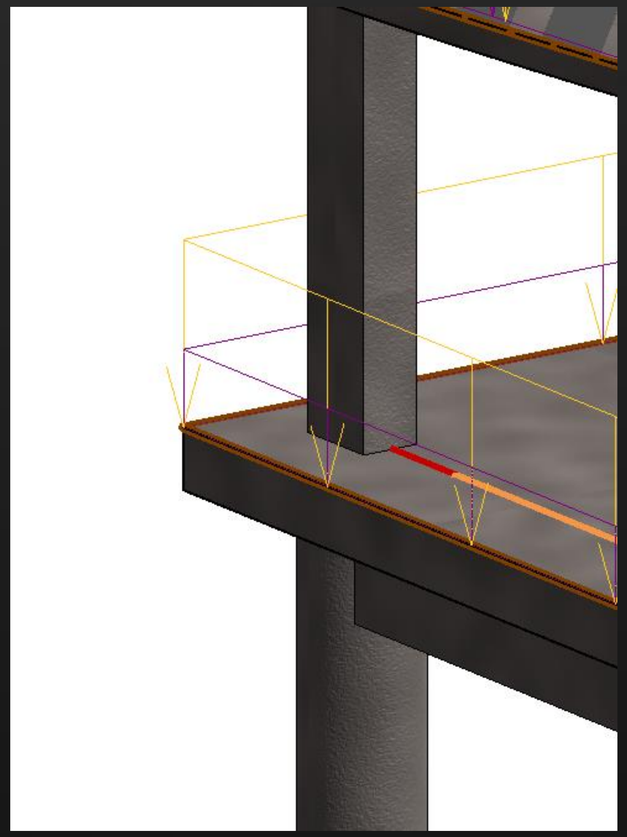
Physical vs. Analytical Model

Physical Model Represents Real Structure

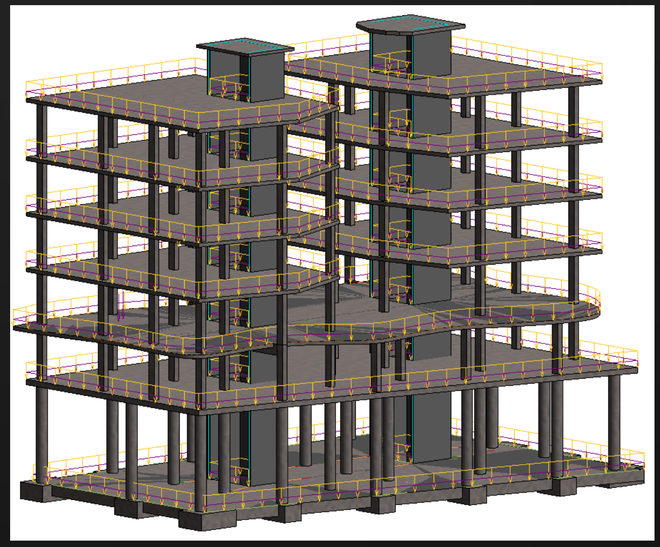
Modeling of a project typically starts with its physical representation:

- Structural Components





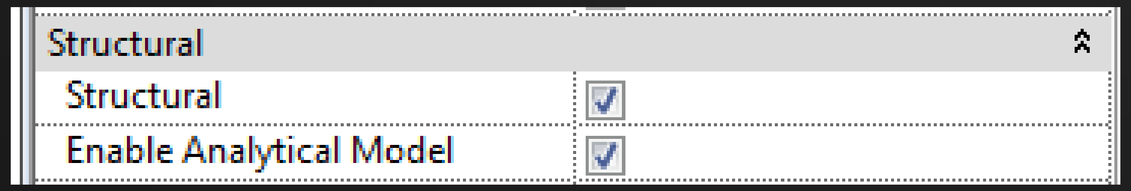
Detail

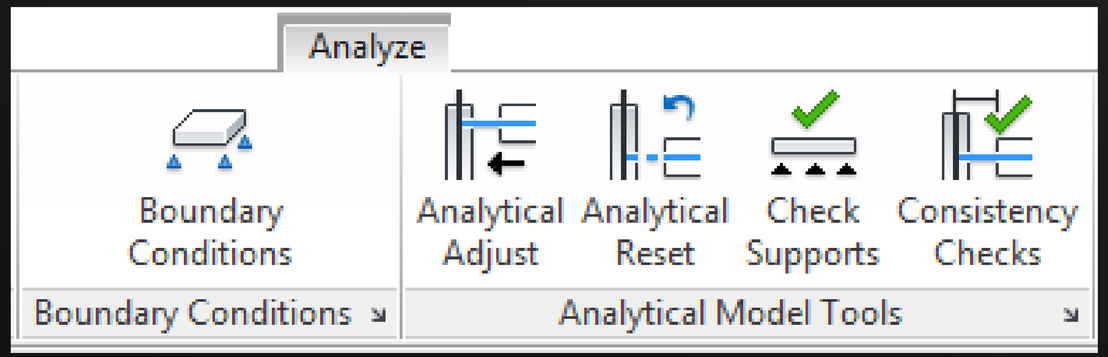


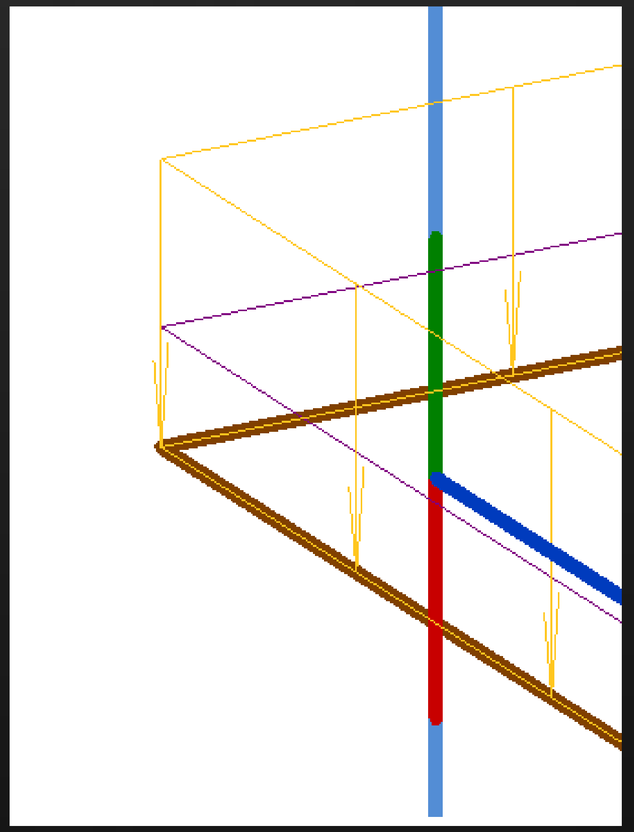
Analytical Model Represents Mathematical Model

Revit Structure creates an underlying analytical model for components :

- Discrete connection points
- Boundary conditions







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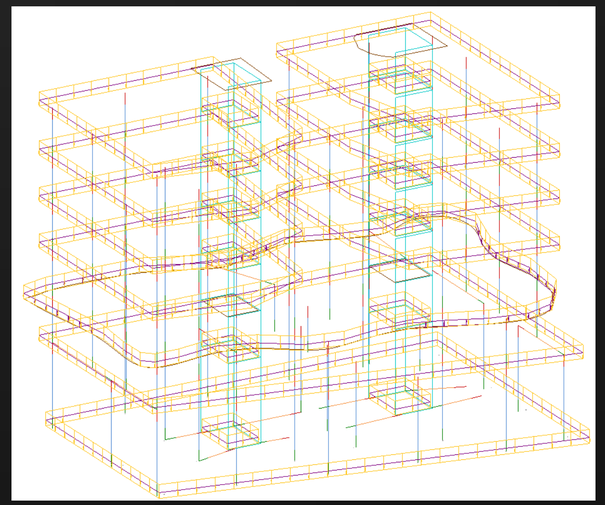


Structural Analysis Information in Revit

Capture Structural Analysis Criteria in Revit

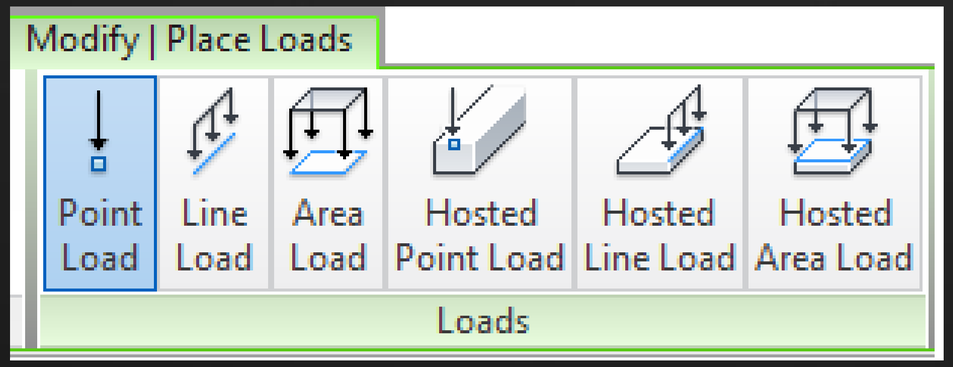
Revit Structure allows you to capture key structural analysis criteria:

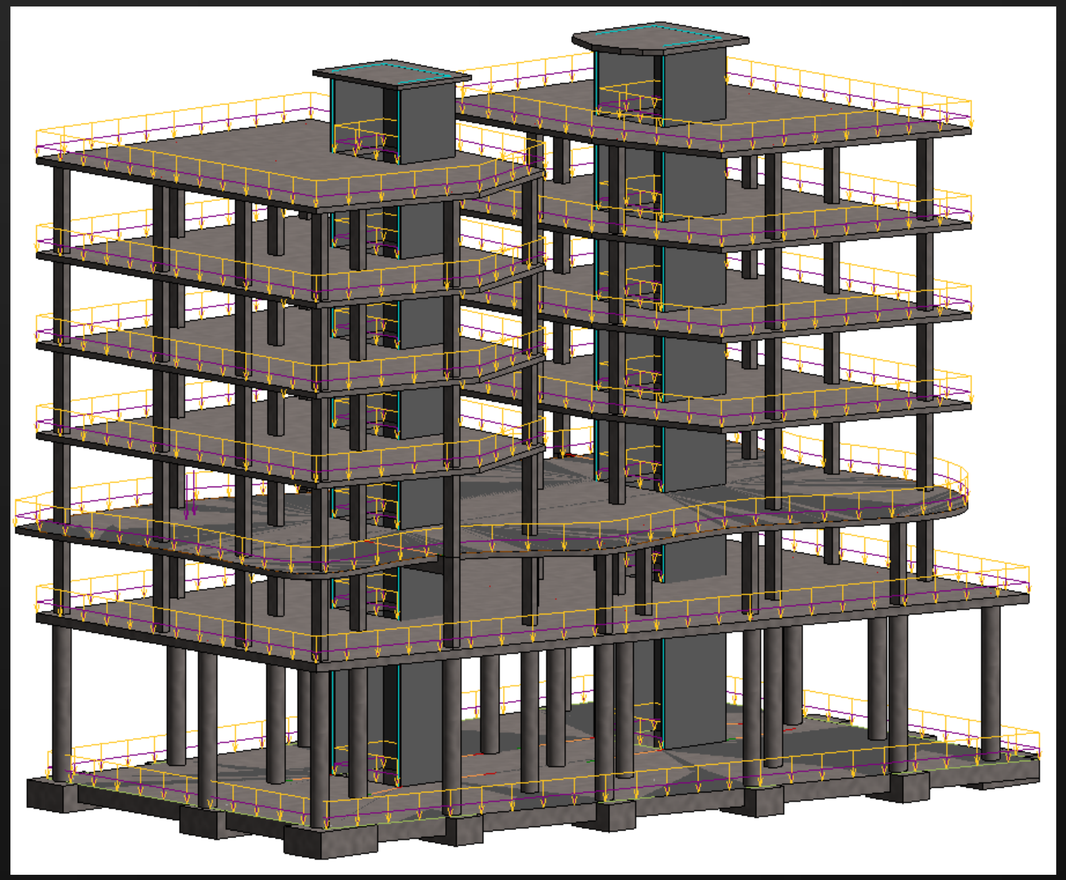
- Applied loads
- Load combinations
- Material properties

Loads Can Be Applied to Your Models

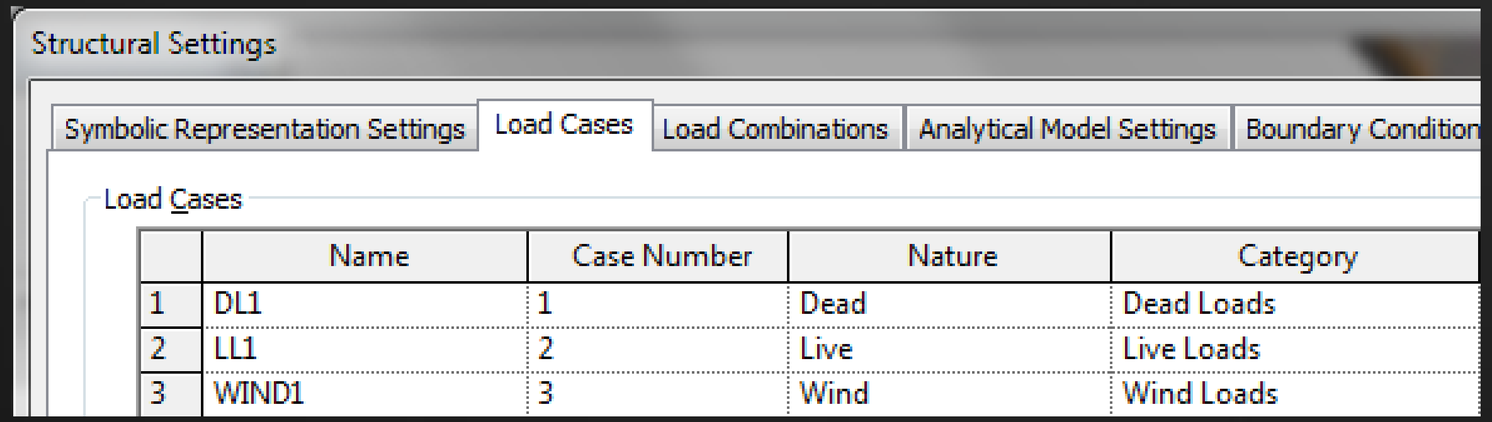
Revit Structure supports the modeling of typical load types:

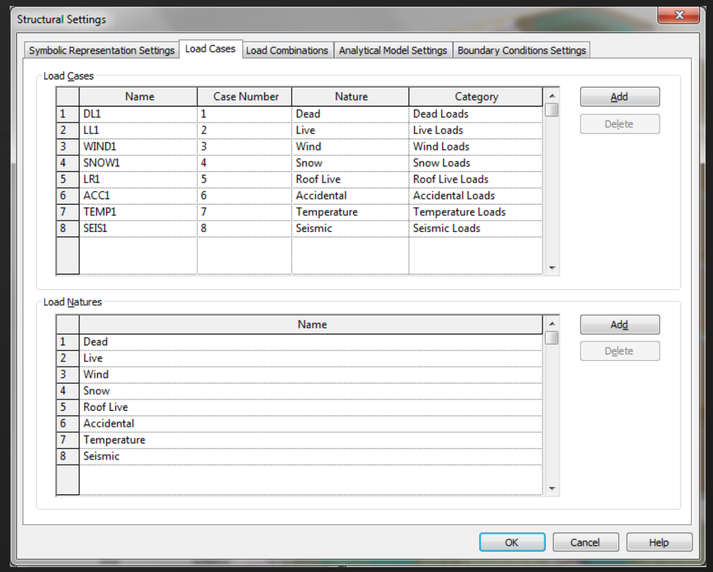
- Point
- Line
- Area

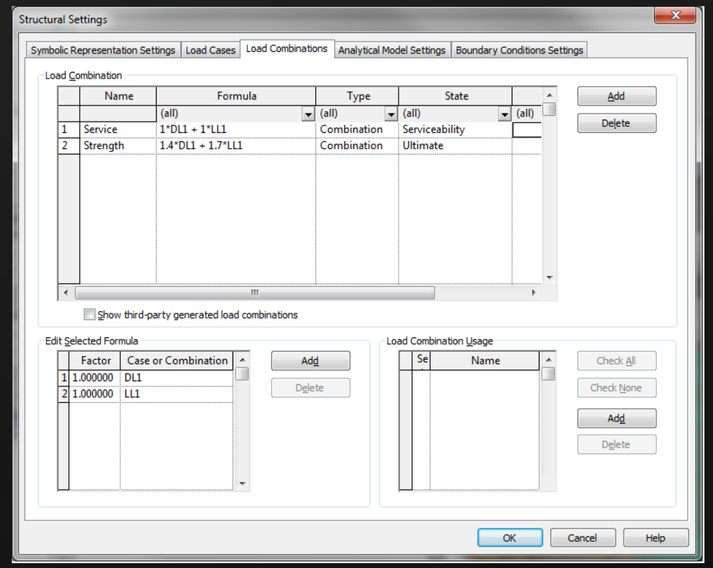




Define and Assign Load Cases

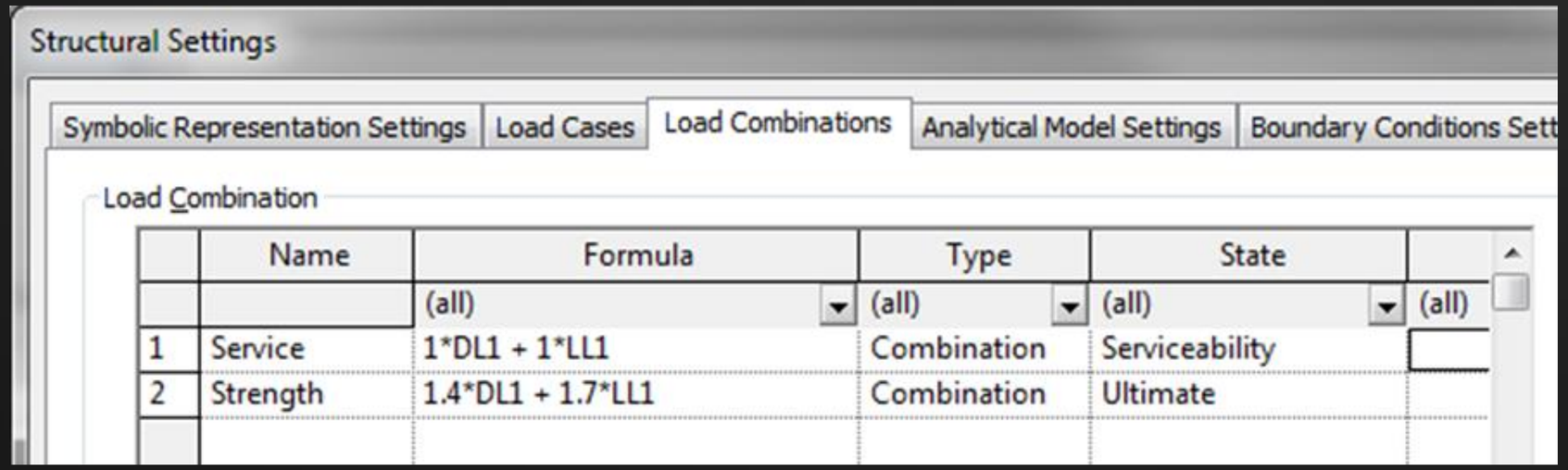


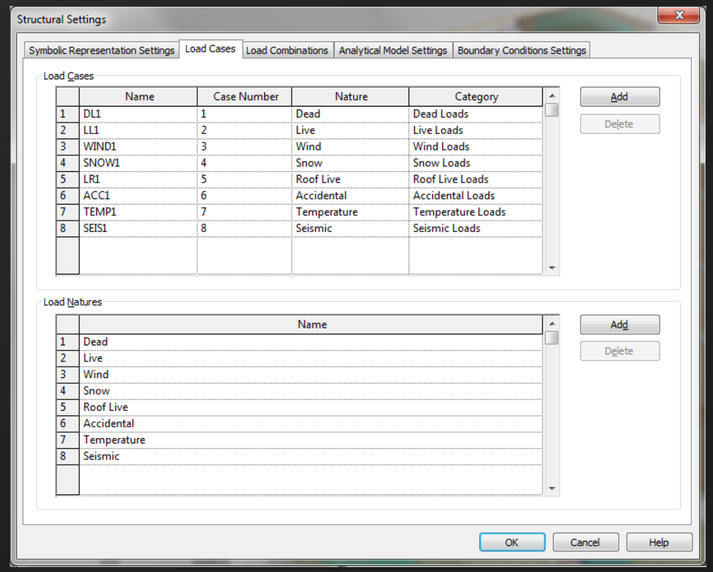


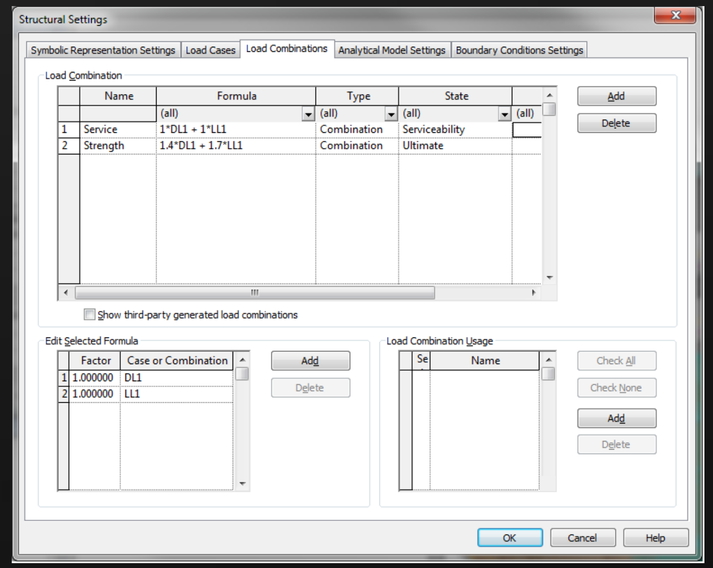


Defining loads, load cases, and combinations centrally in Revit, ensures project-wide consistency

Specify Load Combinations





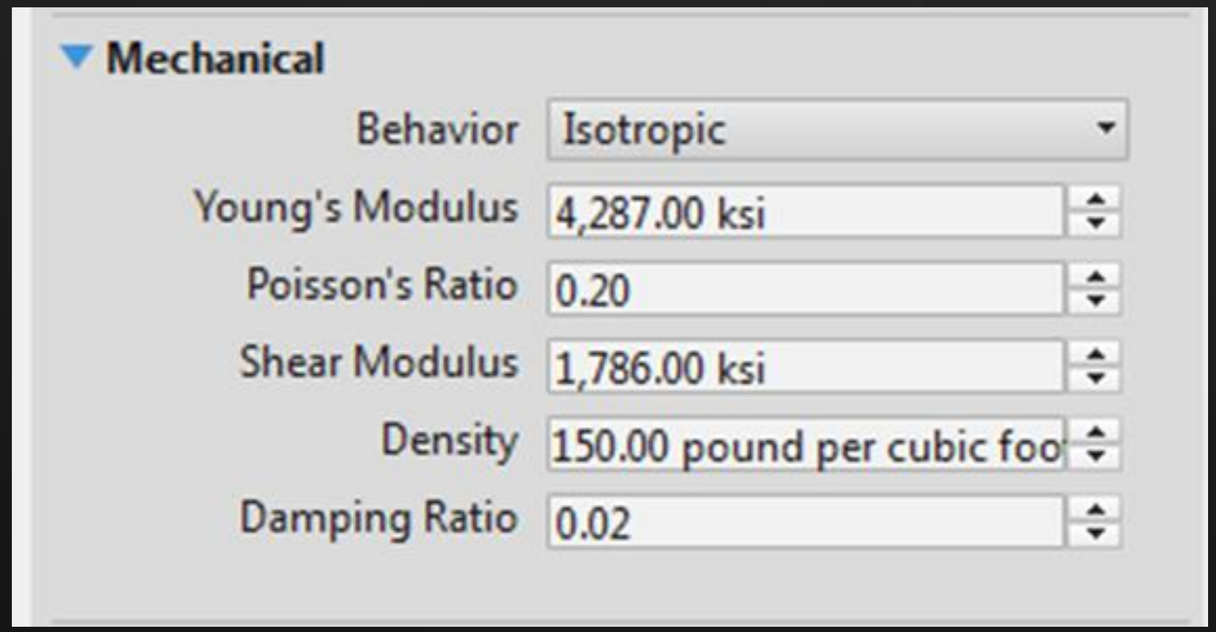


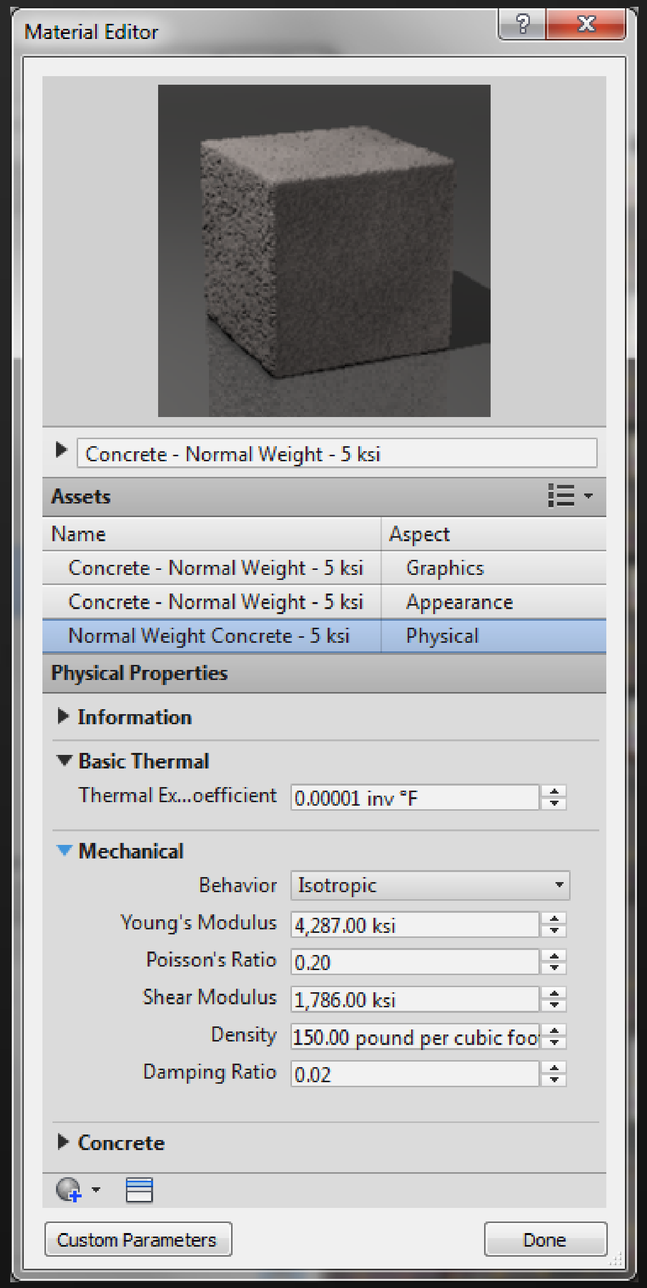
Defining loads, load cases, and combinations centrally in Revit, ensures project-wide consistency

Comprehensive Material Editor

Material Editor records properties needed for analysis:

- Strength
- Density
- …





Structural Concrete Analysis Options

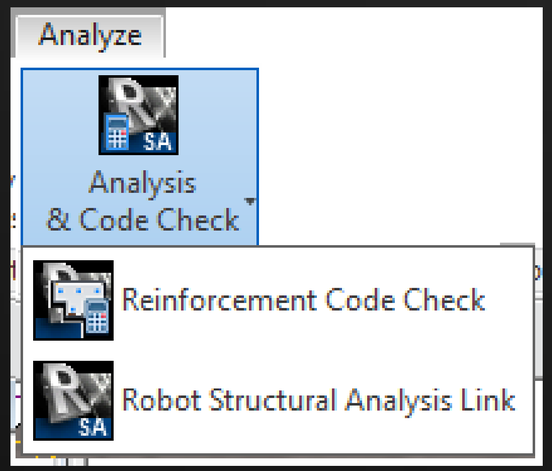
Revit Structure Offers Several Analysis Options

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:

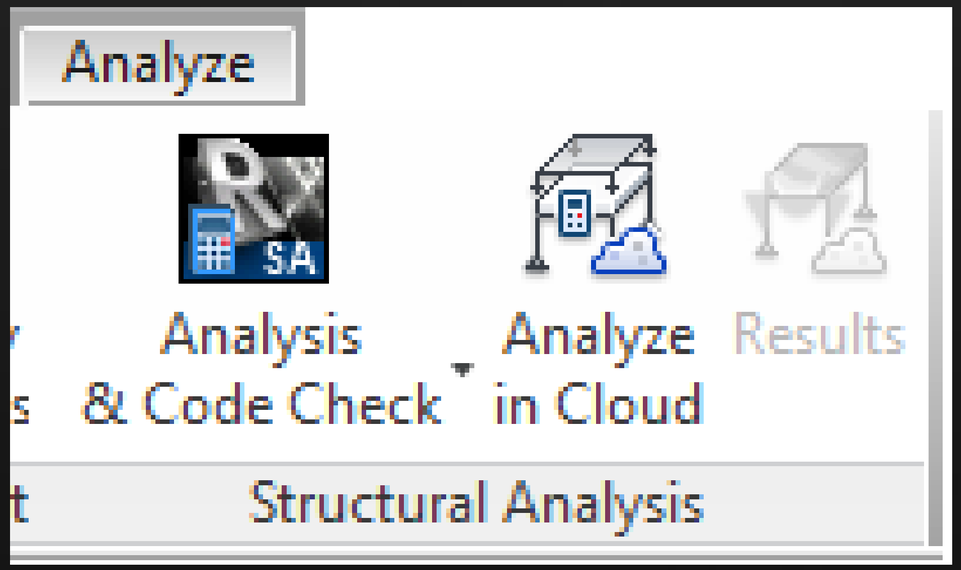


The integration link is embedded in each installation of RST

On-Demand Analysis Services in the Cloud

Autodesk 360 offers integrated, on-demand analysis services:

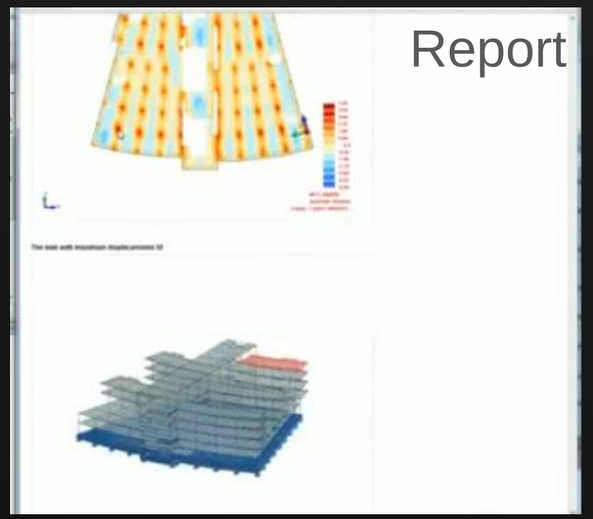
- Usage is measured in “cloud points”
- Certain point allocation comes with annual Subscription
- Then Pay-as-you-go

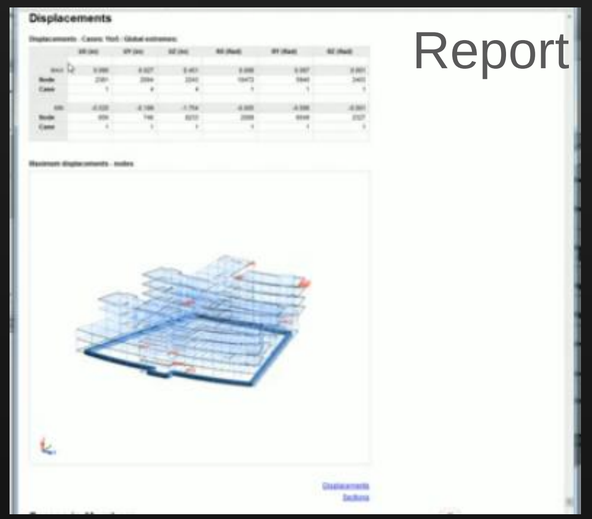


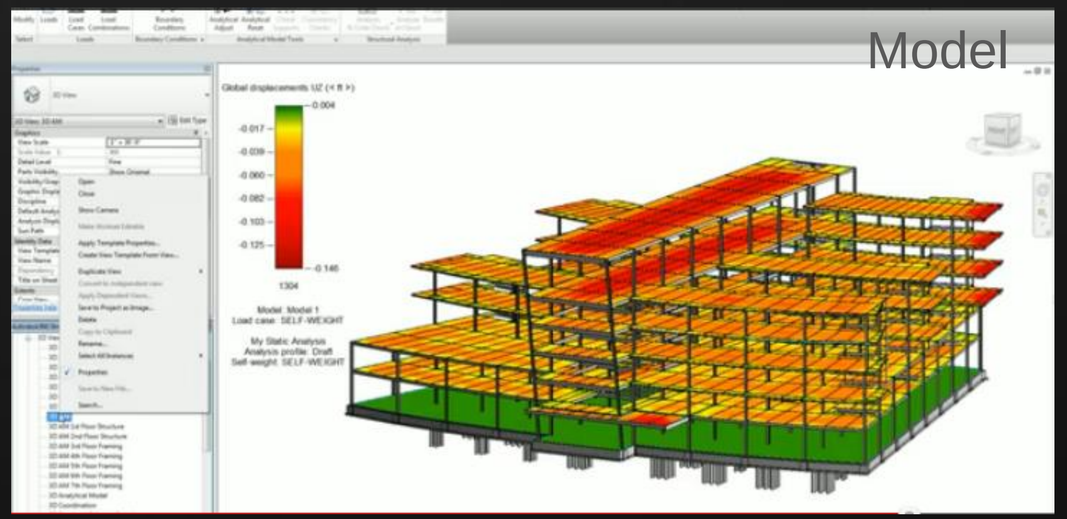
Structural Analysis using Autodesk 360

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



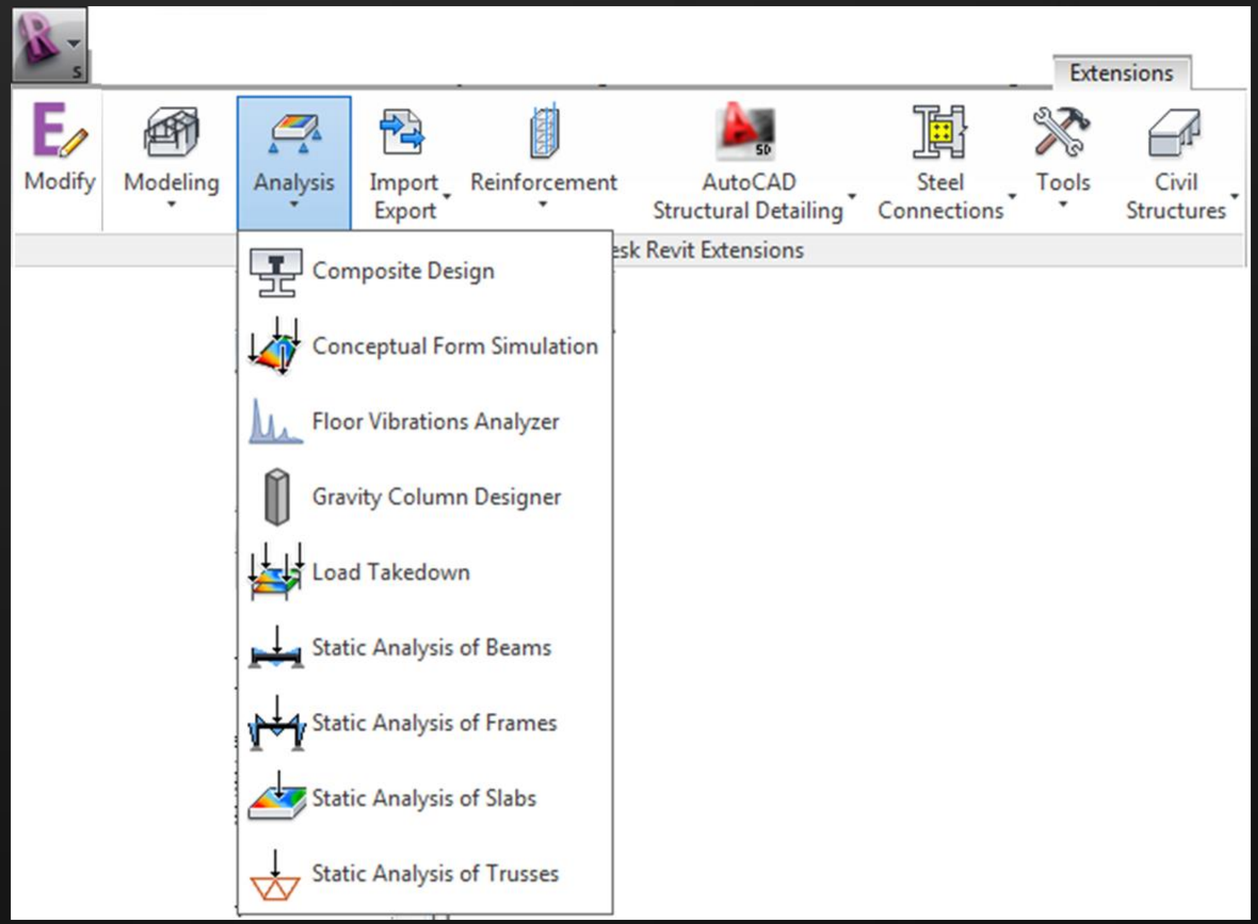




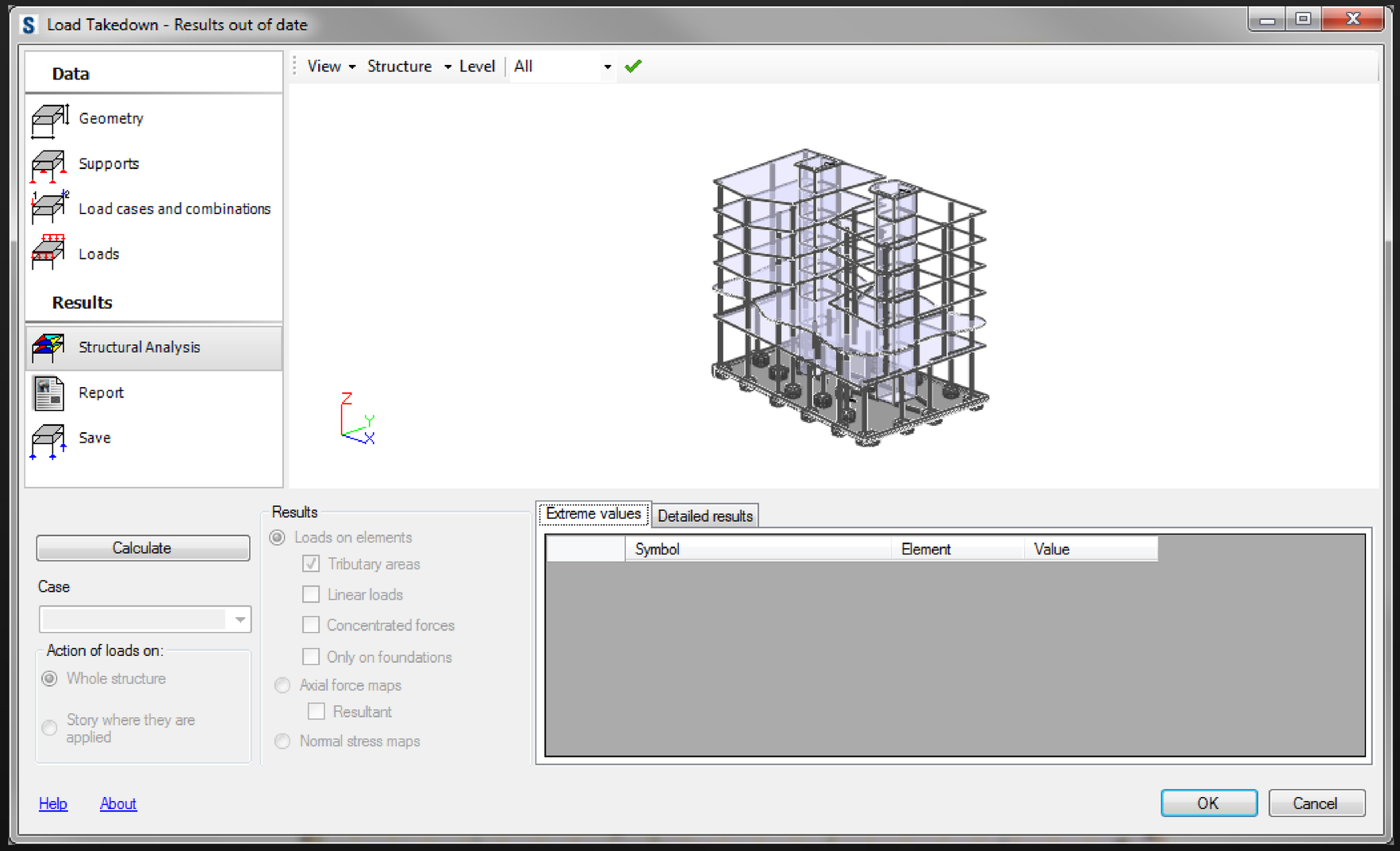
Leveraging Revit Extensions

Extensions offer some great value added tools:

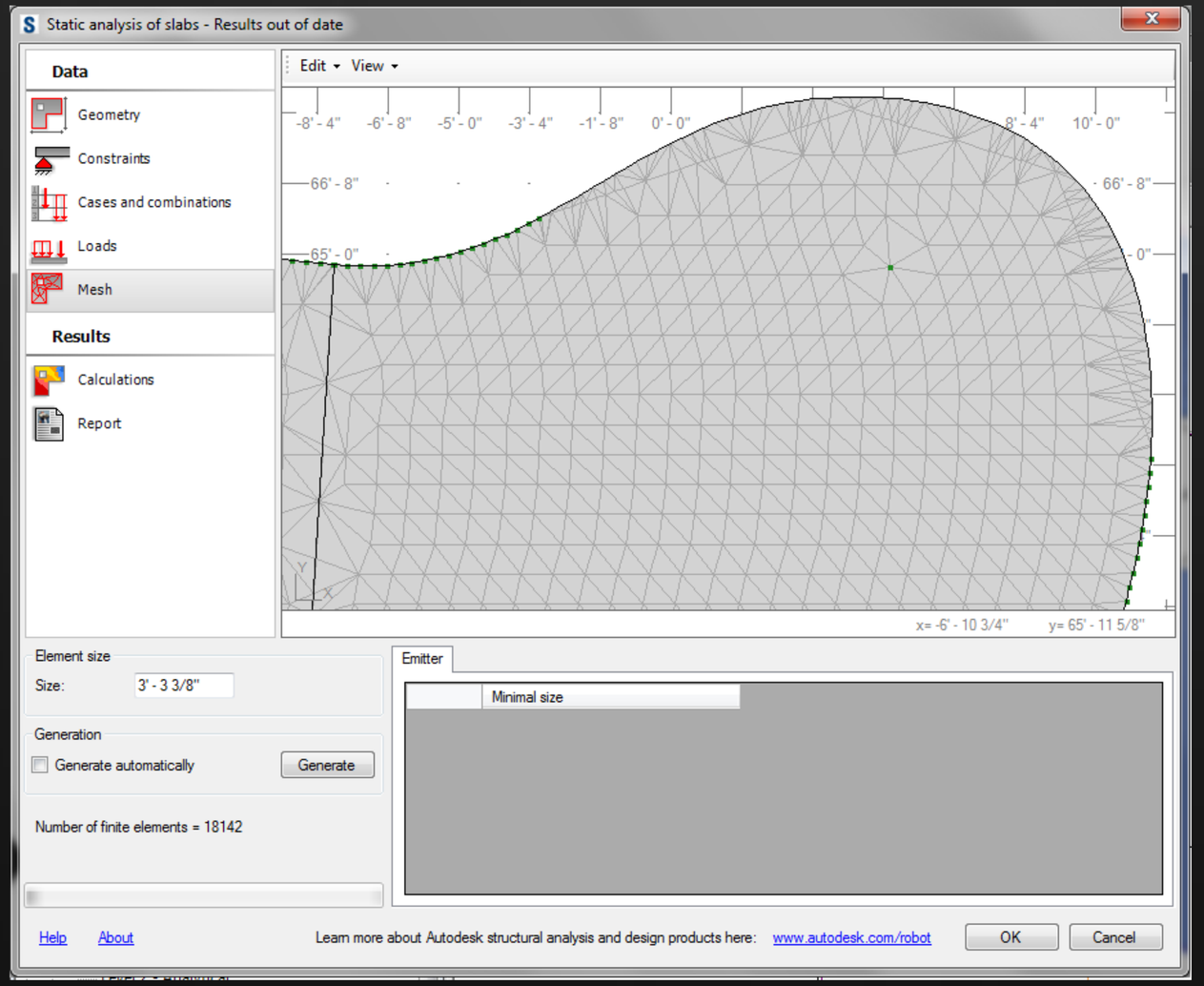
- Good rebar detailing
- Limited concrete analysis/design
  - Load takedown
  - Static analysis of
    - Beams
    - Frames
    - Slabs



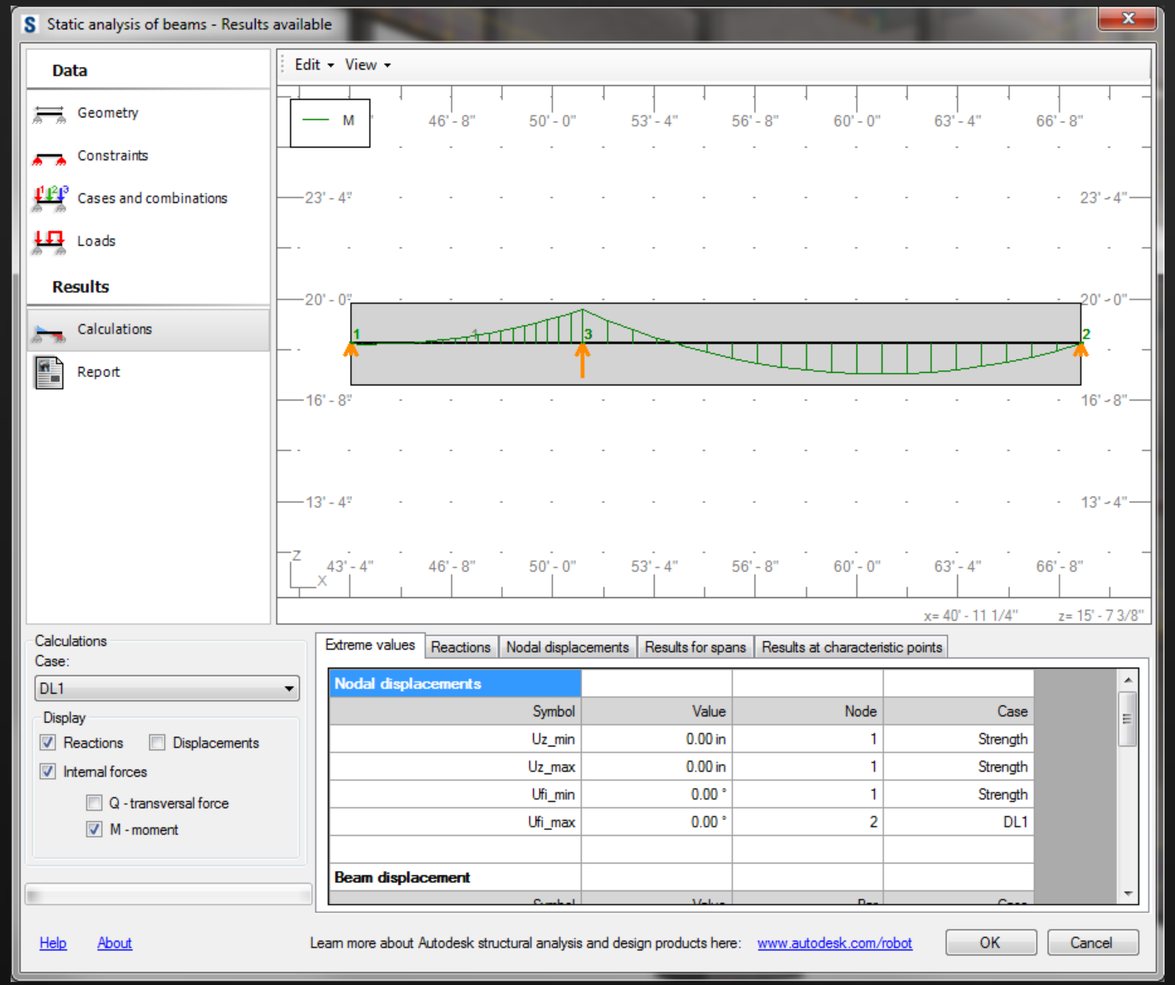
Load Takedown Using Revit Extension

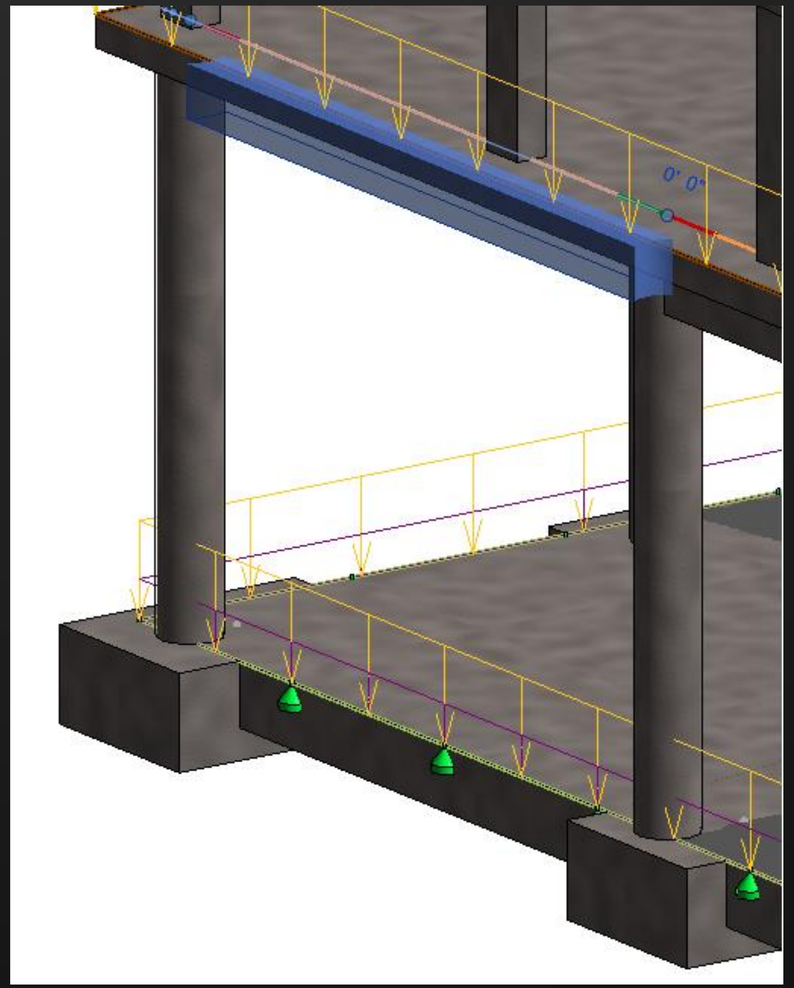


Automatic FEM Mesh Generated by Extension

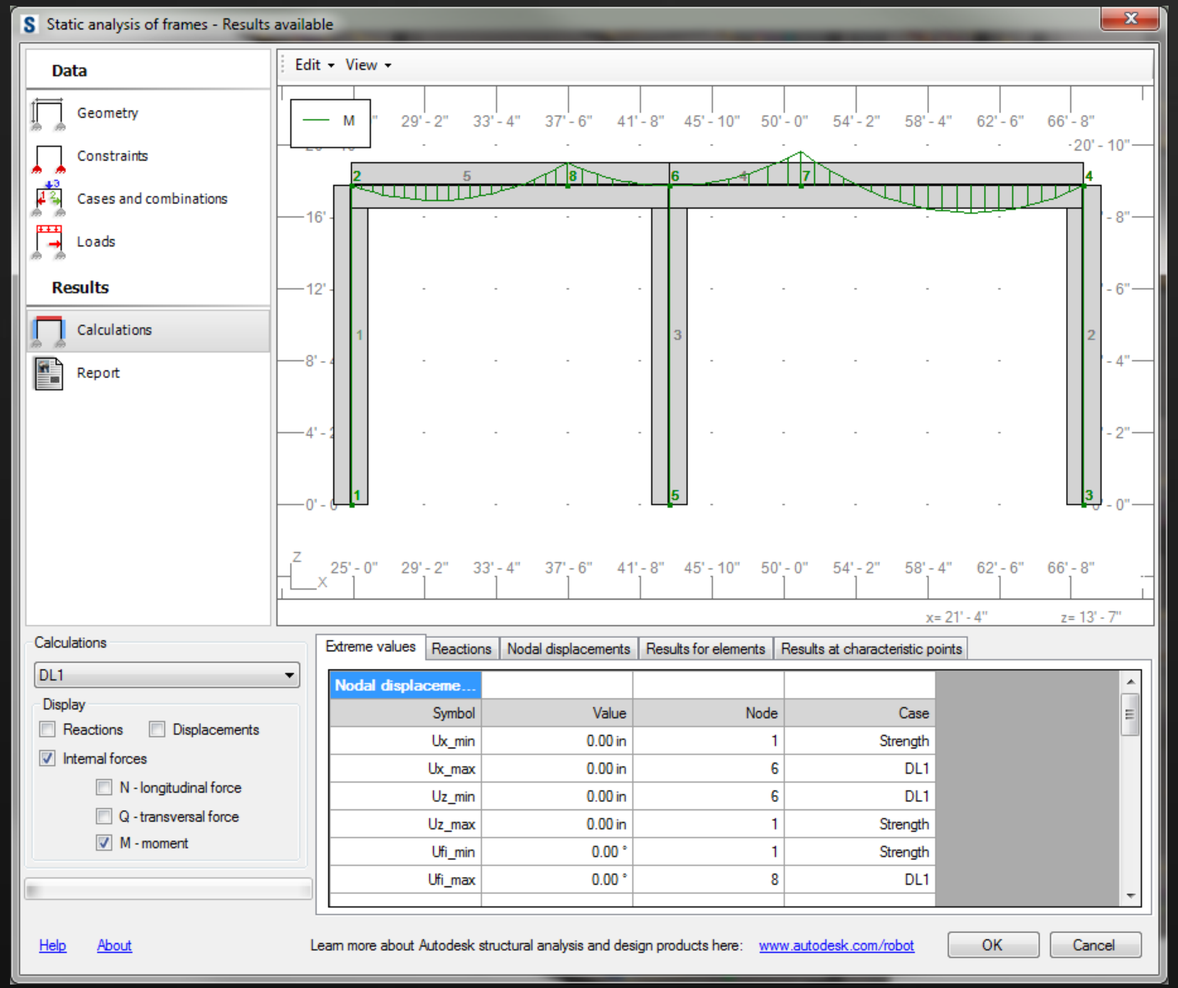


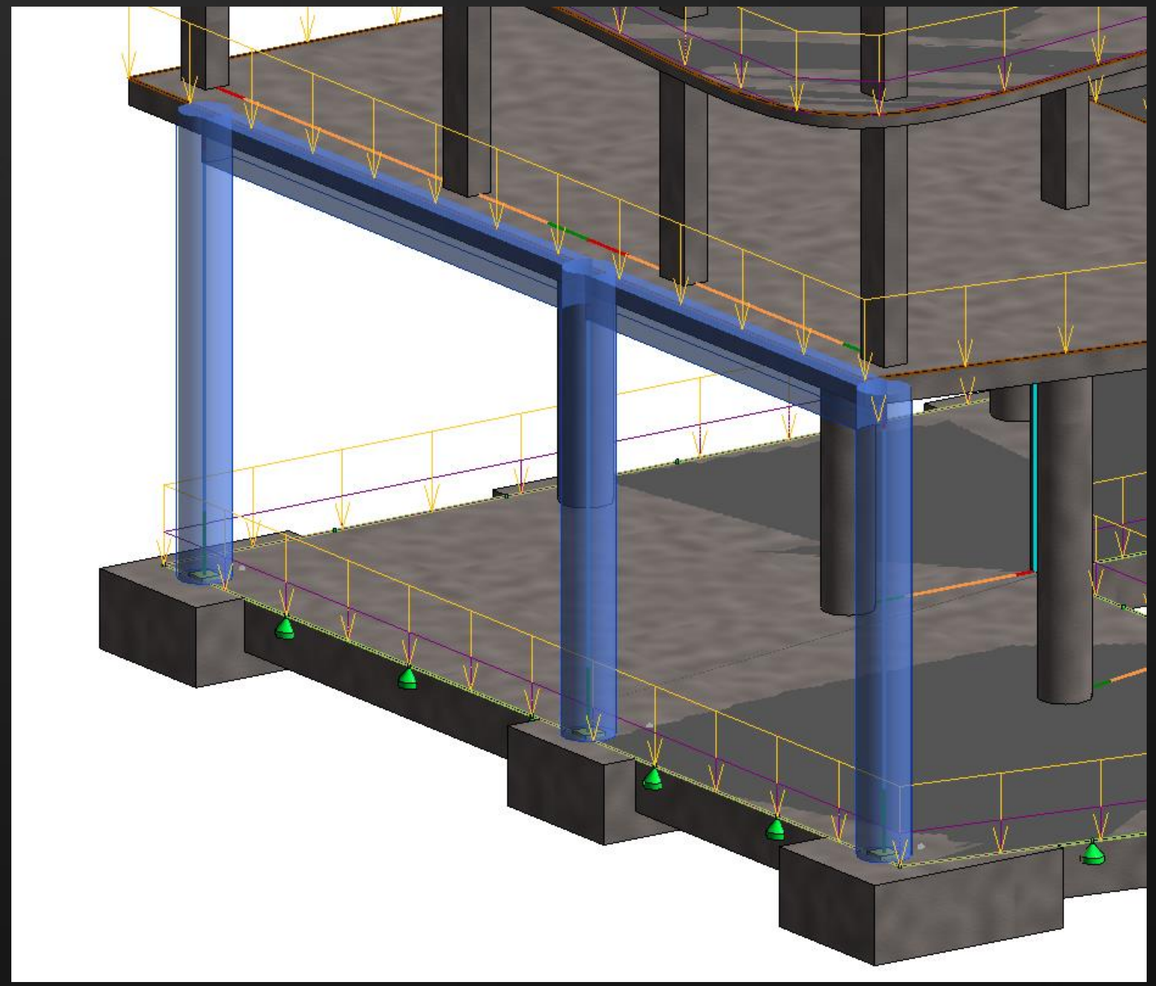
Beam Analysis Using Revit Extension





Frame Analysis Using Revit Extension

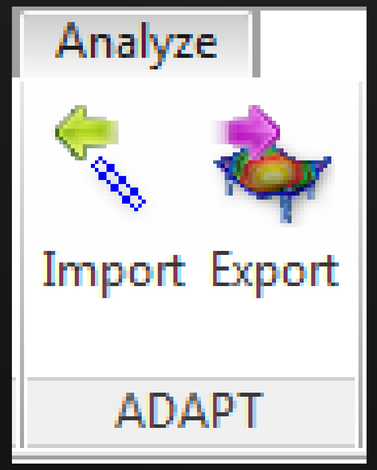


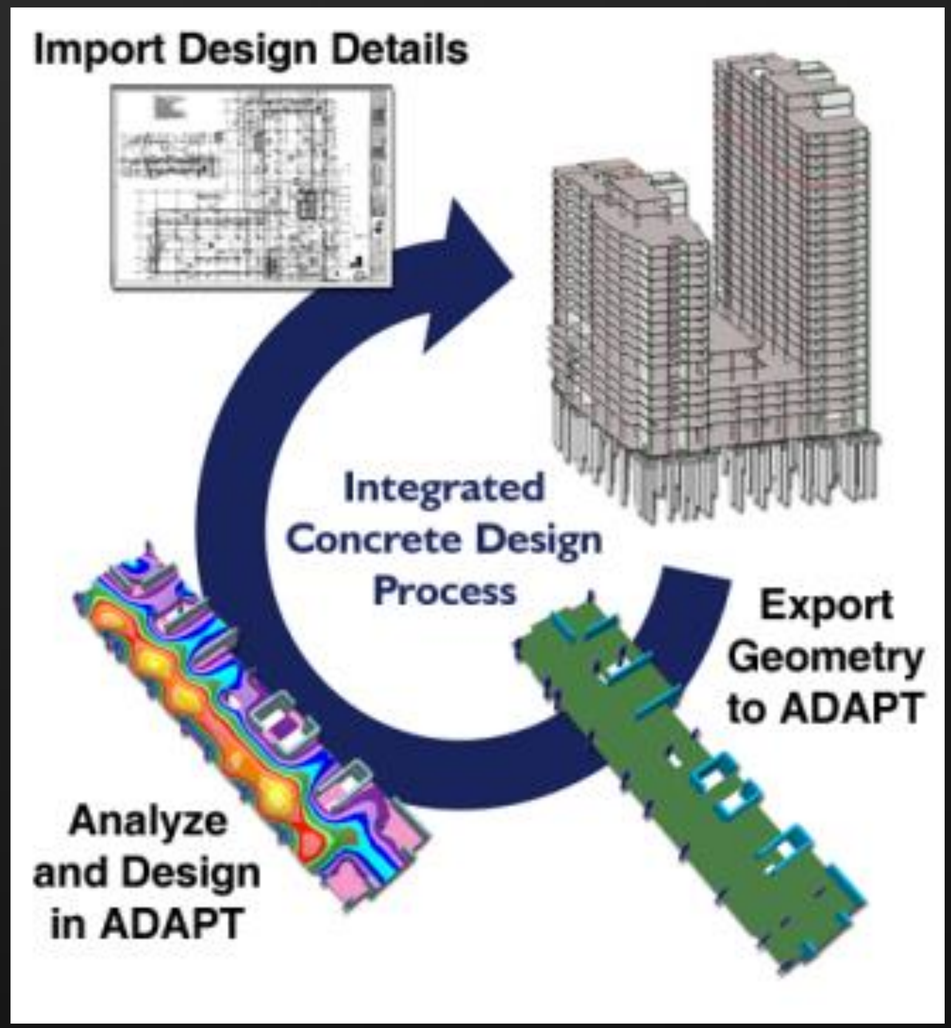


Rely on Specialized 3rd Party Integrated Solutions

ADAPT maintains Integration link:

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



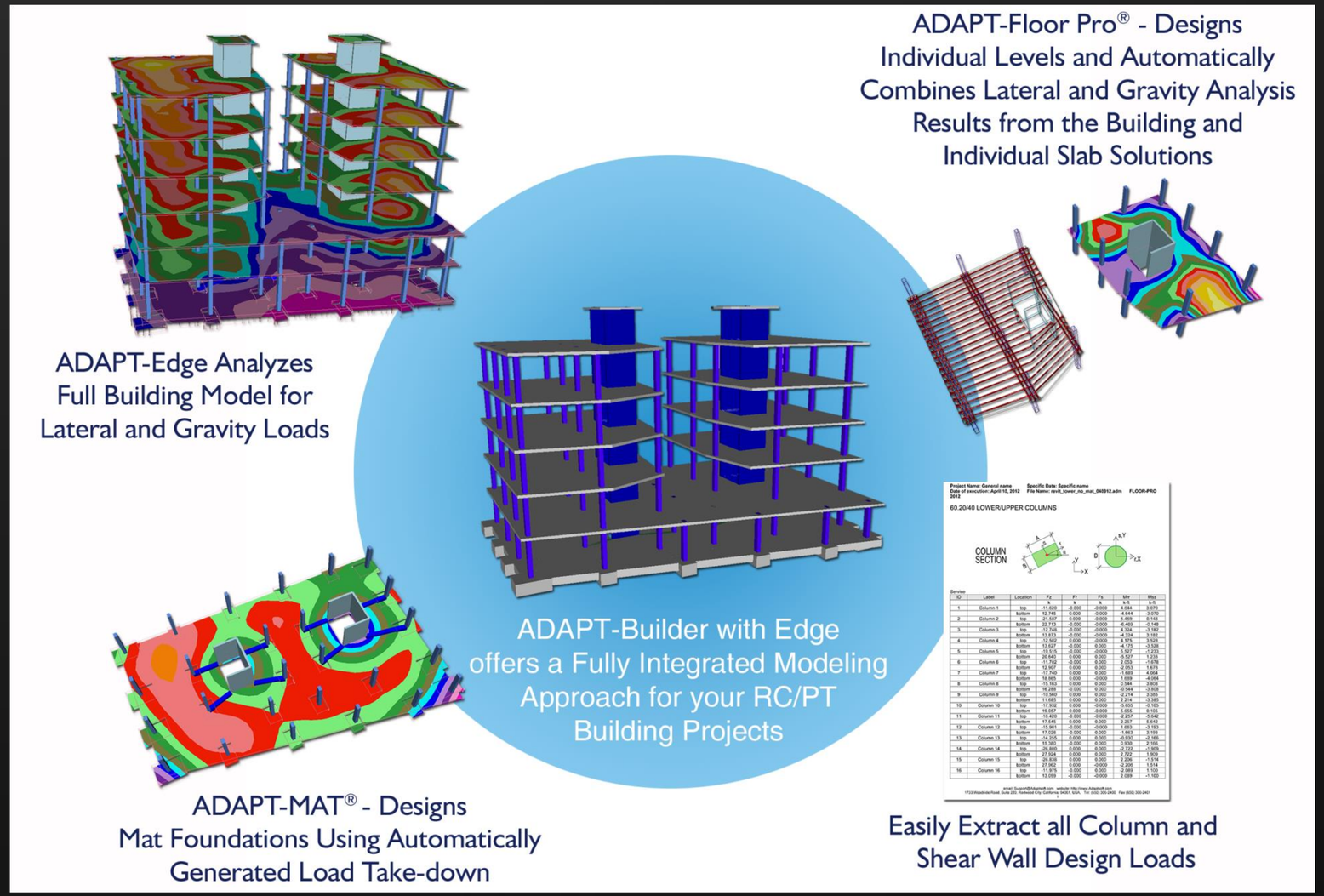


ADAPT-Builder Suite for Analysis/Design of Concrete Revit Models

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



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:

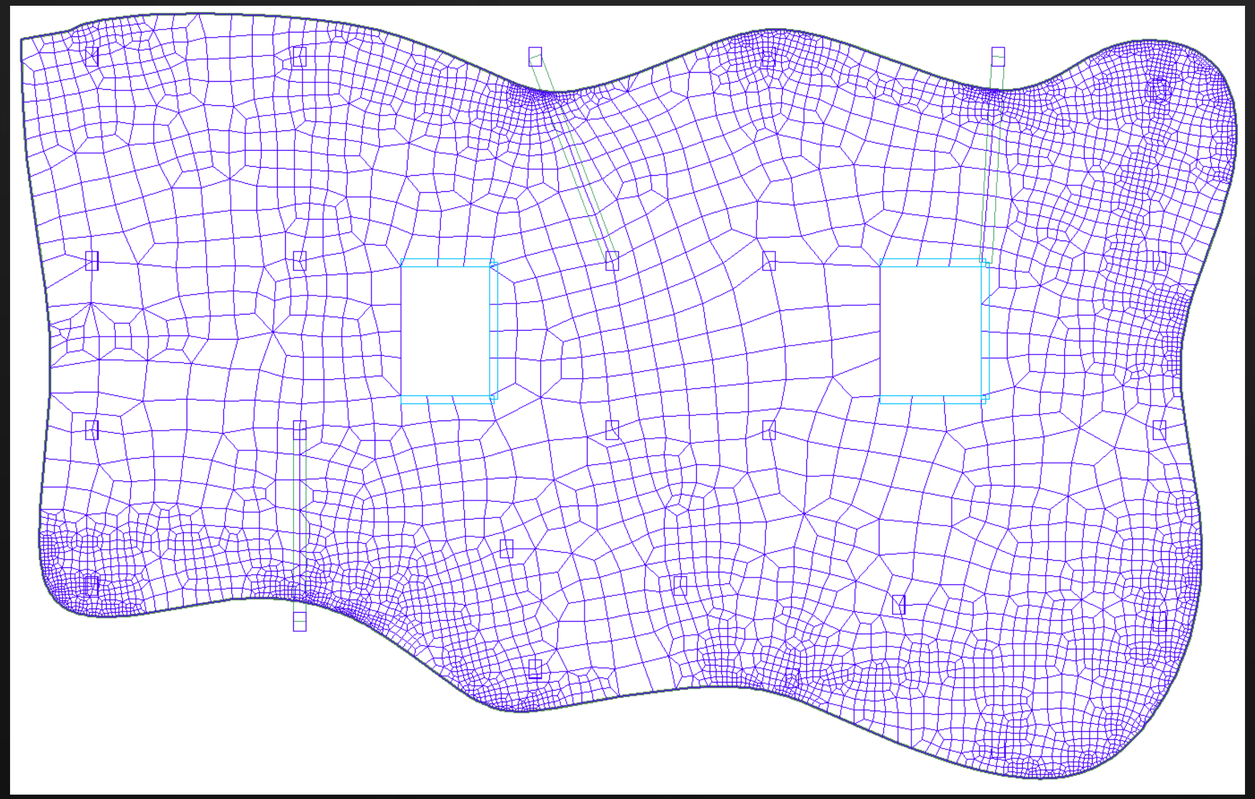
- Save time by avoiding the RST analytical model
- Regional code check and complete design
- Design process the way you want it
- Deep domain expertise
  - Accessible and knowledgeable support team
  - Incorporation of domain specific code requirements
- Maintain more control of your analytical model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

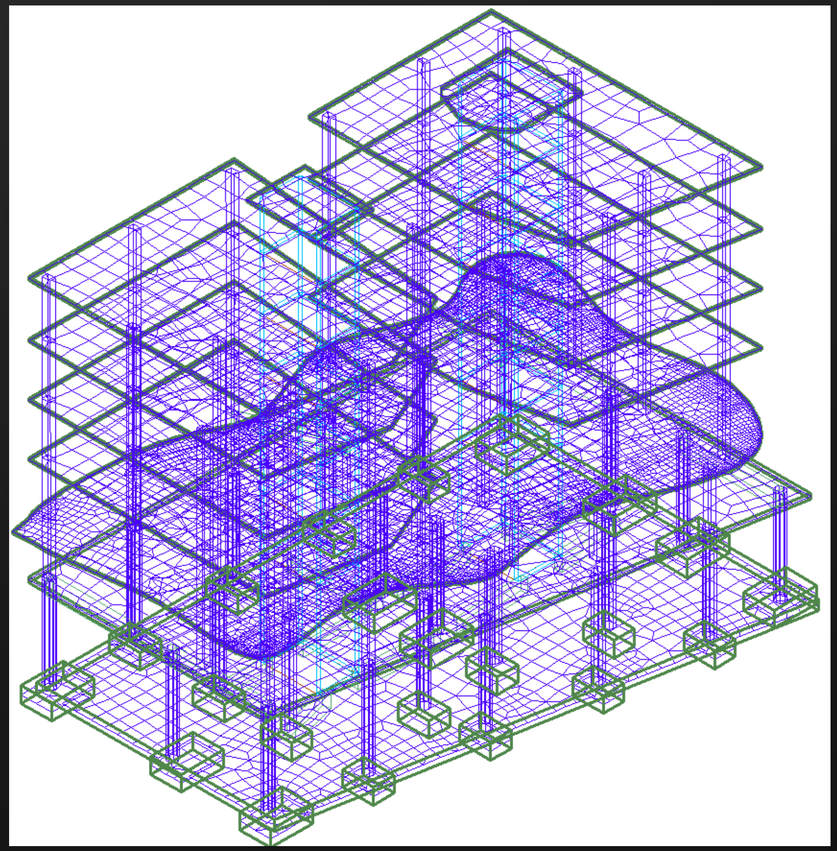
We Know The Options You Have are Changing

… 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

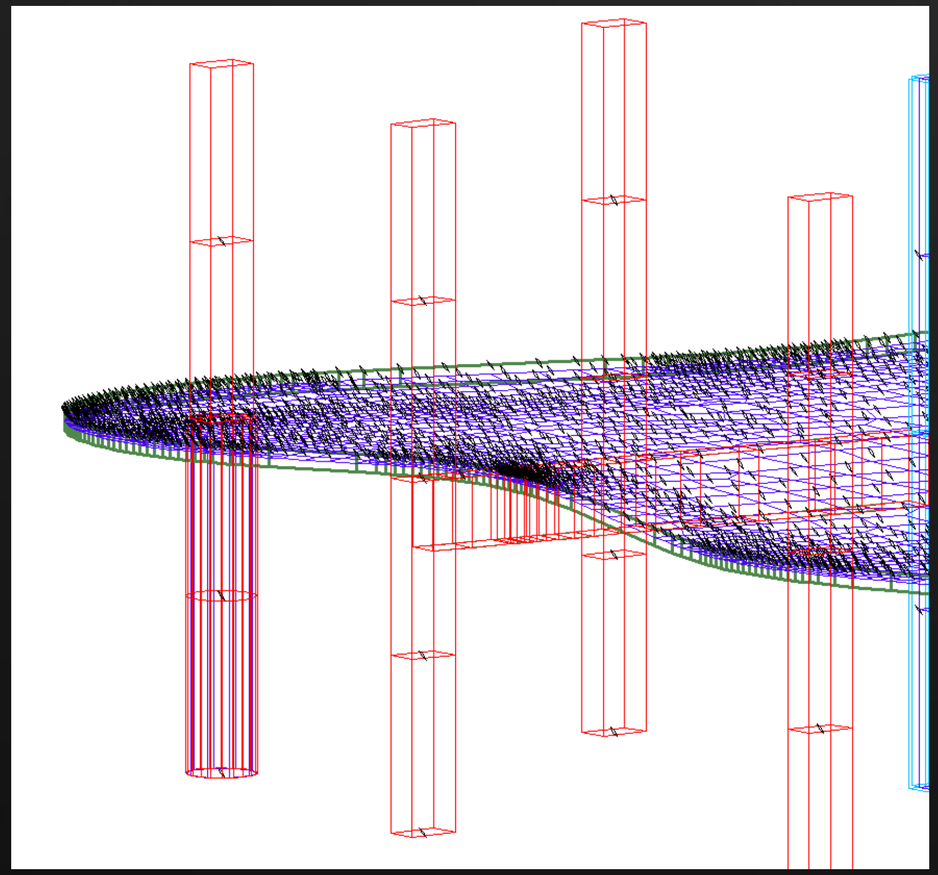
ADAPT generates a detailed 3D Finite Element analytical model from the Revit Physical model:

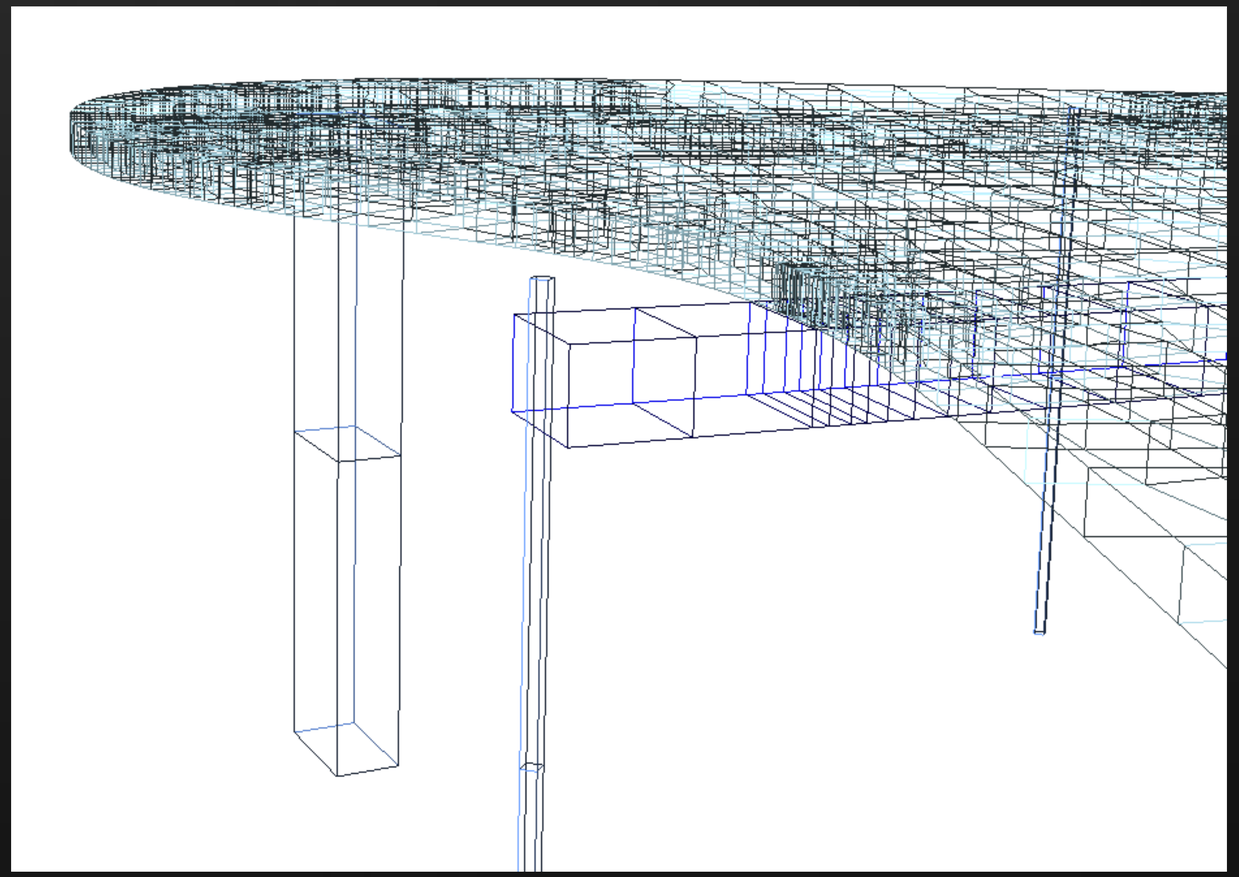




ADAPT Maintains True Offsets in Analytical Model

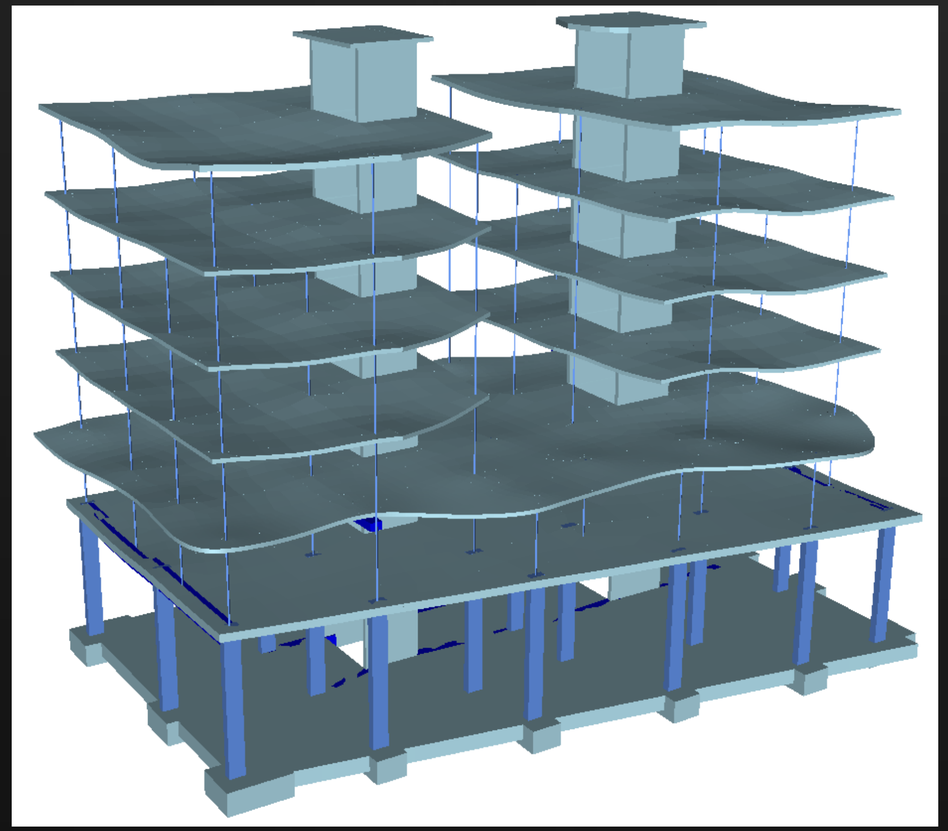
View of beam under slab framing into free-standing column:

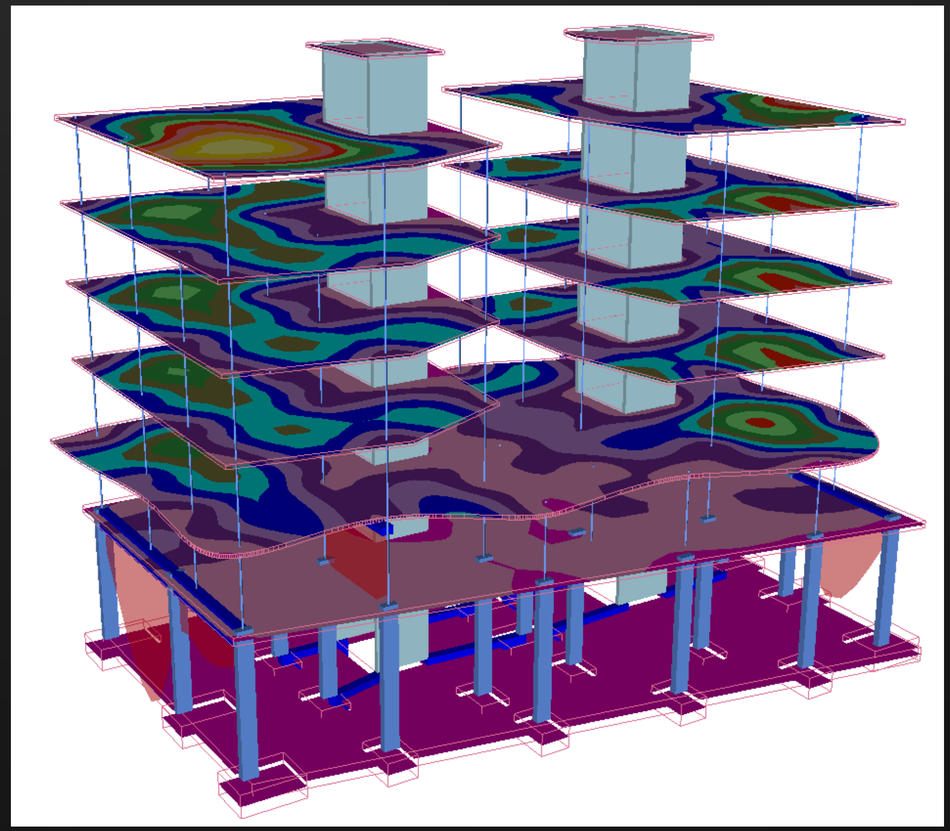




3D FEM Analysis Results in ADAPT

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





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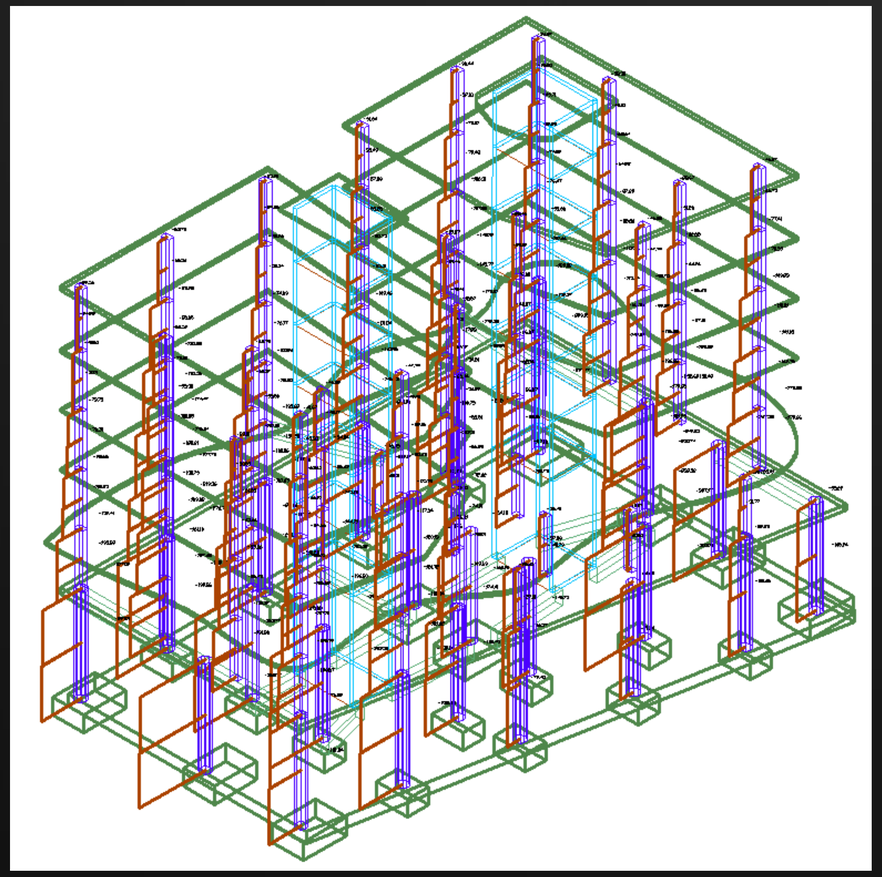
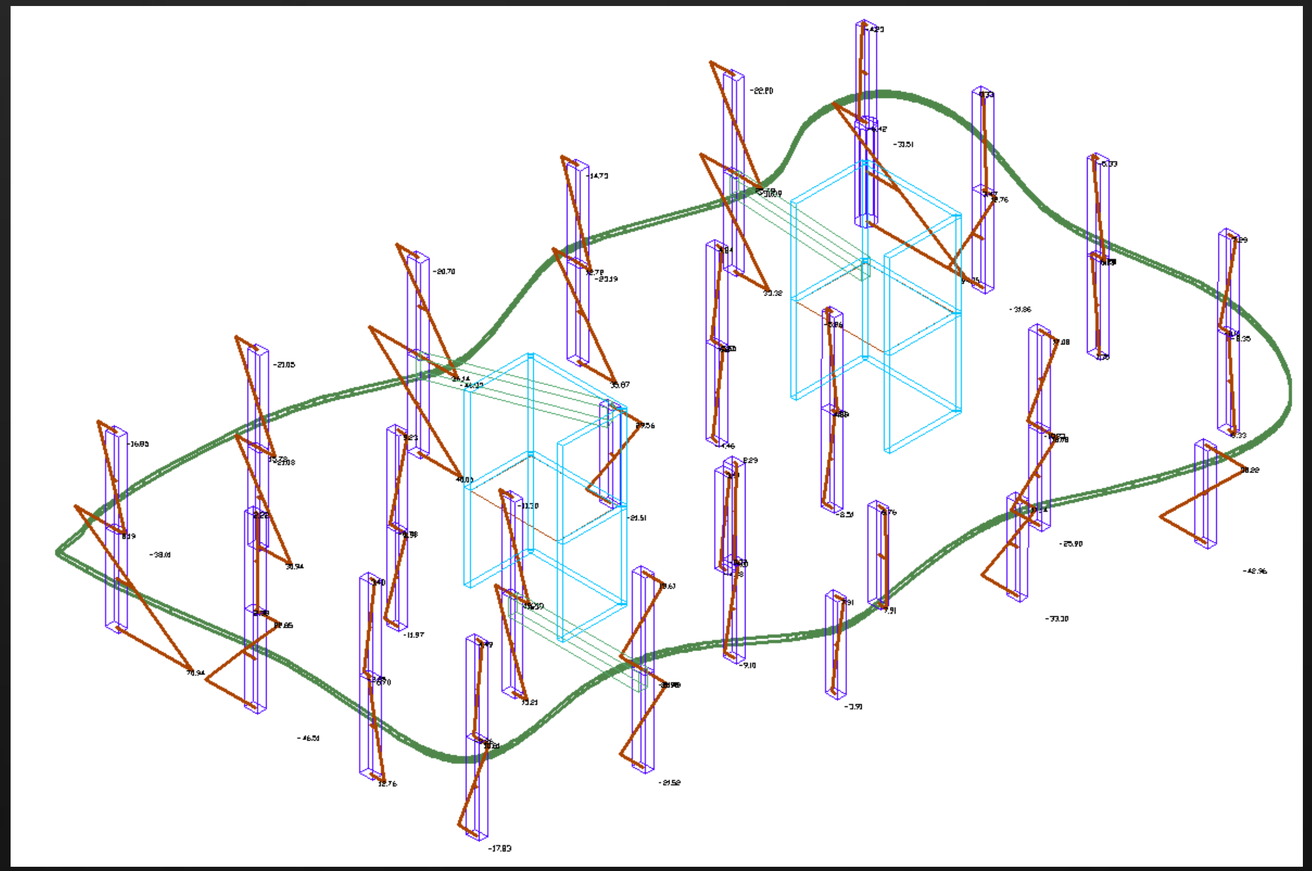
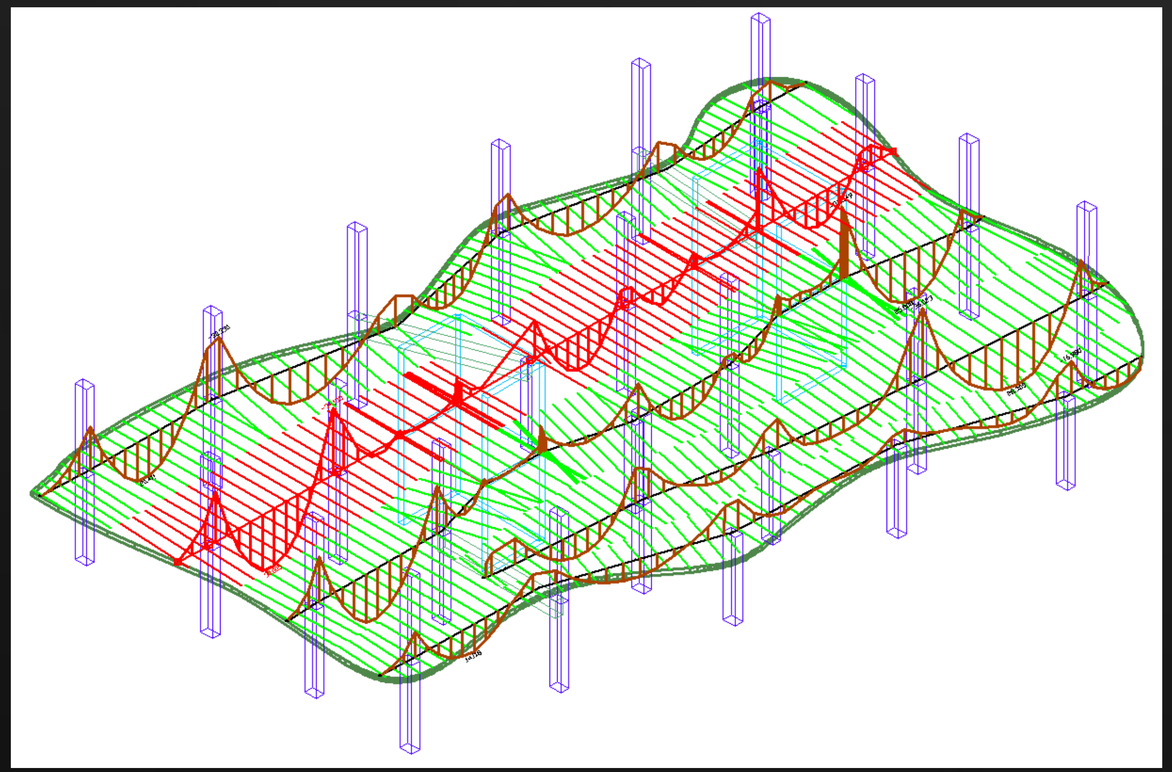
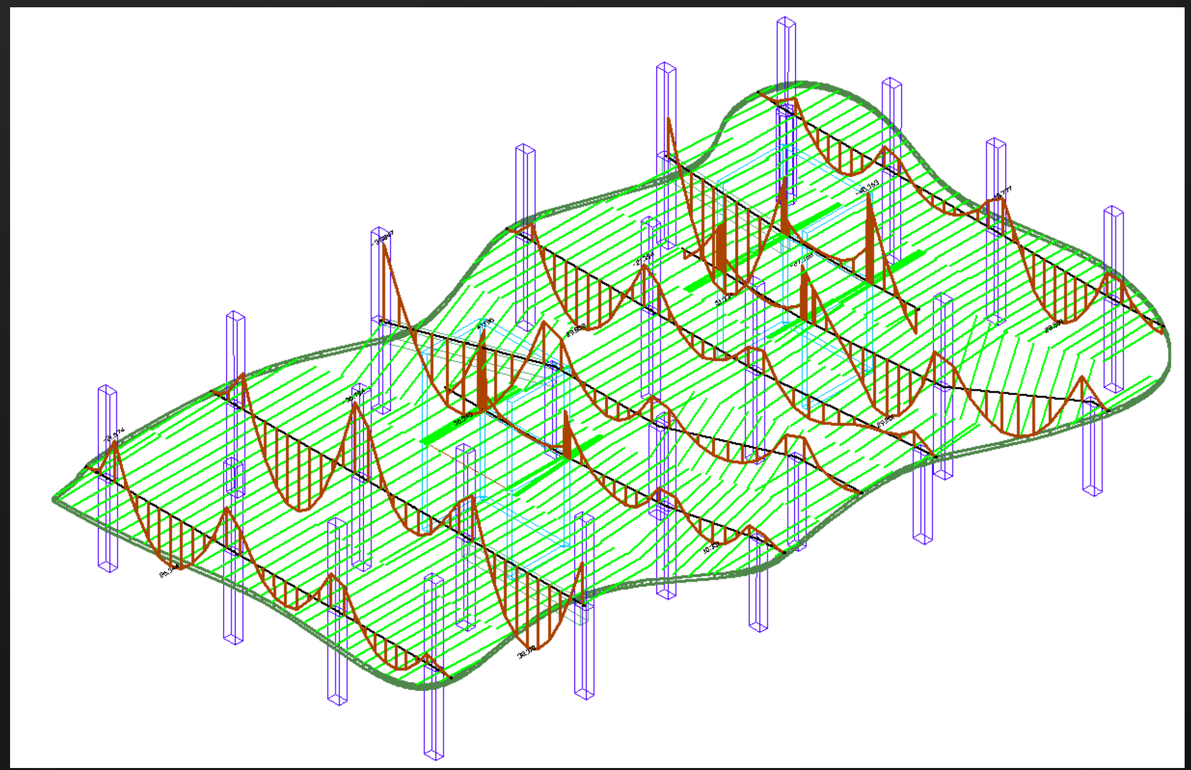




Detailed Slab and Beam Design

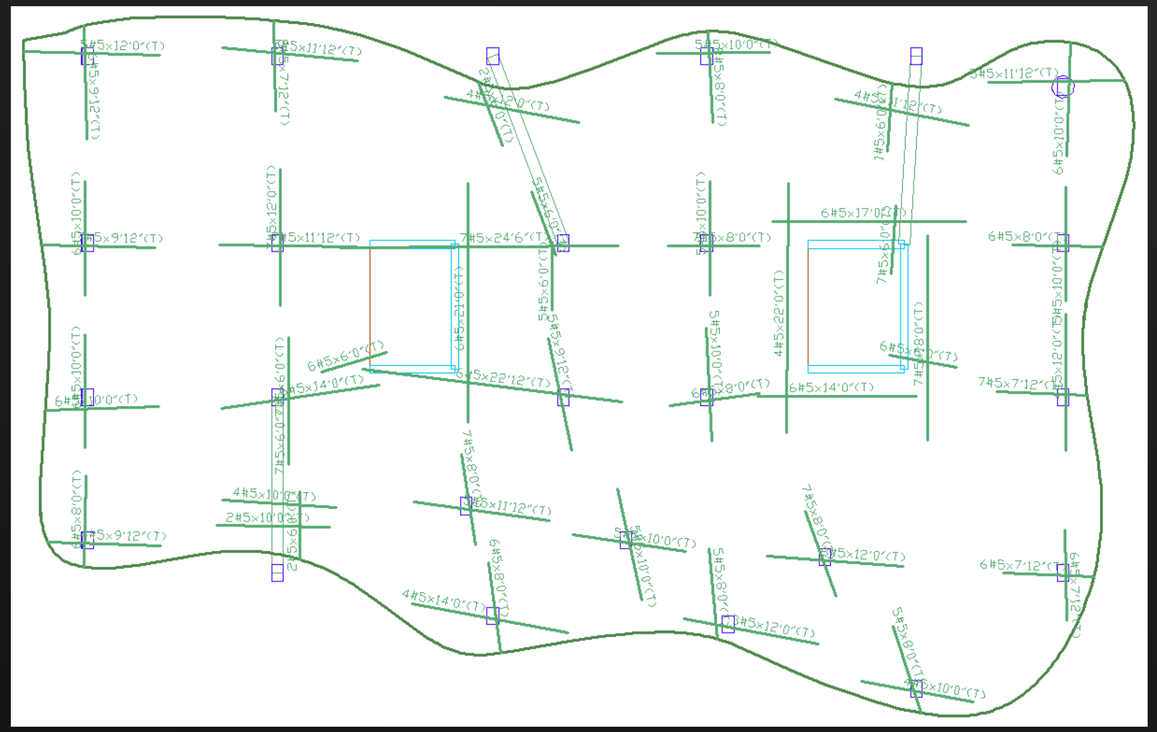
Floor system design is carried out using design strips:



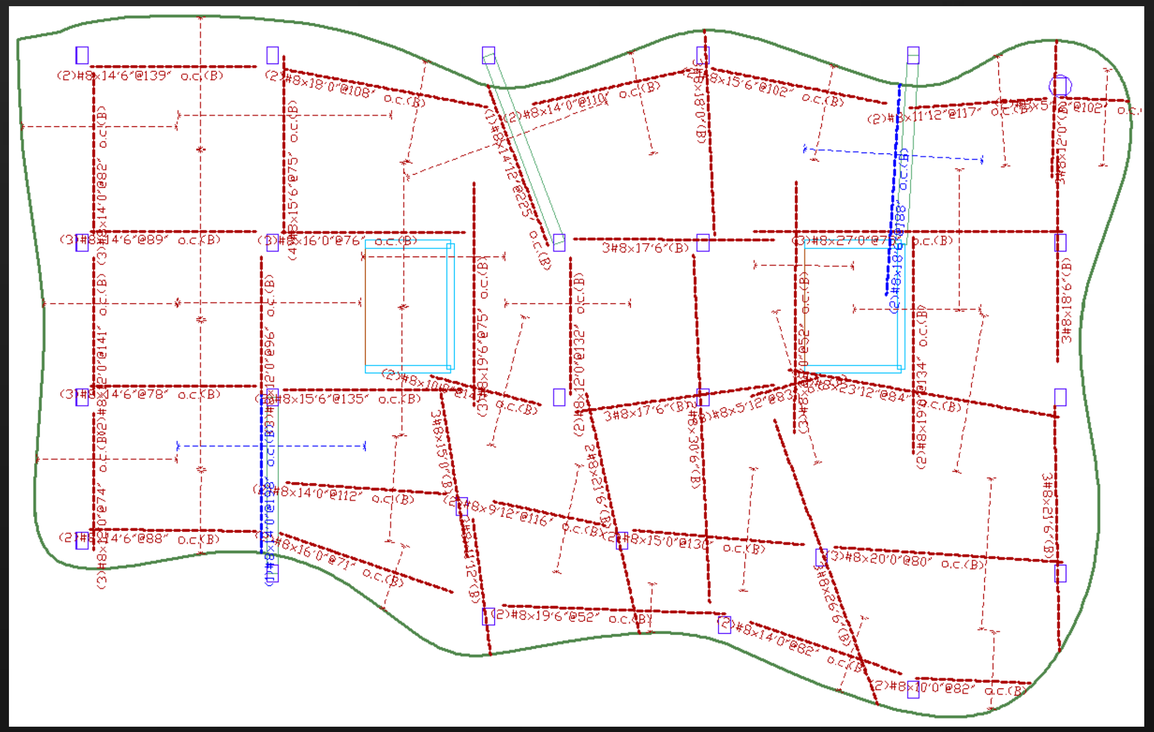


Detailed Slab and Beam Design

Calculated reinforcement is place in the slab and beams:



Top bars



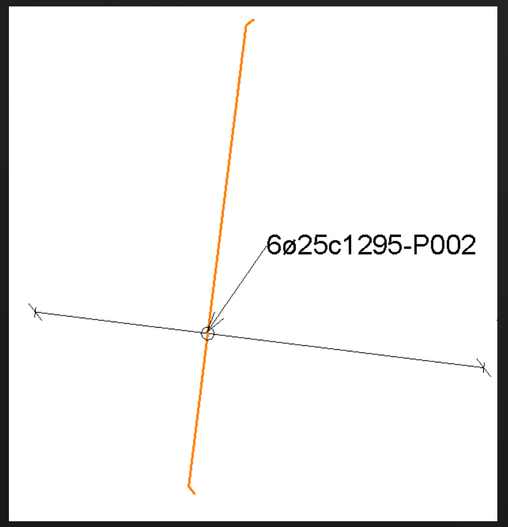
Bottom bars

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

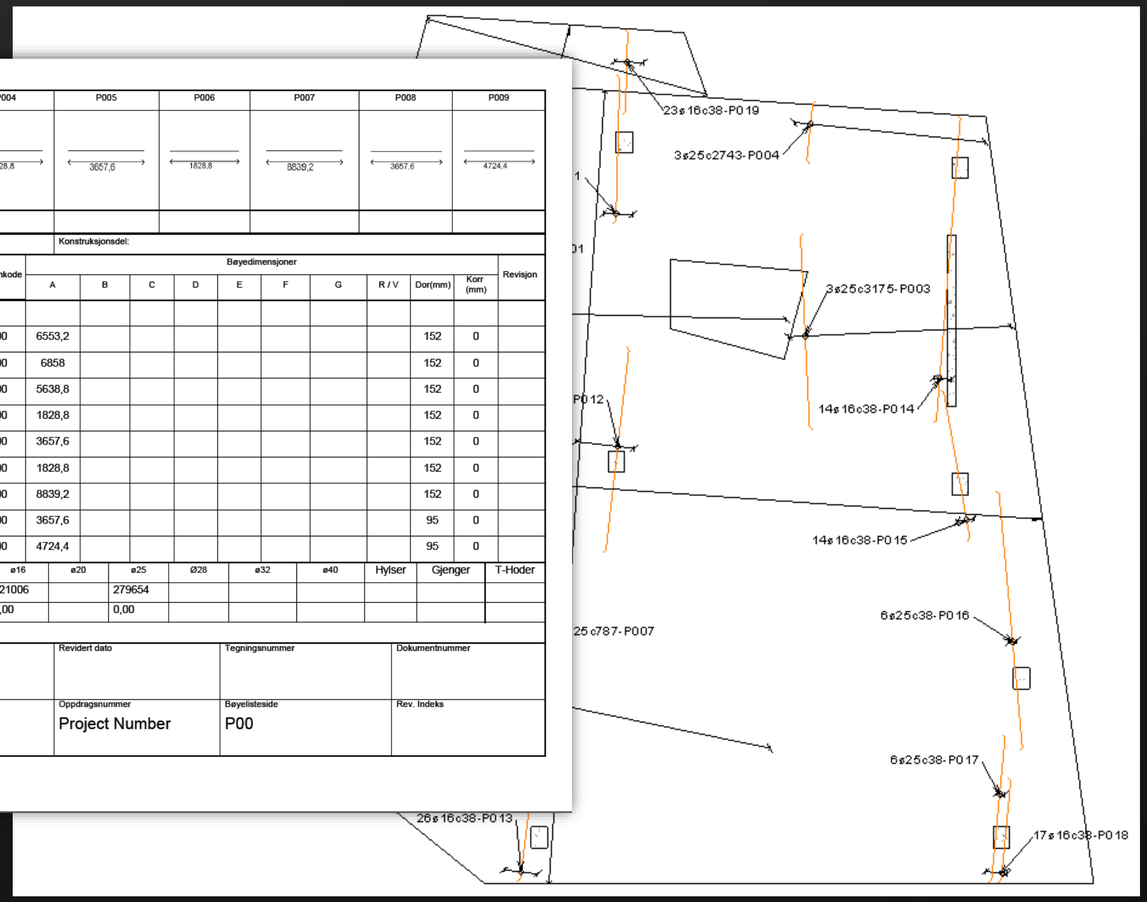
Bøyelisten stemmer overens med: NS-EN ISO3766:2004 — Konstruksjonsdel:

Posnr.	Stålkval.	Diam (mm)	Lengde av hver stang (mm)	Ant. konstr. deler	Stenger pr. del	Totalt antall	Total Lengde (mm)	Formkode	Bøyedimensjoner 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 Informasjonssystemer	Project Name	Issue Date			
Bøyeliste	Oppdragsgiver: Owner	Utarbeidet av	Oppdragsnummer: Project Number	Bøyelisteside: P00	Rev. Indeks



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

ADAPT
Structural Concrete Software

Thank You for Listening

Additional resources:

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