AUTODESK UNIVERSITY

BIM-Centered Workflows for Structural Analysis

Tomasz Fudala
Technical Marketing Manager | @TomekF

Catalin Lang
Senior Product Owner | @CatalinStefanL

Tomasz Fudala

About the speaker

He has almost 20 years of experience in the software industry and a comprehensive background and vast knowledge of structural solutions in the Autodesk portfolio. He achieved a Master of Science degree in Structural Engineering from the Cracow University of Technology, Poland.

Catalin Lang

About the speaker

Former Autodesk customer, currently Autodesk employee, working in constructions field since 2000, going through several branches of the industry, from junior unskilled worker to formwork specialist, storekeeper, project coordinator, project manager, CAD designer, structural designer. He is specialized in structural modeling and detailing. Joined Autodesk since 2014 as Quality Analyst. Currently, Product Owner for one of the teams that develops Revit and Advance Steel structural features. Since 2020, focused on connecting structural engineers to BIM environment, using Revit as coordination tools between physical model and structural analysis solutions.

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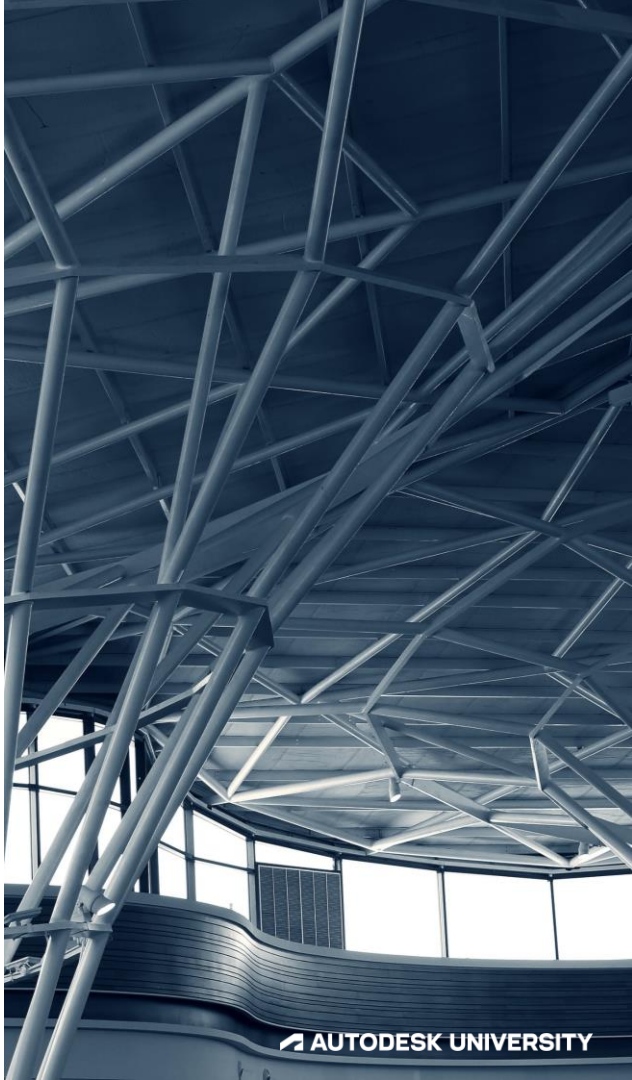
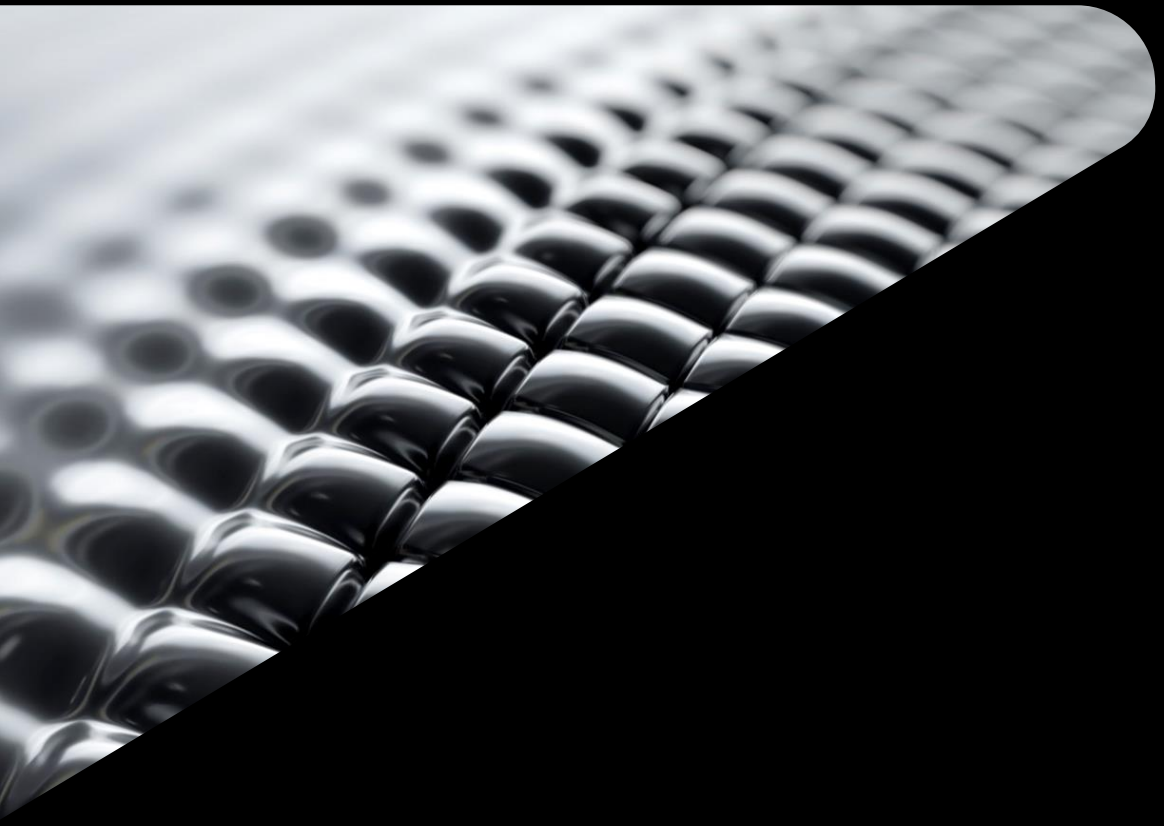
Learning objectives

- Understand the benefits of new workflows for structural analysis available in Revit 2023.
- Learn how to use the new Revit analytical modeling tools.
- Automate structural analytical modeling workflows in Revit.
- Learn about the library-based steel connection design automation workflow.





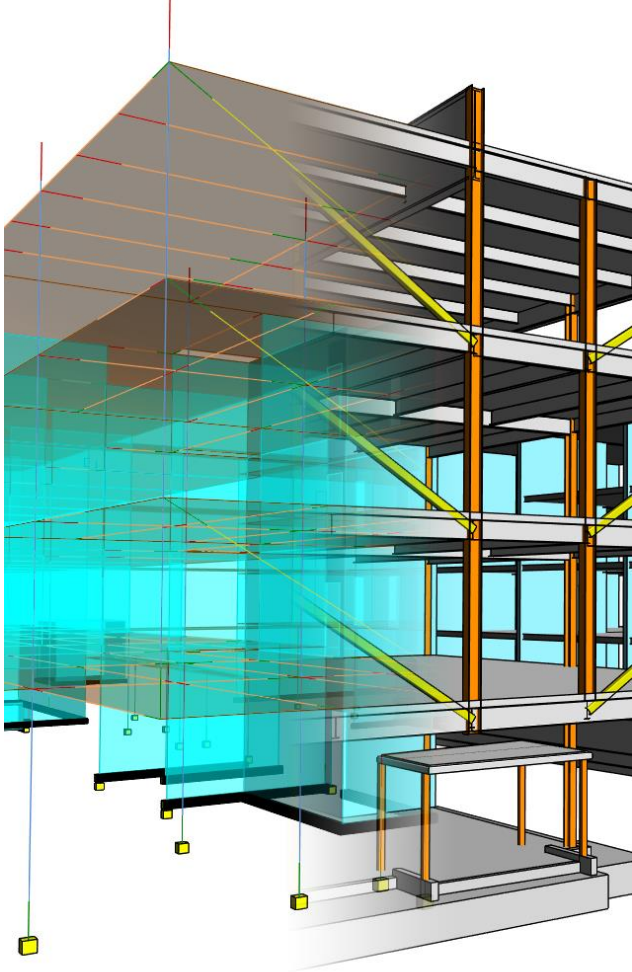
Analytical modeling

Revit 2023

Analytical modeling

What users want to see in a BIM-centric solution for structural analysis

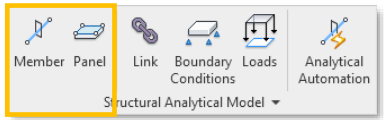
- Accuracy & Versatility with Analytical Modeling in BIM Context
- High Productivity with Analytical Modeling Automation
- Analytical Model Quality Control for BIM Compliance
- Engineering-driven, Analysis-centric workflows from Revit
- Effective Collaboration with Analytical Model Autonomy
- Revit Document Deliverables Completeness with Analytical Model Data

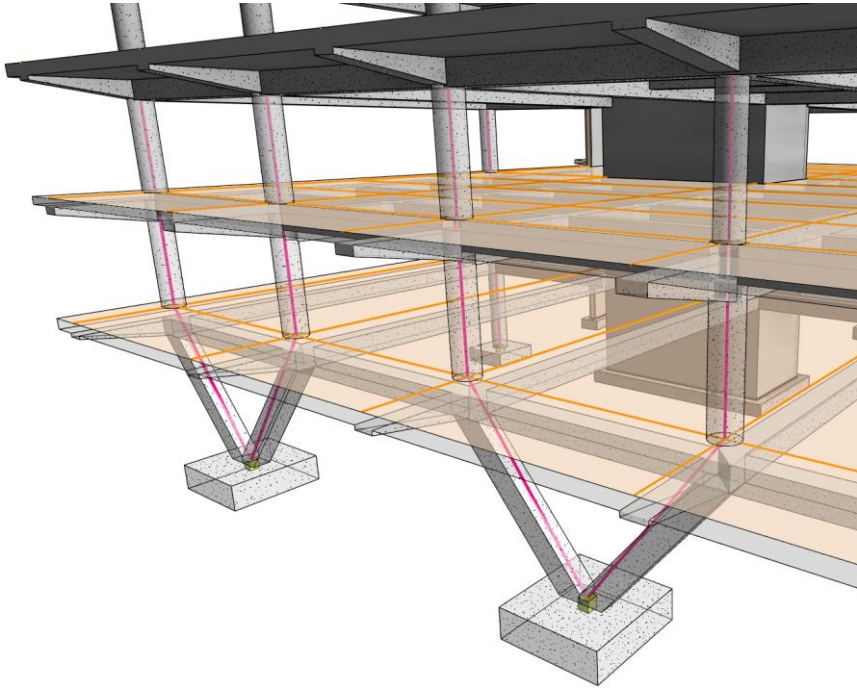


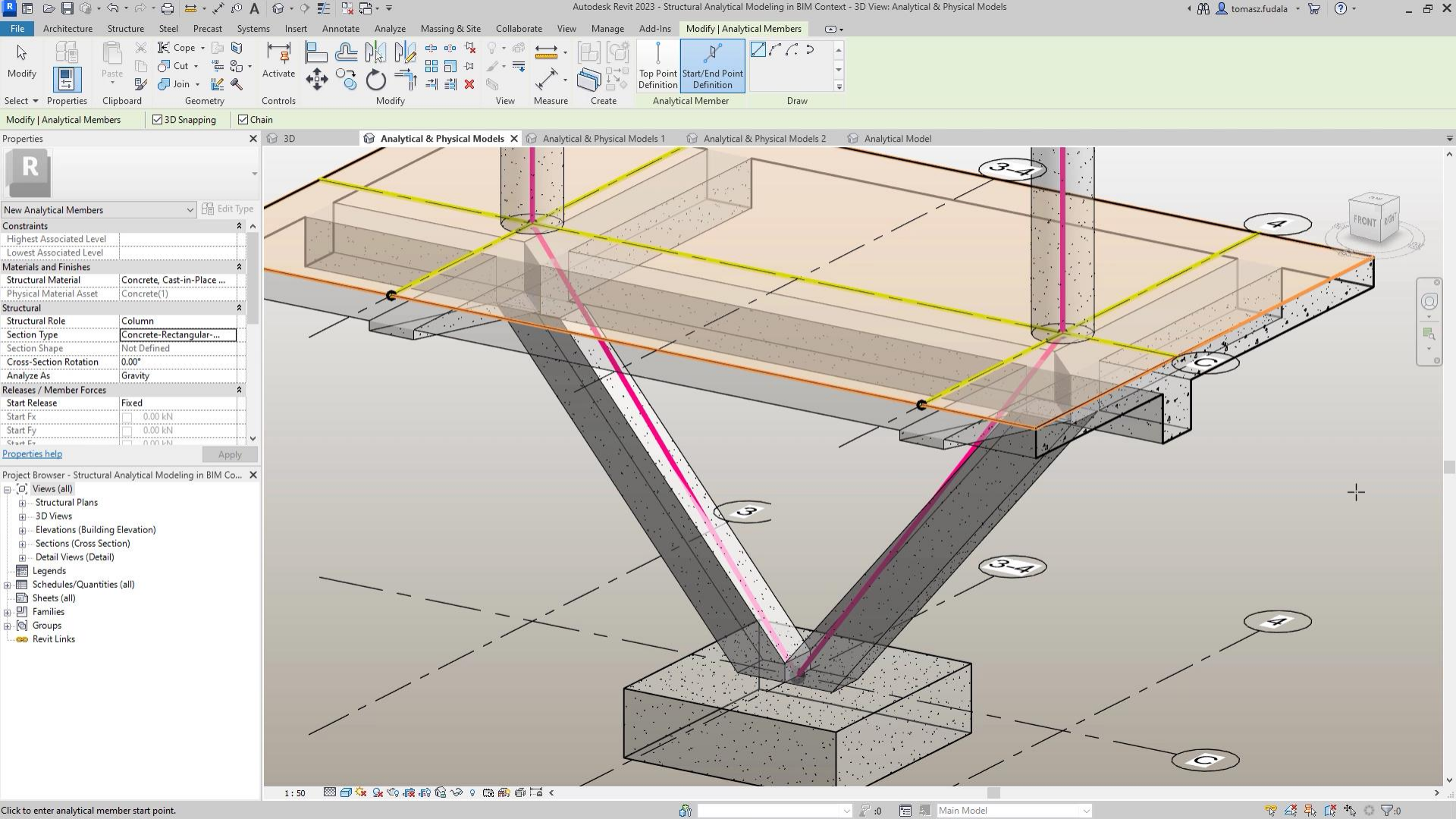
Structural analytical modeling in BIM context

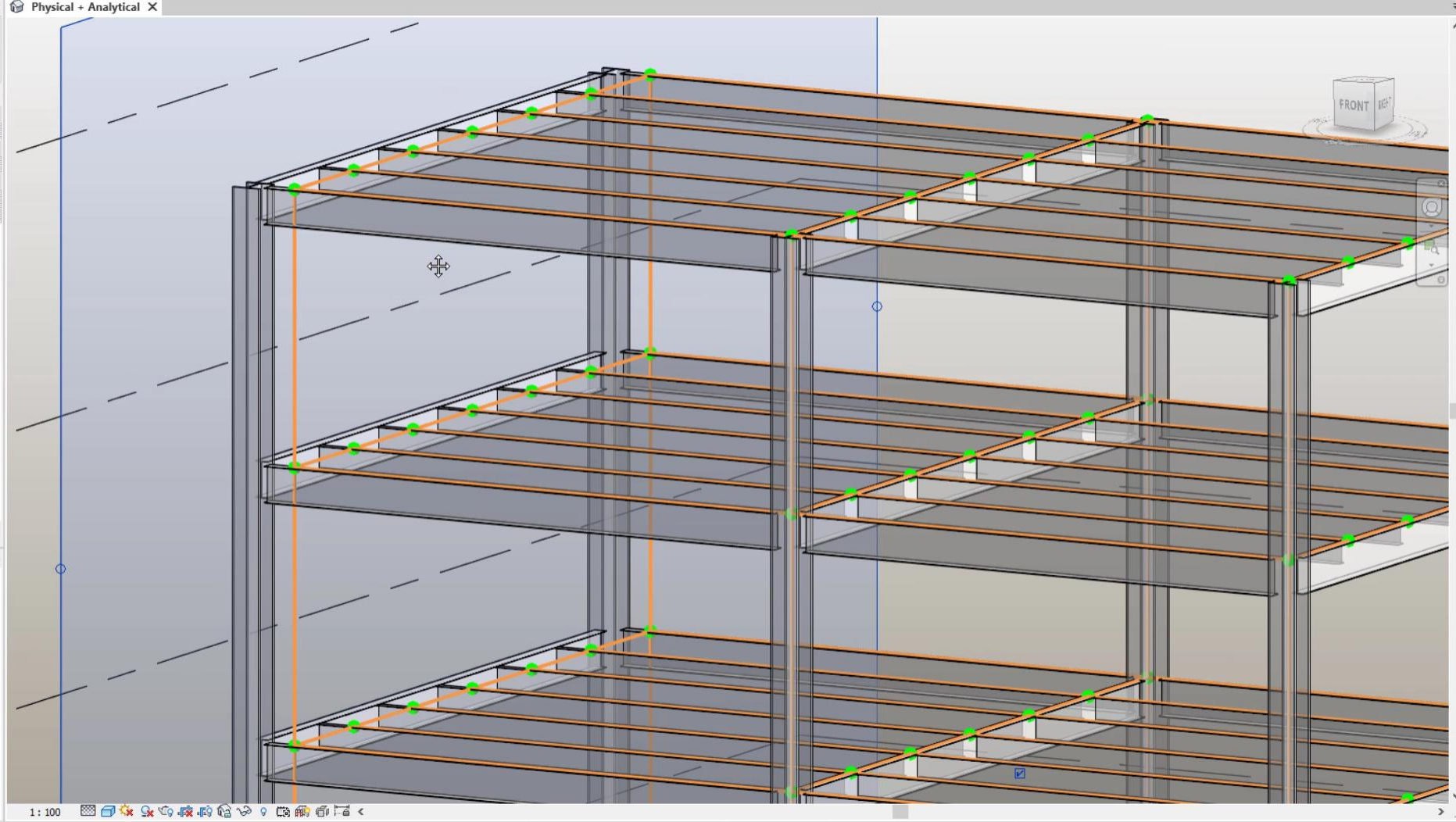
Revit 2023

- Use new tools (Analytical Member & Panel) to create analytical models
- Leverage existing physical geometry as context
- Associate physical and analytical model elements for BIM quality control
- Control changes independently for analytical and physical objects
- Create multiple analytical models for a single physical representation






Autodesk Revit 2023 - Structural Analytical Modeling in BIM Context - 3D View: Analytical & Physical Models
tomasz.fudala
File
Architecture
Structure
Steel
Precast
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Modify | Analytical Members
Modify
Properties
Paste
Cope
Cut
Join
Activate
Top Point Definition
Start/End Point Definition
Select
Clipboard
Geometry
Controls
Modify
View
Measure
Create
Analytical Member
Draw
Modify | Analytical Members
3D Snapping
Chain
Properties
New Analytical Members
Edit Type
Constraints
Highest Associated Level
Lowest Associated Level
Materials and Finishes
Structural Material
Concrete, Cast-in-Place ...
Physical Material Asset
Concrete(1)
Structural
Structural Role
Column
Section Type
Concrete-Rectangular-...
Section Shape
Not Defined
Cross-Section Rotation
0.00°
Analyze As
Gravity
Releases / Member Forces
Start Release
Fixed
Start Fx
0.00 kN
Start Fy
0.00 kN
Properties help
Apply
Project Browser - Structural Analytical Modeling in BIM Co...
Views (all)
Structural Plans
3D Views
Elevations (Building Elevation)
Sections (Cross Section)
Detail Views (Detail)
Legends
Schedules/Quantities (all)
Sheets (all)
Families
Groups
Revit Links
3D
Analytical & Physical Models
Analytical & Physical Models 1
Analytical & Physical Models 2
Analytical Model
3-4
4
C
3
3-4
4
C
FRONT
RIGHT
1 : 50
Click to enter analytical member start point.
Main Model

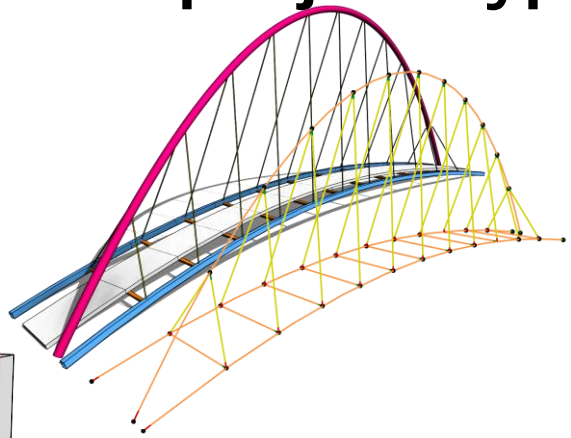

Physical + Analytical
FRONT
1 : 100
Main Model

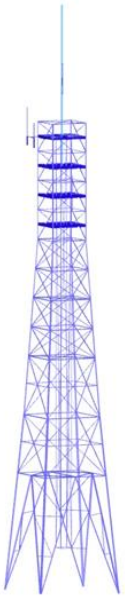
Modeling versatility for diverse project types

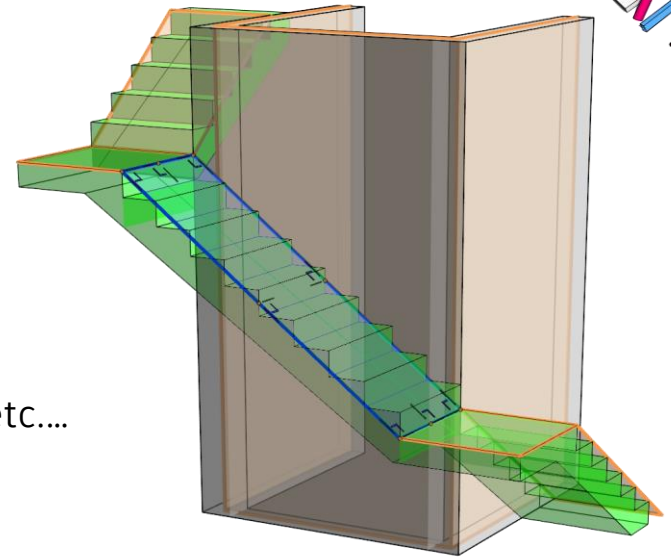
Revit 2023

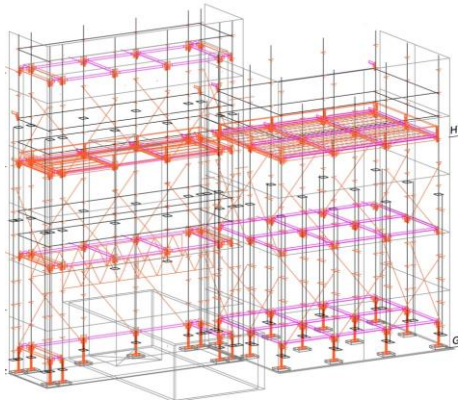
- Engineers decide how analytical model represents physical reality

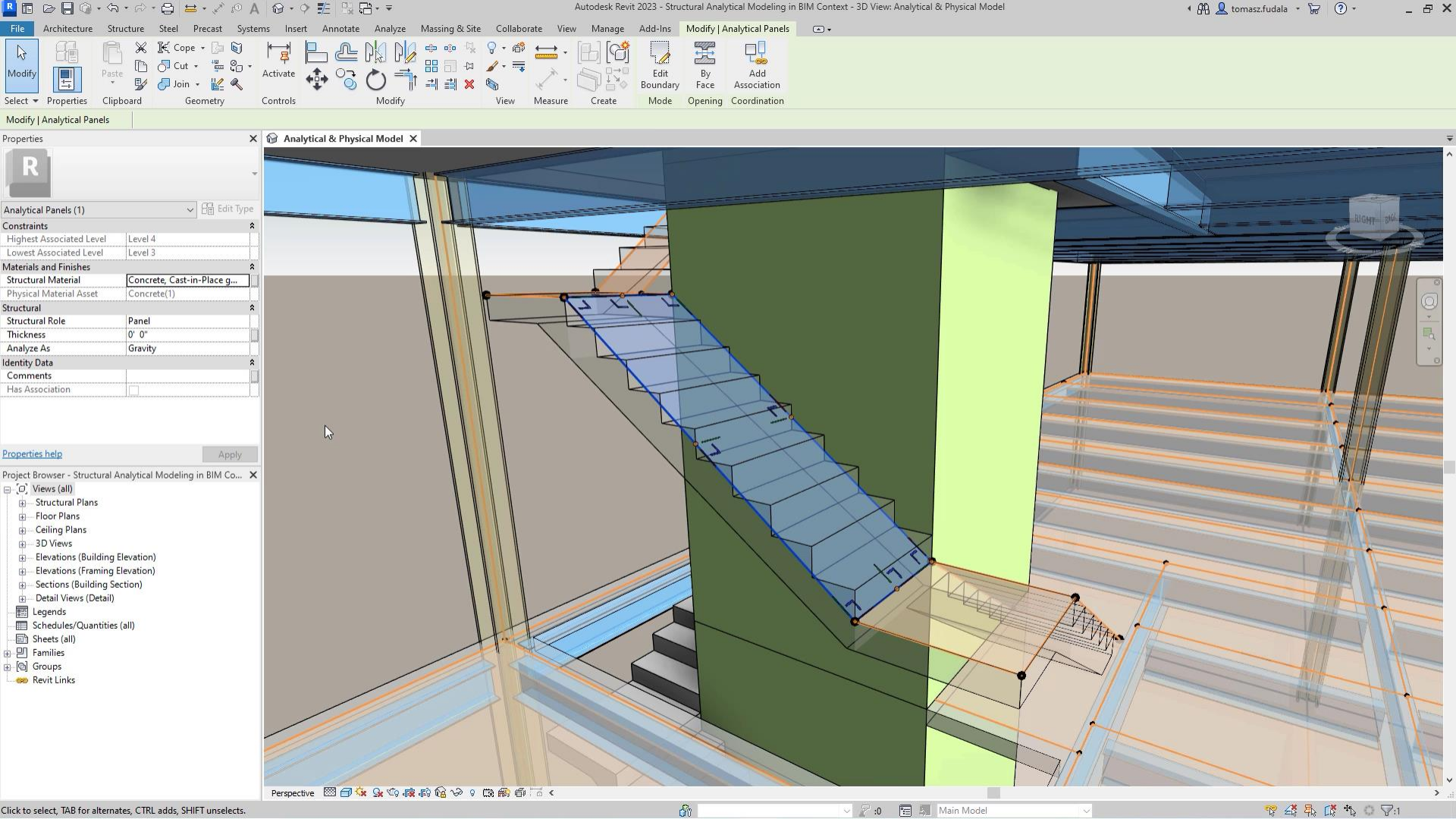
- Various types
  - Building
  - Frames
  - Bridges
  - Tunnels
  - Roofs,
  - Stairs,
  - Generic objects etc.…







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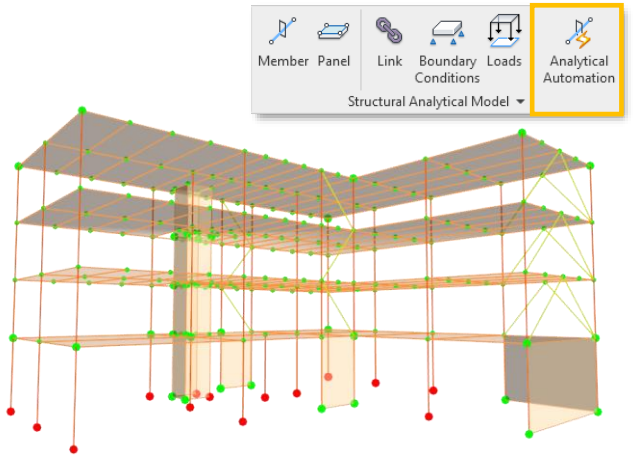
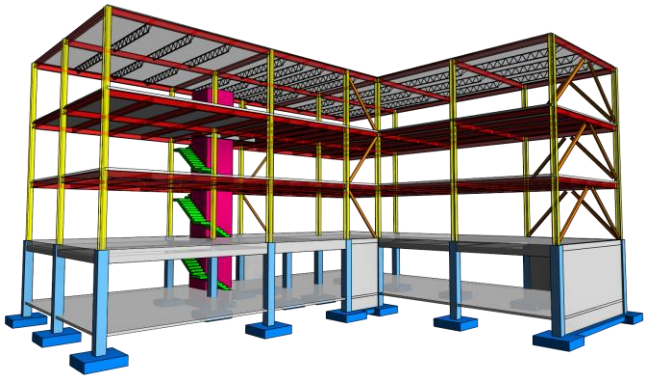
Modify
Select
Properties
Paste
Clipboard
Cope
Cut
Join
Geometry
Activate
Controls
Modify
View
Measure
Create
Edit Boundary
Mode
By Face
Opening
Add Association
Coordination
Modify | Analytical Panels
Properties
Analytical Panels (1)
Edit Type
Constraints
Highest Associated Level
Level 4
Lowest Associated Level
Level 3
Materials and Finishes
Structural Material
Concrete, Cast-in-Place g...
Physical Material Asset
Concrete(1)
Structural
Structural Role
Panel
Thickness
0' 0"
Analyze As
Gravity
Identity Data
Comments
Has Association
Properties help
Apply
Project Browser - Structural Analytical Modeling in BIM Co...
Views (all)
Structural Plans
Floor Plans
Ceiling Plans
3D Views
Elevations (Building Elevation)
Elevations (Framing Elevation)
Sections (Building Section)
Detail Views (Detail)
Legends
Schedules/Quantities (all)
Sheets (all)
Families
Groups
Revit Links
Analytical & Physical Model
RIGHT
Perspective
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.
Main Model

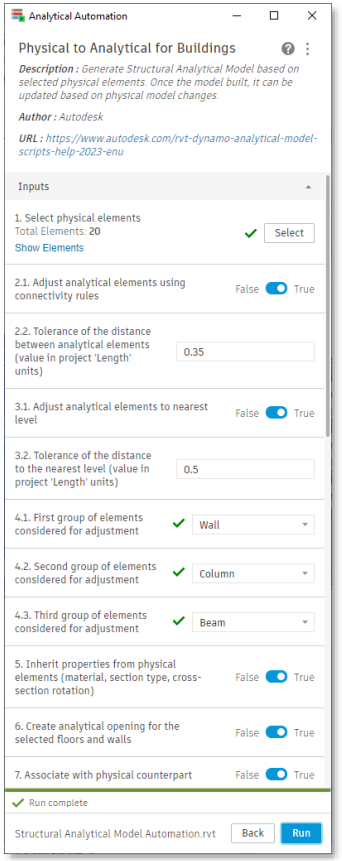
Structural analytical model automation

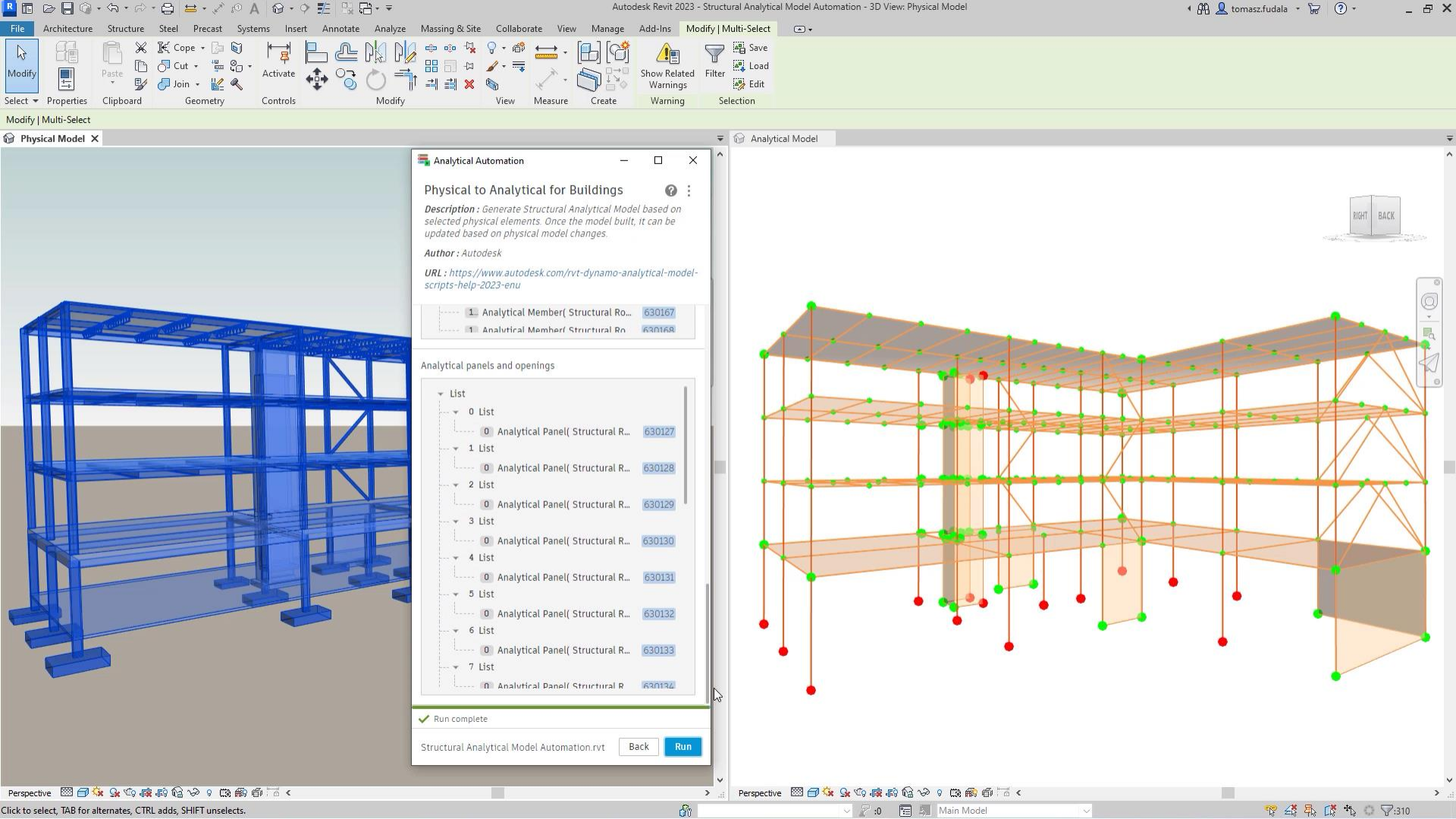
Revit 2023

- Generate a connected and consistent structural analytical model automatically from selected physical geometry
- Customizable automation rules that can be optimized for specific project types
- Update easily analytical models based on physical model changes





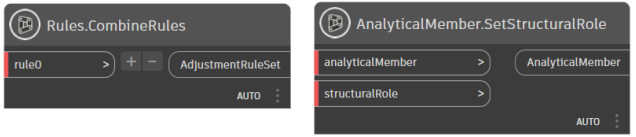


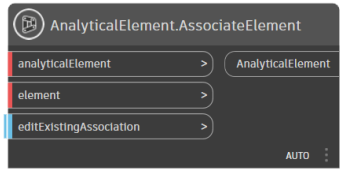

Autodesk Revit 2023 - Structural Analytical Model Automation - 3D View: Physical Model
Modify | Multi-Select
Physical Model
Analytical Model
Analytical Automation
Physical to Analytical for Buildings
Description : Generate Structural Analytical Model based on selected physical elements. Once the model built, it can be updated based on physical model changes.
Author : Autodesk
URL : https://www.autodesk.com/rvt-dynamo-analytical-model-scripts-help-2023-enu
1. Analytical Member(Structural Ro... 630167
Analytical panels and openings
List
0 List
0 Analytical Panel(Structural R... 630127
1 List
0 Analytical Panel(Structural R... 630128
2 List
0 Analytical Panel(Structural R... 630129
3 List
0 Analytical Panel(Structural R... 630130
4 List
0 Analytical Panel(Structural R... 630131
5 List
0 Analytical Panel(Structural R... 630132
6 List
0 Analytical Panel(Structural R... 630133
7 List
Run complete
Structural Analytical Model Automation.rvt
Back
Run
RIGHT
BACK
Perspective
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.
Main Model

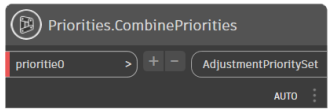
Customizable automation rules

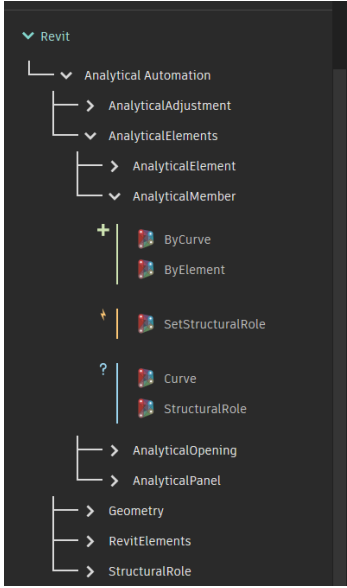
Revit 2023

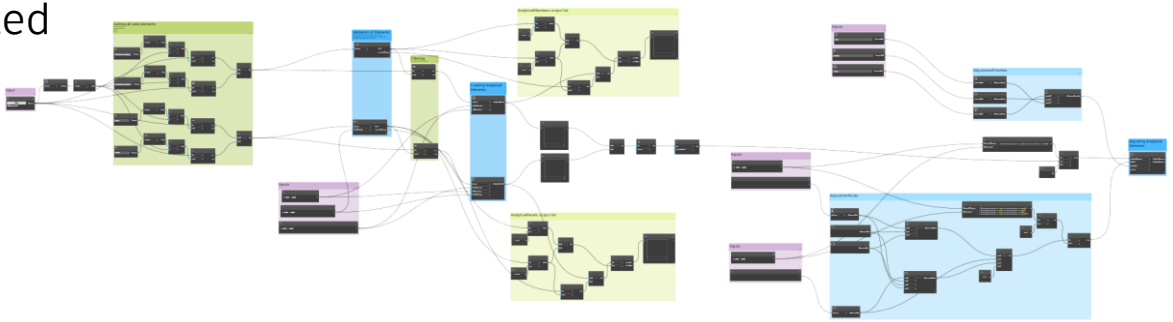
- Automation of users' individual analytical modeling practices
- Easy to use visual programming
- Automation supporting variety of project types
- Enables creation of personalized automation content







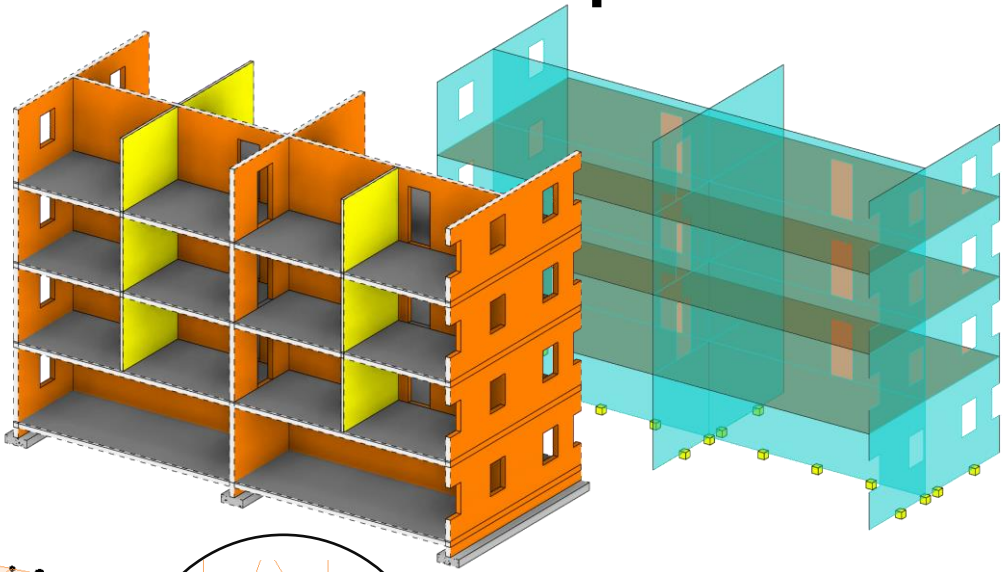


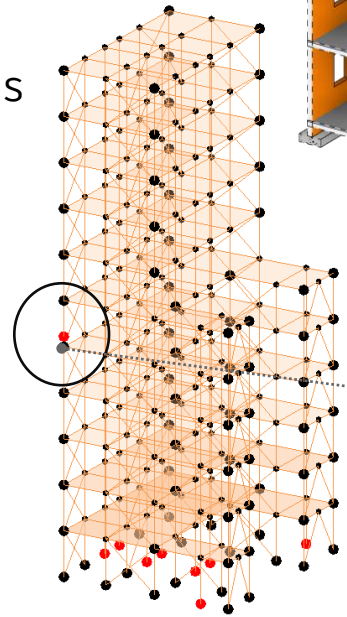


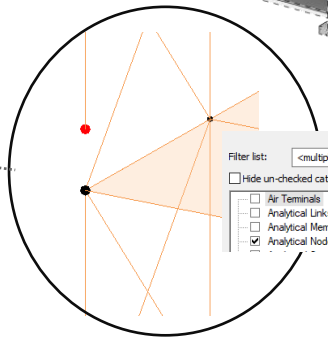
Model connectivity and association inspection

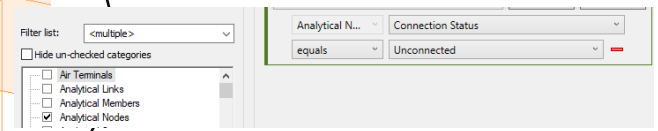
Revit 2023

- Visual inspection for consistency
- Always up-to-date model quality status reports
- Node connectivity status









<Analytical Node Schedule>

A	B	C
Associated Level	Location Mark	Connection Status
Level 1	A-3	Unconnected
Level 1	A-4	Unconnected
Level 1	B-4	Unconnected
Level 1	B-3	Unconnected
Level 1	C-3	Unconnected
Level 1	C-4	Unconnected
Level 1	D-6	Unconnected
Level 1	D-1	Unconnected
Level 6	A-1	Unconnected

API

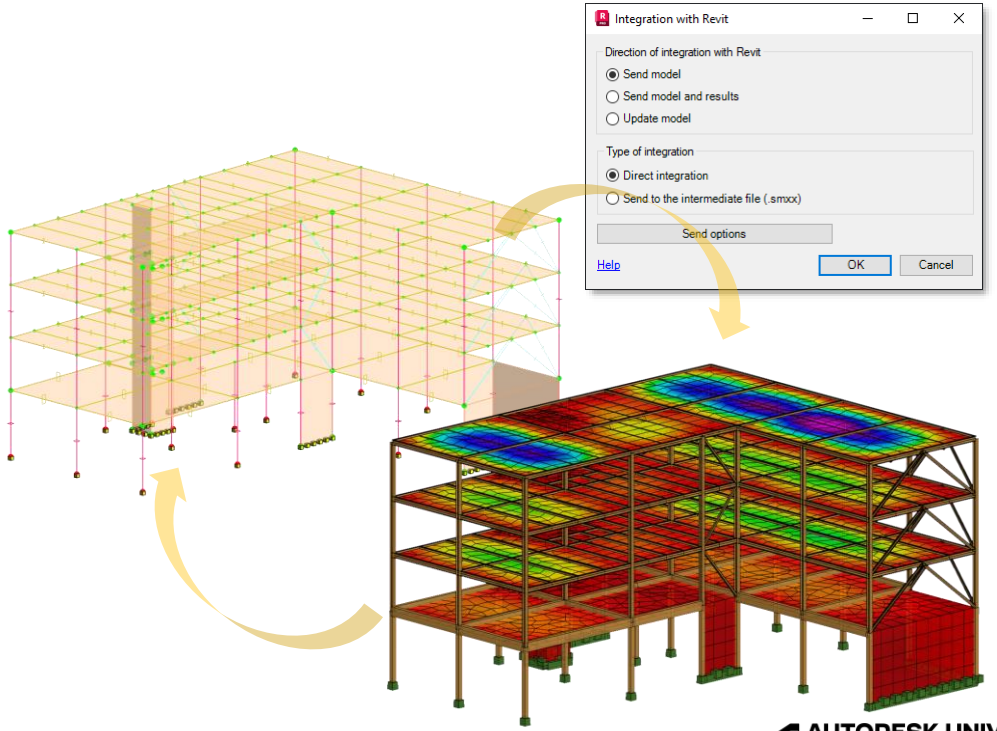
Revit 2023

- New API to create and adjust the analytical model.
- Direct control over analytical elements
- Ability to control the physical-analytical relation
- Control the analytical elements' connectivity

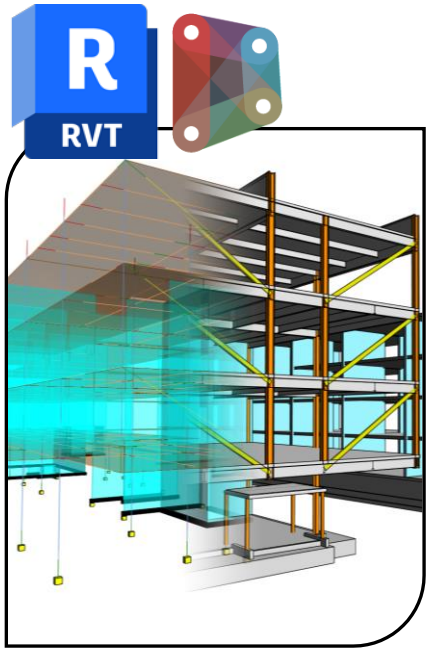
Revit contextual analytical model integration

Revit 2023 & Robot Structural Analysis Professional 2023

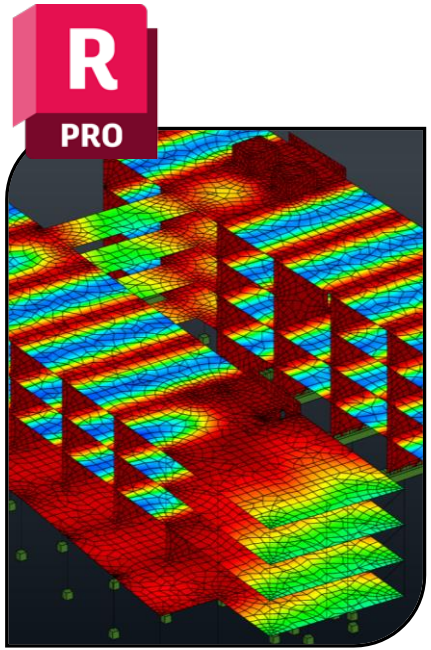
- BIM connectivity updates to Revit contextual analytical model
- Bidirectional analytical model exchange
- Two types of integration



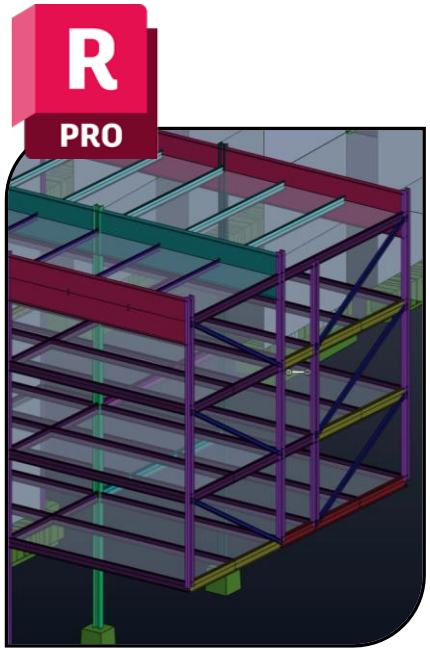
Structural design and analysis



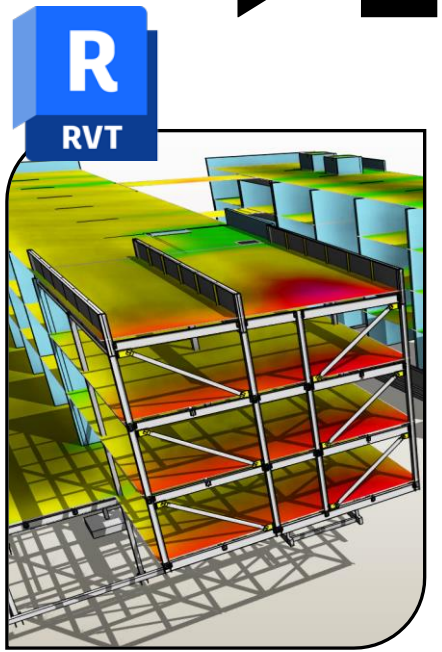
Structural modeling



Structural analysis



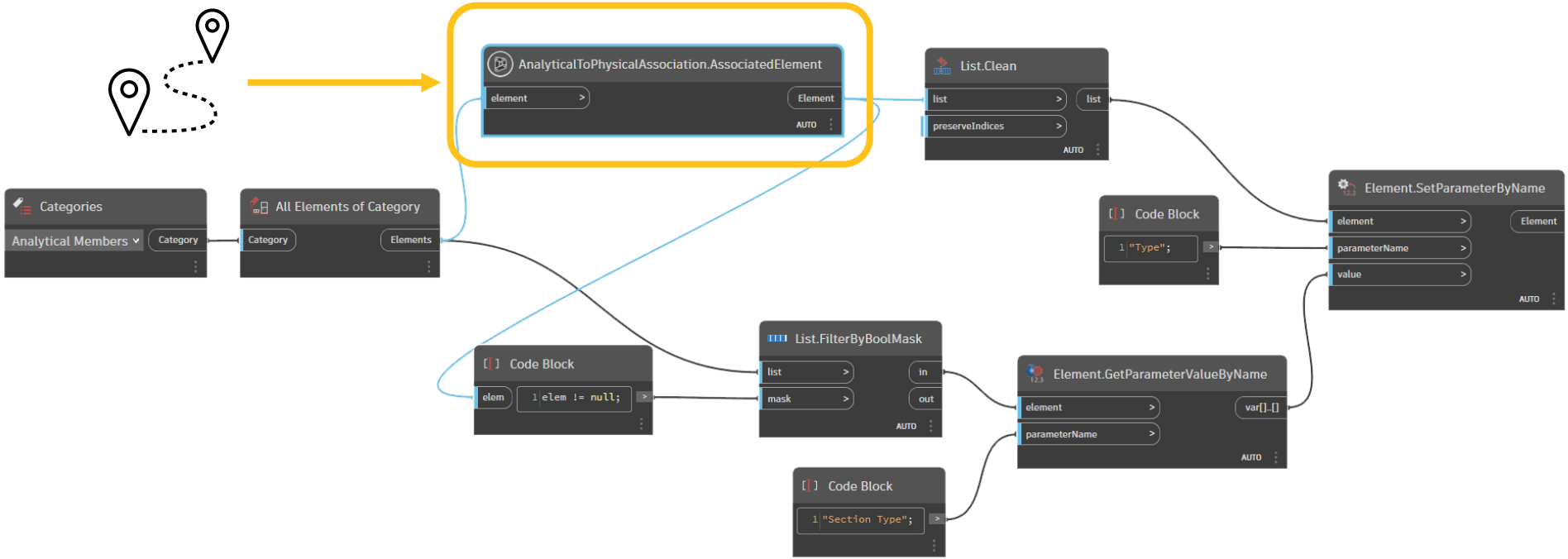
Code check design

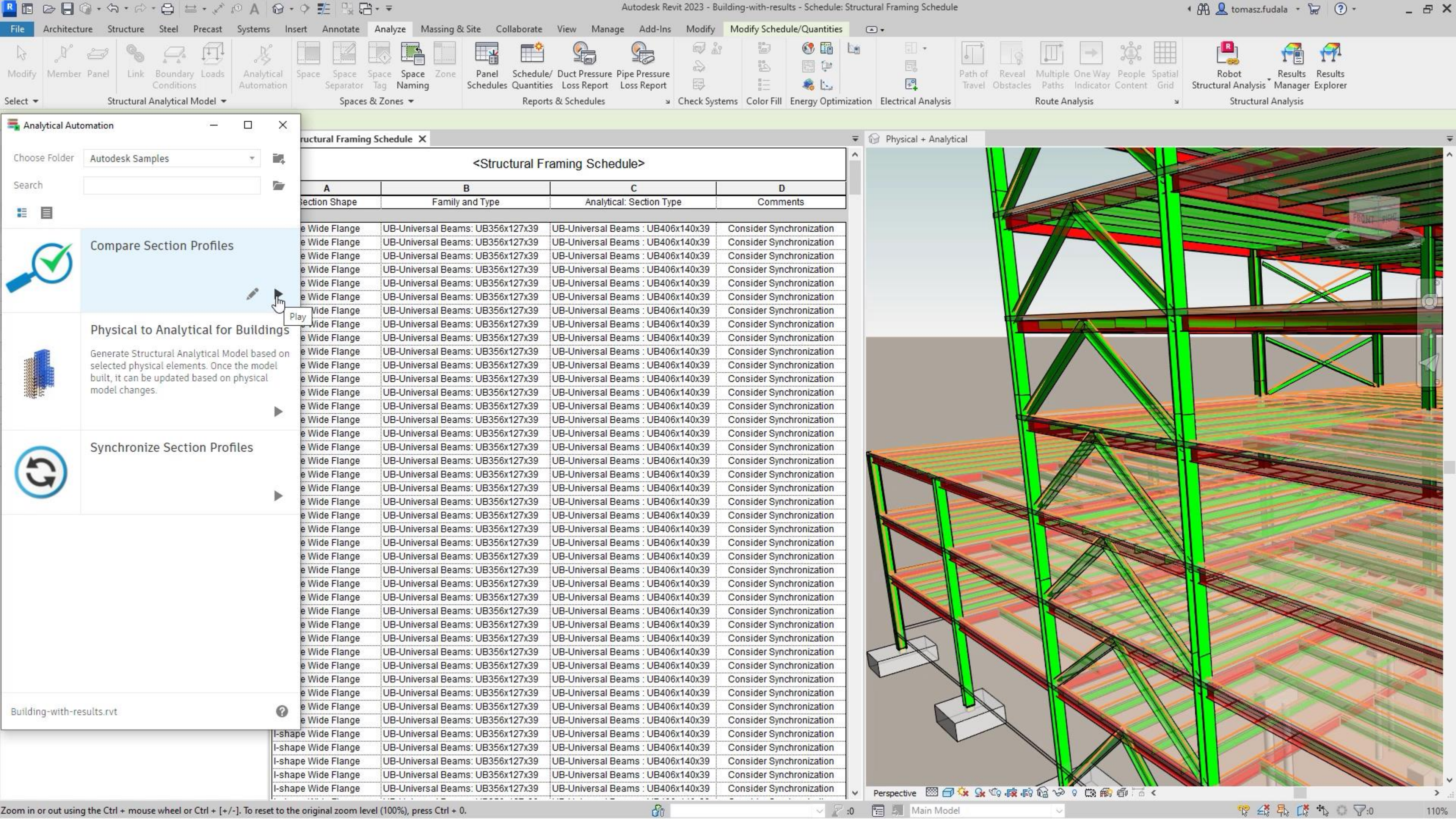


Updated model

Analytical and physical model synchronization

Structural Design Dynamo package



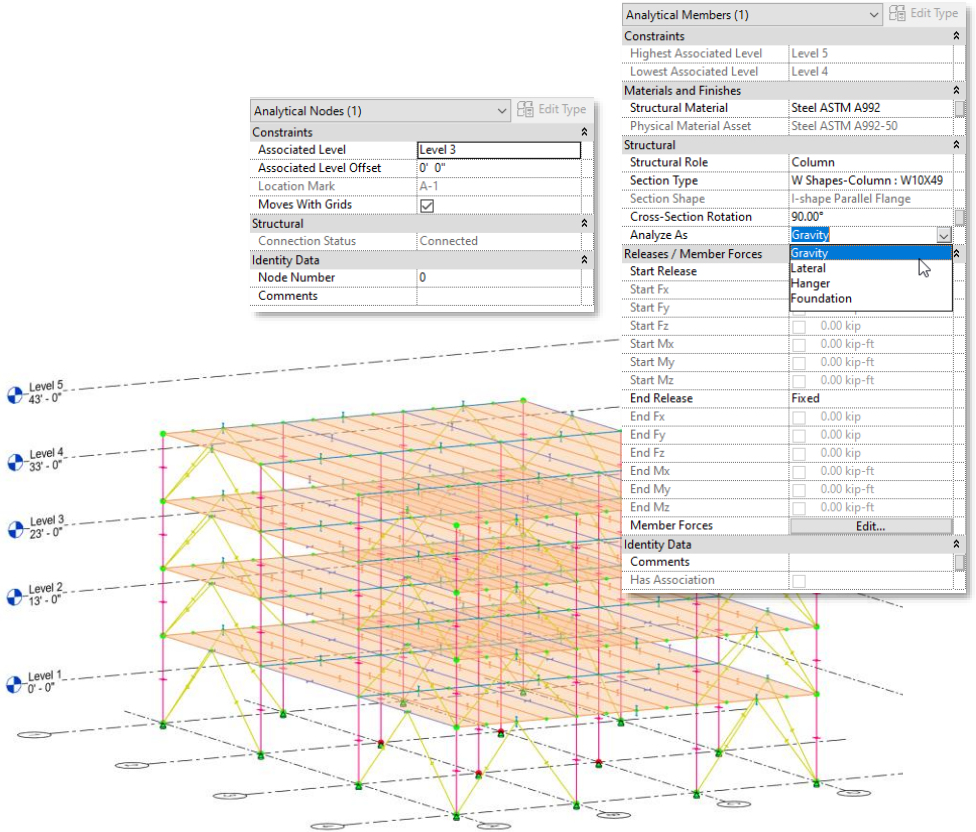


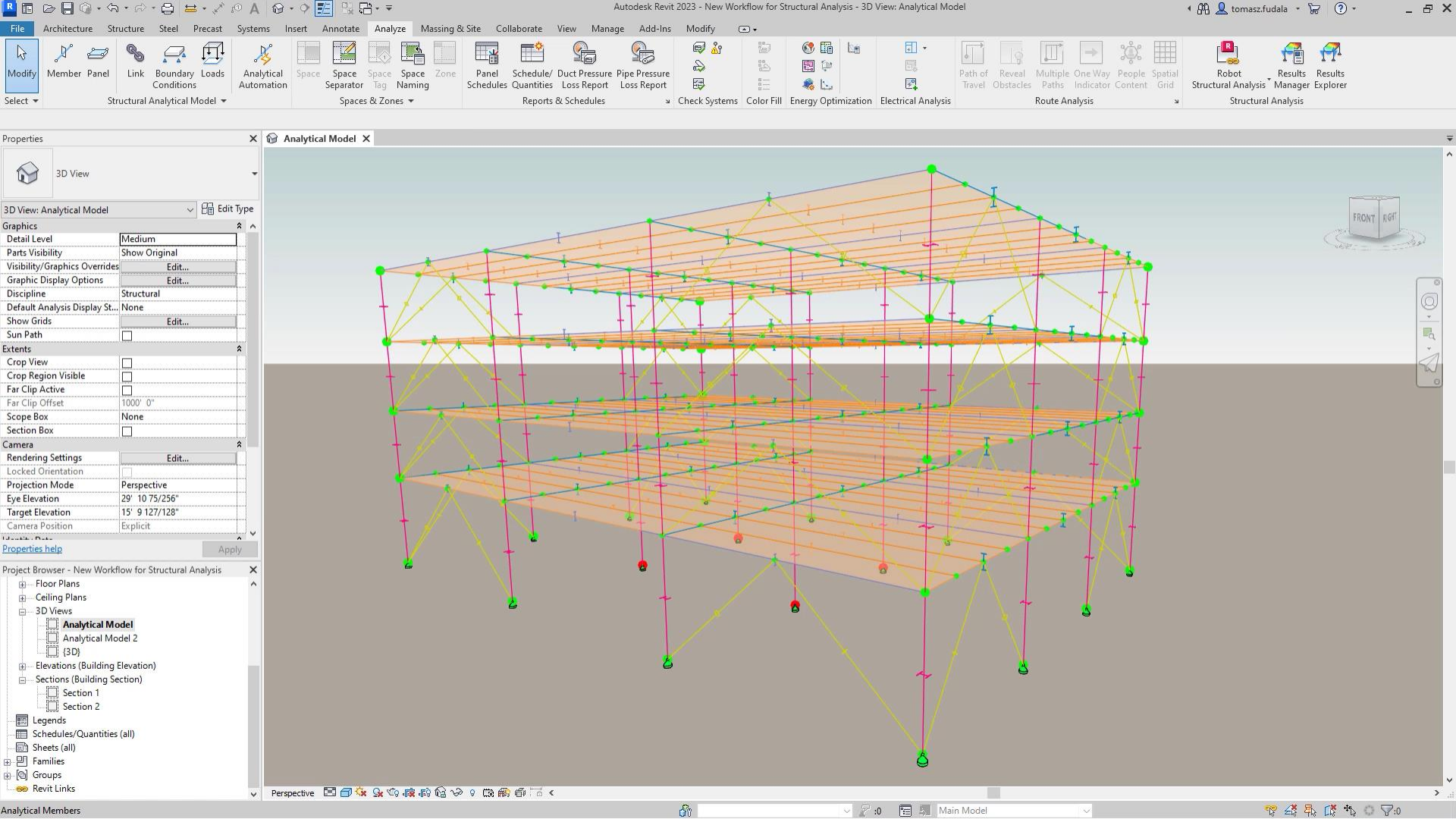
Autodesk Revit 2023 - Building-with-results - Schedule: Structural Framing Schedule
tomasz.fudala
File
Architecture
Structure
Steel
Precast
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Modify
Modify Schedule/Quantities
Modify
Member
Panel
Link
Boundary Conditions
Loads
Analytical Automation
Space
Space Separator
Space Tag
Space Naming
Zone
Panel Schedules
Schedule/ Quantities
Duct Pressure Loss Report
Pipe Pressure Loss Report
Path of Travel
Reveal Obstacles
Multiple Paths
One Way Indicator
People Content
Spatial Grid
Robot Structural Analysis
Results Manager
Results Explorer
Select
Structural Analytical Model
Spaces & Zones
Reports & Schedules
Check Systems
Color Fill
Energy Optimization
Electrical Analysis
Route Analysis
Structural Analysis
Analytical Automation
Choose Folder
Autodesk Samples
Search
Compare Section Profiles
Play
Physical to Analytical for Buildings
Generate Structural Analytical Model based on selected physical elements. Once the model built, it can be updated based on physical model changes.
Synchronize Section Profiles
Building-with-results.rvt
ructural Framing Schedule
Physical + Analytical
<Structural Framing Schedule>
A
B
C
D
ection Shape
Family and Type
Analytical: Section Type
Comments
e Wide Flange
UB-Universal Beams: UB356x127x39
UB-Universal Beams : UB406x140x39
Consider Synchronization
I-shape Wide Flange
Perspective
Main Model
Zoom in or out using the Ctrl + mouse wheel or Ctrl + [+/-]. To reset to the original zoom level (100%), press Ctrl + 0.
110%

New workflow for structural analysis

Revit 2023

- Create a structural analytical model in Revit without physical geometry
- Model fully parametric analytical elements
- Associate analytical model with grids and levels to control element positioning through datums
- Document analytical model data




Autodesk Revit 2023 - New Workflow for Structural Analysis - 3D View: Analytical Model
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View
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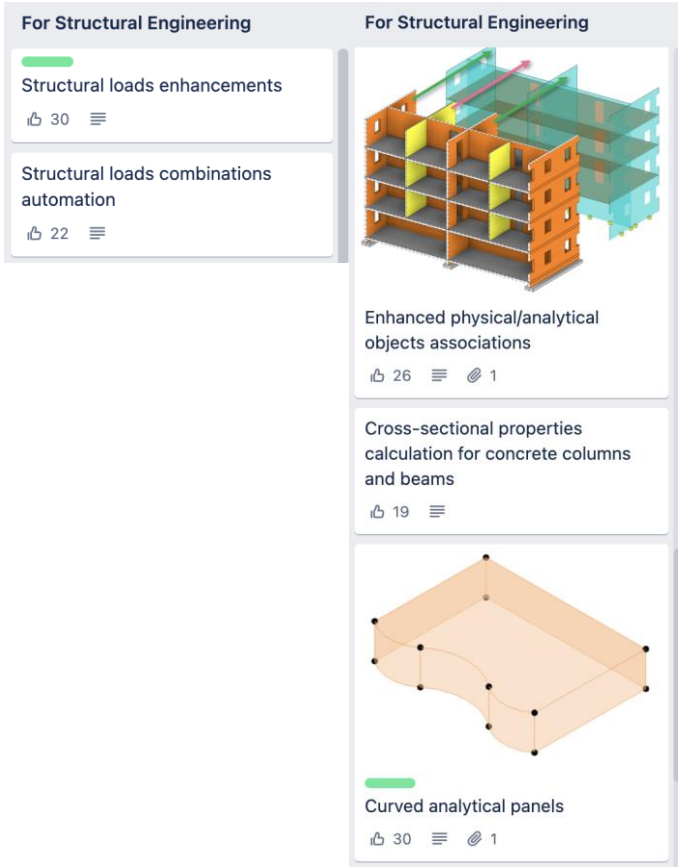
Modify
Member
Panel
Link
Boundary Conditions
Loads
Analytical Automation
Structural Analytical Model
Space
Space Separator
Space Tag
Space Naming
Zone
Spaces & Zones
Panel Schedules
Schedule/ Quantities
Duct Pressure Loss Report
Pipe Pressure Loss Report
Reports & Schedules
Check Systems
Color Fill
Energy Optimization
Electrical Analysis
Path of Travel
Reveal Obstacles
Multiple Paths
One Way Indicator
People Content
Spatial Grid
Route Analysis
Robot Structural Analysis
Results Manager
Results Explorer
Structural Analysis
Properties
3D View
3D View: Analytical Model
Edit Type
Graphics
Detail Level
Medium
Parts Visibility
Show Original
Visibility/Graphics Overrides
Edit...
Graphic Display Options
Edit...
Discipline
Structural
Default Analysis Display St...
None
Show Grids
Edit...
Sun Path
Extents
Crop View
Crop Region Visible
Far Clip Active
Far Clip Offset
1000' 0"
Scope Box
None
Section Box
Camera
Rendering Settings
Edit...
Locked Orientation
Projection Mode
Perspective
Eye Elevation
29' 10 75/256"
Target Elevation
15' 9 127/128"
Camera Position
Explicit
Properties help
Apply
Project Browser - New Workflow for Structural Analysis
Floor Plans
Ceiling Plans
3D Views
Analytical Model
Analytical Model 2
{3D}
Elevations (Building Elevation)
Sections (Building Section)
Section 1
Section 2
Legends
Schedules/Quantities (all)
Sheets (all)
Families
Groups
Revit Links
Analytical Model
FRONT
RIGHT
Perspective
Analytical Members
Main Model

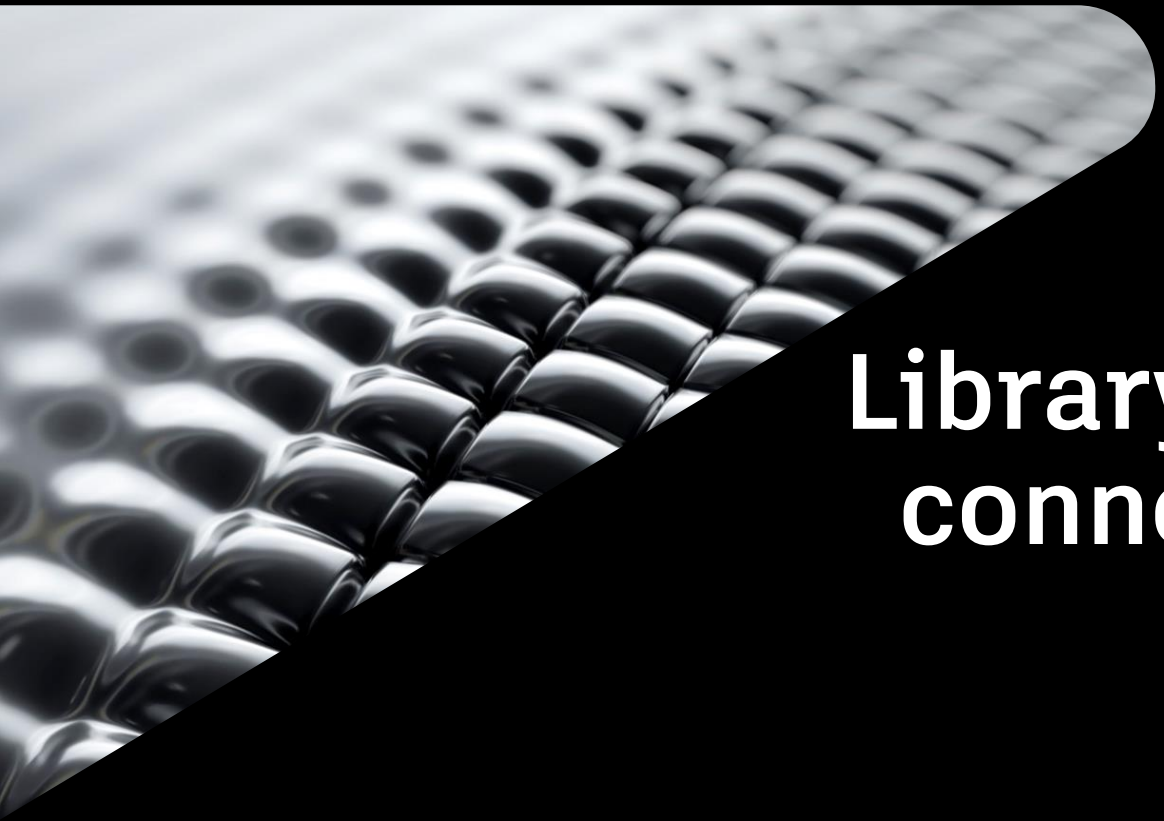
More to come

Analytical model in Revit

- New Dynamo nodes
- Structural loads
- Loads combinations automation
- Enhanced physical/analytical objects associations
- Curved analytical panels
- …

Revit Public Roadmap Update | Spring 2022





Library-based steel connection design

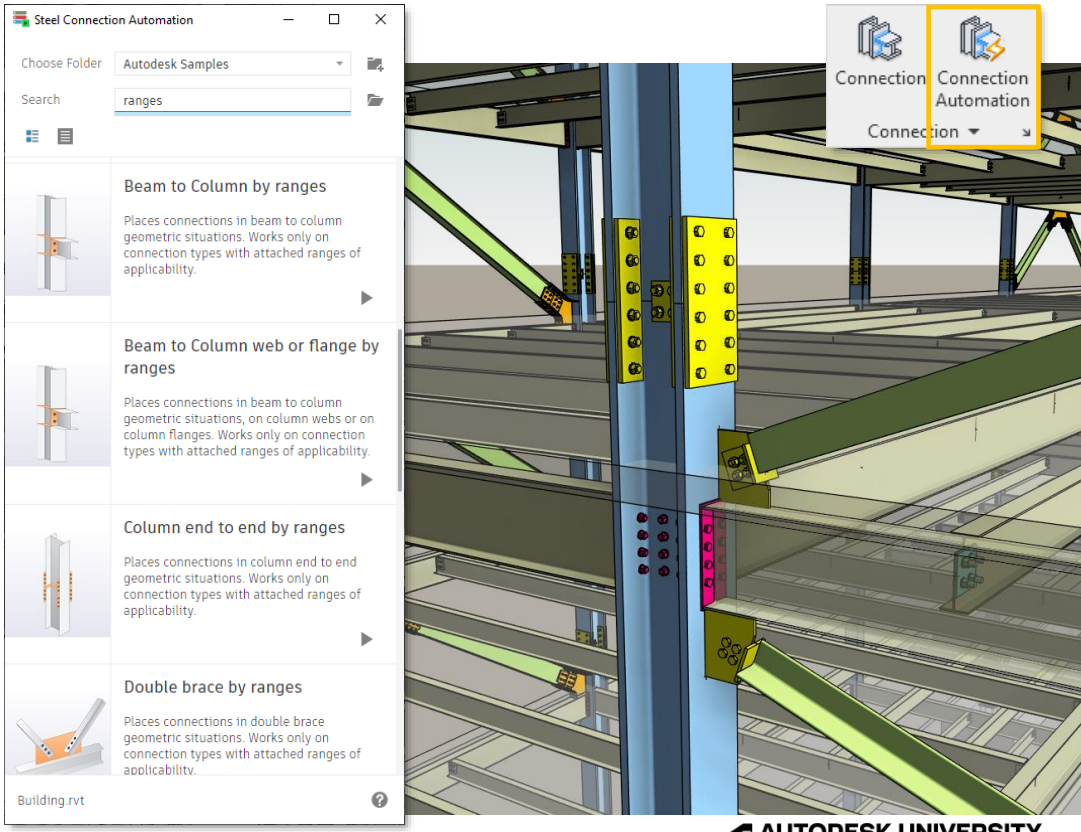
Revit 2023


Steel desgn

Library-based connection design automation

Revit 2023

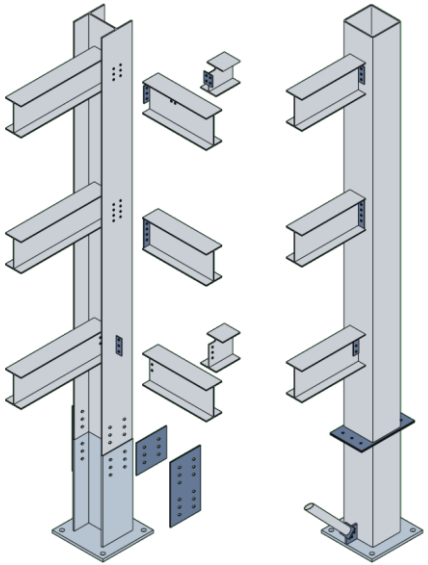
- Model design intent with connections more quickly and accurately
- Perform cost estimation earlier
- Reduce iterations using design and fabrication rules
- Automatically apply logic based on international standards
- Expand predefined libraries to create your own



Steel connections library content

Library-based connection design automation

- Available via your Autodesk account portal or Autodesk Knowledge Network
- Automatically apply popular typical steel connections
- Logic based on international standards
- Create own libraries by expanding the predefined ones

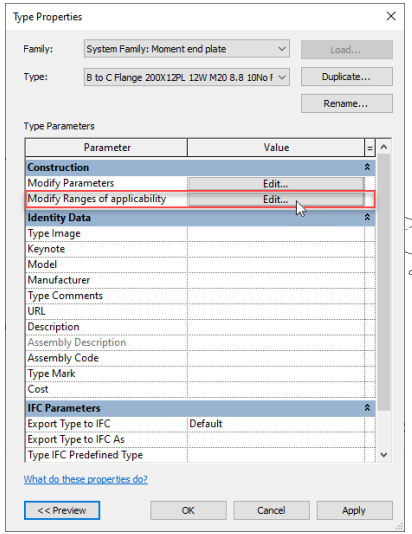


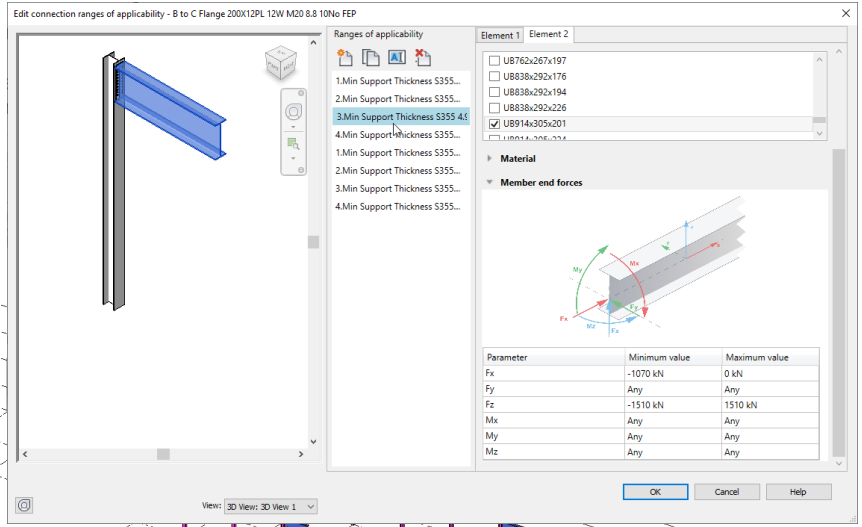
¾-in. Bolts				Bolt and Angle Design Strength, kips			
9 Rows				Angle Thickness, in.			
W44, 40, 36, 33	ASTM Desig.	Thread Cond.	Hole Type	¼	5/16	⅜	½
	A325	N	—	243	286	286	286
		X	—	243	304	358	358
		SC Class A	STD	188	188	188	188
			OVS	160	160	160	160
			SSLT	160	160	160	160
		SC Class B	STD	243	285	285	285
			OVS	228	242	242	242
			SSLT	242	242	242	242
	A490	N	—	243	304	358	358
		X	—	243	304	365	447
		SC Class A	STD	235	235	235	235
			OVS	200	200	200	200
			SSLT	200	200	200	200
		SC Class B	STD	243	304	356	356
			OVS	228	285	303	303
			SSLT	243	303	303	303

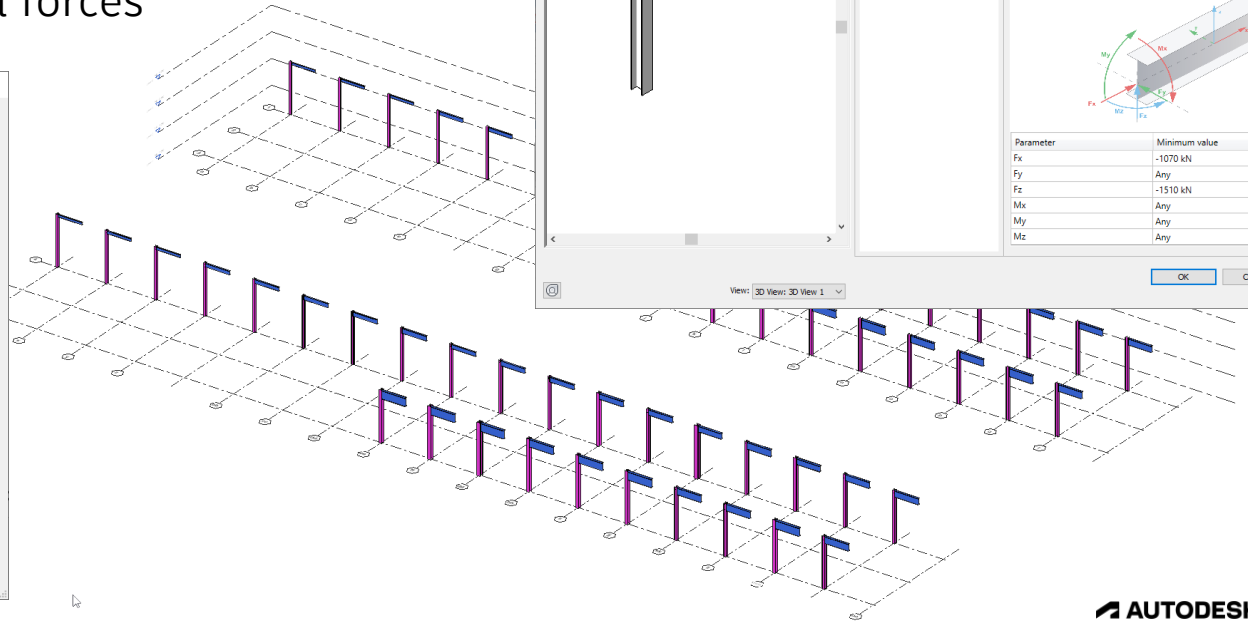
Customization of steel connection libraries

Library-based connection design automation

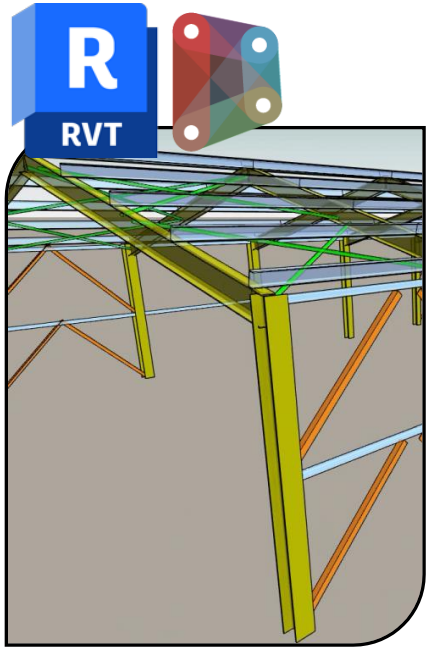
- Create new connection types
- Associate connections with profile sizes and internal forces



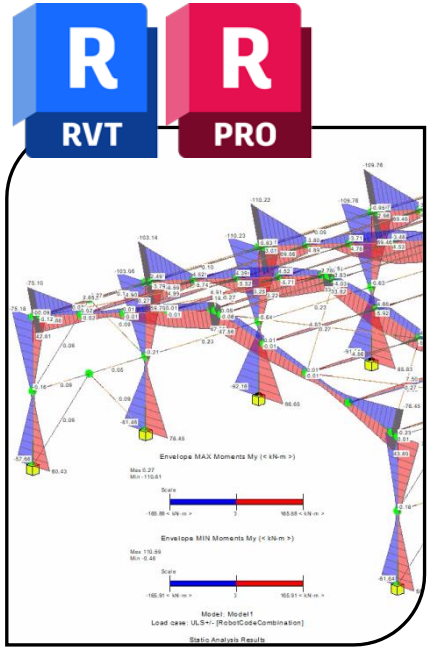




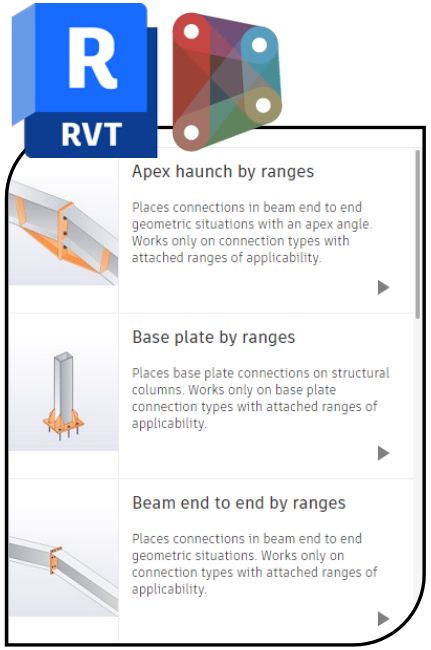
Automation of steel connections



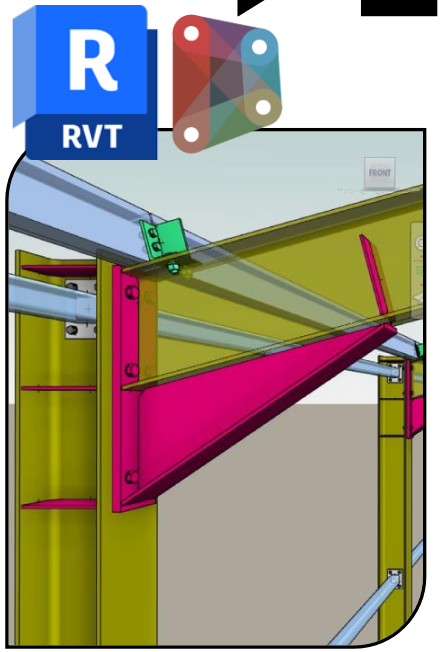
Input parameters



Retrieve model data



Library-based design

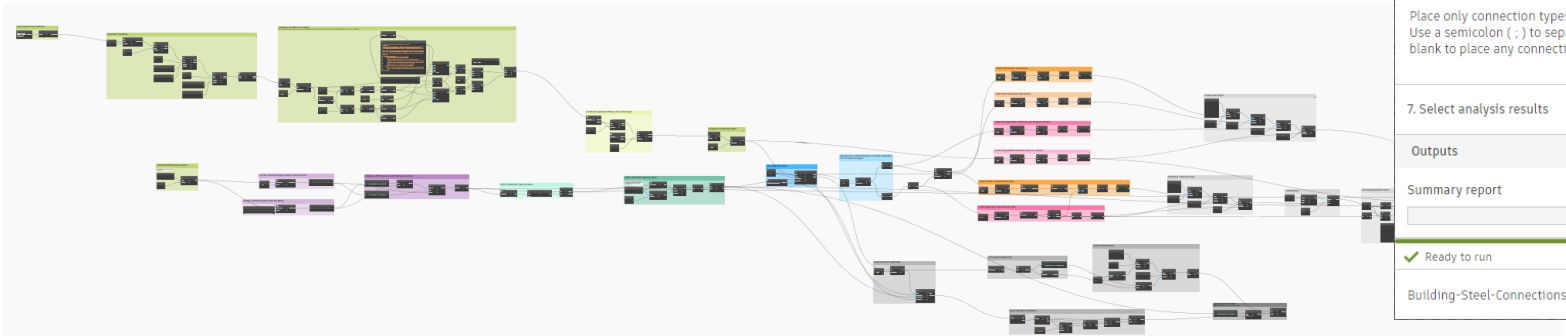


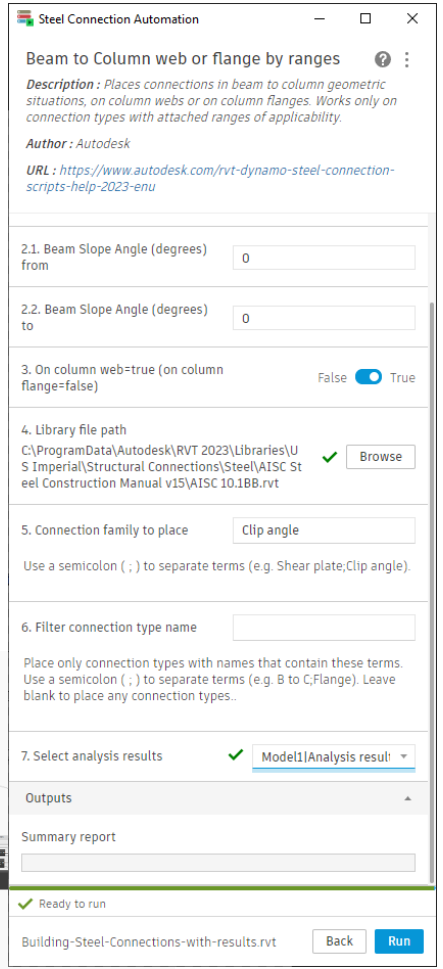
Steel connections generation

Rules

Library-based connection design automation

- Dedicated rules for each of the typical kinds of connections
- Reduce potential large wastes of material
- Reduce the risk of troublesome scenarios

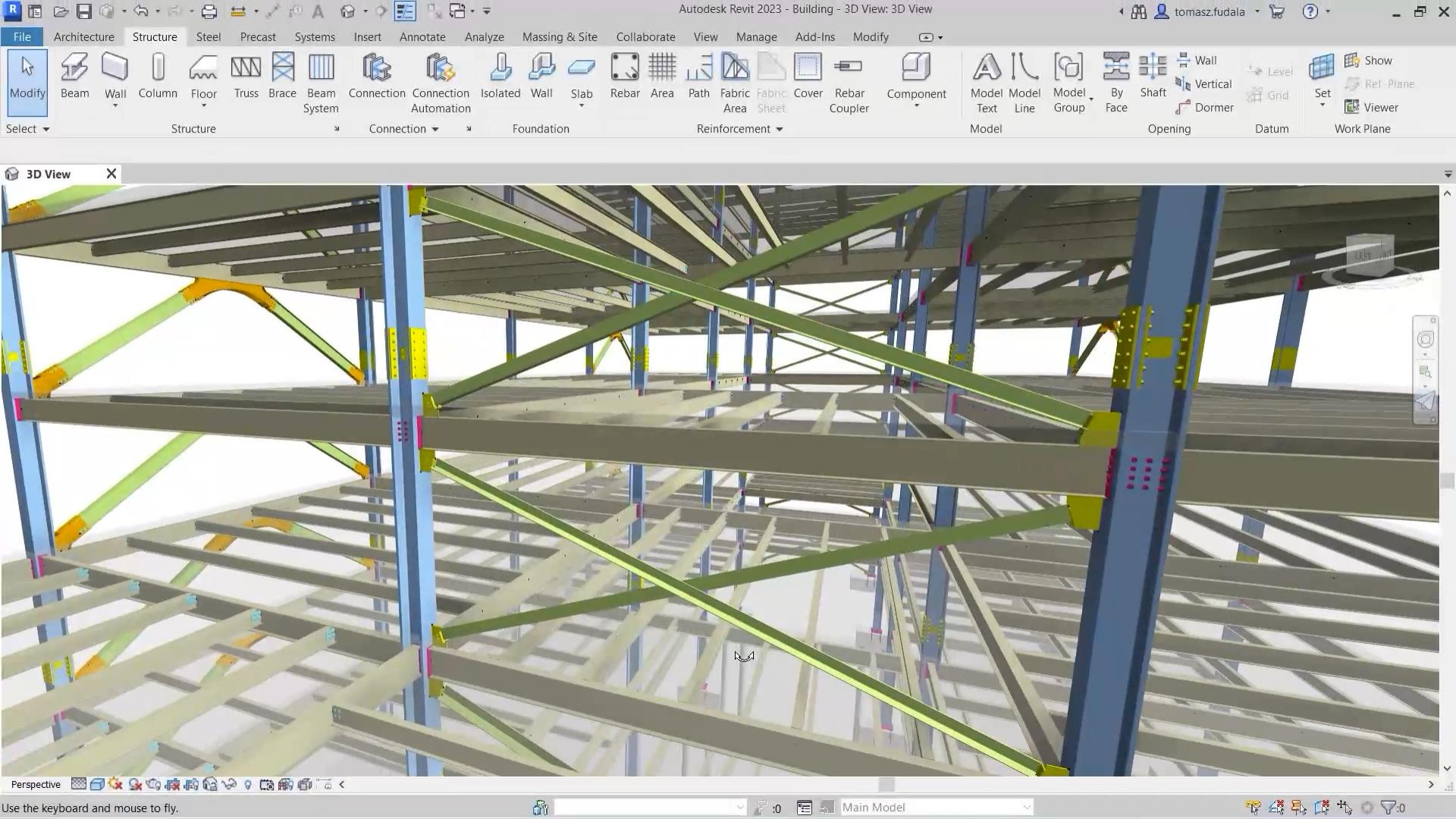




Performance

Library-based connection design automation

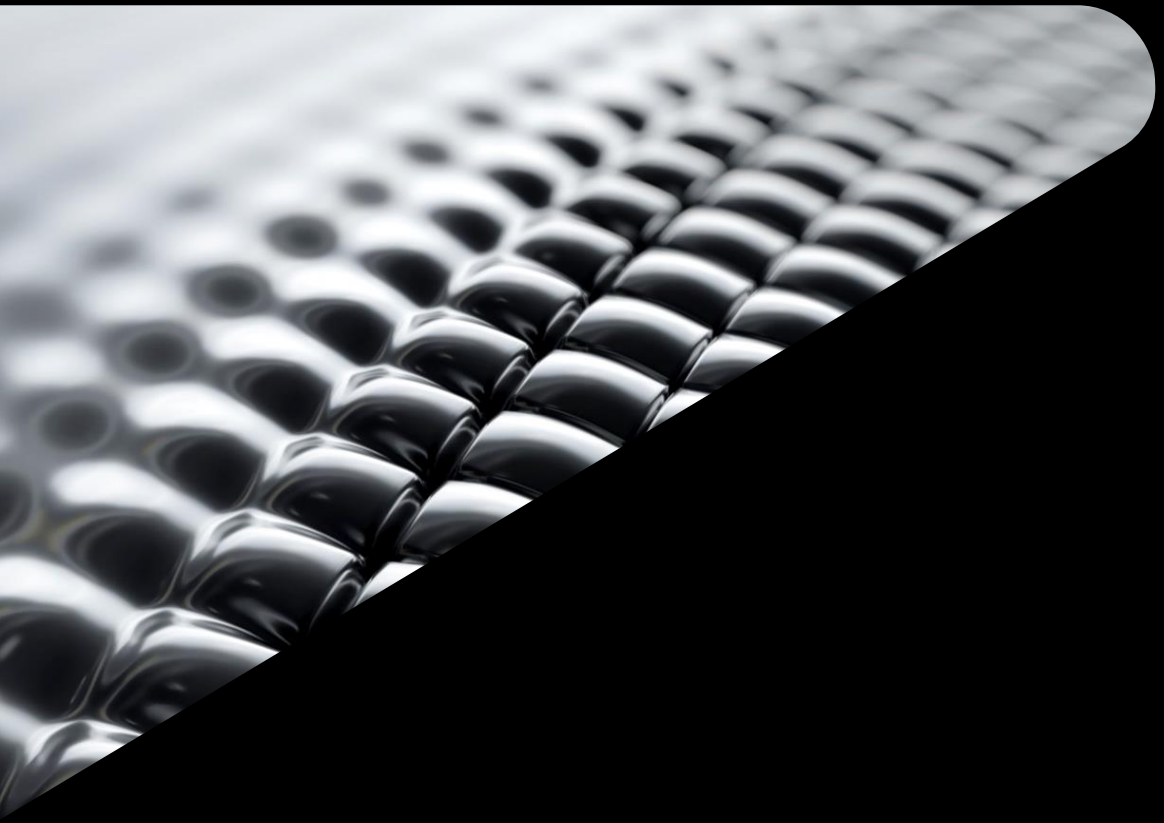
- Average improvement of 35%
- Editing detailed models with steel connections is up to 50% faster


Autodesk Revit 2023 - Building - 3D View: 3D View
tomasz.fudala
File
Architecture
Structure
Steel
Precast
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Modify
Modify
Beam
Wall
Column
Floor
Truss
Brace
Beam System
Connection
Connection Automation
Isolated
Wall
Slab
Rebar
Area
Path
Fabric Area
Fabric Sheet
Cover
Rebar Coupler
Component
Model Text
Model Line
Model Group
By Face
Shaft
Wall
Vertical
Dormer
Level
Grid
Set
Show
Ref. Plane
Viewer
Select
Structure
Connection
Foundation
Reinforcement
Model
Opening
Datum
Work Plane
3D View
Perspective
Use the keyboard and mouse to fly.
Main Model

Constructability and costs

Library-based connection design automation

- Estimate faster and more accurately proposals before submitting it for a tender
- Get more time to do more iterations on the design
- Takes away part of the tedious stage of modeling connections



Wrapping up

Thank you!

(Please remember to complete a session survey!)