Reinforced Concrete Workflows Automation

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About the speaker

Sorin Bularca

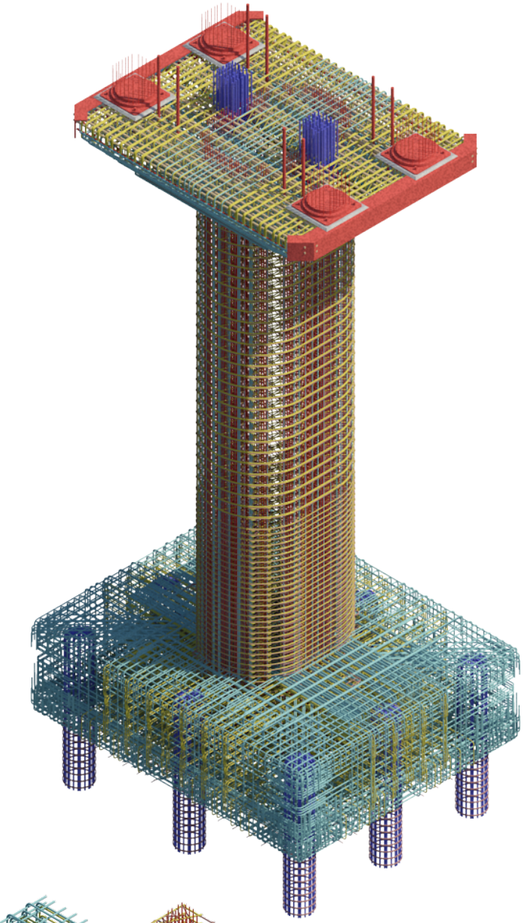
- **AEC Technical Sales Specialist** for connected BIM and computational design at Autodesk Middle East
- master's degree in **Civil and Structural engineering** from Technical University of Cluj-Napoca, **Romania**
- main area of expertise is in the **Autodesk AEC portfolio** with products like Revit, Advance Steel, Dynamo, Navisworks and the BIM360 family
- been with Autodesk for over four years spent in **Singapore and Dubai** offices with focus on a mix of **consulting and technical sales services** in countries like Singapore, Australia, Malaysia, Thailand, India, UAE and the Gulf region, Egypt and South Africa.
- over the past 14 years worked on several **large projects** like: stadiums, shopping malls and residential buildings
- customized Dynamo solutions that are helping users save more than 50% of the time spent with their **design to fabrication** process.

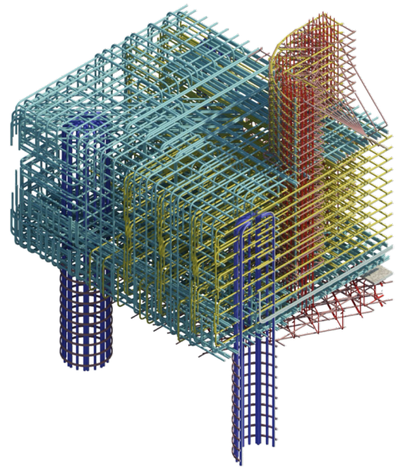
Find me on LinkedIn: https://www.linkedin.com/in/sorinbularca/

Agenda:

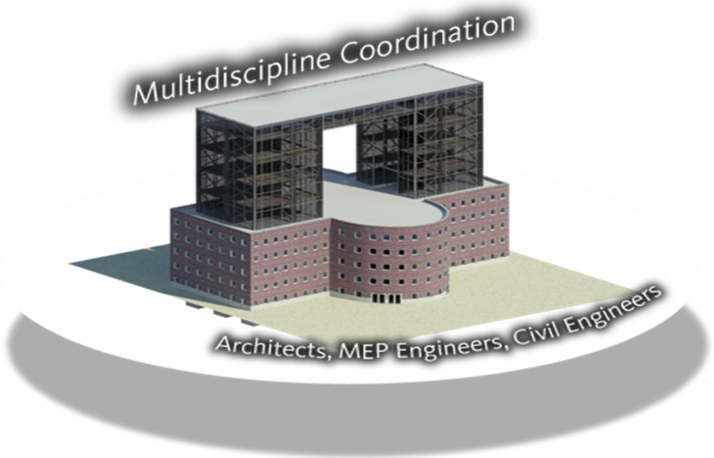
In this class you will learn about the latest Revit tools and capabilities for concrete reinforcement and how visual programing interface of Dynamo can be used to automate the concrete design workflows and minimize manual and redundant work.

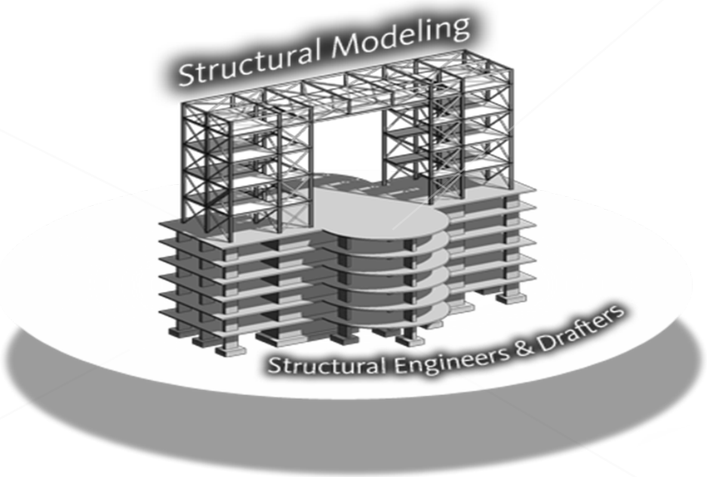
- **Revit default Rebar modelling tools**
- **Numbering and portioning**
- **Documentation tools**
  - Annotations
  - Drawings
  - Bar bending schedules
- **Advanced modelling tools**:
  - Free form modelling
- **Structural Precast in Revit**
- **Automation**
  - Dynamo for Rebar and Precast
  - Naviate Rebar extension
  - Industry Partners
- **Connected BIM for RC**
- **What's new in Revit for RC**

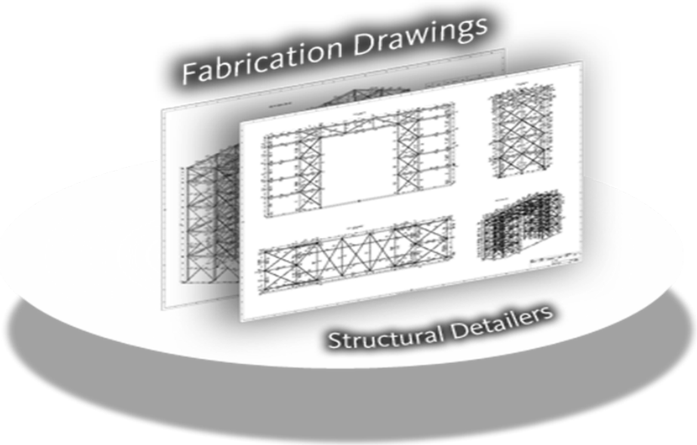


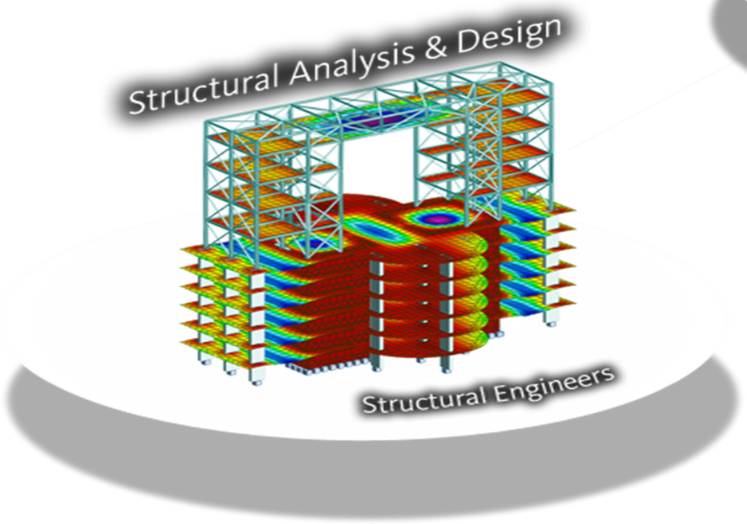


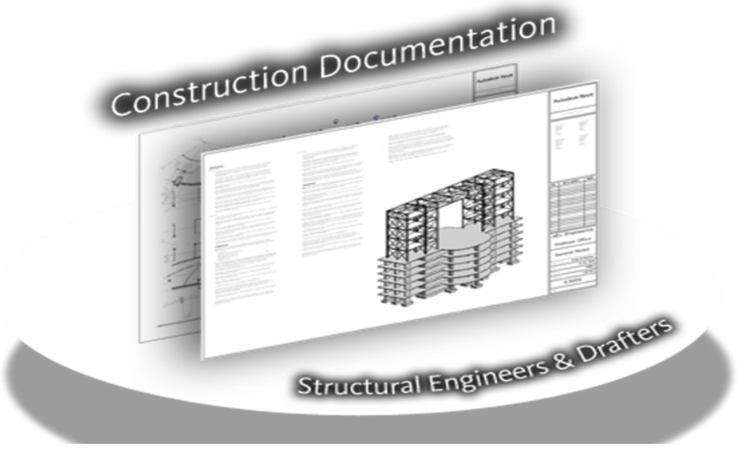
BIM for Structural Design and Fabrication Workflow



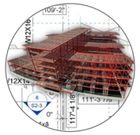
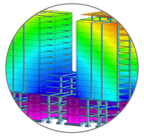
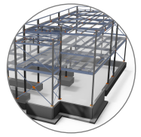
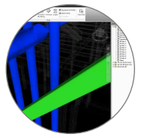








AEC Collection - Structural Engineering Portfolio

Structural Model	Analyze & Verify	Detailing	Fabricate & Install

Products in the AEC Collection for structural professionals

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AUTODESK® BIM 360™ BUILD

AUTODESK® REVIT®

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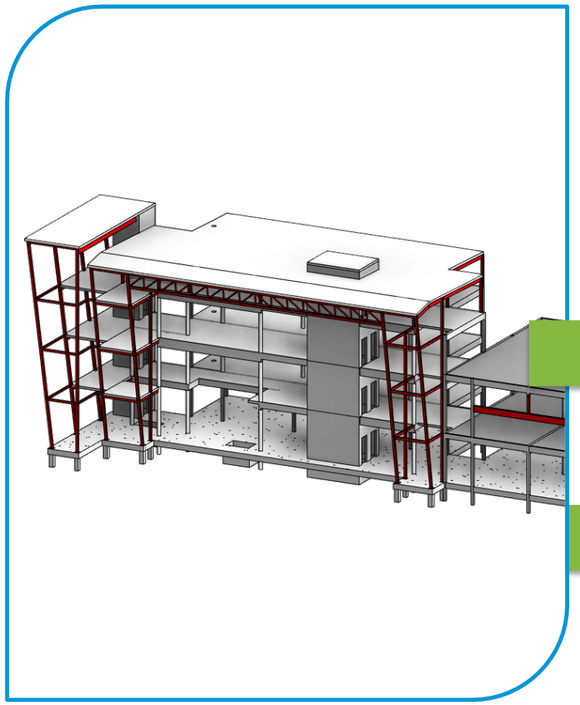
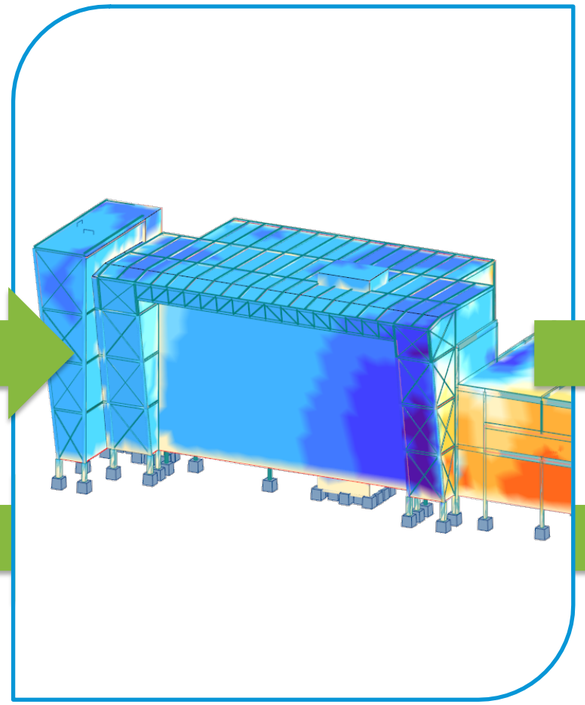
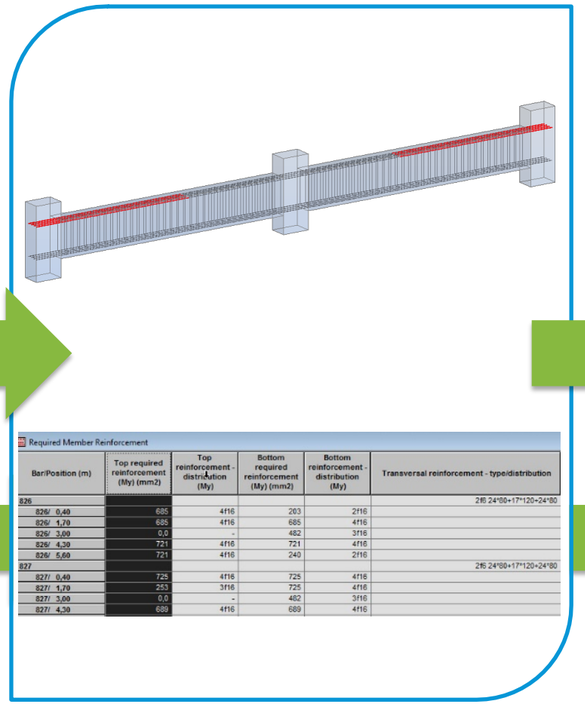
Designer	Engineer	Detailer	Fabricator Contractor

Design Focused Workflow for Reinforced Concrete

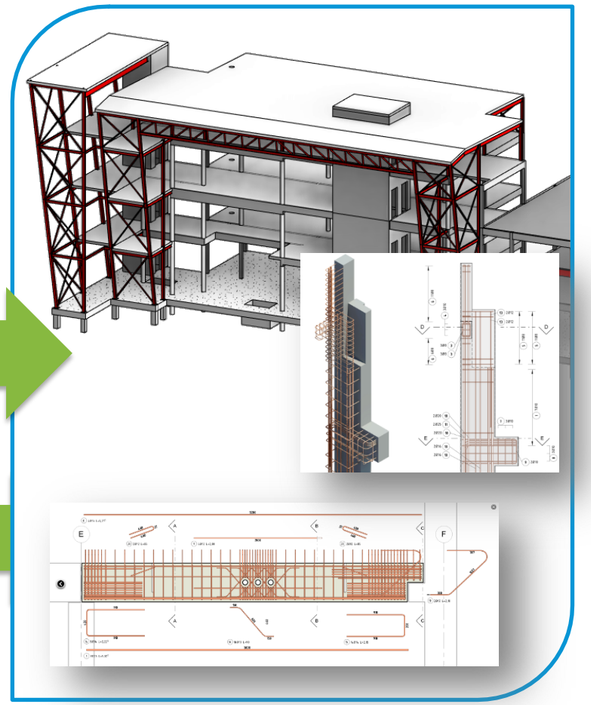






Required Member Reinforcement

Bar\Position (m)	Top required reinforcement (My) (mm2)	Top reinforcement - distribution (My)	Bottom required reinforcement (My) (mm2)	Bottom reinforcement - distribution (My)	Transversal reinforcement - type\distribution
B26					2fi 24*80+17*120+24*80
B26/ 0,40	685	4fi16	283	2fi16	
B26/ 1,70	685	4fi16	685	4fi16	
B26/ 3,00	0,0	-	482	3fi16	
B26/ 4,30	721	4fi16	721	4fi16	
B26/ 5,60	721	4fi16	240	2fi16	
B27					2fi 24*80+17*120+24*80
B27/ 0,40	725	4fi16	725	4fi16	
B27/ 1,70	253	3fi16	725	4fi16	
B27/ 3,00	0,0	-	482	3fi16	
B27/ 4,30	689	4fi16	689	4fi16	



Structural Modelling	Structural Analysis	Code Check Design	Updated model & Detailing
AUTODESK® REVIT®	AUTODESK® ROBOT™ STRUCTURAL ANALYSIS PROFESSIONAL	AUTODESK® ROBOT™ STRUCTURAL ANALYSIS PROFESSIONAL	AUTODESK® REVIT® + SOFiSTiK

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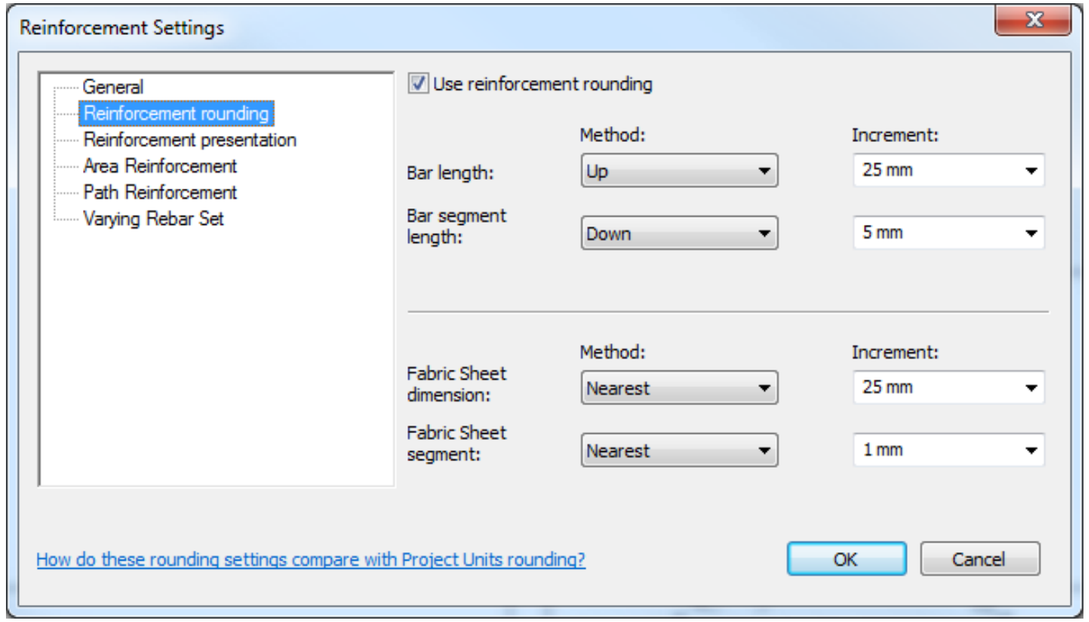
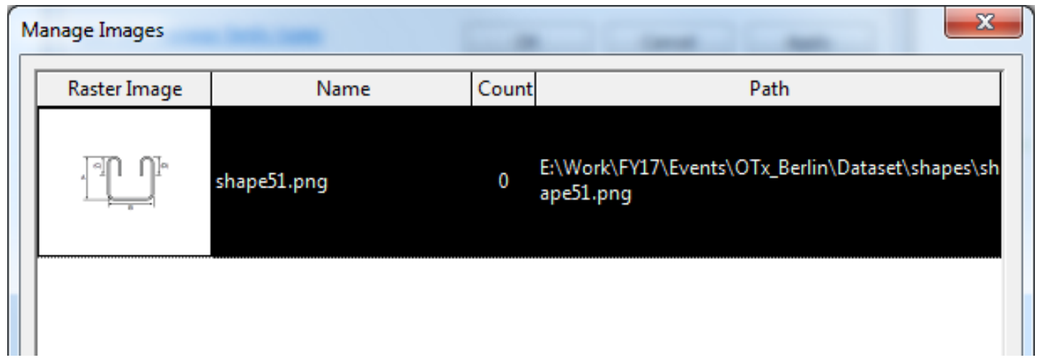
Concrete Reinforcement in Revit Modeling

Concrete Reinforcement in Revit - Modeling

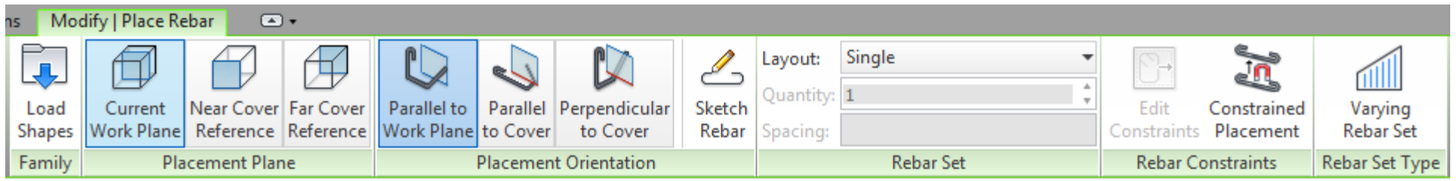
- Set up templates
  - Add shape images for rebar shape families
- Reinforcement settings
  - Reinforcement placement
  - Rounding
  - Rebar presentation
  - Tag abbreviations
  - Numbering for varying rebar sets

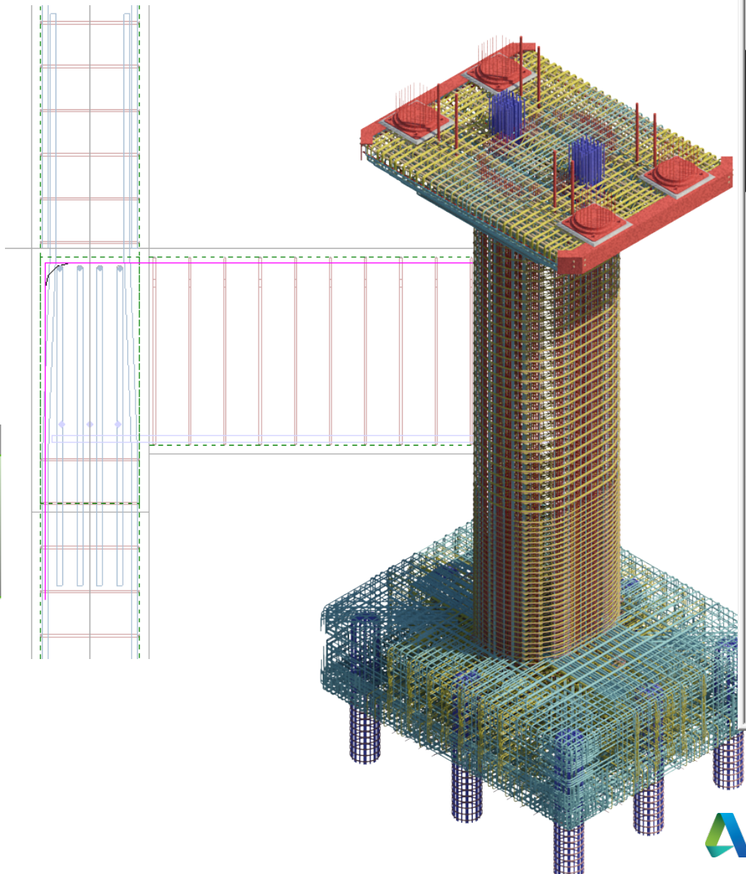


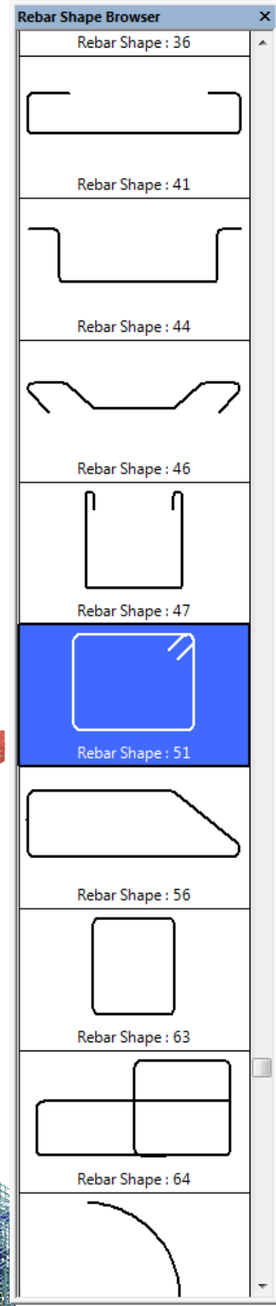


Concrete Reinforcement in Revit - Modeling

- Rebar definition
  - Use any plan, section, or elevation view to place rebar
  - Placement orientation
  - Placement plane
  - Rebar Shape Browser
  - Sketch rebar







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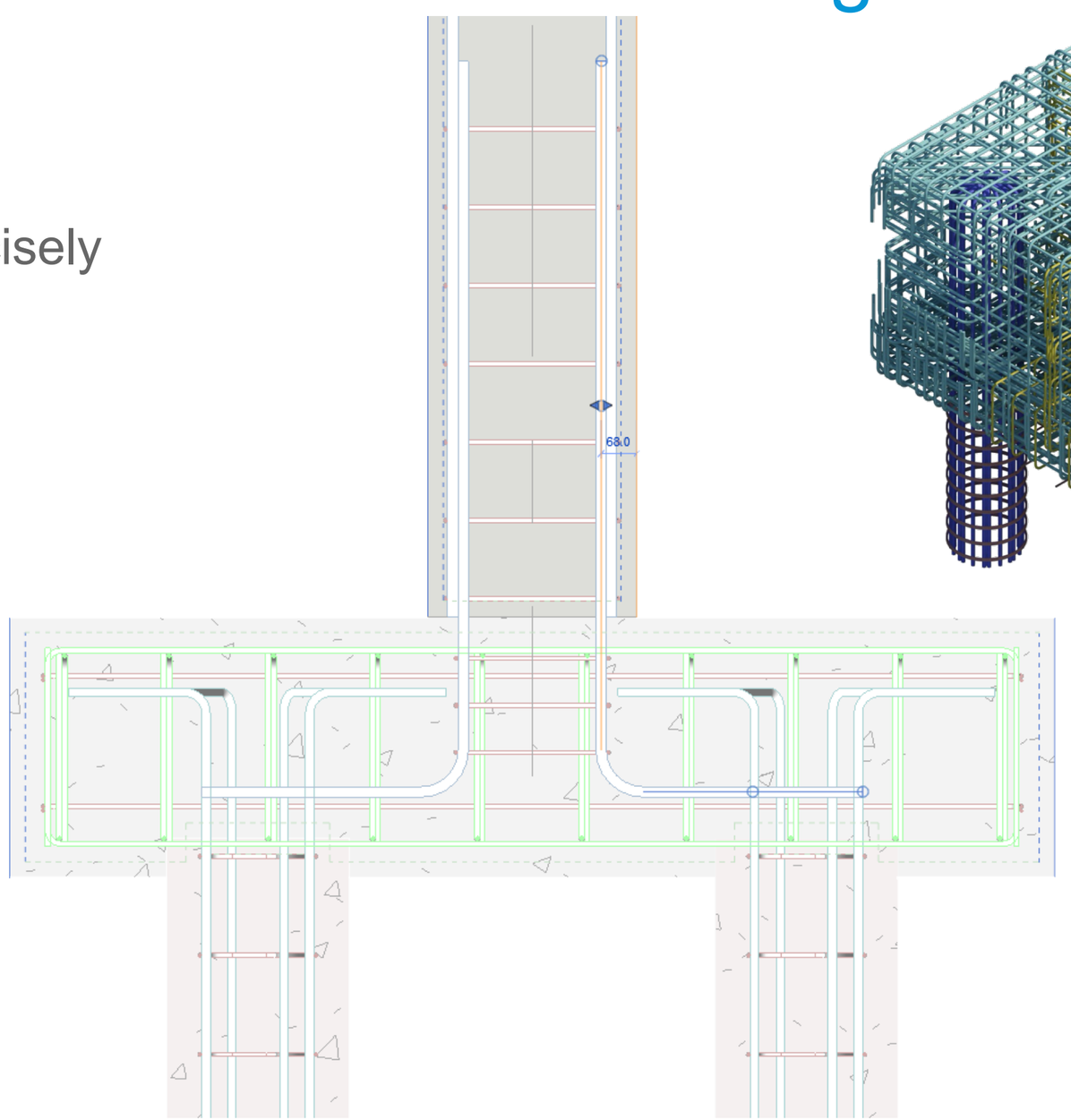
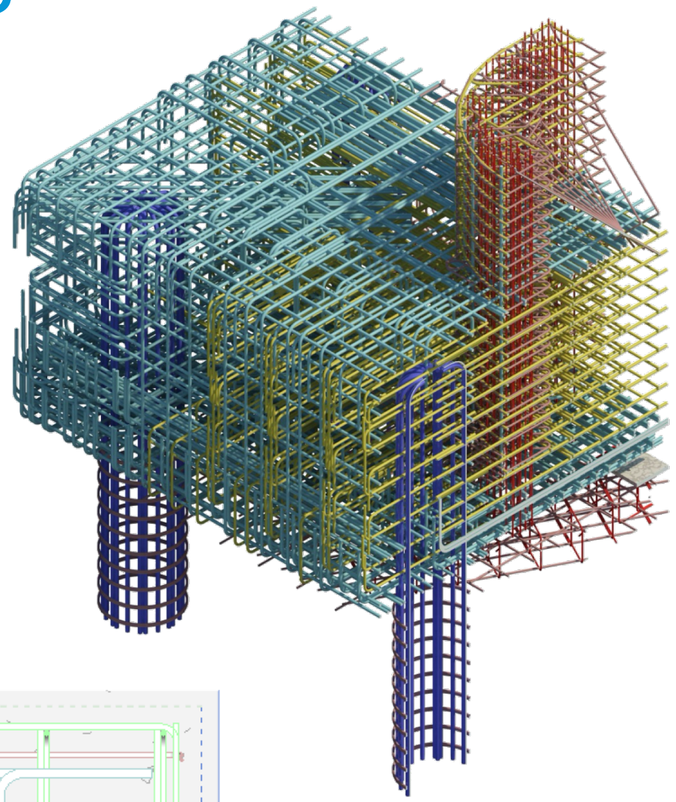
Concrete Reinforcement in Revit - Modeling

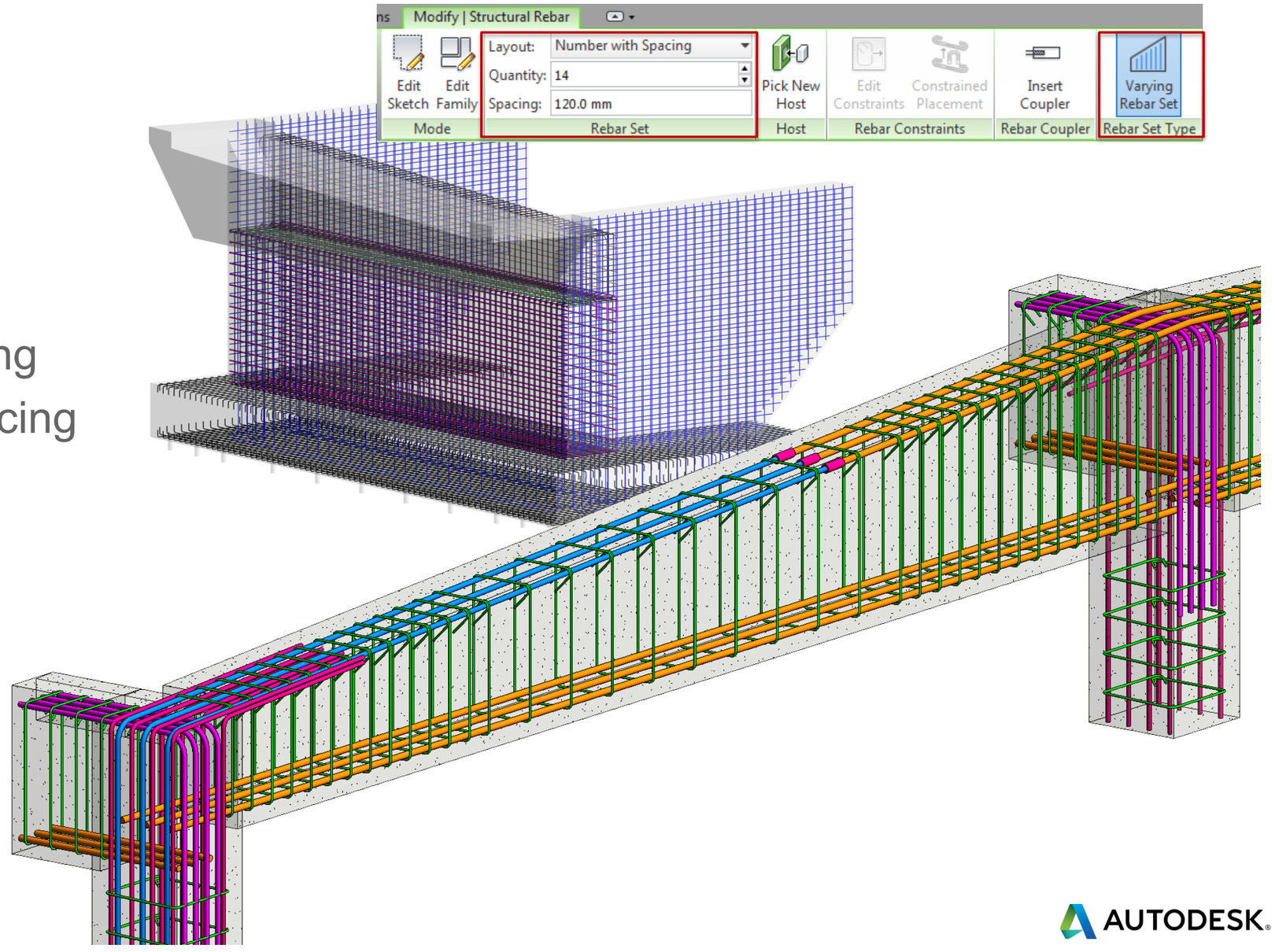
- Rebar constraints
  - Place rebar more precisely
  - Constraint to faces
  - In-canvas tool





Concrete Reinforcement in Revit - Modeling

- Rebar sets
  - Options
    - Fixed number
    - Maximum spacing
    - Number with spacing
    - Minimum clear spacing
  - Multi-rebar annotation
  - Types
    - Regular set
    - Varying rebar set



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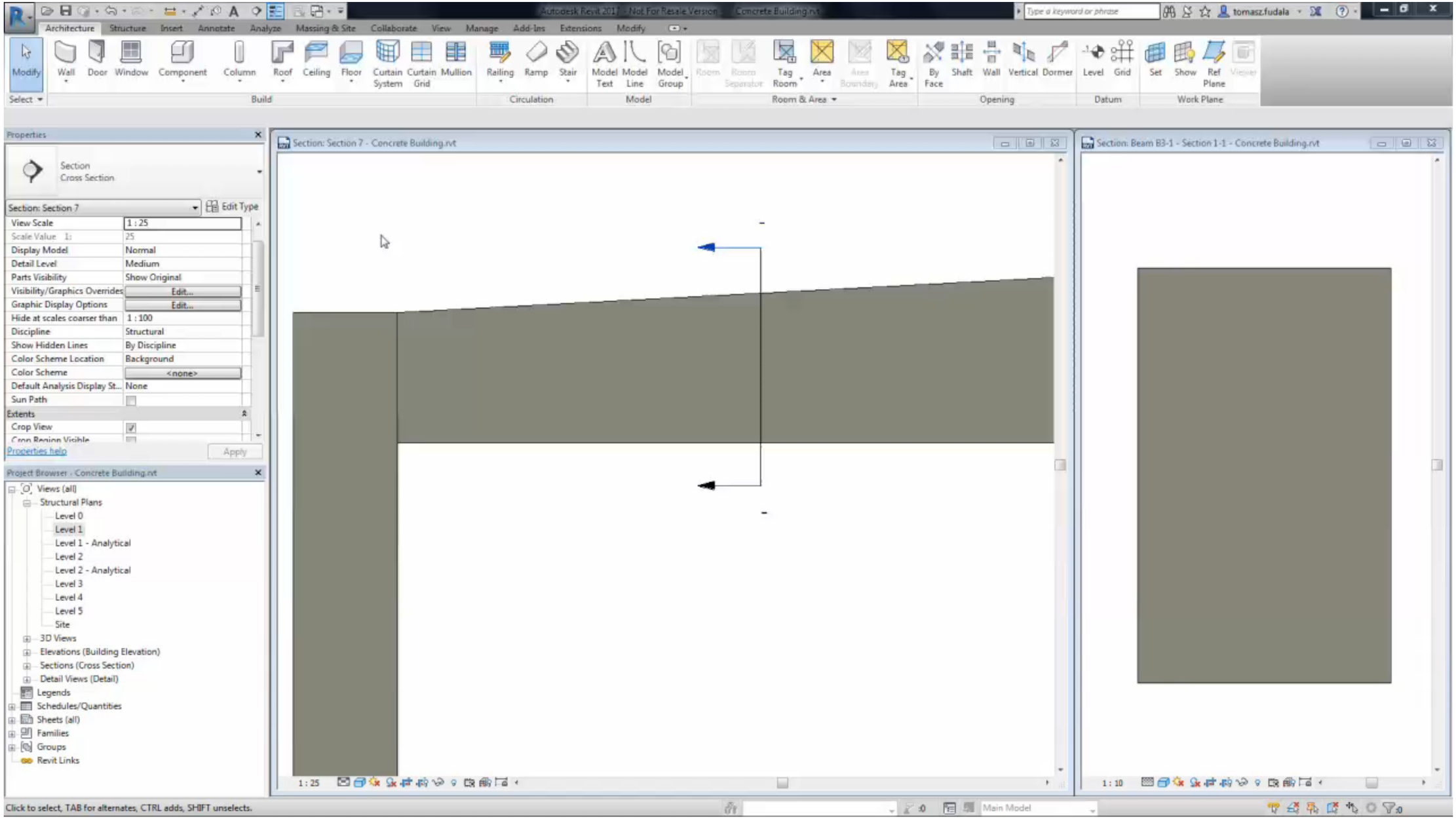
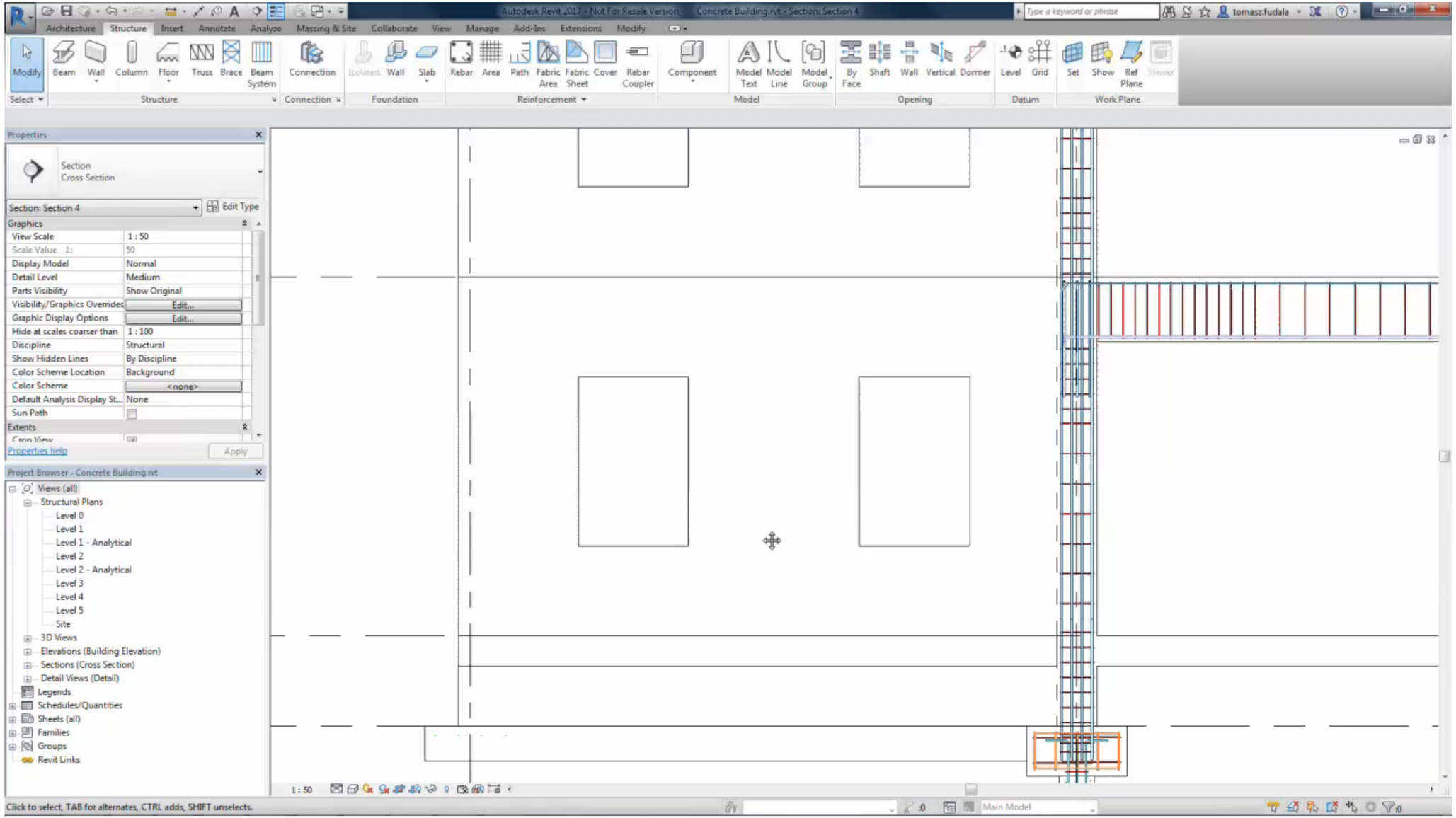
Concrete Reinforcement in Revit - Modeling



Area and Path Reinforcement



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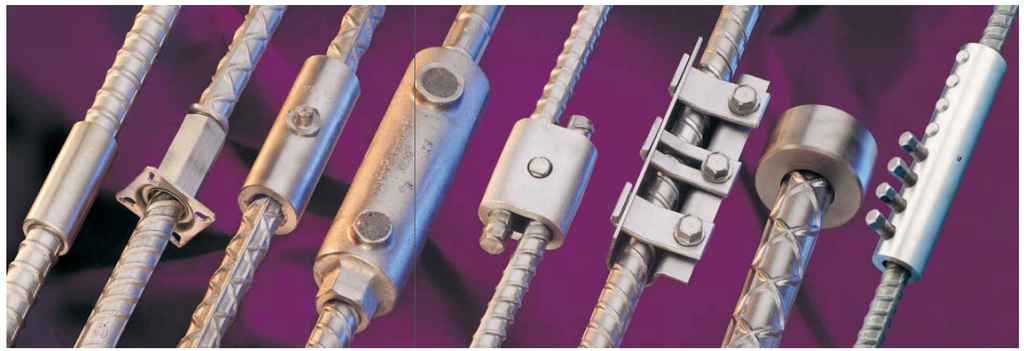
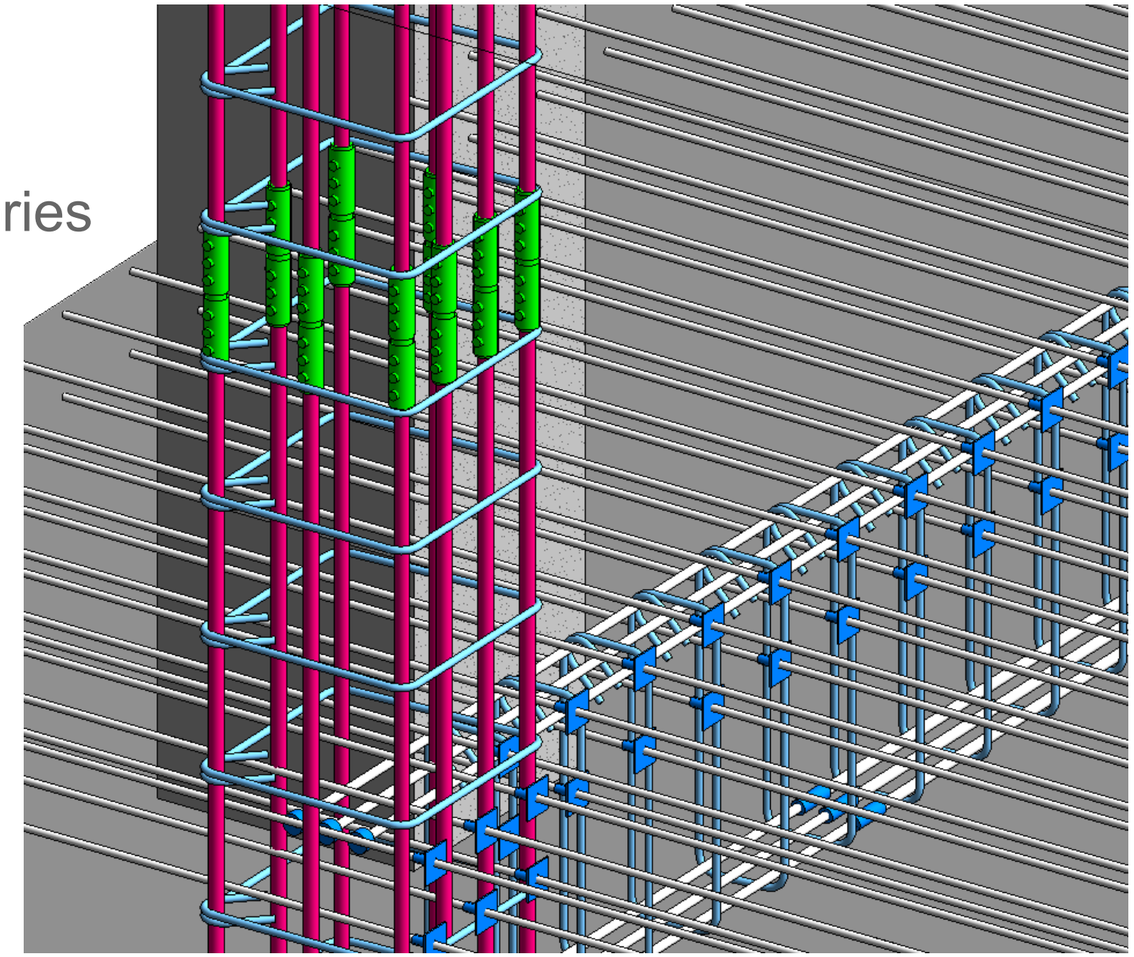
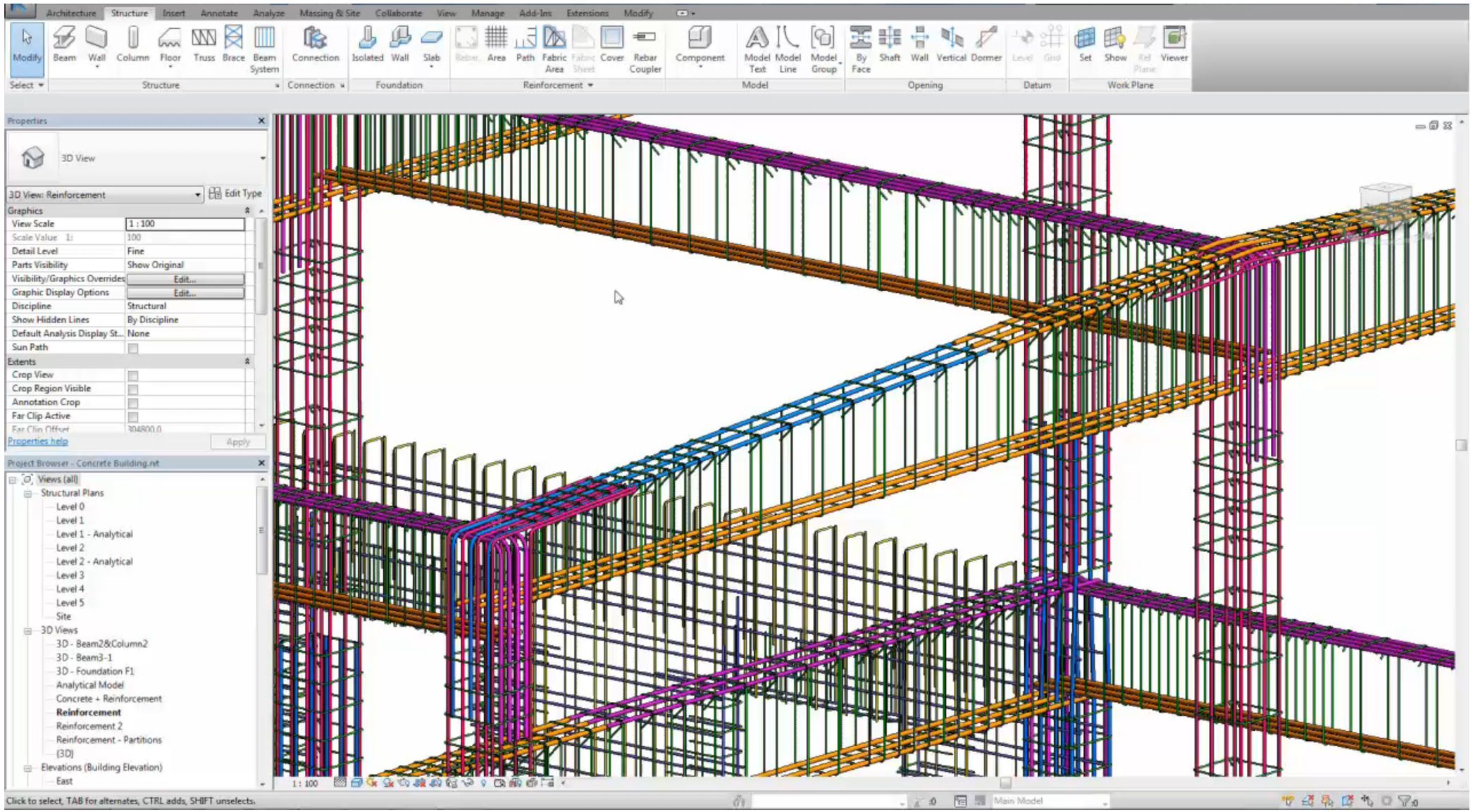
Concrete Reinforcement in Revit - Modeling

- Reinforcement connectors
  - Define rebar connections requirements
  - Comprehensive and detailed model
  - Symbolic representations for rebar accessories
  - Coupler numbering





Reinforcement Connectors



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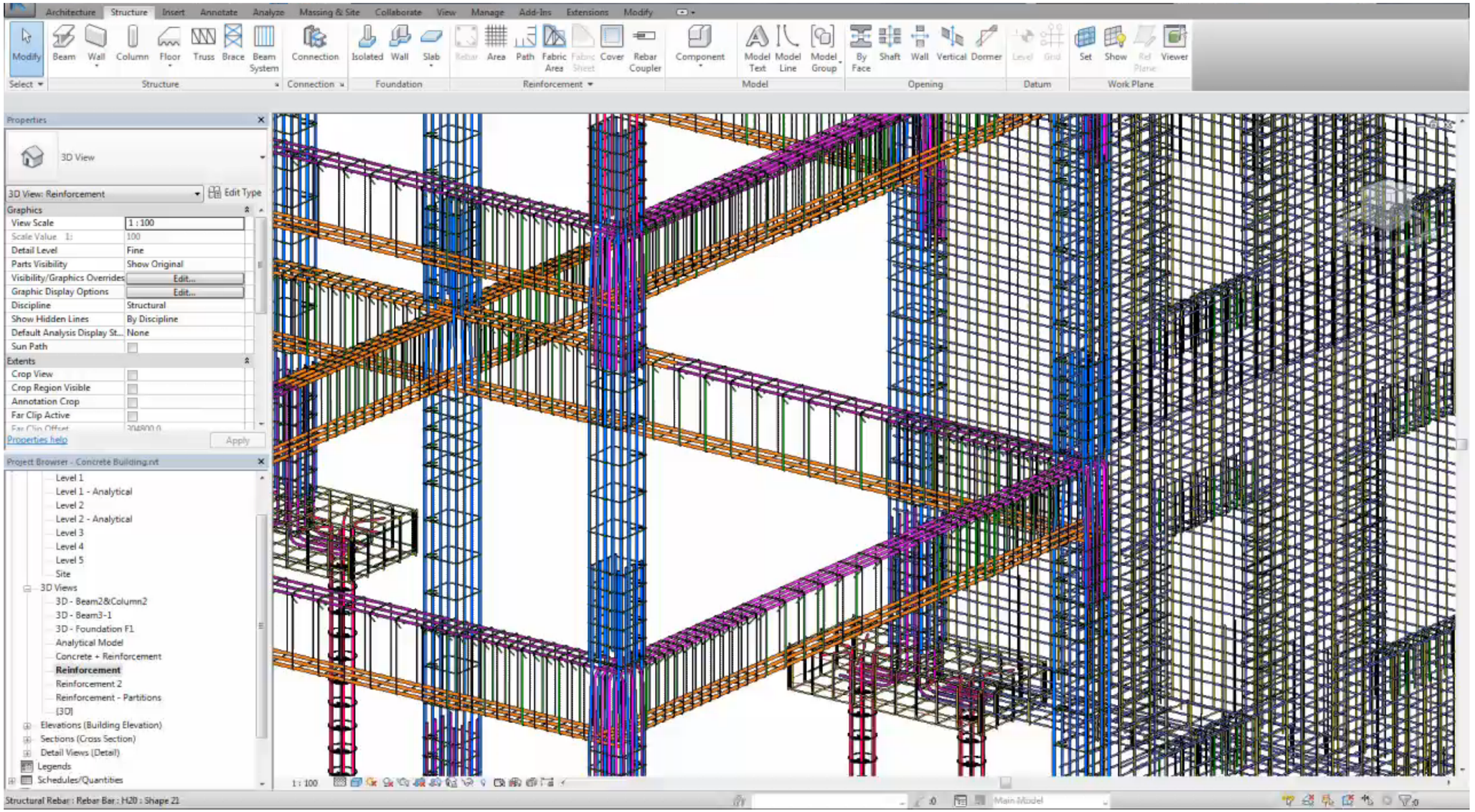
Reinforced Concrete Elements



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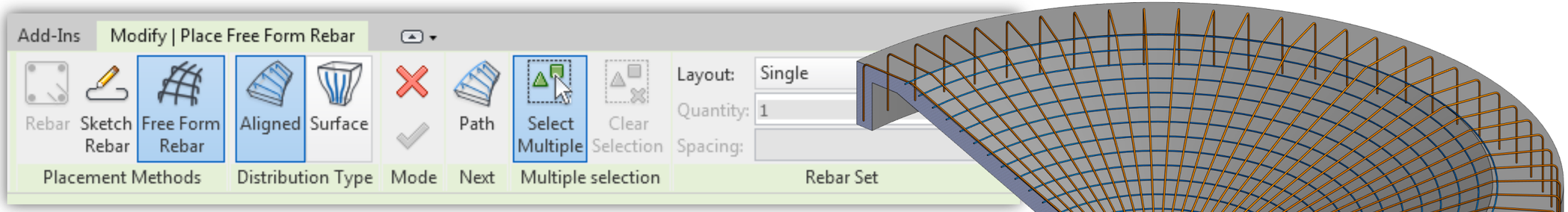
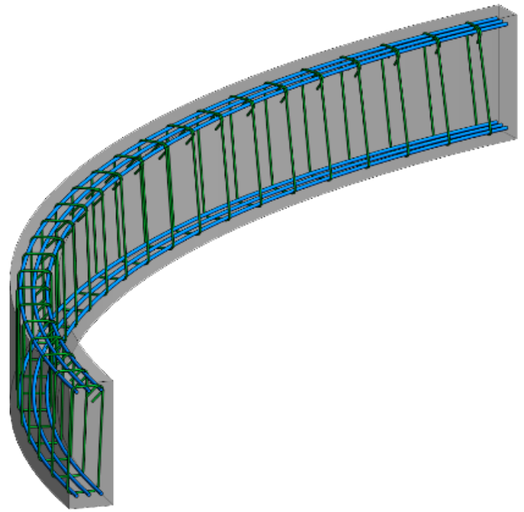
Create

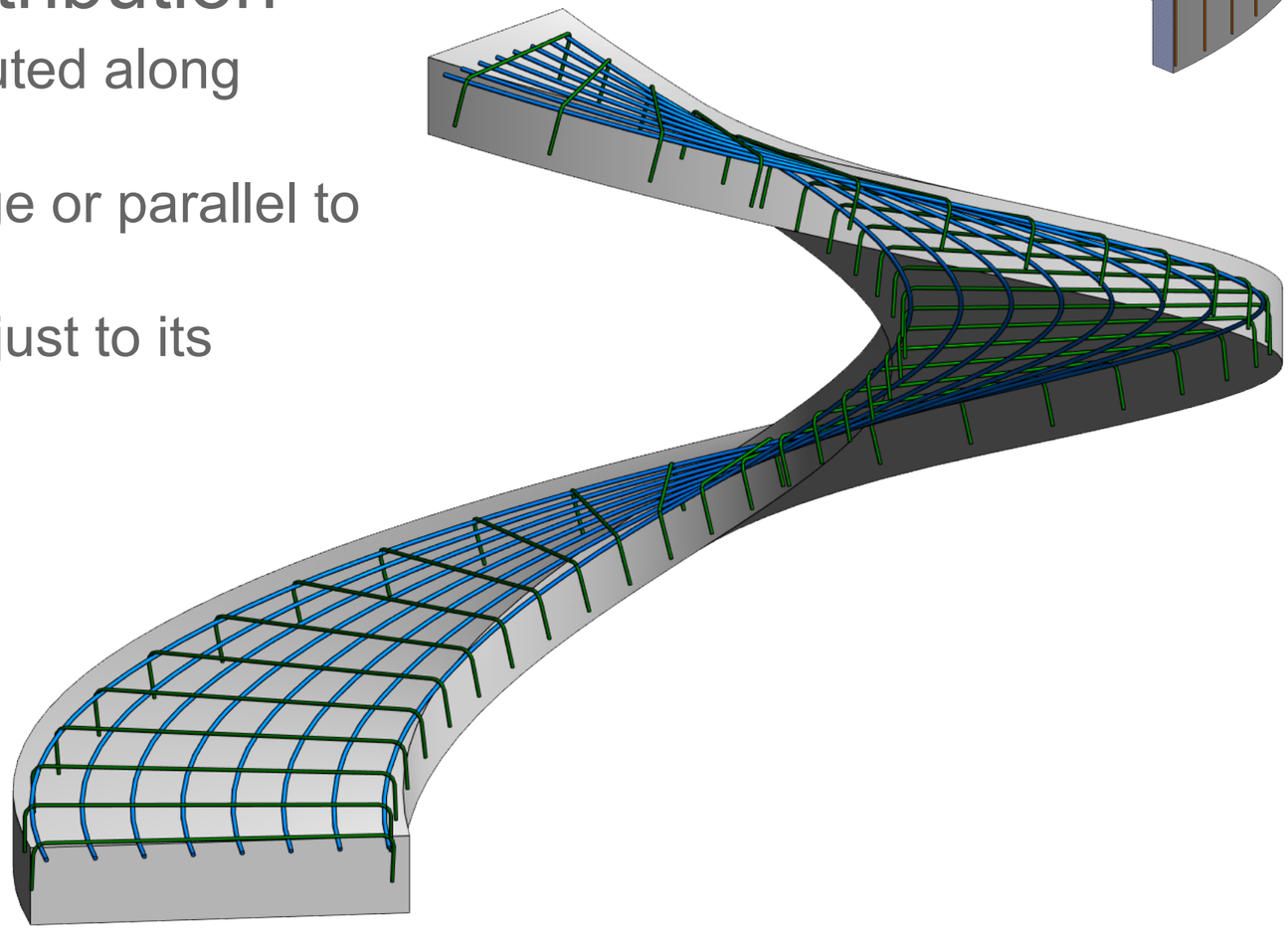
Autodesk Revit 2019.1



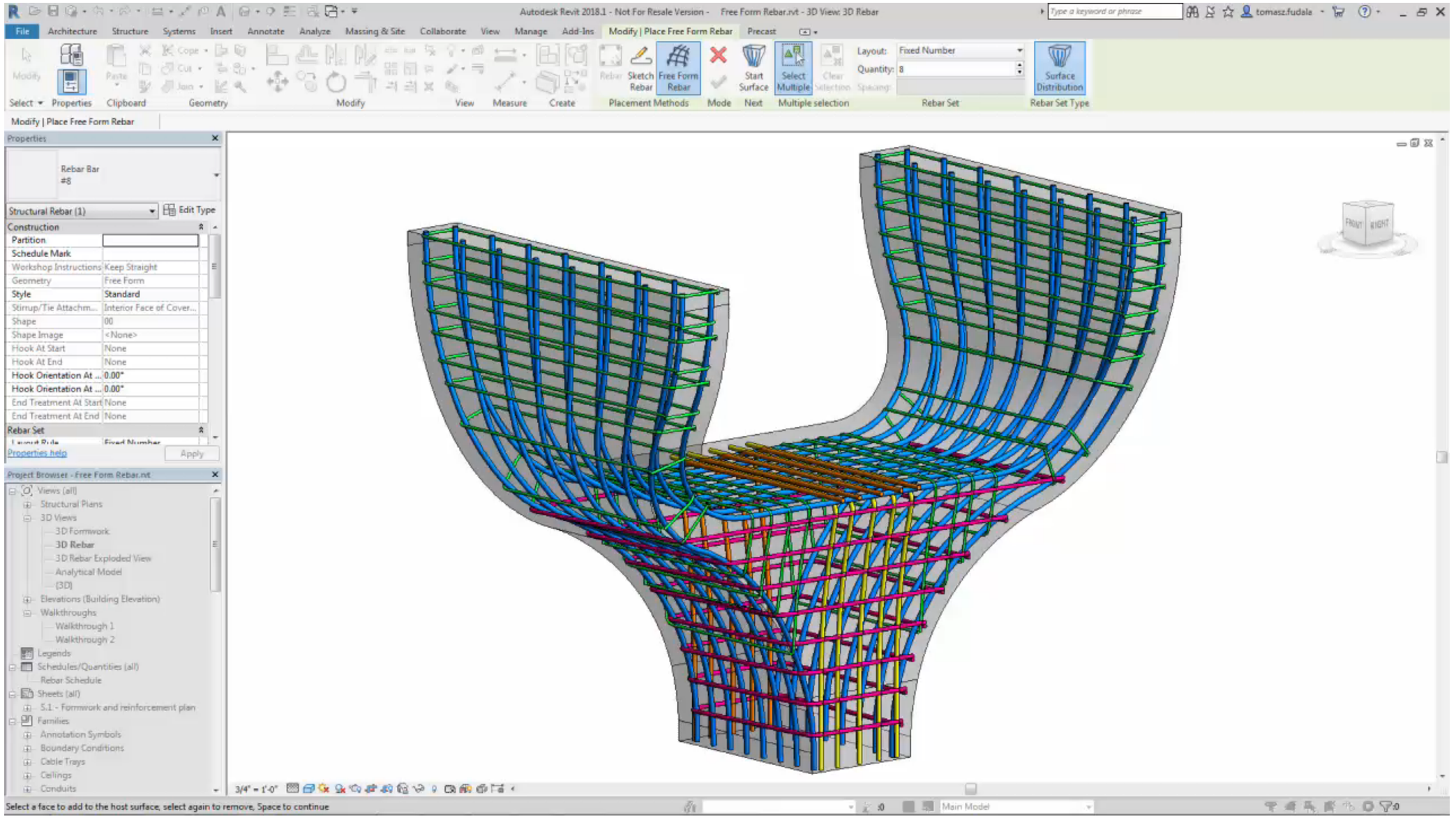
Free Form Rebar - Aligned Distribution

- Create sets with planar bars, distributed along complex structural elements
- Bars can be perpendicular to an edge or parallel to a selected face
- Constrained to the formwork and adjust to its changes





Free form Rebar distribution



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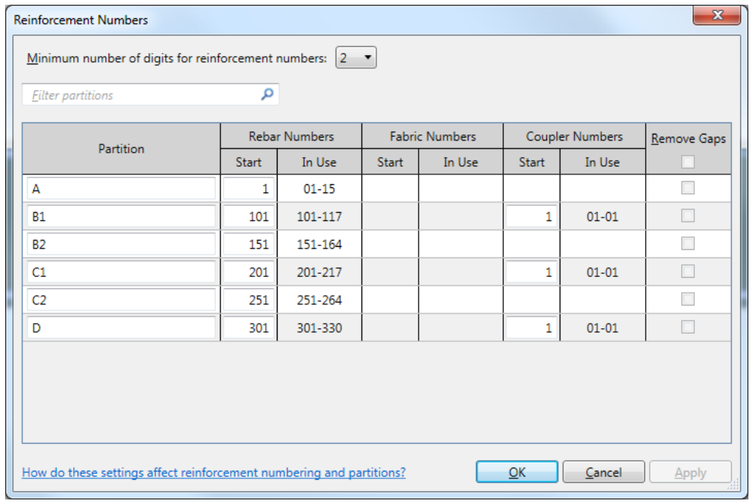
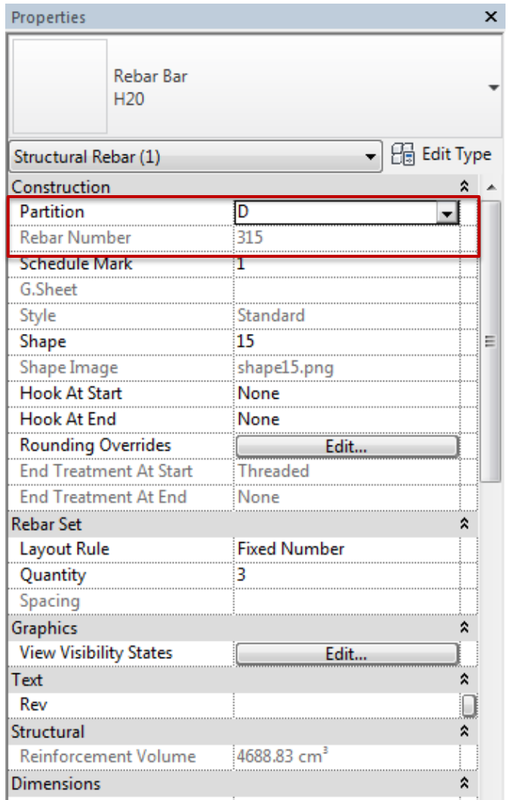
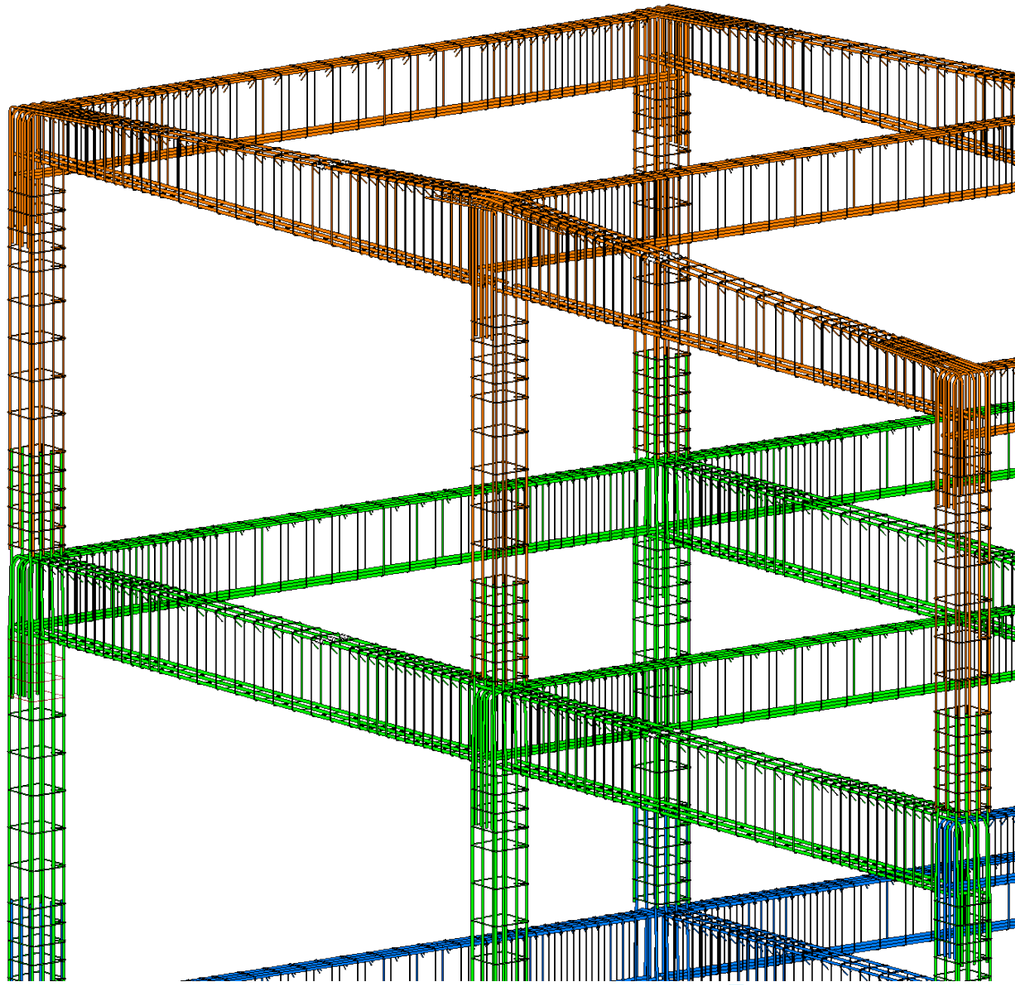
Concrete Reinforcement in Revit Numbering

Concrete Reinforcement in Revit - Numbering

- Reinforcement numbering and partitioning
  - Numbering automation & customization
  - Annotating for shop drawings
  - Rebar scheduling
  - Pouring sequencing







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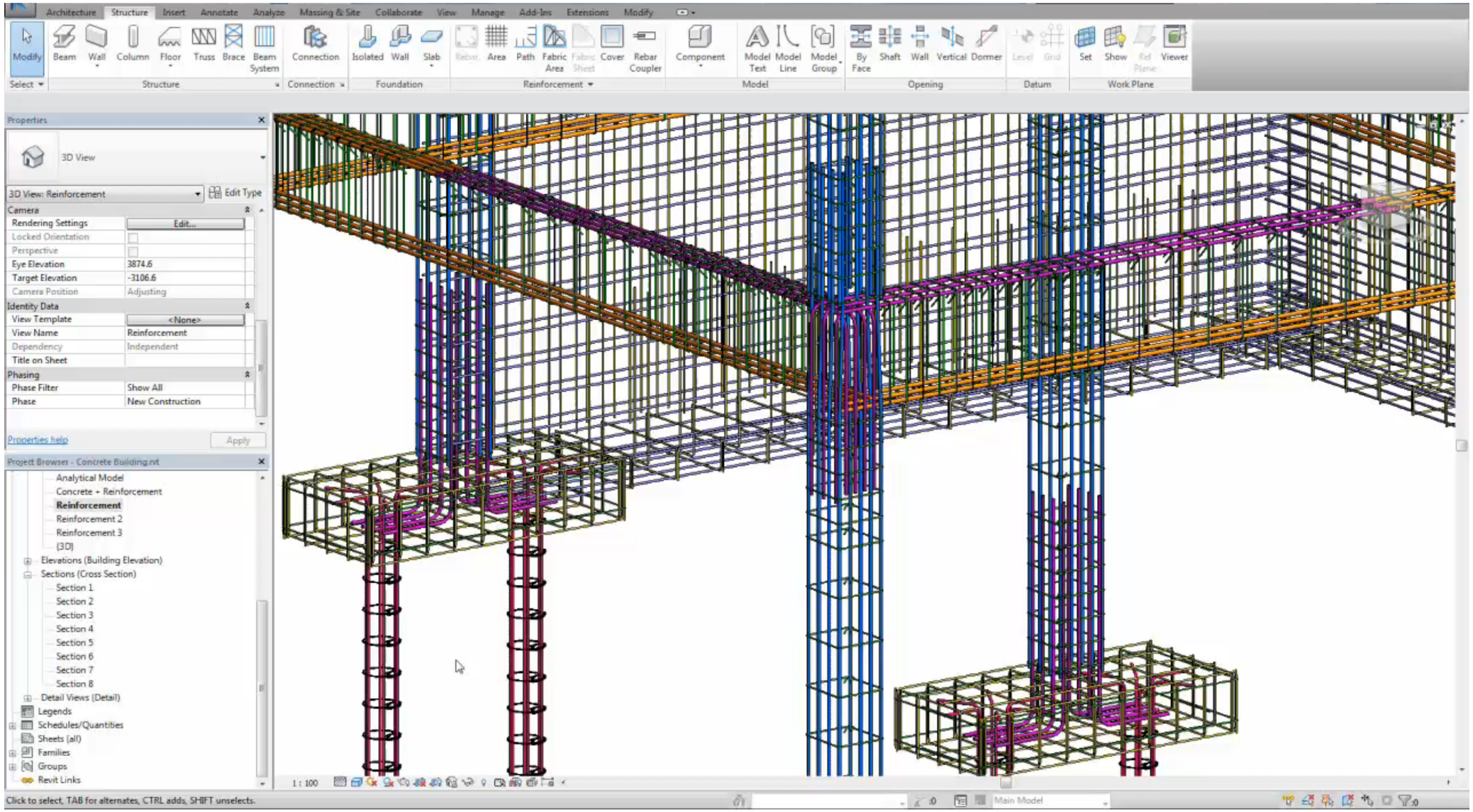
Reinforcement numbering and partitioning



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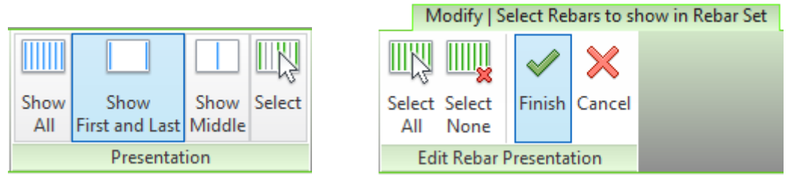
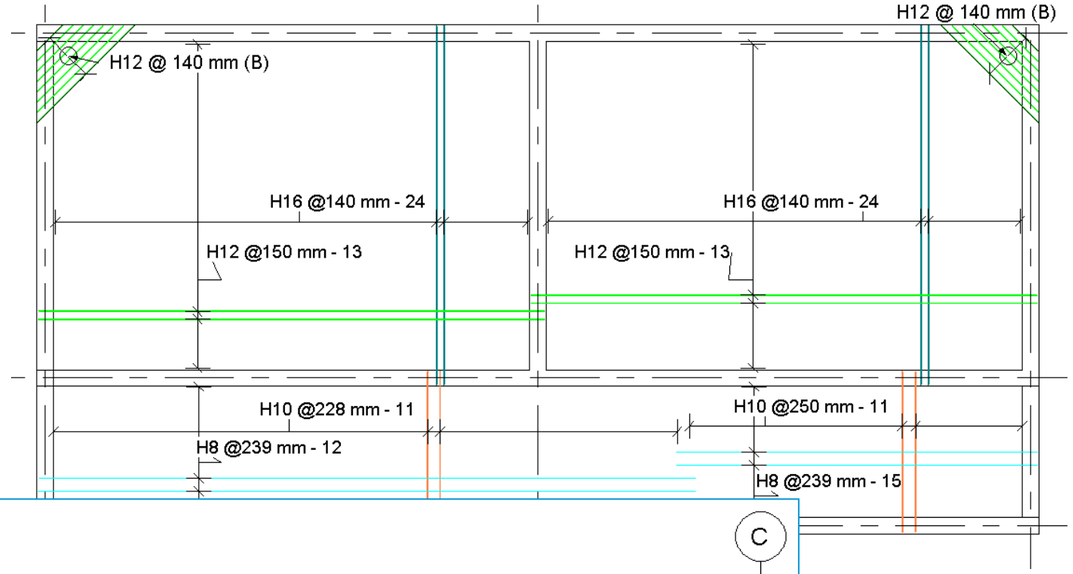
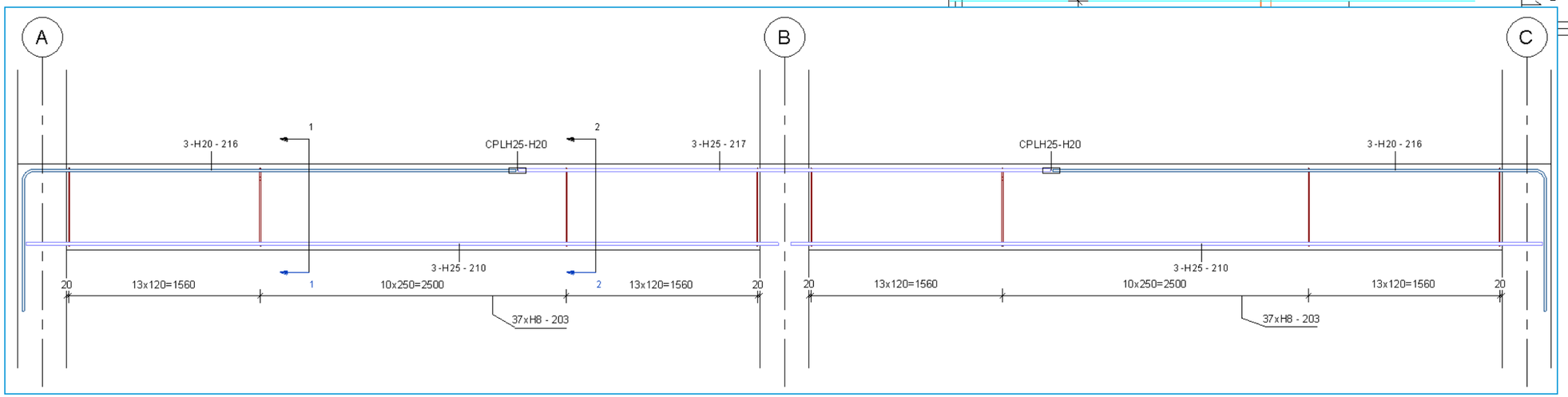
Concrete Reinforcement in Revit Drawing Production

Concrete Reinforcement in Revit – Drawings

- Presentation for rebar sets
  - Showing a representative subset
  - Different bar presentation for a rebar set in each separate view







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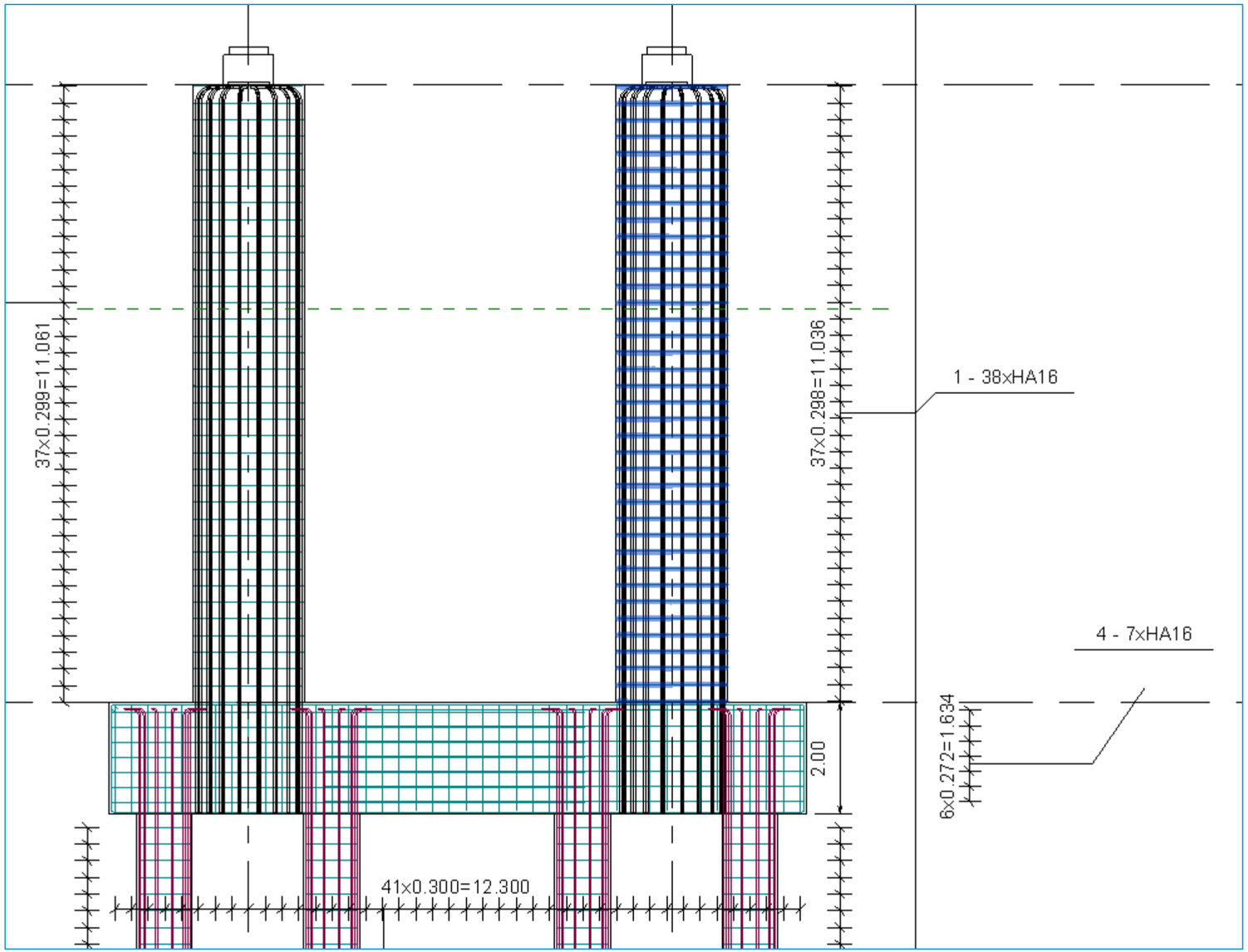
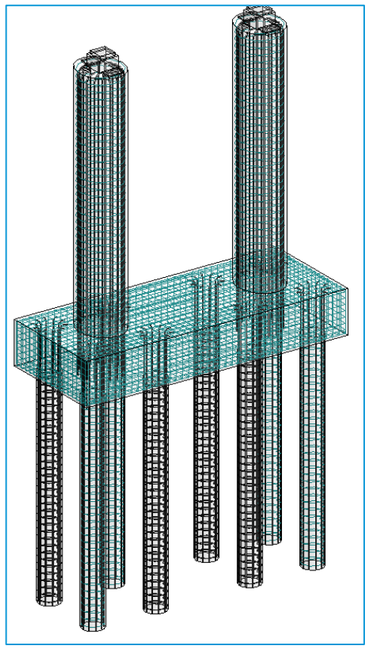
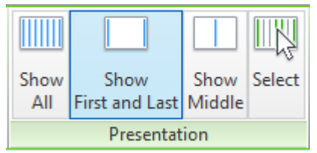
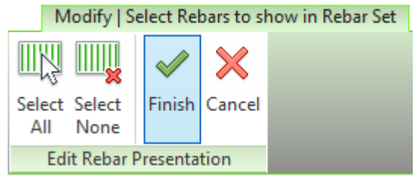
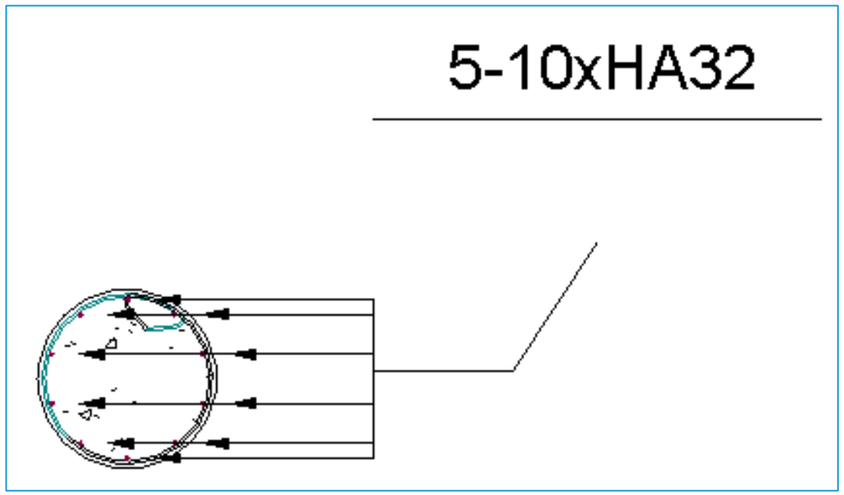
Concrete Reinforcement in Revit – Drawings











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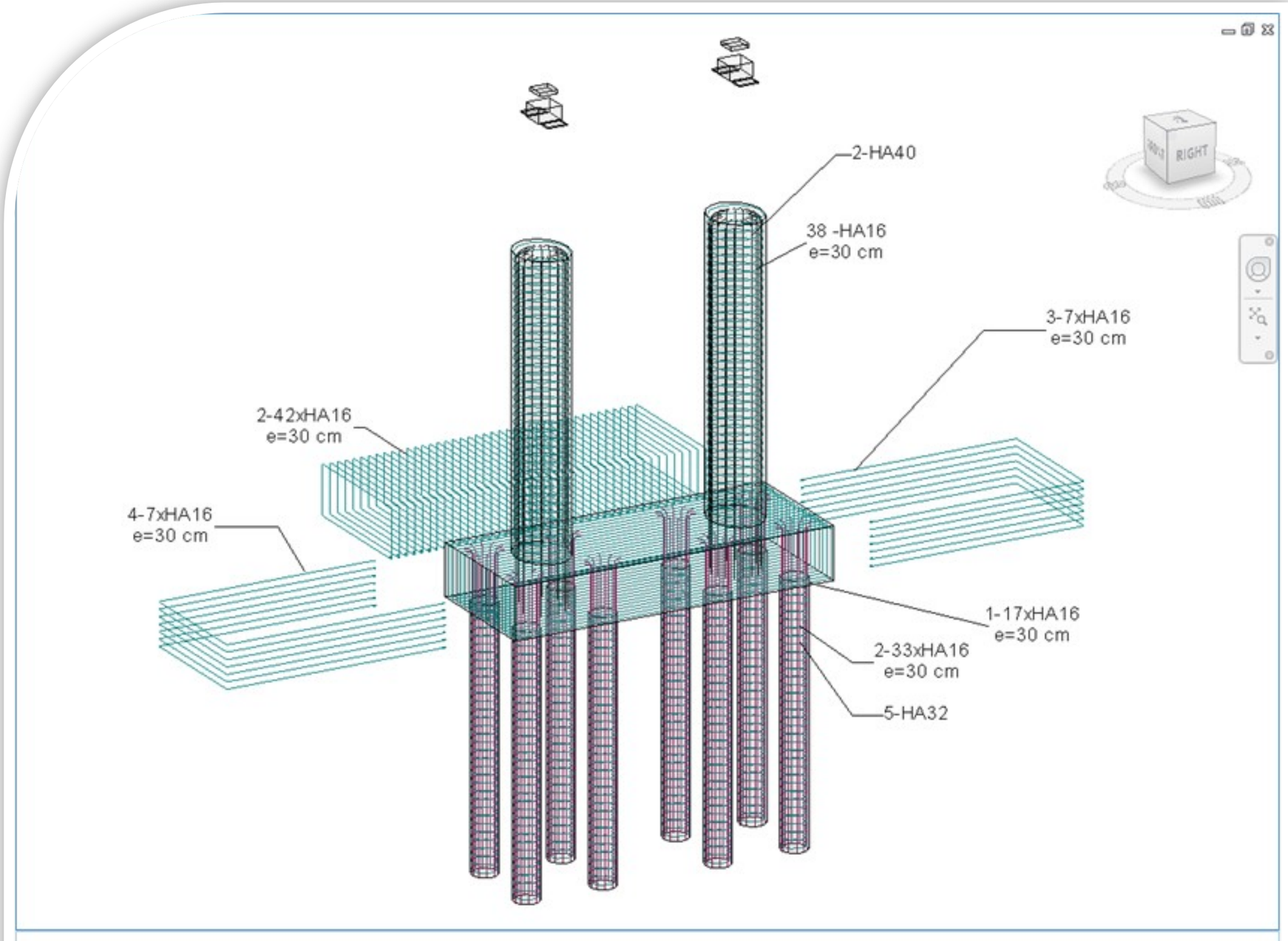
Concrete Reinforcement in Revit – Drawings



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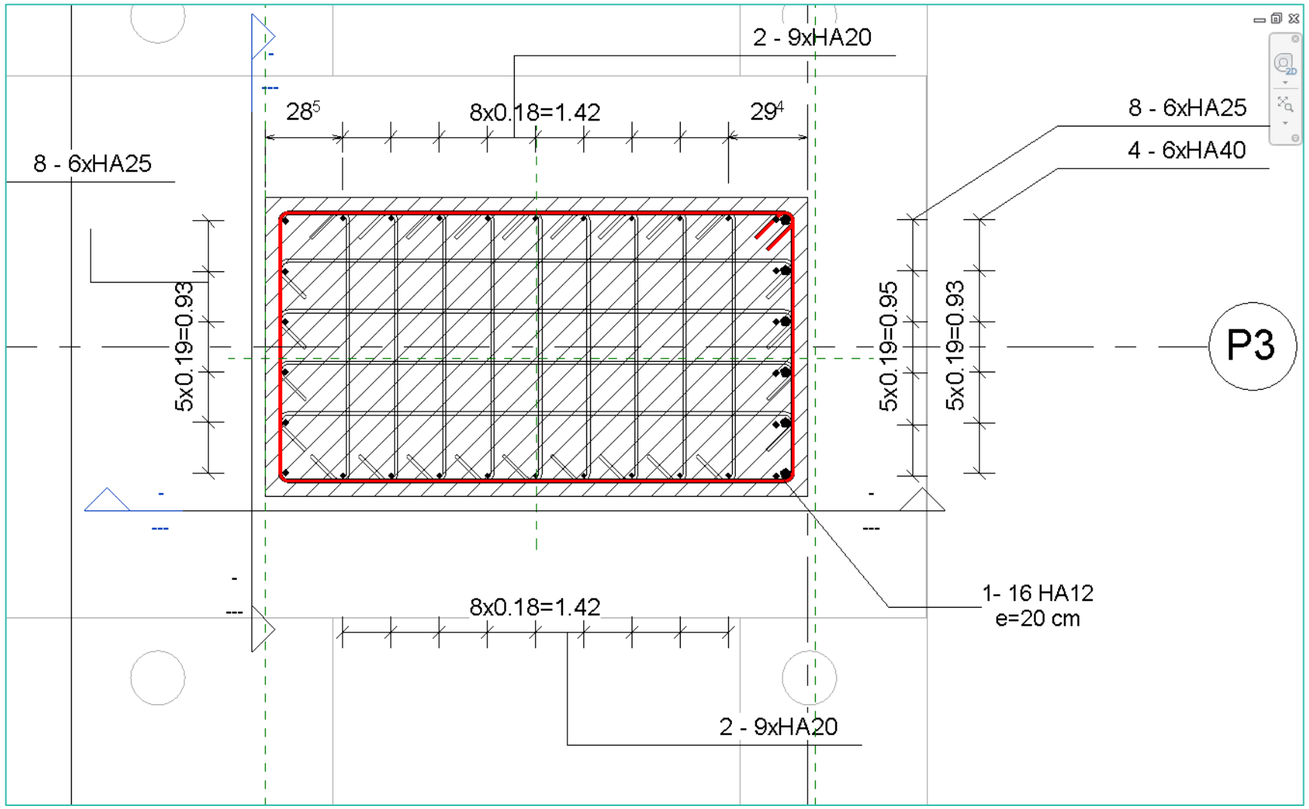
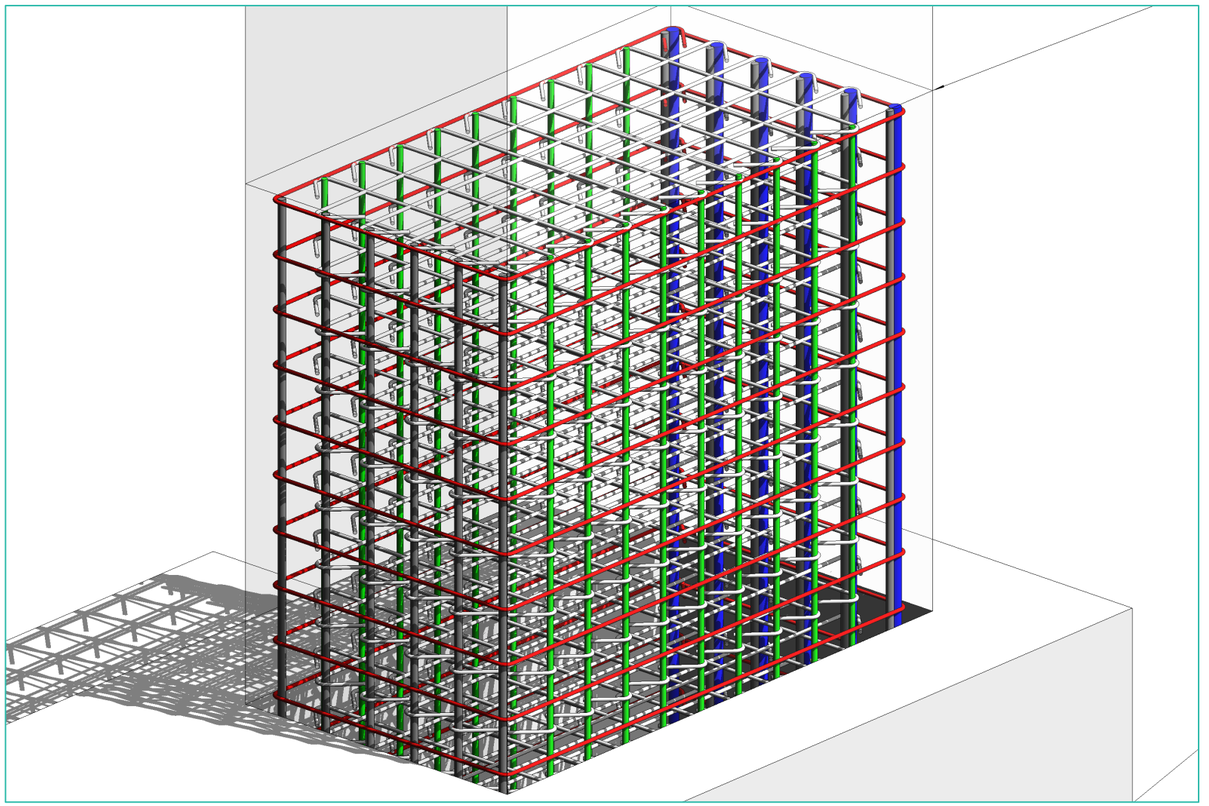
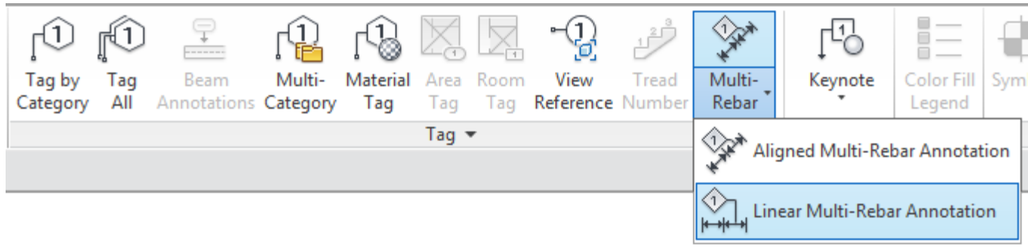
Concrete Reinforcement in Revit – Drawings

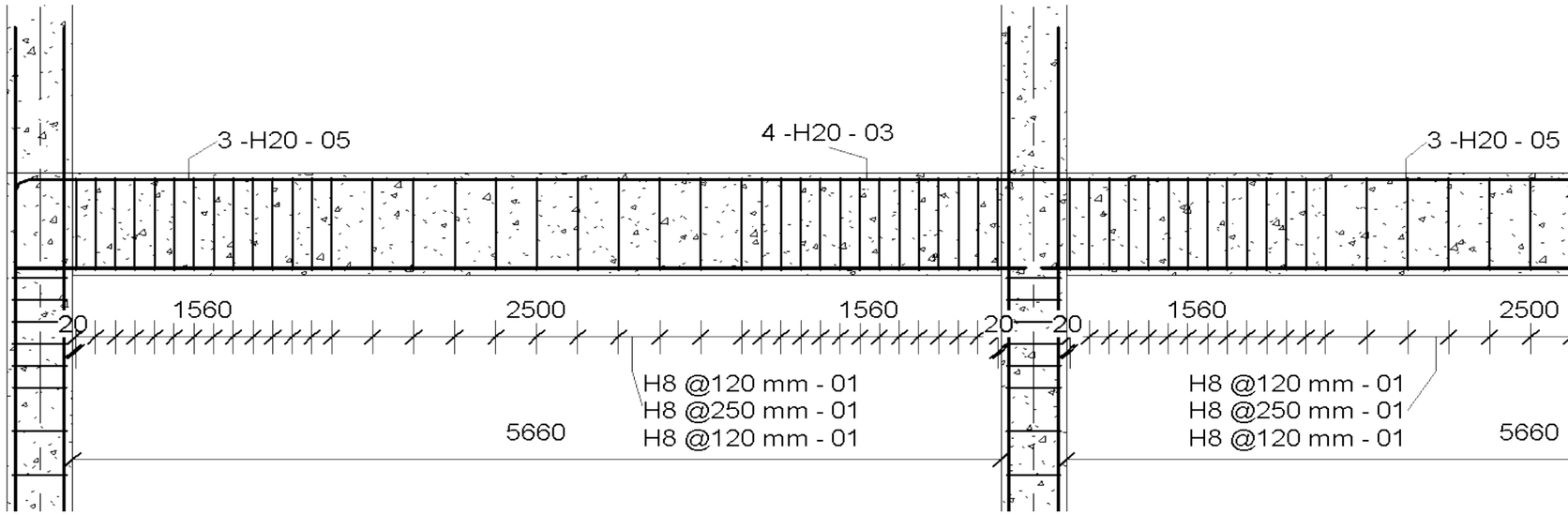




Concrete Reinforcement in Revit – Drawings

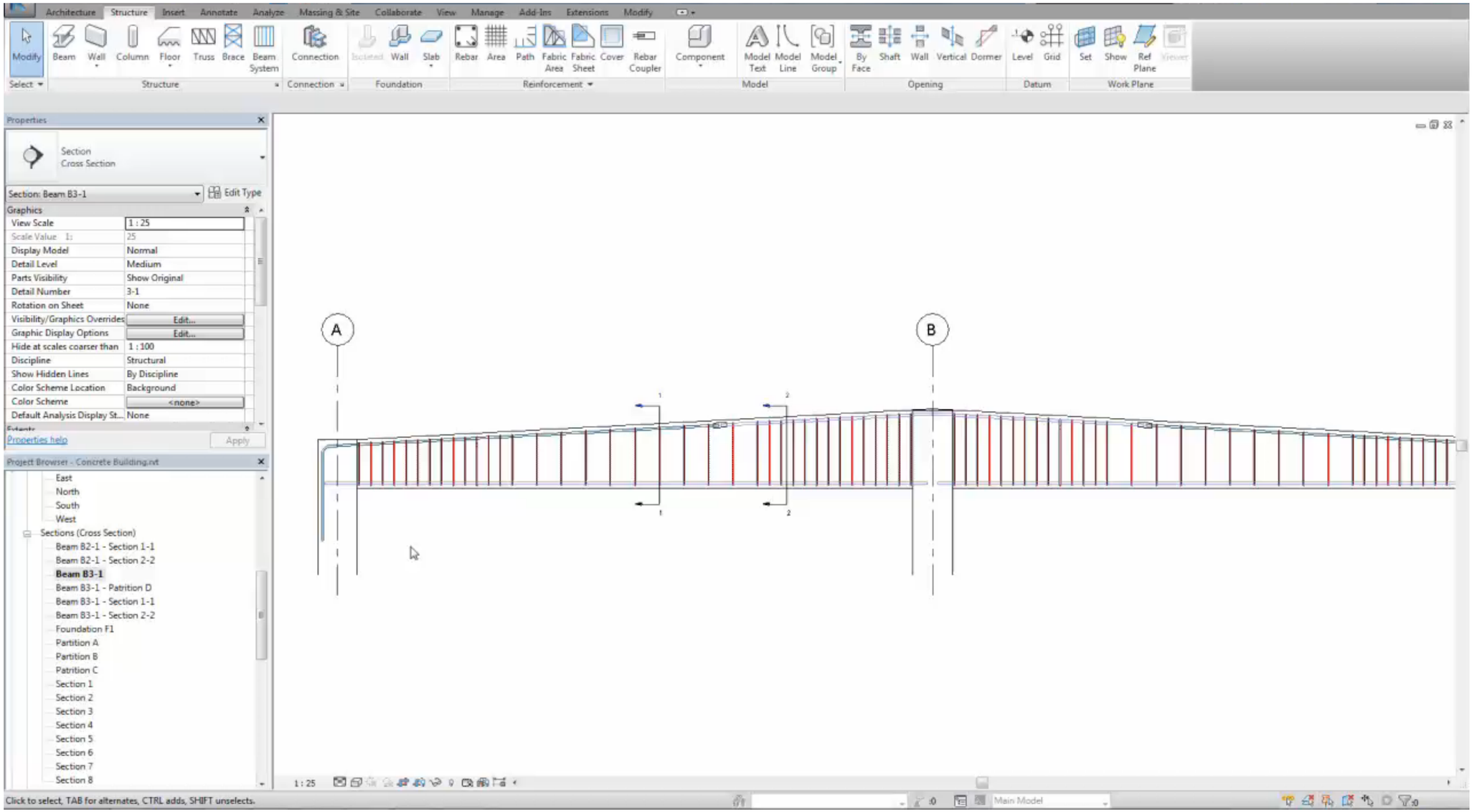
- Rebar annotations
  - Single rebar annotation
  - Rebar set annotation
  - Multi-rebar annotation





AUTODESK.

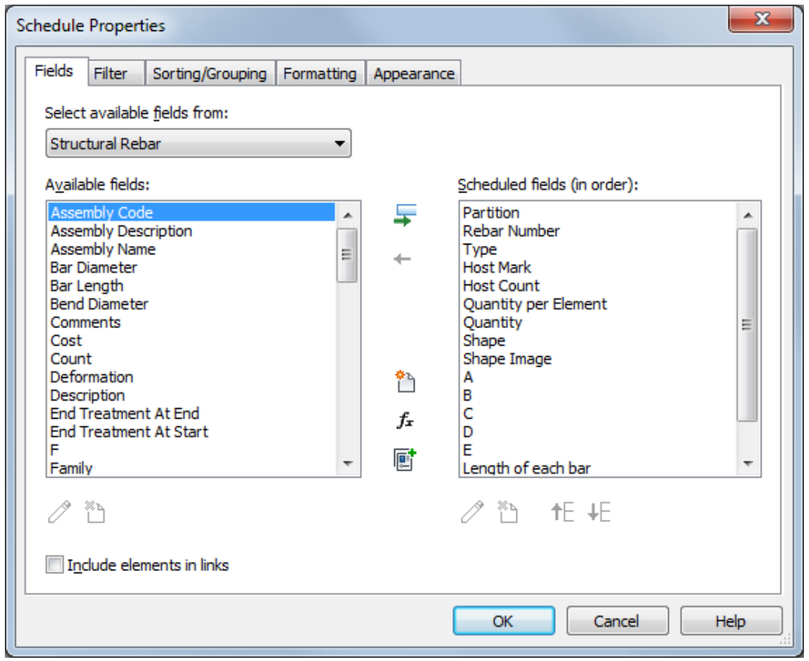
Tagging, Presentation of rebar sets



AUTODESK.

Concrete Reinforcement in Revit – Schedules

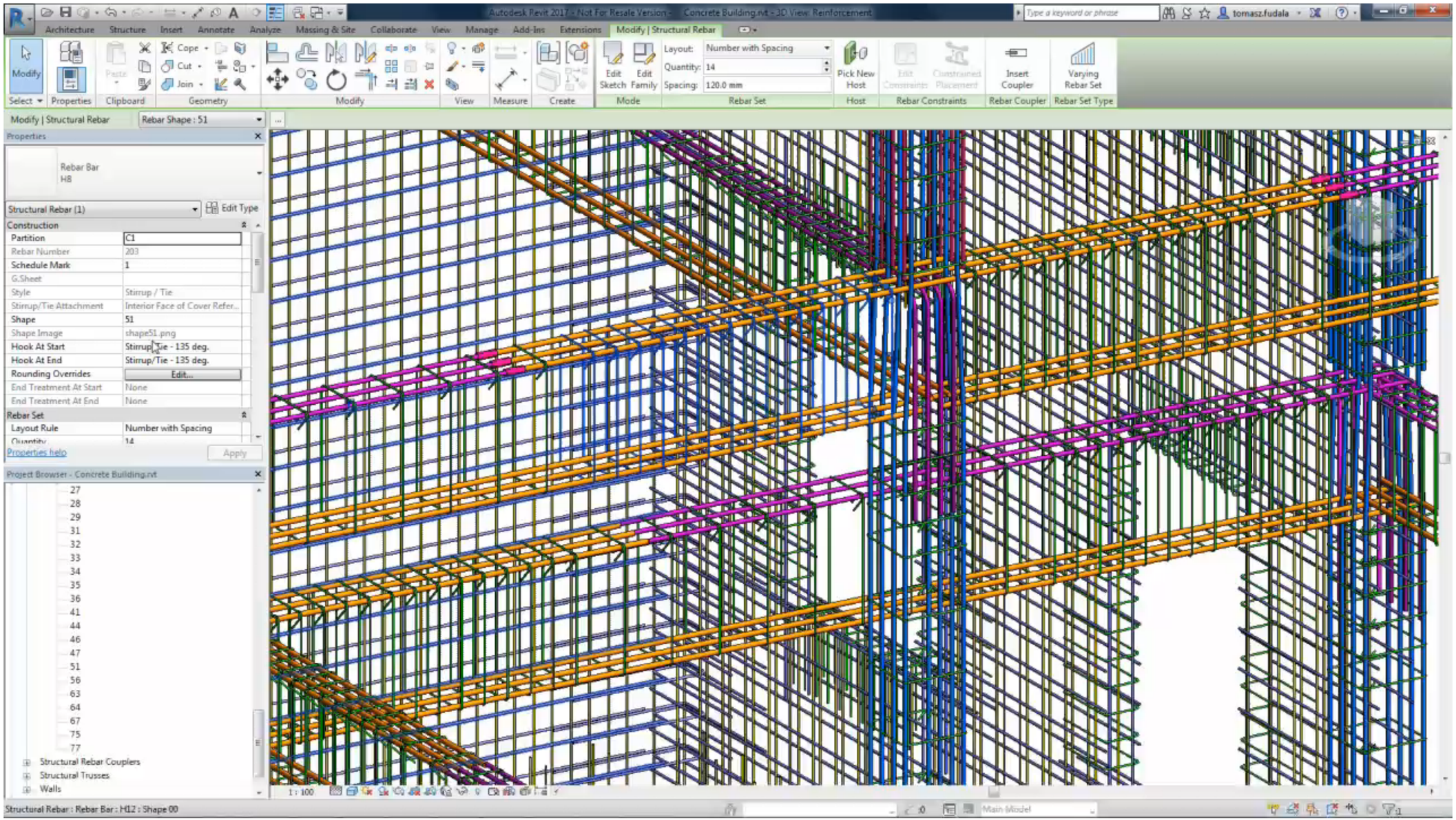
- Rebar schedules
  - Grouping, sorting, filtering rebars
  - Grouping rebar by host
  - Rebar shapes included



Partition	Rebar Number	Type and size	Host Mark	Host Count	Quantity per Element	Quantity	Shape code	Shape Image	A* mm	B* mm	C* mm	D* mm	E* mm	Length of each bar + mm	Total Bar Length
A	03	H20	F1	8	8	64	11		510	1410	0	0	0	1875	120000 mm
A	04	H8	F1	8	3	24	51		340	300	115	115	0	1425	34800 mm
A	11	H8	F1	8	4	32	21		590	1880	590	0	0	3025	96800 mm
A	12	H10	F1	8	10	80	21		380	1865	380	0	0	2575	206000 mm
A	13	H10	F1	8	20	160	21		360	845	360	0	0	1525	244000 mm
A	14	H8	F1	8	64	512	75		230	175	0	0	0	875	563200 mm
A	15	H16	F1	8	12	96	11		270	6230	0	0	0	6475	621600 mm

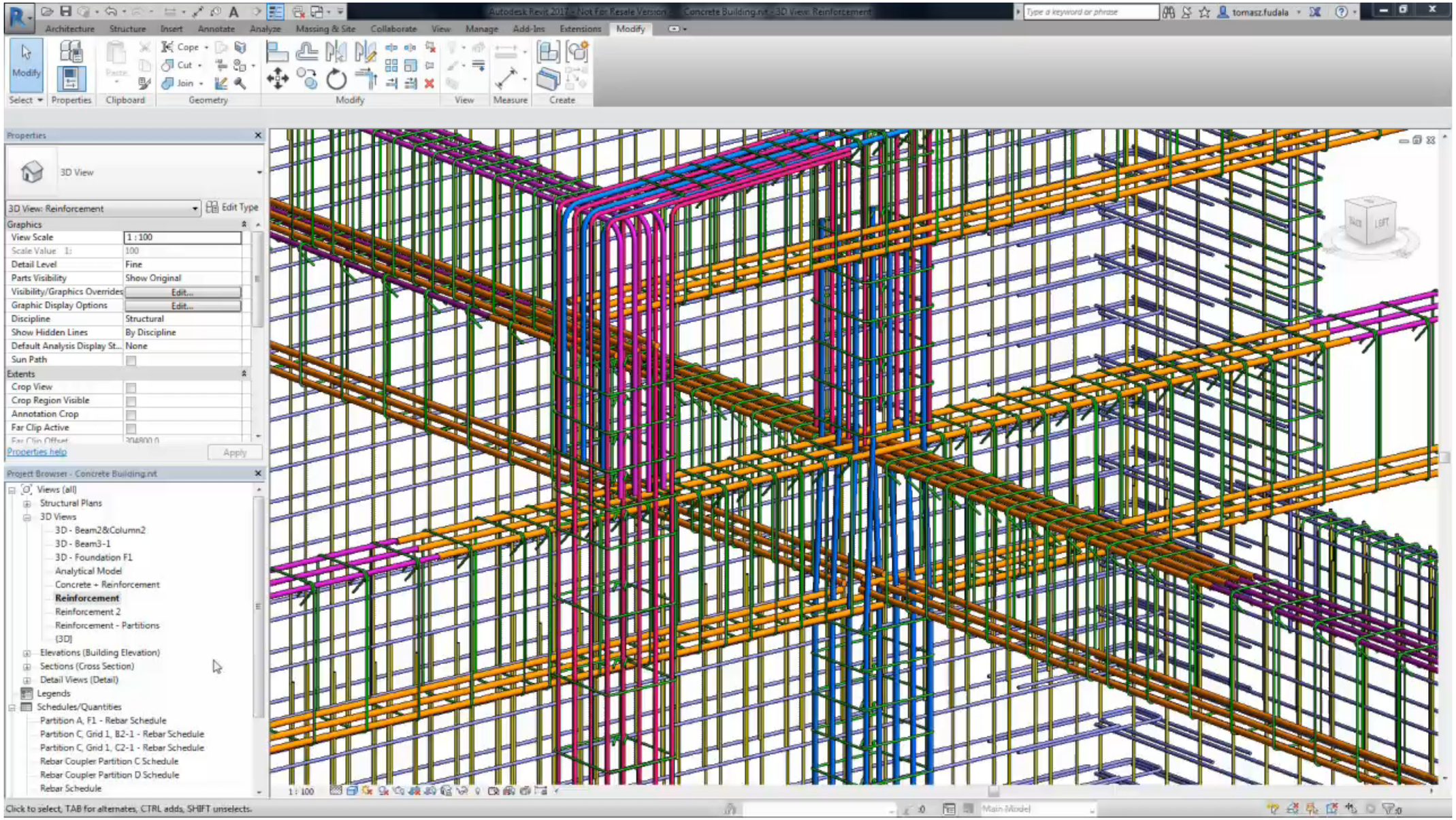
AUTODESK.

Rebar Bending Schedules



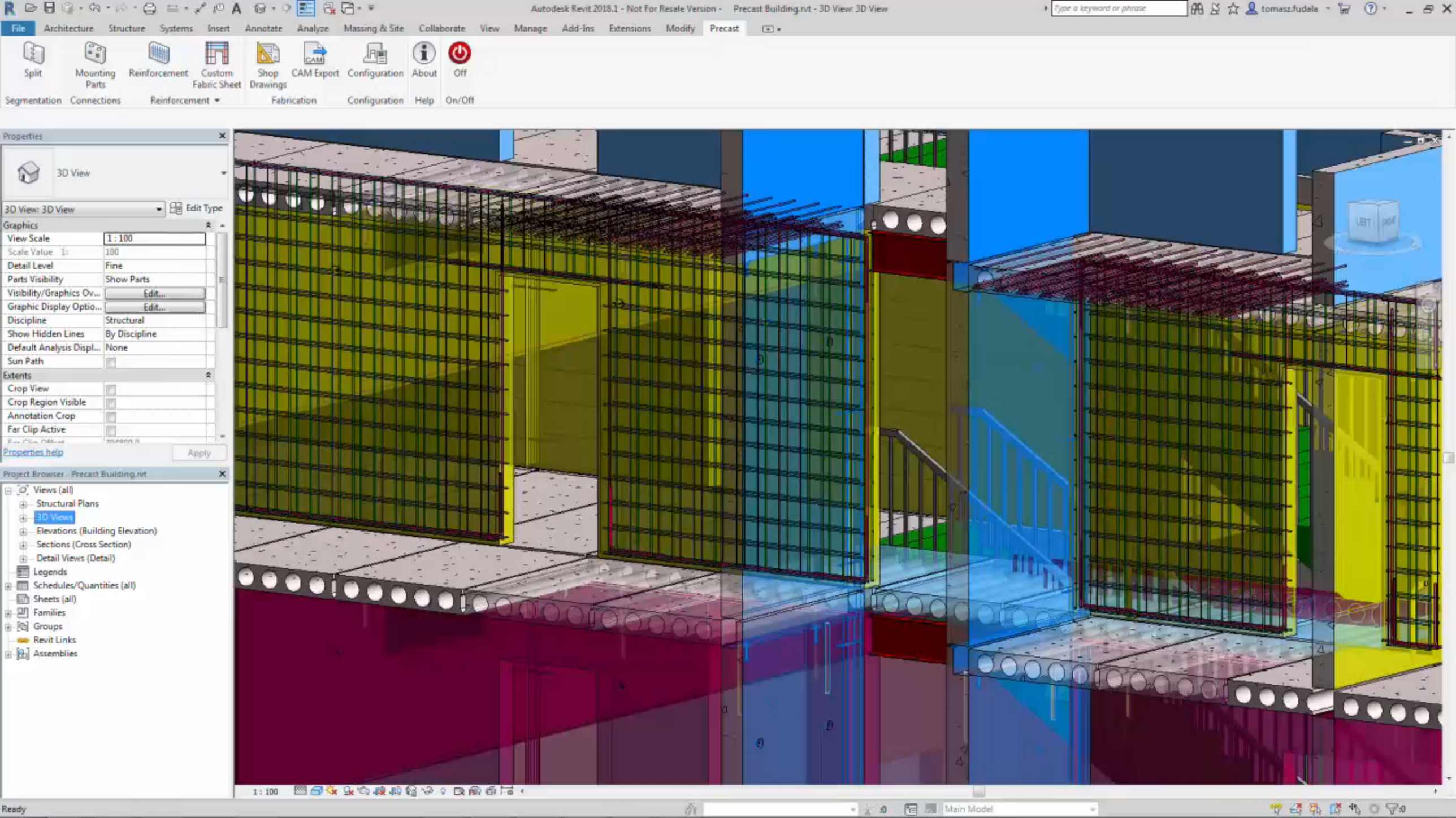
AUTODESK.

Final Shop Drawings

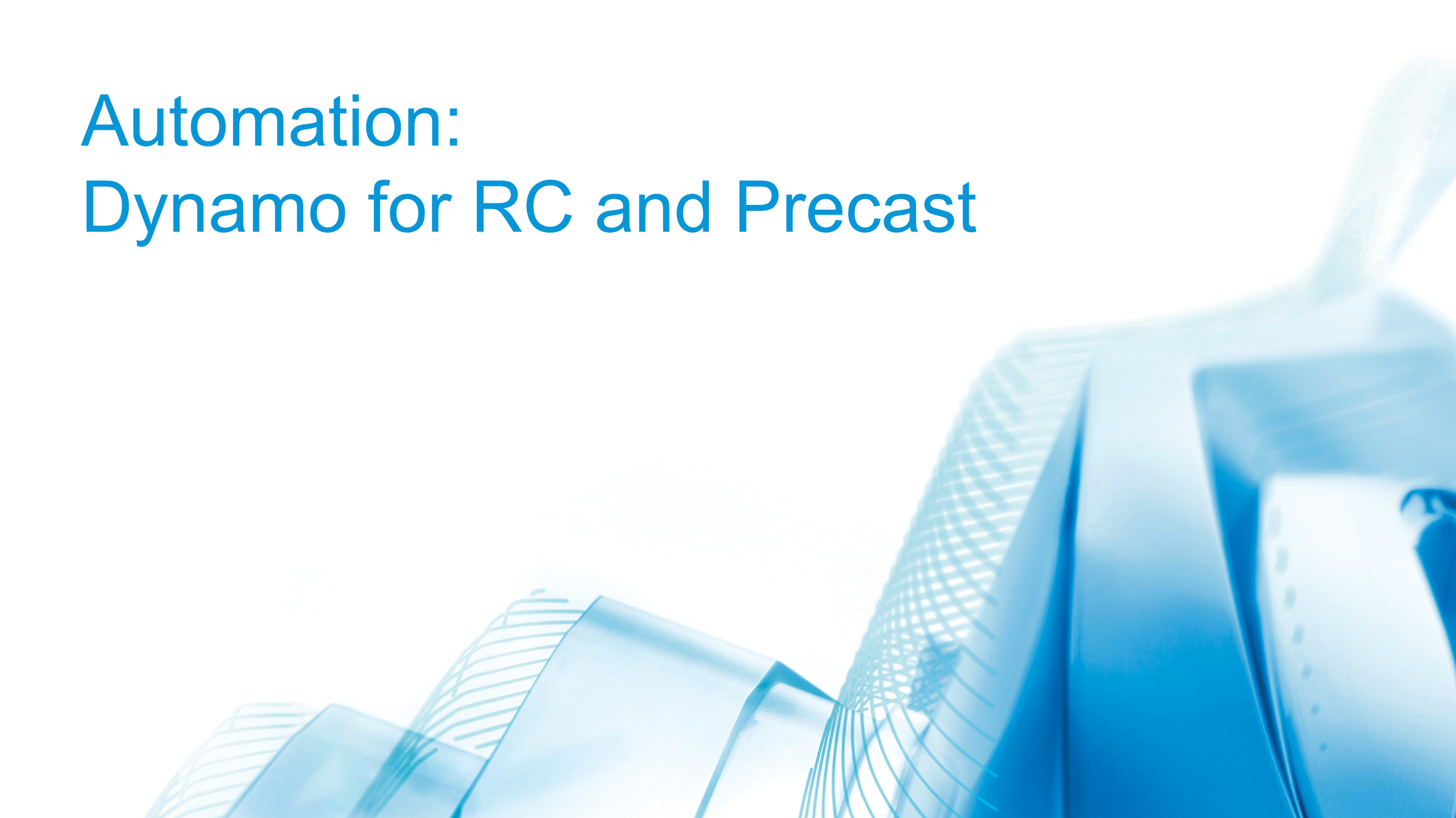


AUTODESK.

Structural Precast in Revit


Autodesk Revit 2018.1 - Not For Resale Version - Precast Building.rvt - 3D View: 3D View
File
Architecture
Structure
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Extensions
Modify
Precast
Split
Mounting Parts
Reinforcement
Custom Fabric Sheet
Shop Drawings
CAM Export
Configuration
About
Off
Segmentation
Connections
Reinforcement
Fabrication
Configuration
Help
On/Off
Properties
3D View
3D View: 3D View
Edit Type
Graphics
View Scale
1 : 100
Scale Value 1:
100
Detail Level
Fine
Parts Visibility
Show Parts
Visibility/Graphics Ov...
Edit...
Graphic Display Optio...
Edit...
Discipline
Structural
Show Hidden Lines
By Discipline
Default Analysis Displ...
None
Sun Path
Extents
Crop View
Crop Region Visible
Annotation Crop
Far Clip Active
Properties help
Apply
Project Browser - Precast Building.rvt
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
Assemblies
1 : 100
Ready
Main Model

Automation:
Dynamo for RC and Precast

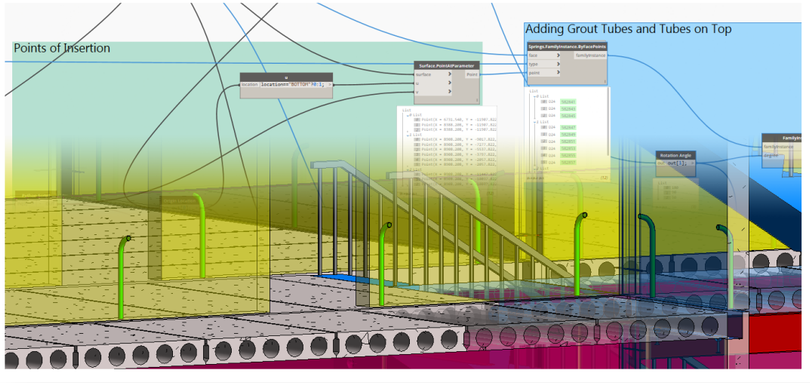


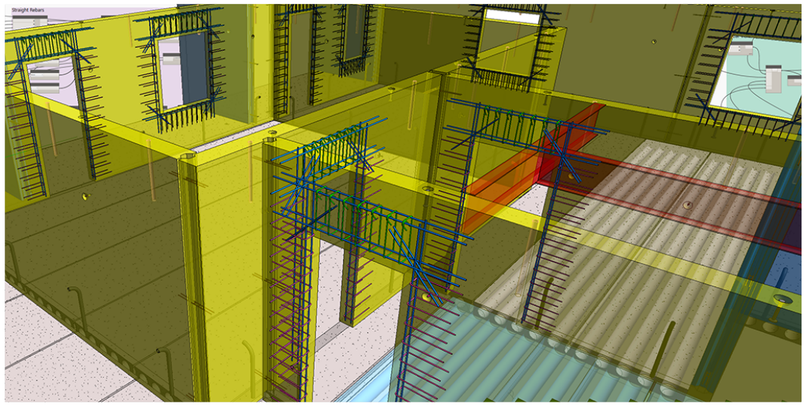
Structural Design Dynamo package

Automate Concrete Workflows with Dynamo

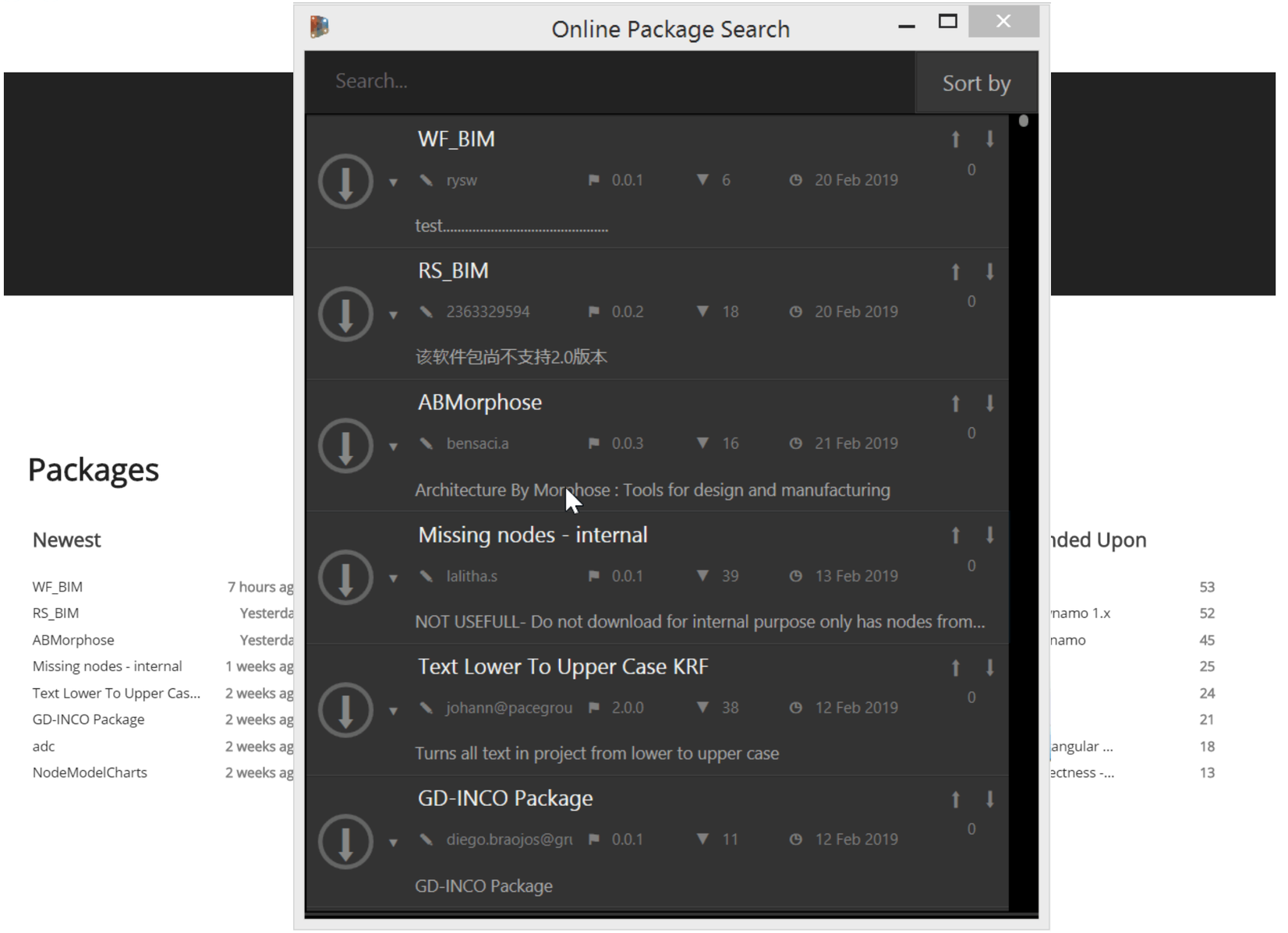
Overview

- Supports various structural workflows in Dynamo and Revit
- Compatible with Dynamo 2
- Nodes are shared with example scripts to automate workflows
- Cross-industry nodes
- **64 nodes** and the number is growing…





Open Source | Free Packages

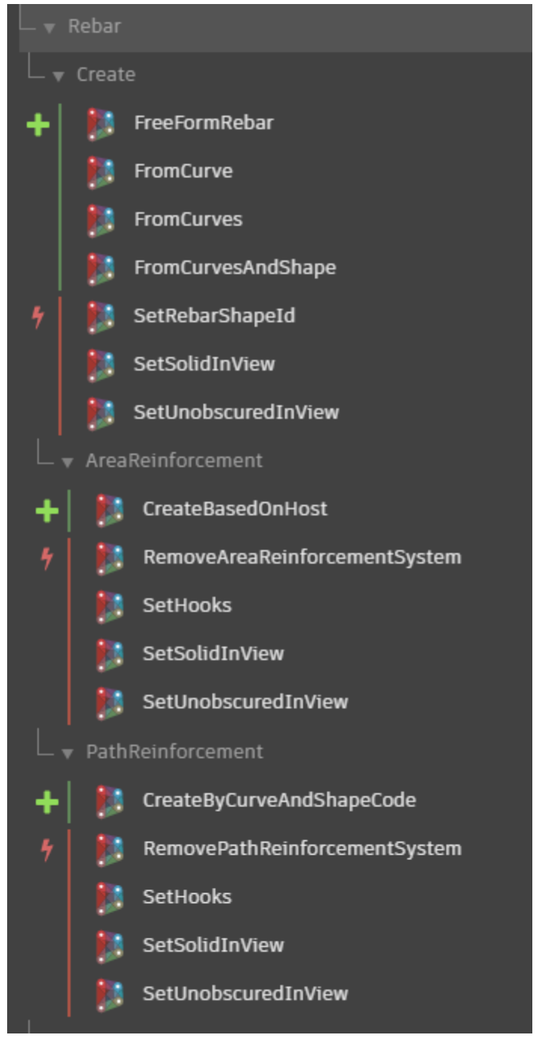


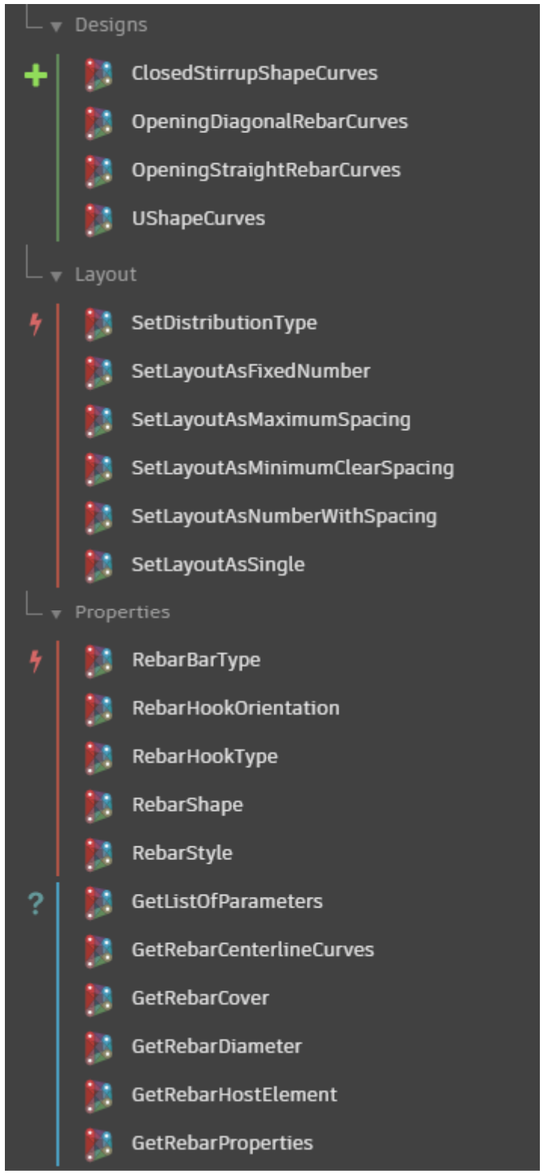
Rebar Detailing

Structural Design Dynamo package

Rebar Nodes

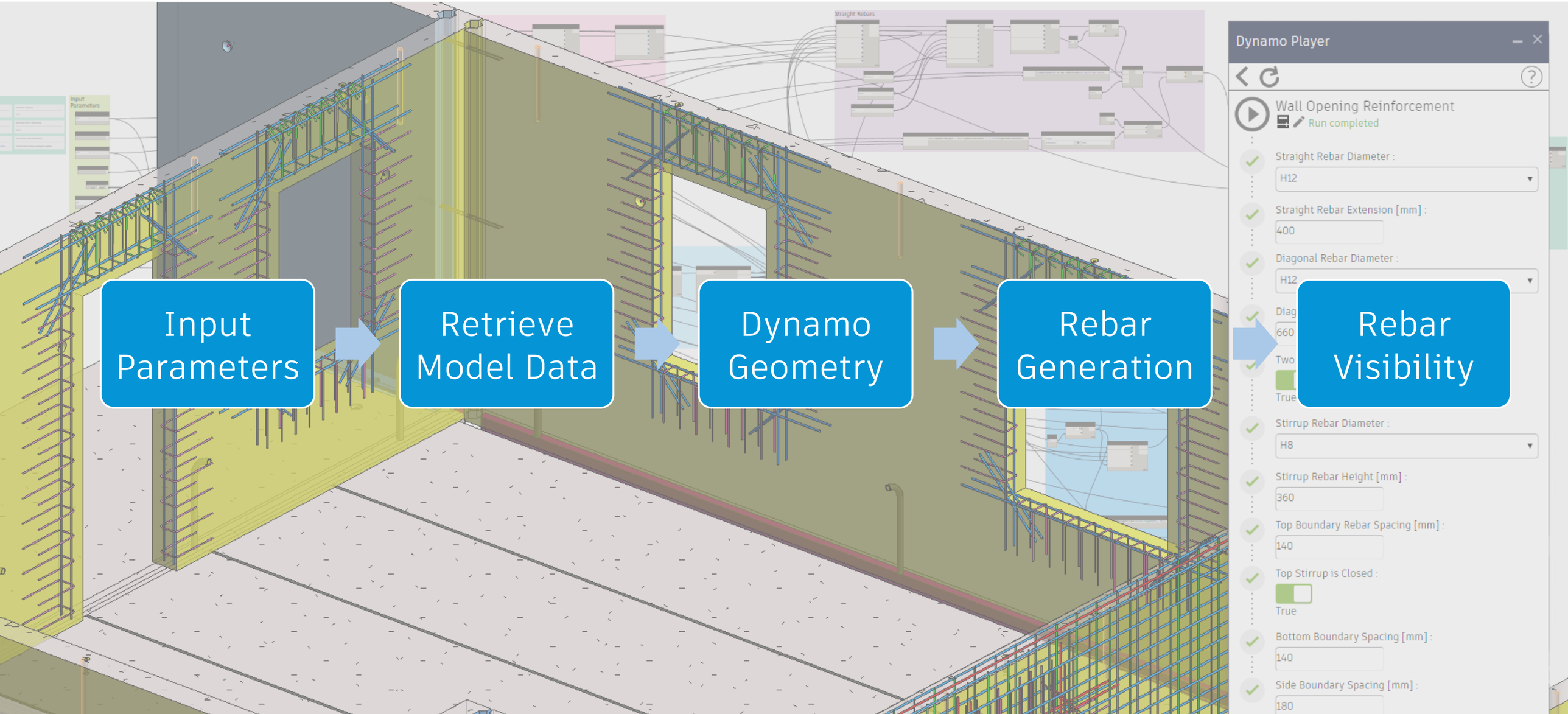
- **38** nodes to automate rebar detailing
- Area & Path reinforcement
- Typical Rebar Designs
- Rebar Visibility Control





Rebar Detailing: Process

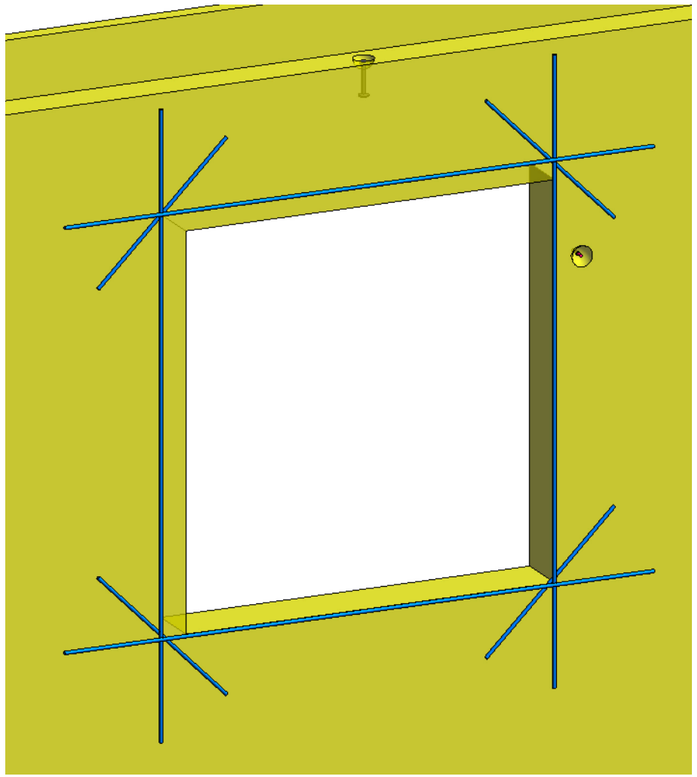
Structural Design Dynamo package



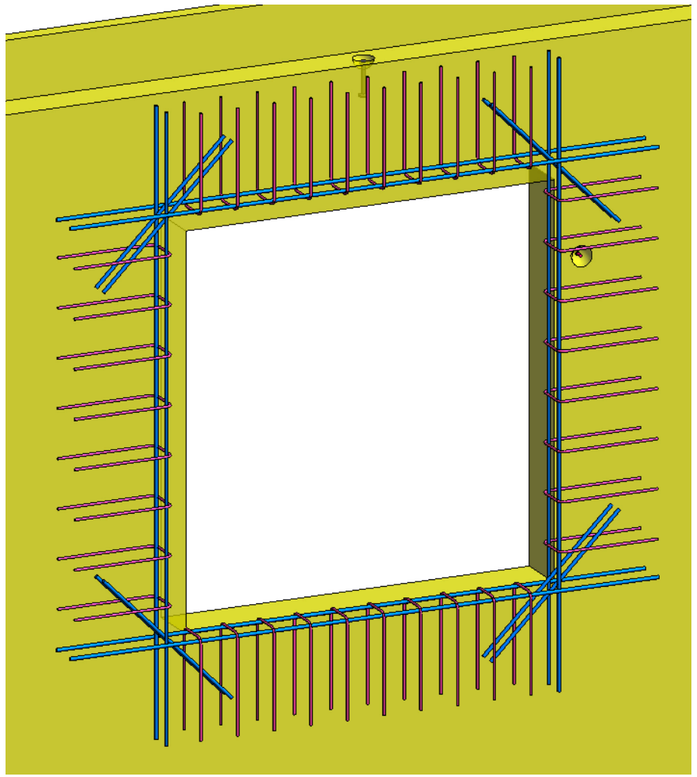
Rebar Detailing

Structural Design Dynamo package

Automated process of reinforcement detailing around wall openings

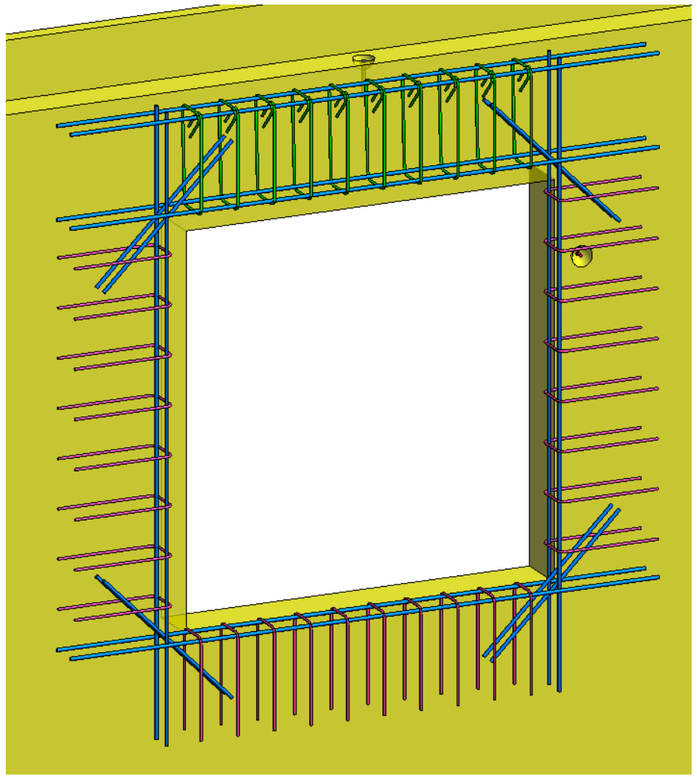


One Layer



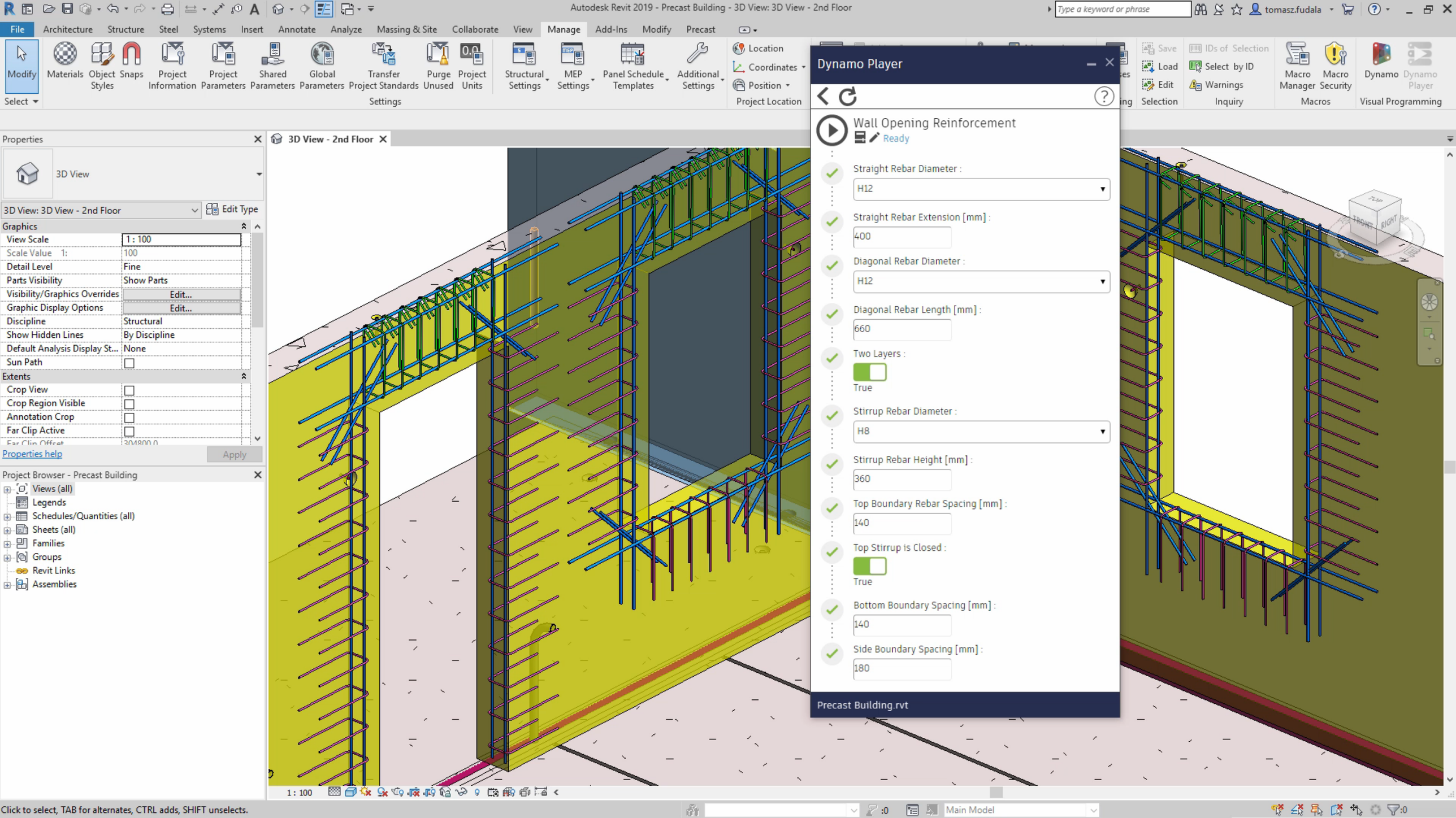
Two Layers &

Top Stirrups with U-shape



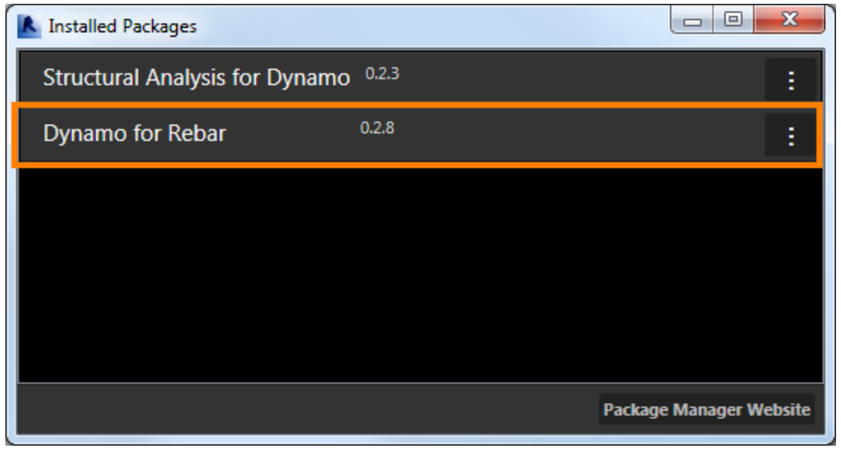
Two Layers &

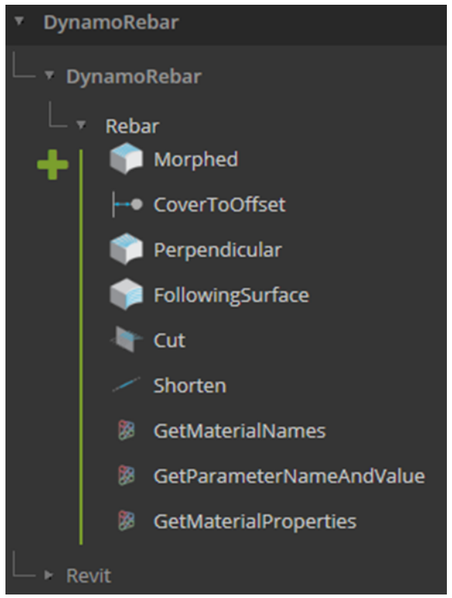
Top Stirrups are Closed

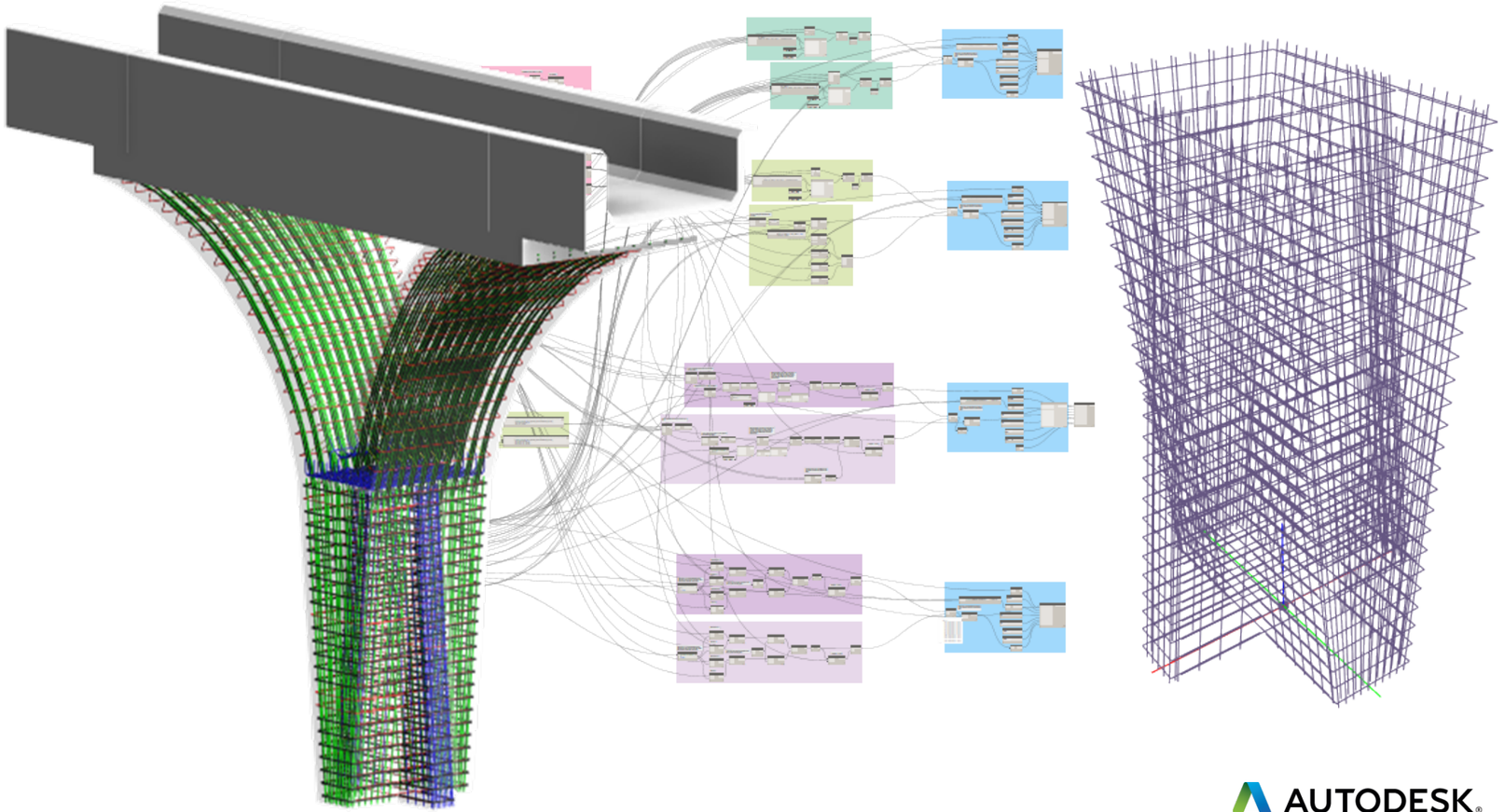

Autodesk Revit 2019 - Precast Building - 3D View: 3D View - 2nd Floor
File
Architecture
Structure
Steel
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Modify
Precast
Modify
Materials
Object Styles
Snaps
Project Information
Project Parameters
Shared Parameters
Global Parameters
Transfer Project Standards
Purge Unused
Project Units
Structural Settings
MEP Settings
Panel Schedule Templates
Additional Settings
Settings
Location
Coordinates
Position
Project Location
Save
Load
Edit
Selection
IDs of Selection
Select by ID
Warnings
Inquiry
Macro Manager
Macro Security
Macros
Dynamo
Dynamo Player
Visual Programming
Properties
3D View
3D View: 3D View - 2nd Floor
Edit Type
Graphics
View Scale 1 : 100
Scale Value 1: 100
Detail Level Fine
Parts Visibility Show Parts
Visibility/Graphics Overrides Edit...
Graphic Display Options Edit...
Discipline Structural
Show Hidden Lines By Discipline
Default Analysis Display St... None
Sun Path
Extents
Crop View
Crop Region Visible
Annotation Crop
Far Clip Active
Properties help
Apply
Project Browser - Precast Building
Views (all)
Legends
Schedules/Quantities (all)
Sheets (all)
Families
Groups
Revit Links
Assemblies
3D View - 2nd Floor
Dynamo Player
Wall Opening Reinforcement
Ready
Straight Rebar Diameter :
H12
Straight Rebar Extension [mm] :
400
Diagonal Rebar Diameter :
H12
Diagonal Rebar Length [mm] :
660
Two Layers :
True
Stirrup Rebar Diameter :
H8
Stirrup Rebar Height [mm] :
360
Top Boundary Rebar Spacing [mm] :
140
Top Stirrup is Closed :
True
Bottom Boundary Spacing [mm] :
140
Side Boundary Spacing [mm] :
180
Precast Building.rvt
1 : 100
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.
Main Model

Dynamo for Rebar

- Complex concrete shapes
- Fabrication factors in early design
- Rebar detailing for free forms







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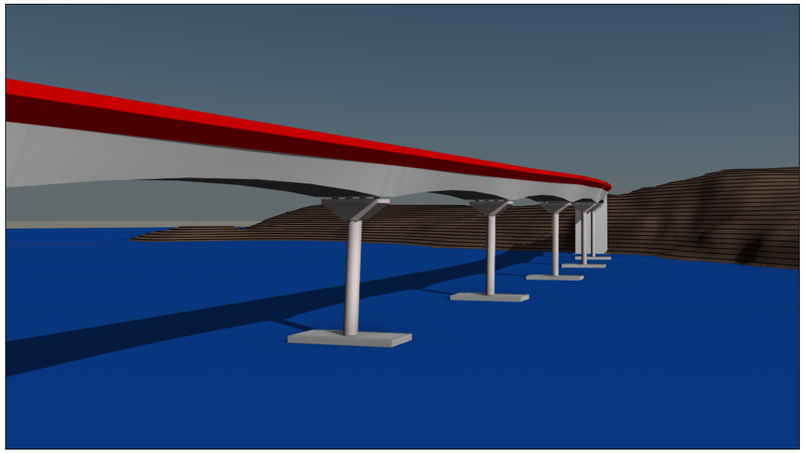
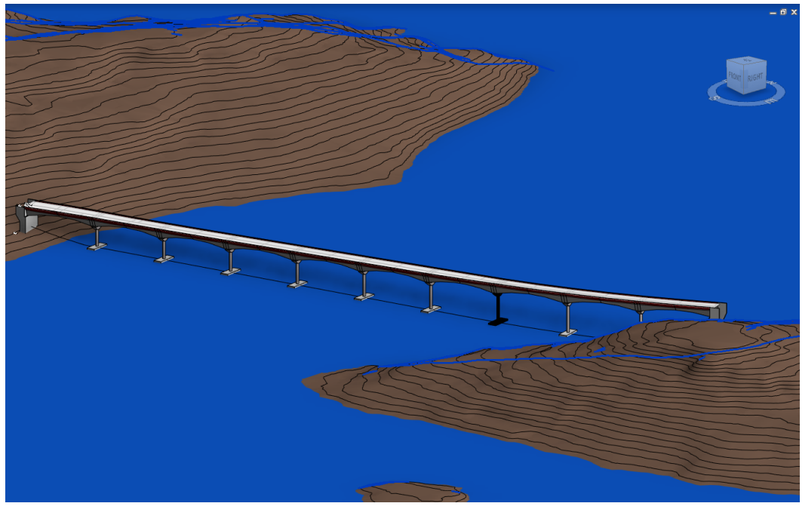
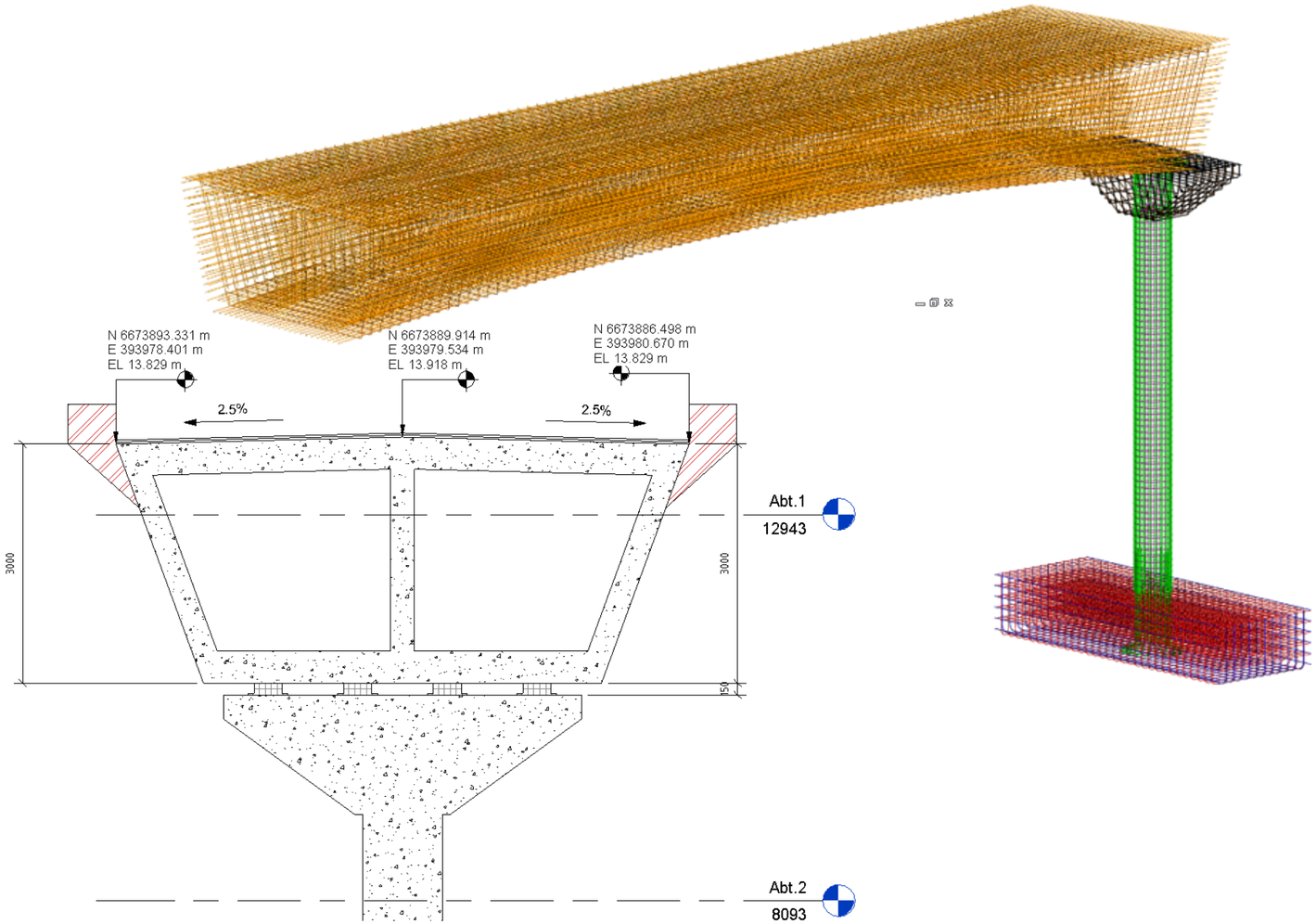
Concrete Box Girder Bridge

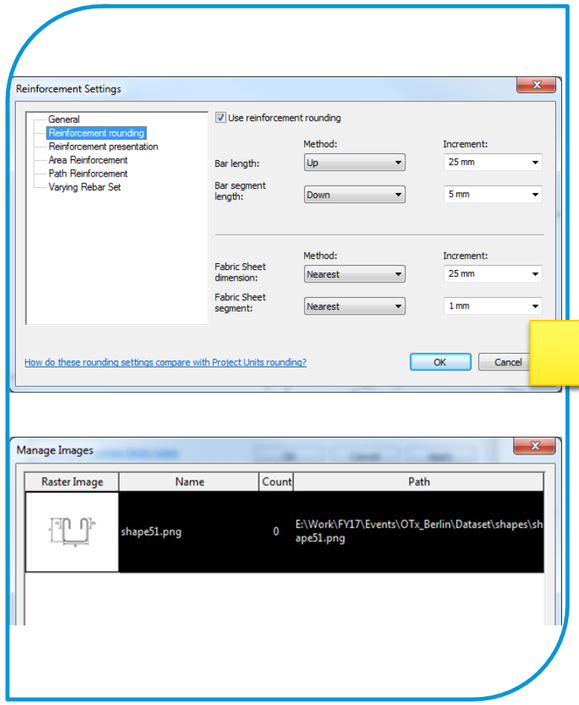






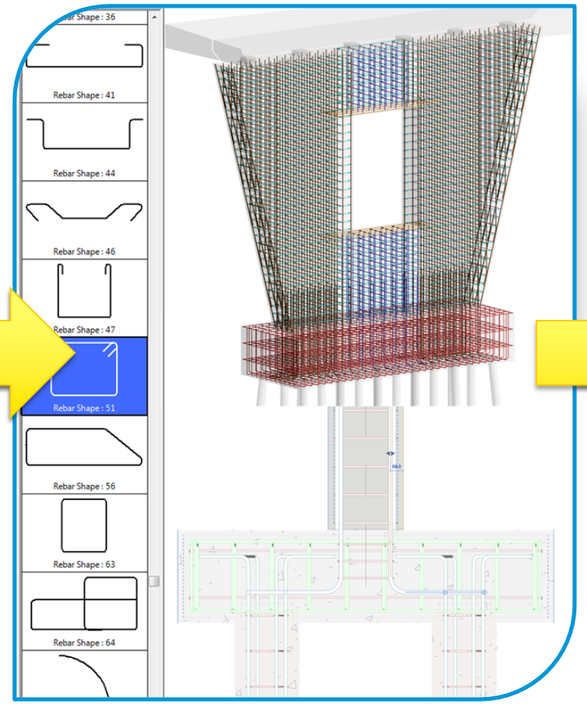
Parametric reinforcement modelling

AUTODESK® REVIT®



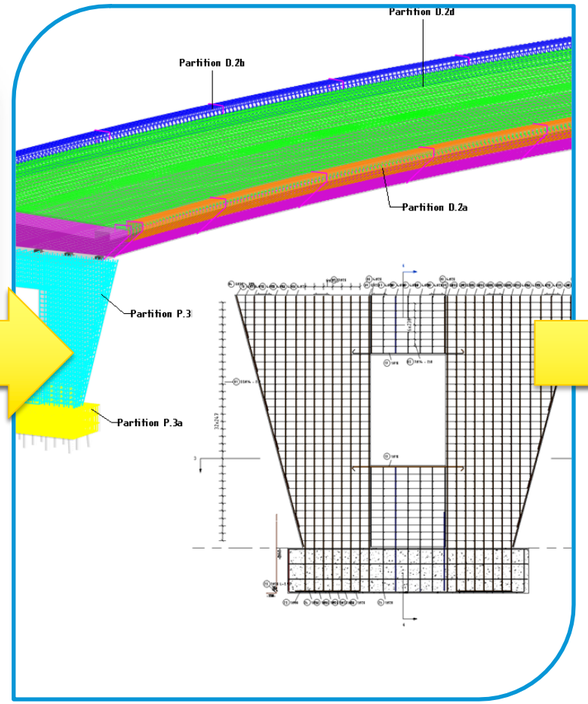
Rebar settings

AUTODESK® REVIT®



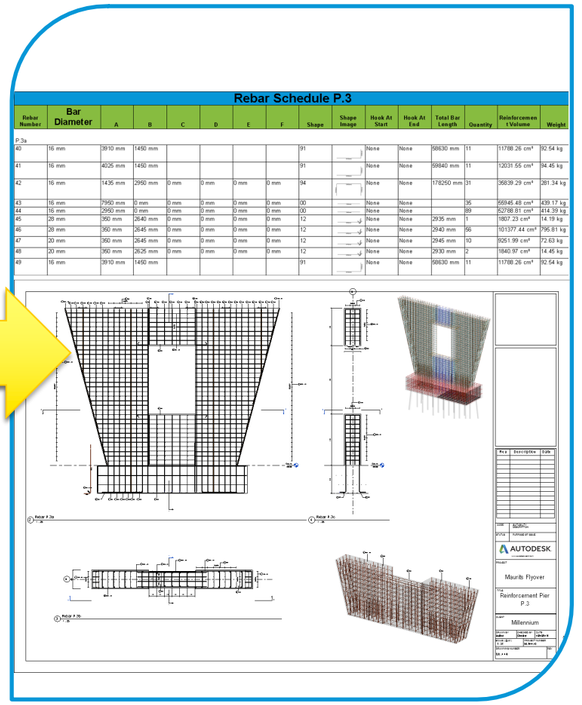
Rebar modelling

AUTODESK® REVIT®



Rebar annotation

AUTODESK® REVIT®

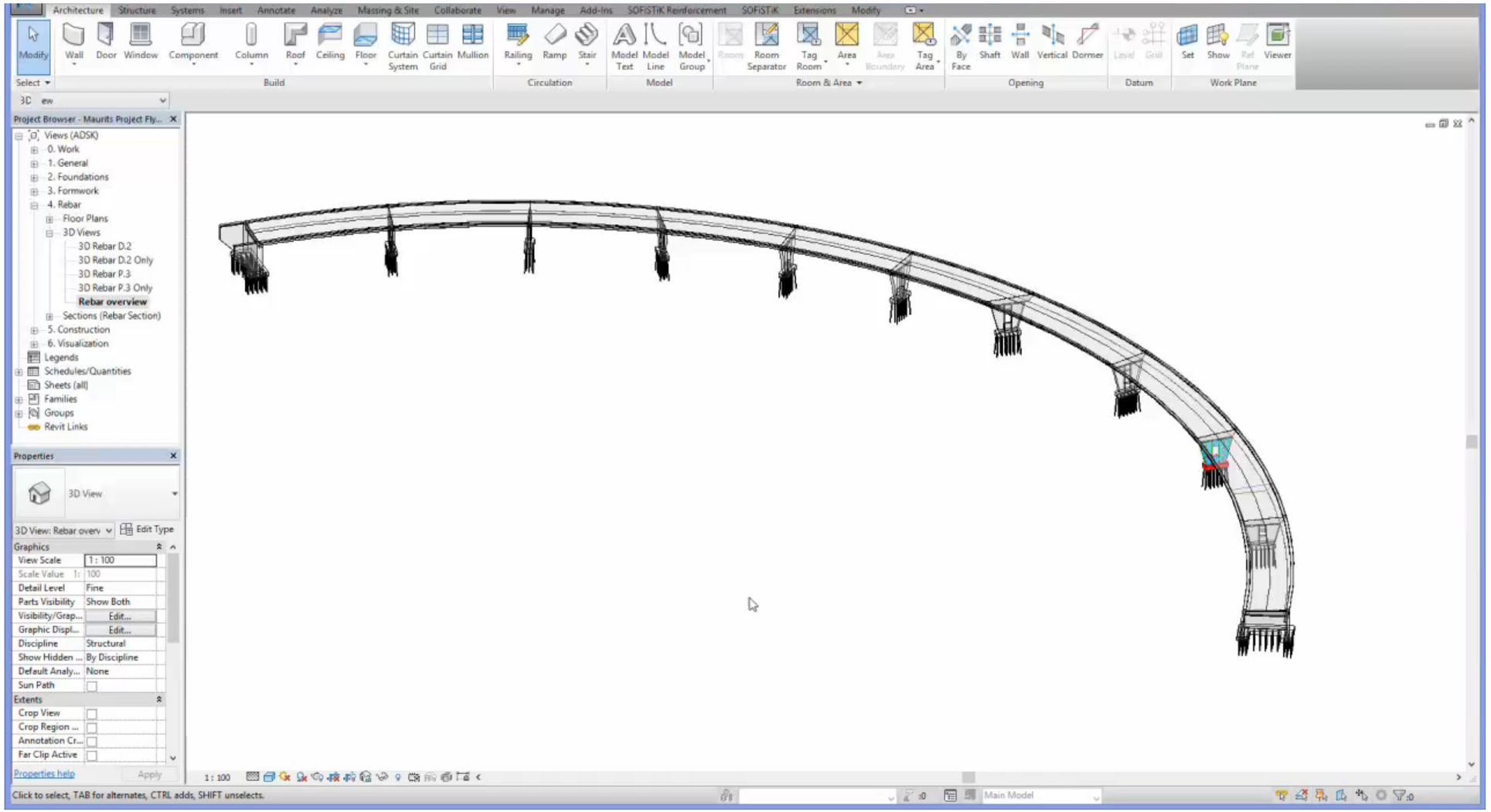


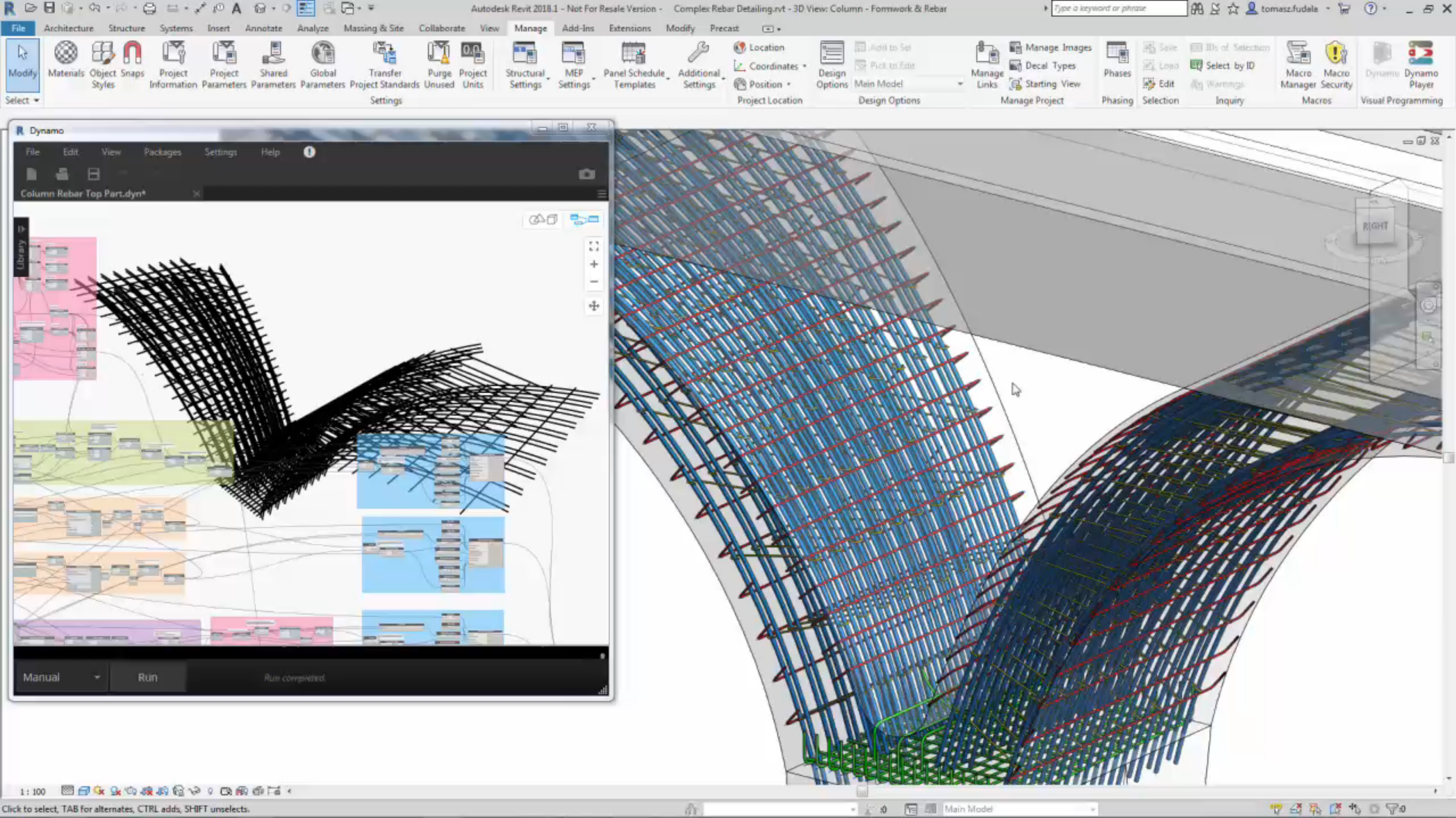
Documentation

AUTODESK®

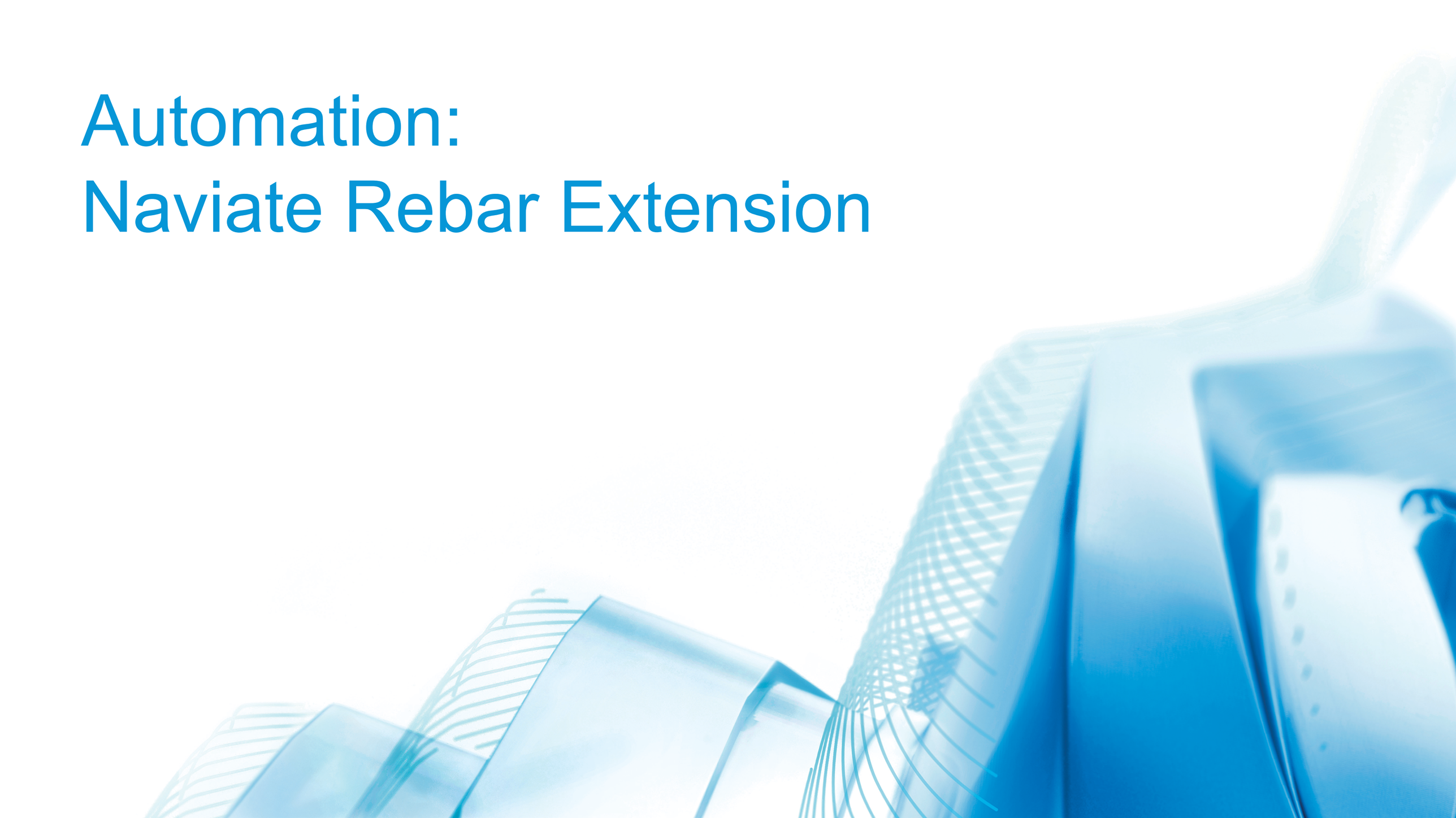
Computational Rebar modelling

Autodesk Revit® & Dynamo



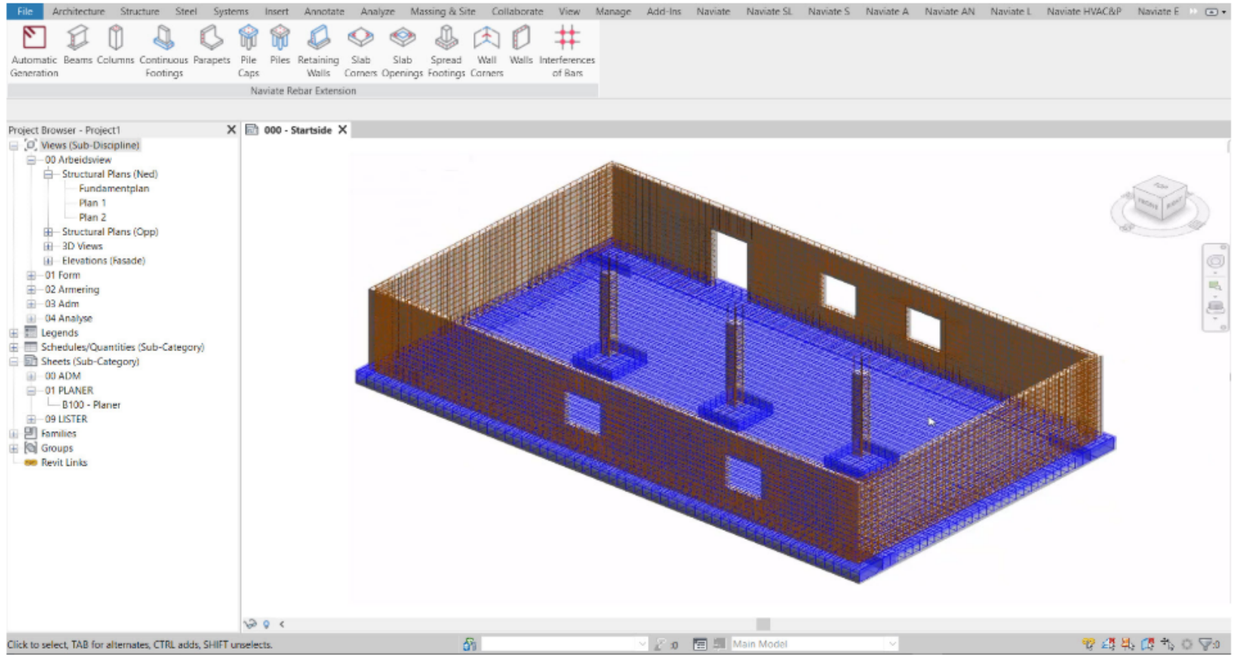

Autodesk Revit 2018.1 - Not For Resale Version - Complex Rebar Detailing.rvt - 3D View: Column - Formwork & Rebar
File
Architecture
Structure
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Extensions
Modify
Precast
Modify
Materials
Object Styles
Snaps
Project Information
Project Parameters
Shared Parameters
Global Parameters
Transfer Project Standards
Purge Unused
Project Units
Settings
Structural Settings
MEP Settings
Panel Schedule Templates
Additional Settings
Location
Coordinates
Position
Project Location
Design Options
Main Model
Manage Links
Manage Images
Decal Types
Starting View
Manage Project
Phases
Phasing
Edit
Selection
Select by ID
Inquiry
Macro Manager
Macro Security
Macros
Dynamo Player
Visual Programming
Dynamo
File
Edit
View
Packages
Settings
Help
Column Rebar Top Part.dyn*
Library
Manual
Run
Run completed.
RIGHT
1 : 100
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.
Main Model

Automation:
Naviate Rebar Extension



Naviate Rebar Extension (Free plug-in)

- Features
  - Automatic reinforcement generation
  - Beams
  - Columns
  - Continuous footings
  - Parapets
  - Pile caps
  - Piles
  - Retaining walls
  - Slab corners
  - Slab openings
  - Spread footings
  - Walls corners
  - Walls
  - Interference of reinforcing bars



https://www.naviate.com/product/naviate-rebar-extension/p-660

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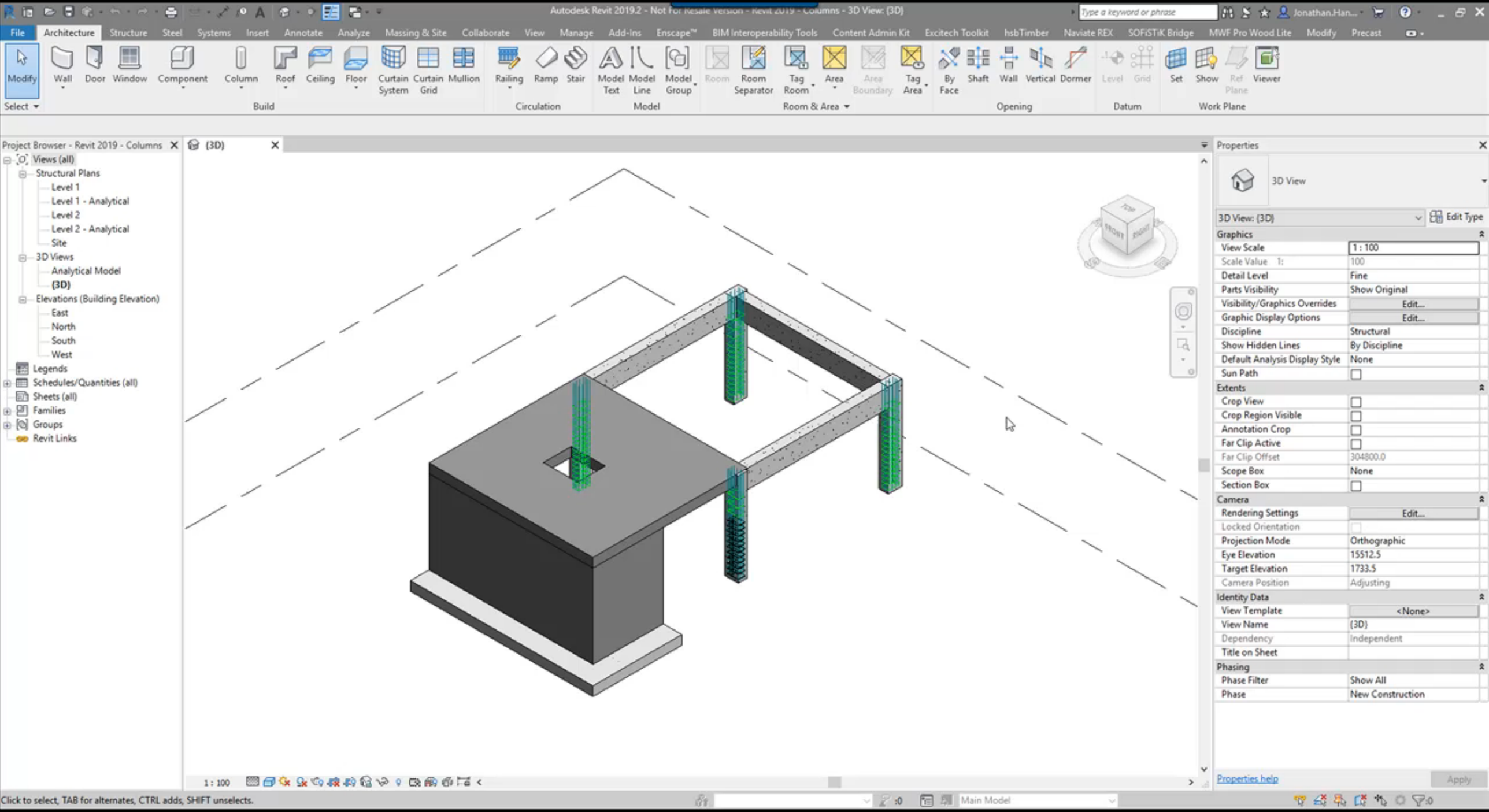
Autodesk Revit 2019.2 - Not For Resale Version - Revit 2019 - Columns - 3D View: {3D}
File
Architecture
Structure
Steel
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Enscape™
BIM Interoperability Tools
Content Admin Kit
Excitech Toolkit
hsbTimber
Naviate REX
SOFiSTiK Bridge
MWF Pro Wood Lite
Modify
Precast
Modify
Wall
Door
Window
Component
Column
Roof
Ceiling
Floor
Curtain System
Curtain Grid
Mullion
Railing
Ramp
Stair
Model Text
Model Line
Model Group
Room
Room Separator
Tag Room
Area
Area Boundary
Tag Area
By Face
Shaft
Wall
Vertical
Dormer
Level
Grid
Set
Show
Ref Plane
Viewer
Select
Build
Circulation
Model
Room & Area
Opening
Datum
Work Plane
Project Browser - Revit 2019 - Columns
Views (all)
Structural Plans
Level 1
Level 1 - Analytical
Level 2
Level 2 - Analytical
Site
3D Views
Analytical Model
{3D}
Elevations (Building Elevation)
East
North
South
West
Legends
Schedules/Quantities (all)
Sheets (all)
Families
Groups
Revit Links
{3D}
Properties
3D View
3D View: {3D}
Edit Type
Graphics
View Scale
1 : 100
Scale Value 1:
100
Detail Level
Fine
Parts Visibility
Show Original
Visibility/Graphics Overrides
Edit...
Graphic Display Options
Edit...
Discipline
Structural
Show Hidden Lines
By Discipline
Default Analysis Display Style
None
Sun Path
Extents
Crop View
Crop Region Visible
Annotation Crop
Far Clip Active
Far Clip Offset
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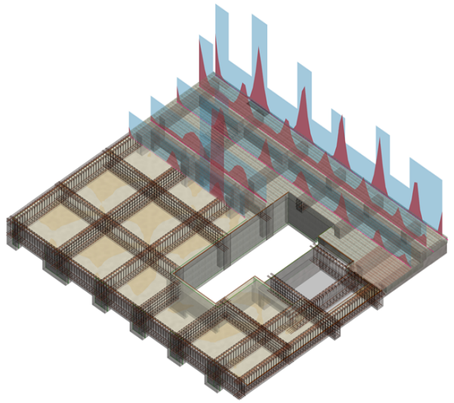
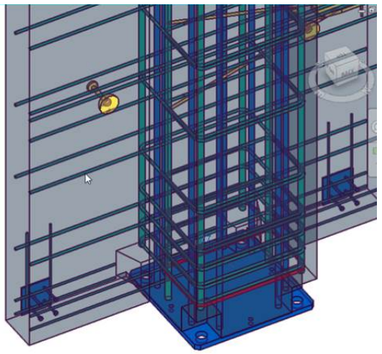
Scope Box
None
Section Box
Camera
Rendering Settings
Edit...
Locked Orientation
Projection Mode
Orthographic
Eye Elevation
15512.5
Target Elevation
1733.5
Camera Position
Adjusting
Identity Data
View Template
<None>
View Name
{3D}
Dependency
Independent
Title on Sheet
Phasing
Phase Filter
Show All
Phase
New Construction
Properties help
Apply
1 : 100
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.
Main Model

Other Industry Partners



- Industry Partners build on top of Revit to:
  - Extend and complete Revit to domain specific workflows
  - Turn platforms into mature solutions
  - Provide domain and country specific expertise to Revit



SOFiSTiK http://www.sofistik.com/

GRAITEC http://www.graitec.com/

EDGE^REVIT http://www.edgeforrevit.com/

PTAC CONSULTING ENGINEERS http://ptac.com/

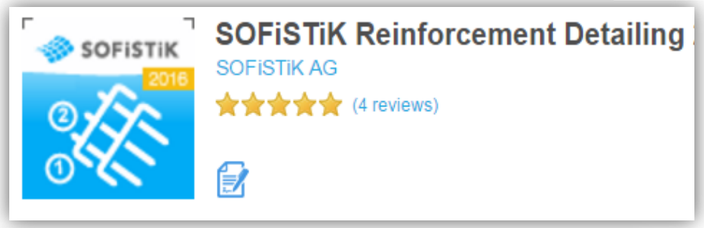
aSa® http://www.asarebar.com/

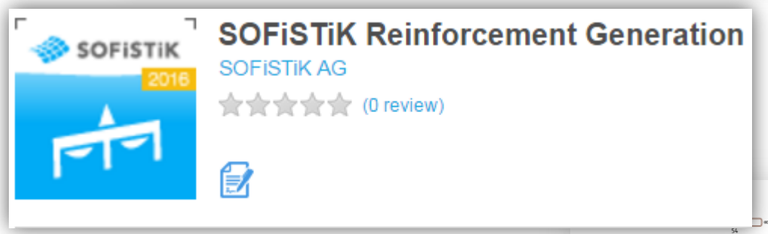
IDAT http://www.idat.de/

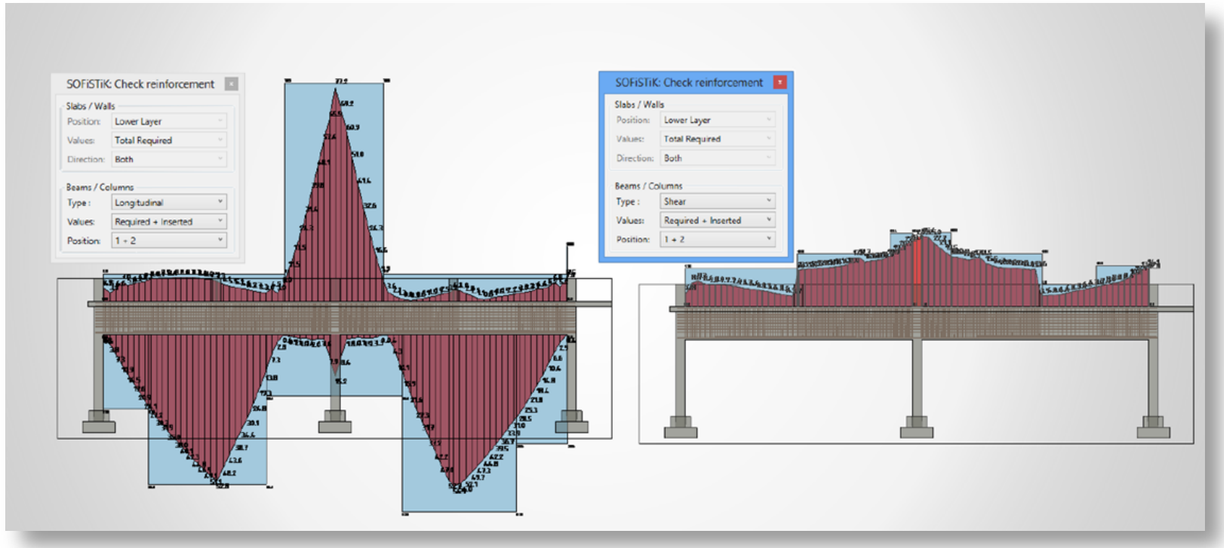
AUTODESK.

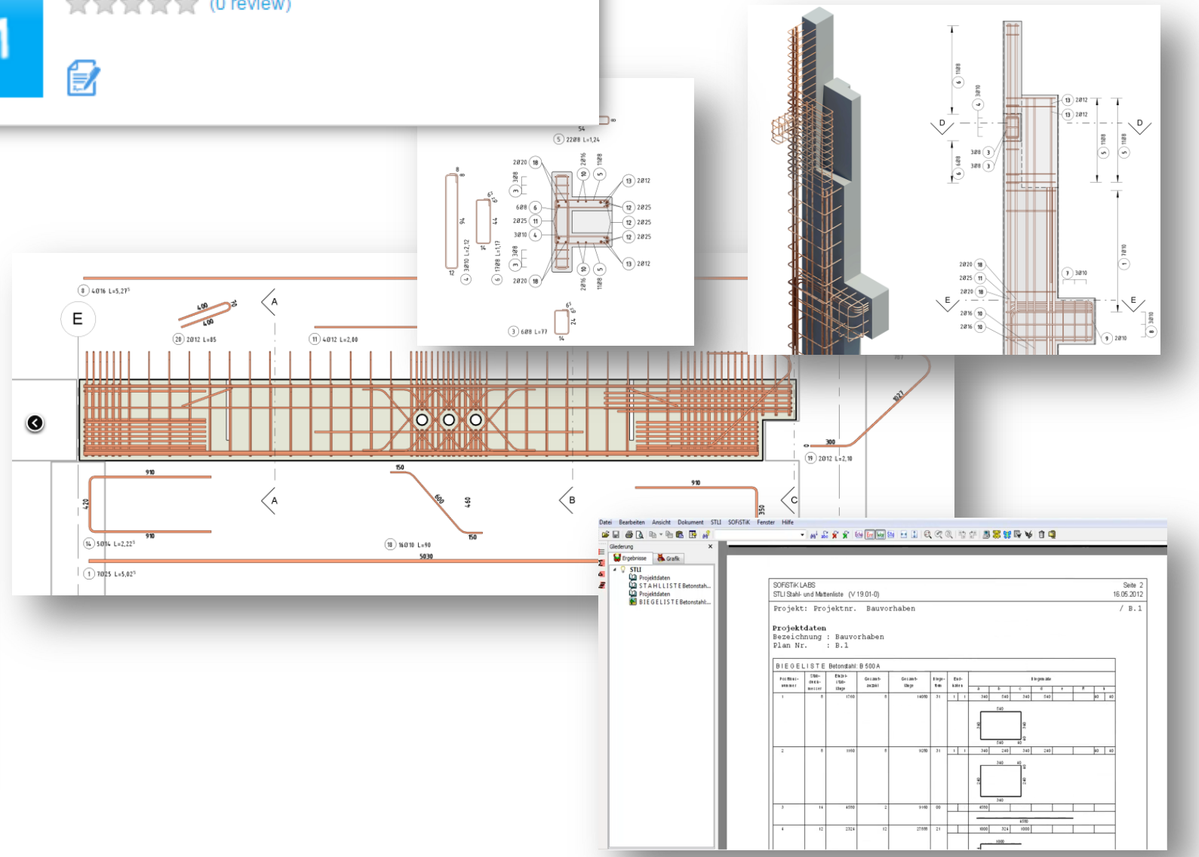
Reinforcement Detailing based on results

- Sofistik Reinforcement Generation
- Use Result Packages in Revit
- Available on [Autodesk App Store]









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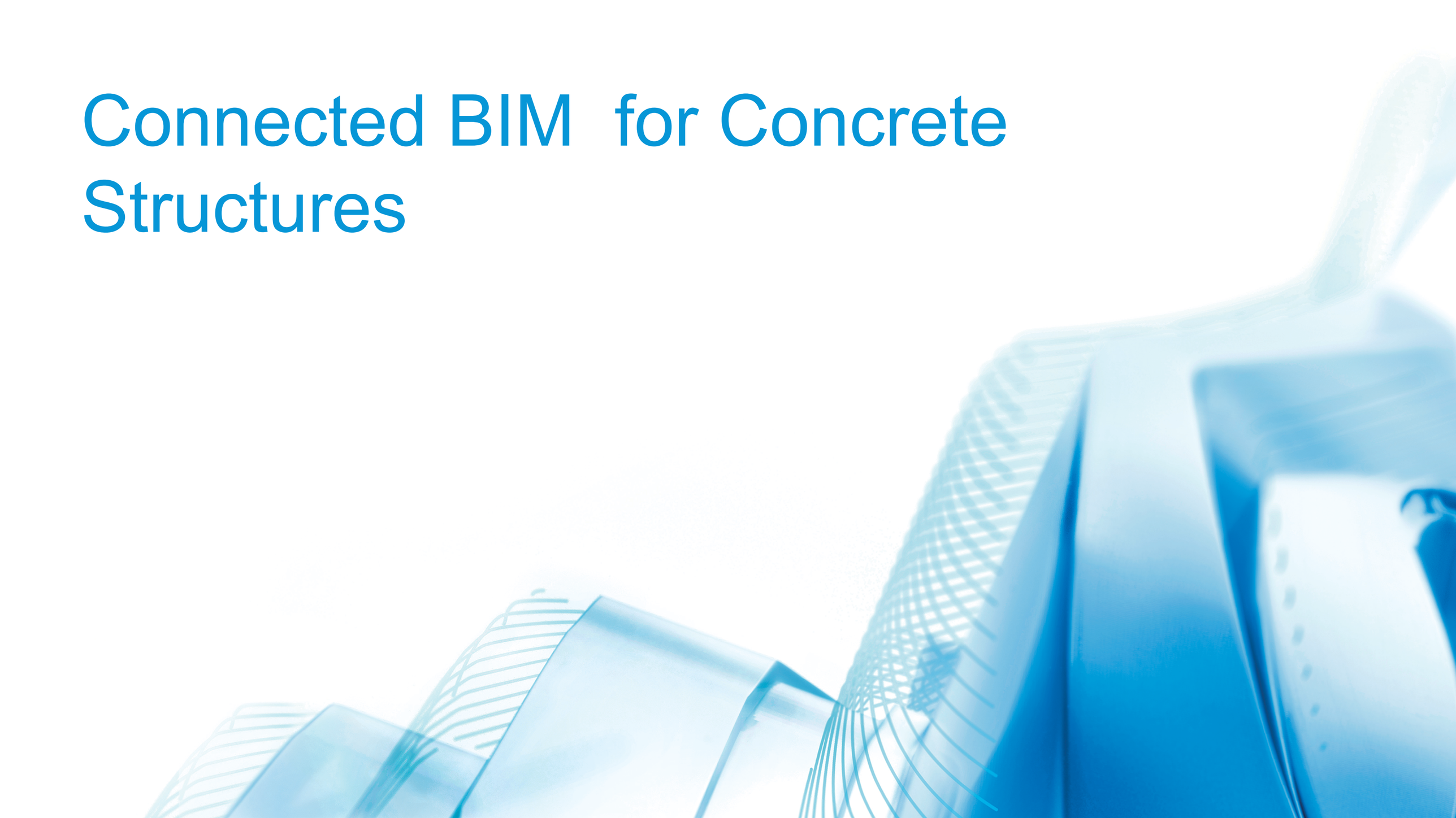
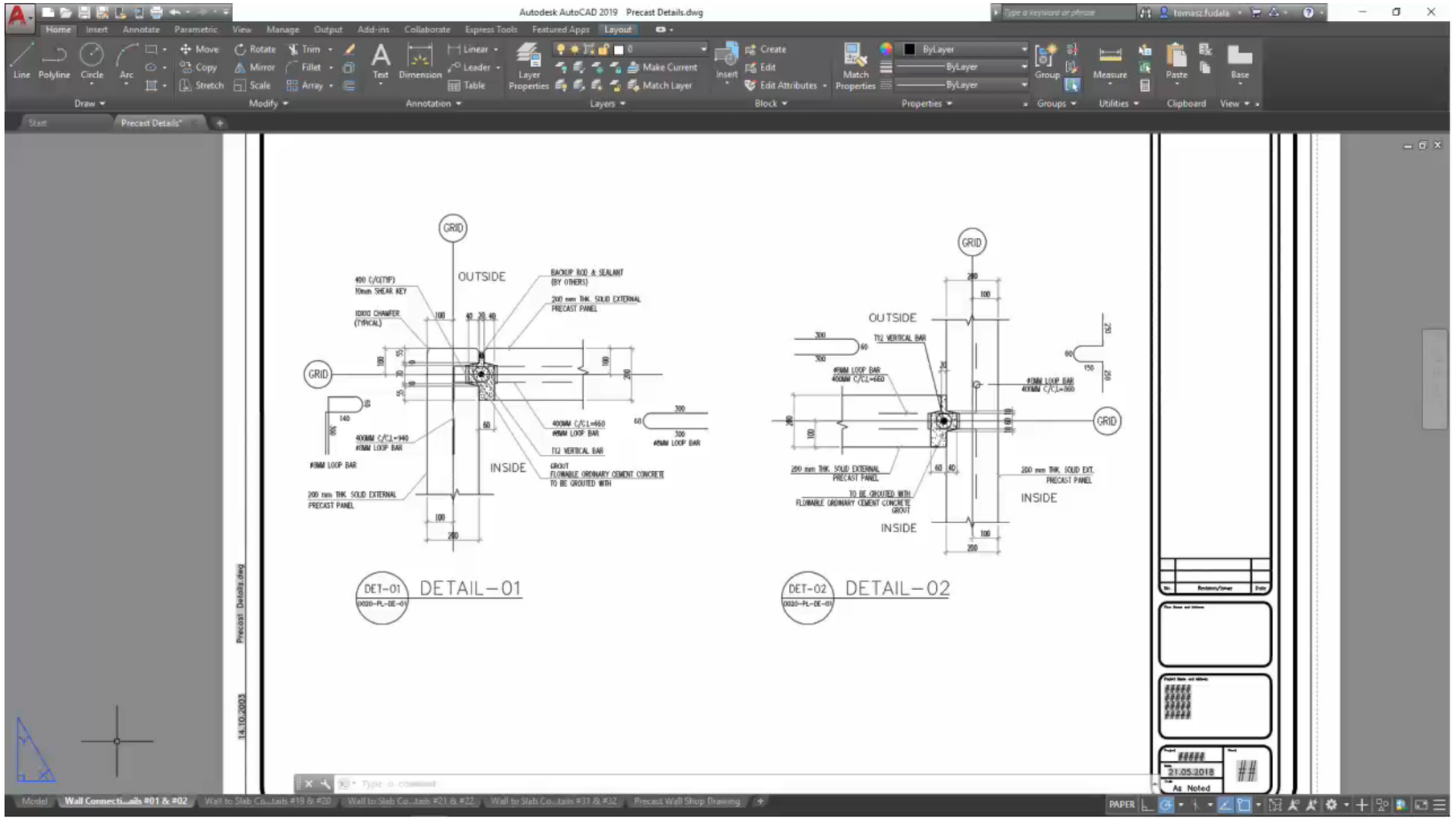
Connected BIM for Concrete Structures



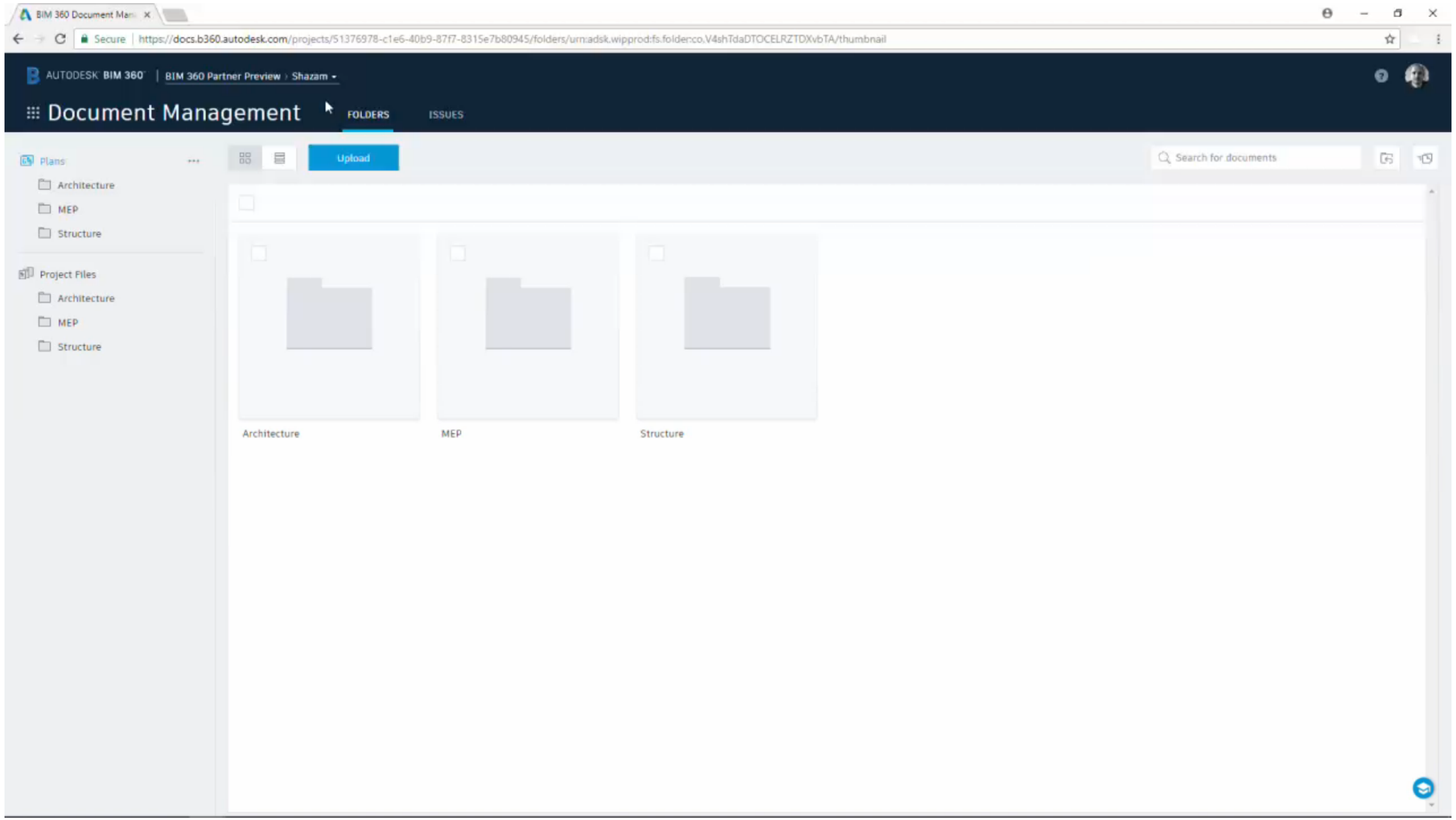
Connected BIM for Concrete Structures

Communication of Designs using BIM 360 Docs



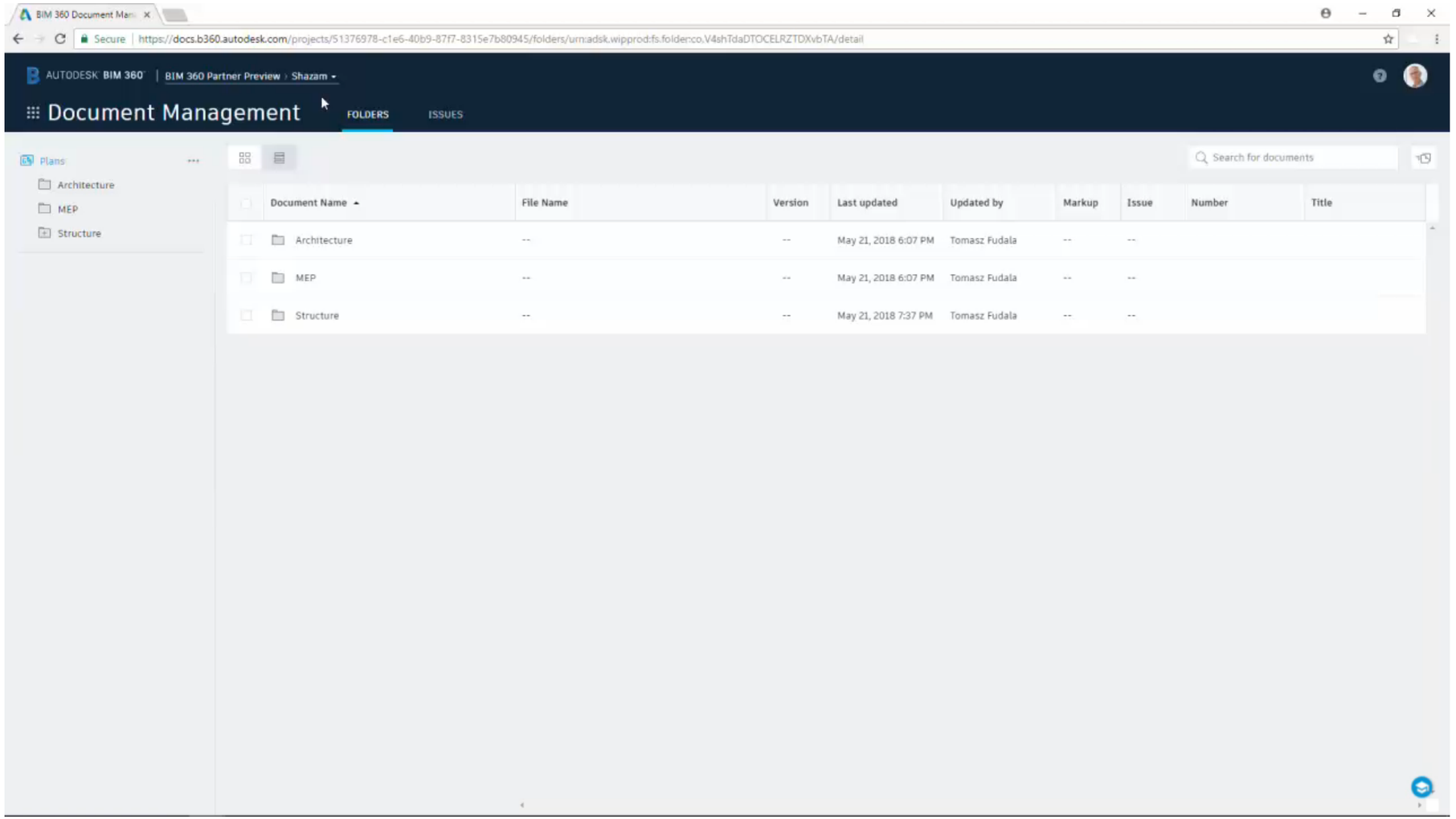
Connected BIM for Concrete Structures

Creation of LOD 400 model



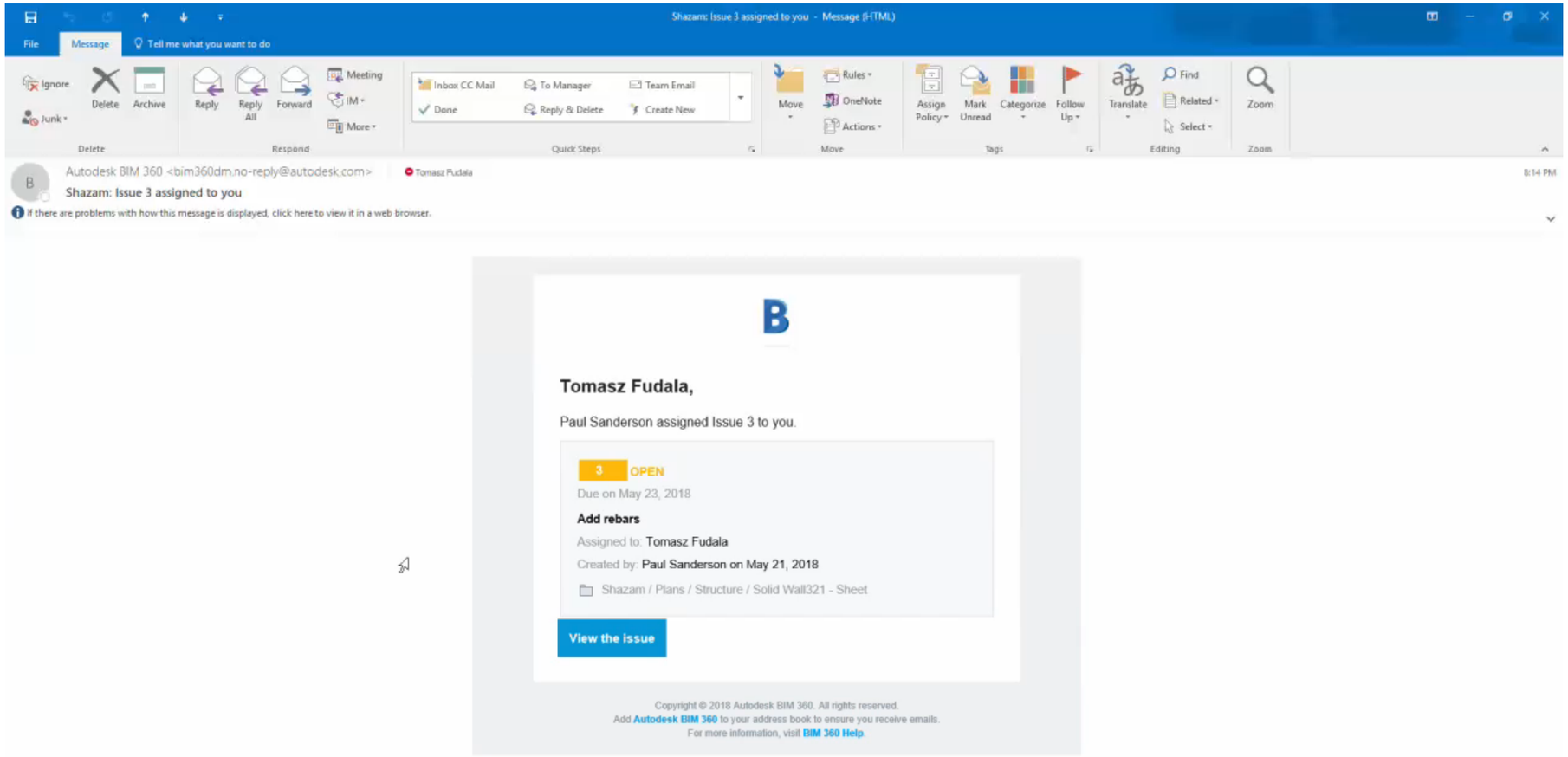
Connected BIM for Concrete Structures

Design Review Process



Connected BIM for Concrete Structures

Update Design



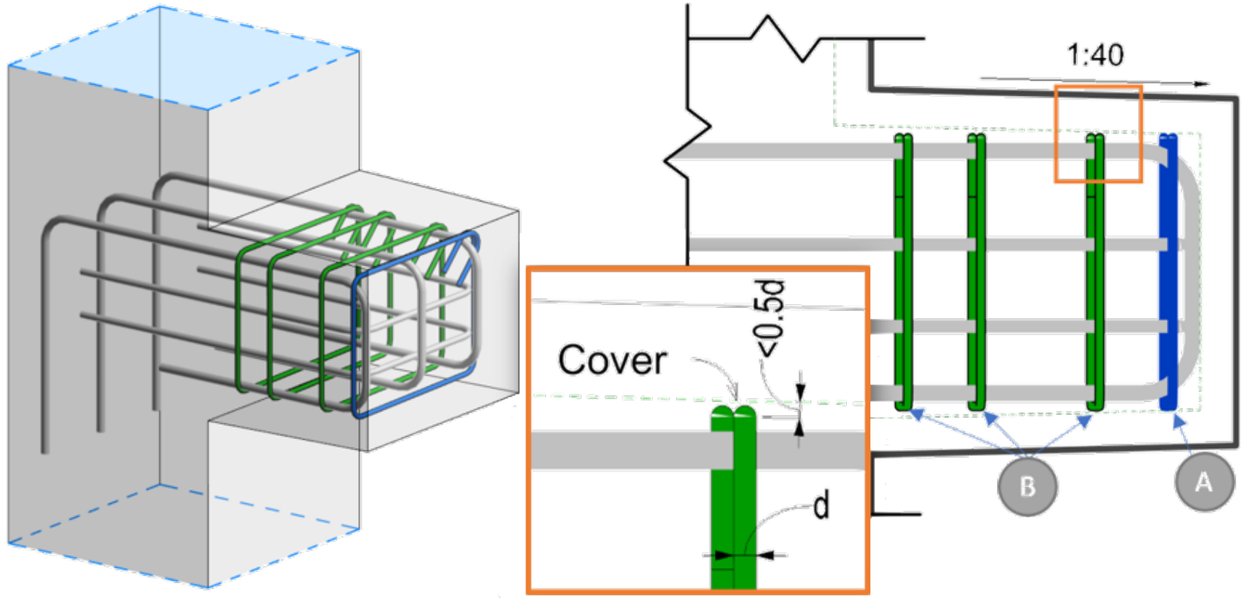
What’s new for RC in Revit

New feature

Autodesk Revit 2020

Improved Rebar Copy & Move Logic

- Improved rebar snapping to the cover
- Preserve bar dimensions during interaction with concrete cover
- Get consistent rebar fabrication data when copying bars



Increased precision for Fabrication for copied and edited rebar

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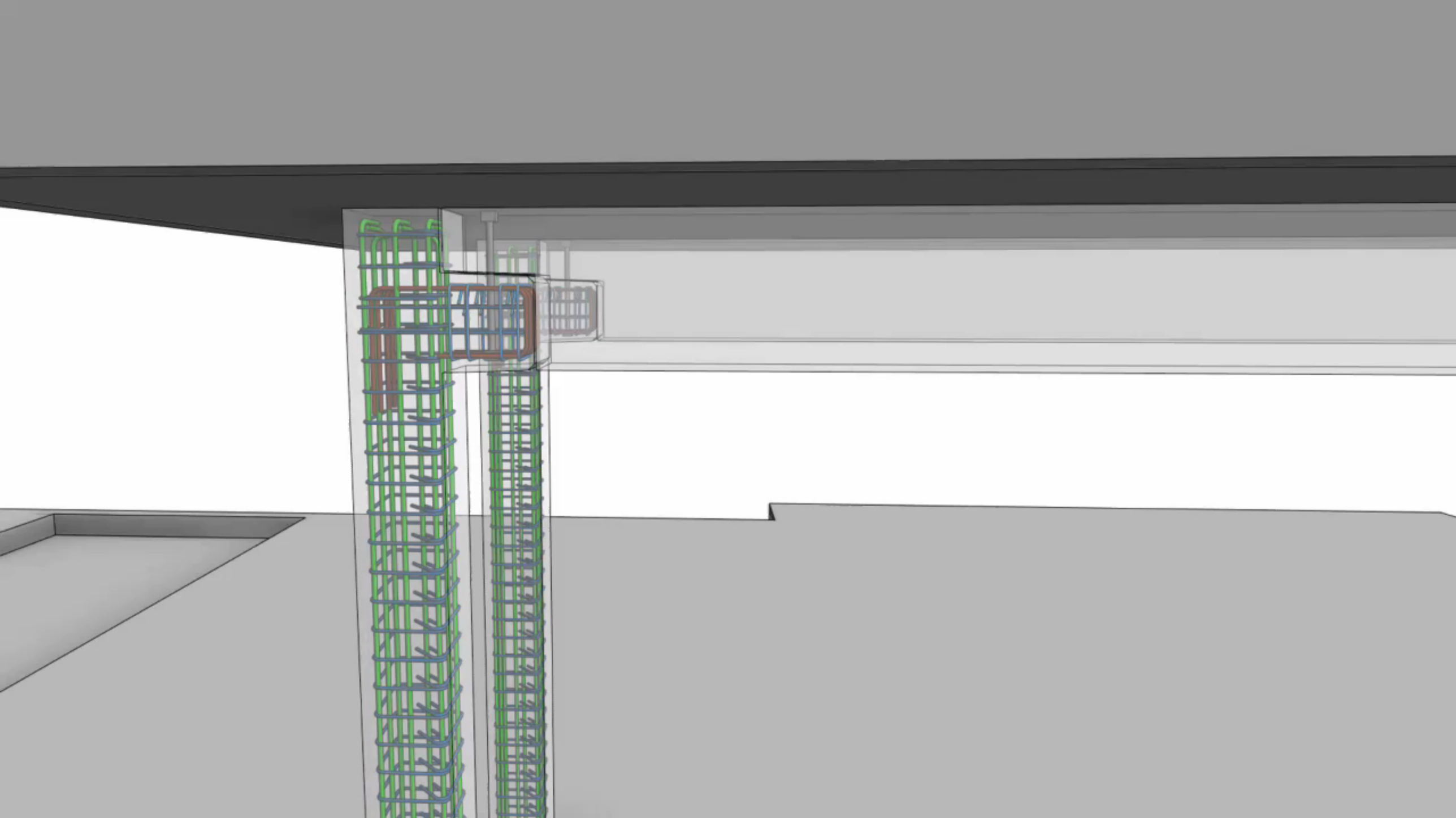
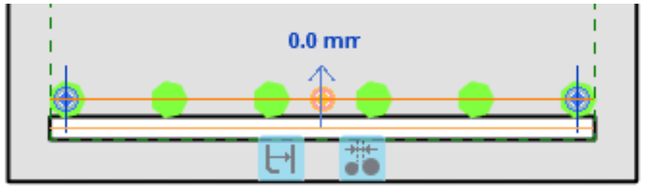


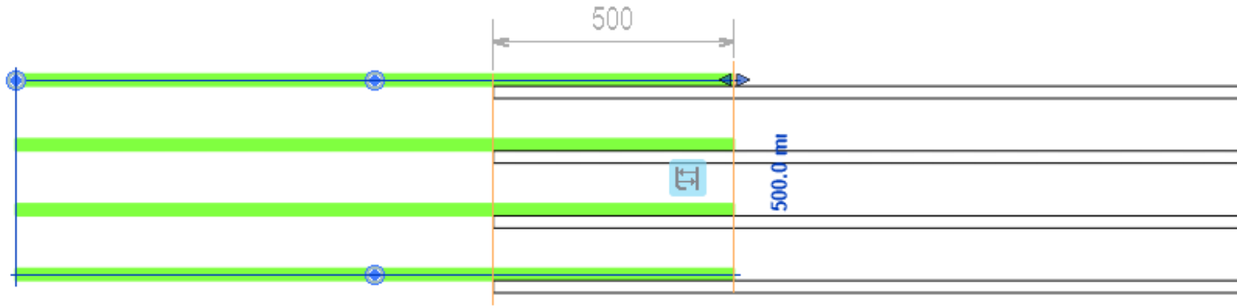
New feature

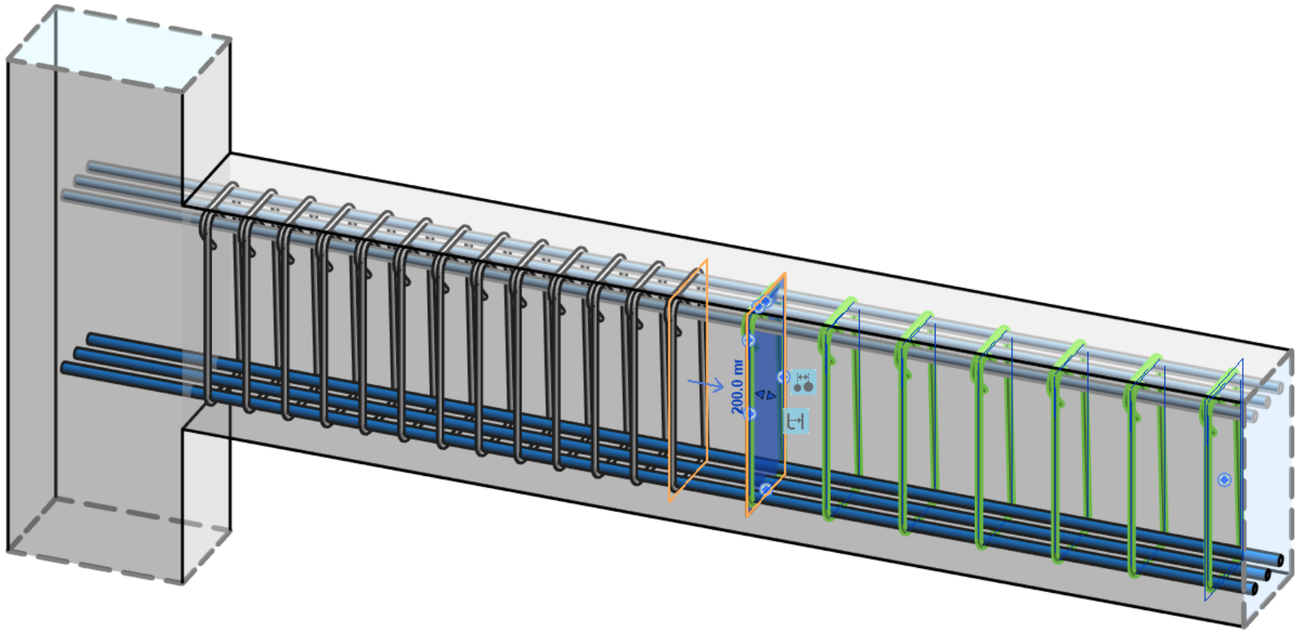
Autodesk Revit 2020.1

New Rebar to Rebar Constraint Types

- Smart rebar layers
- Parametric associations between bars
- Rebar overlapping
- Two-way constraints
- Constraints to any rebar or host in the project







Help keep designs coordinated and more accurate

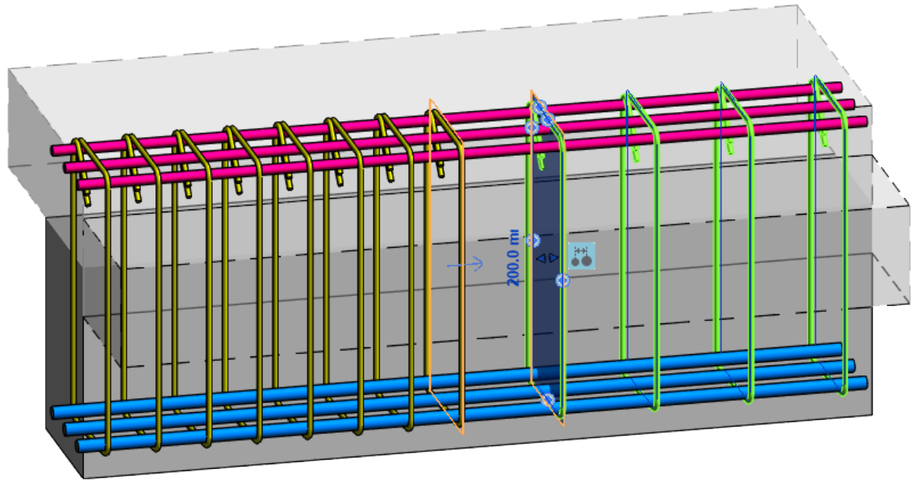
AUTODESK.

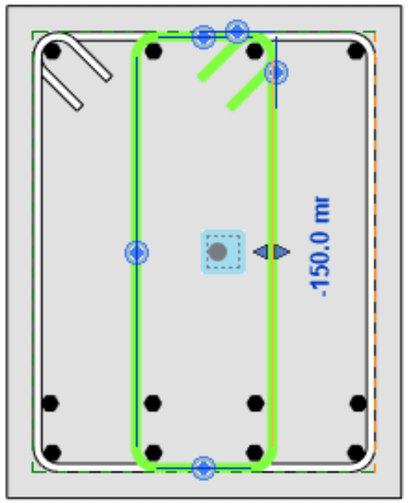
New feature

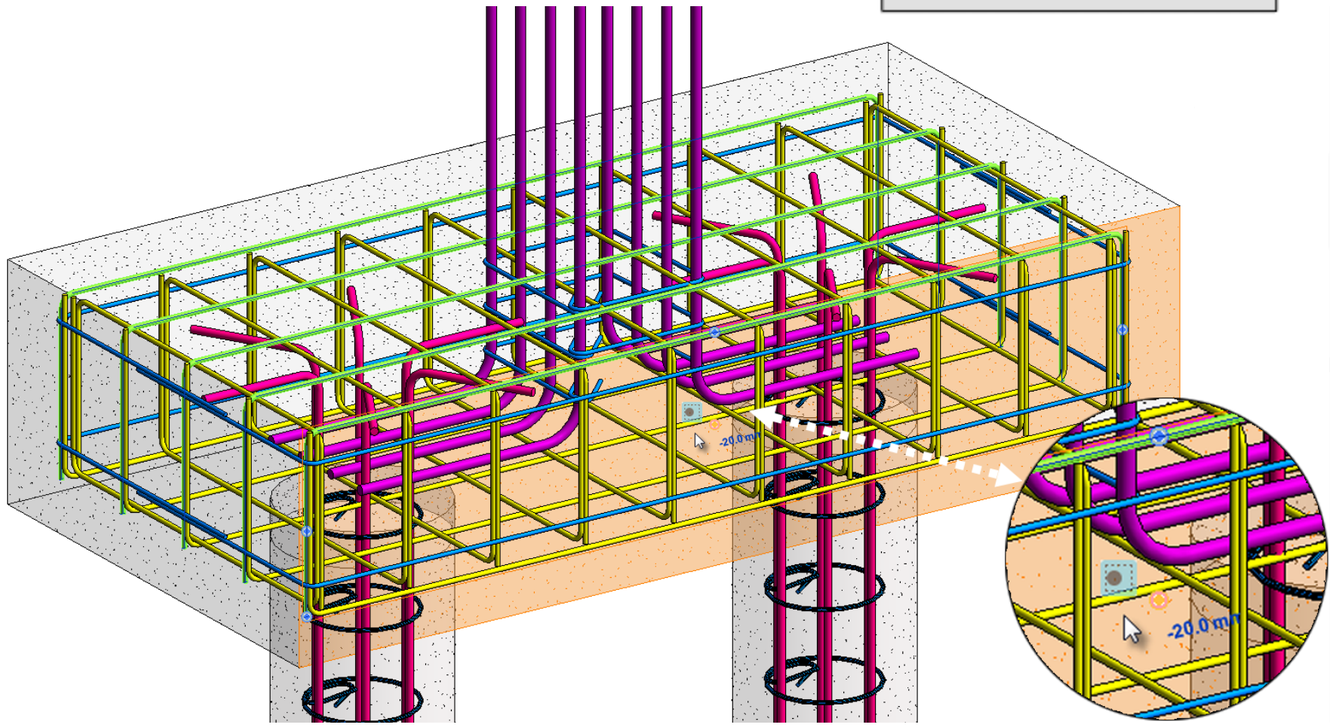
Autodesk Revit 2020.1

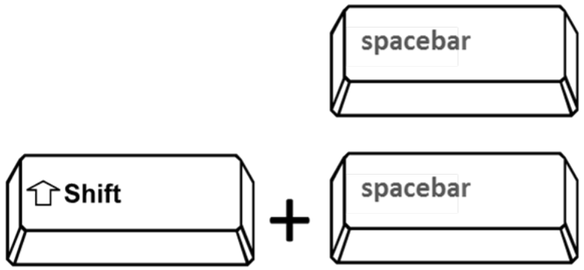
Intuitive Rebar Constraints Visualization and Editing

- New rebar constraints controls
- Precise keyboard-based adjustment o the bar geometry
- Easier selection of rebar handles and constraint targets









Provide faster model definition completeness

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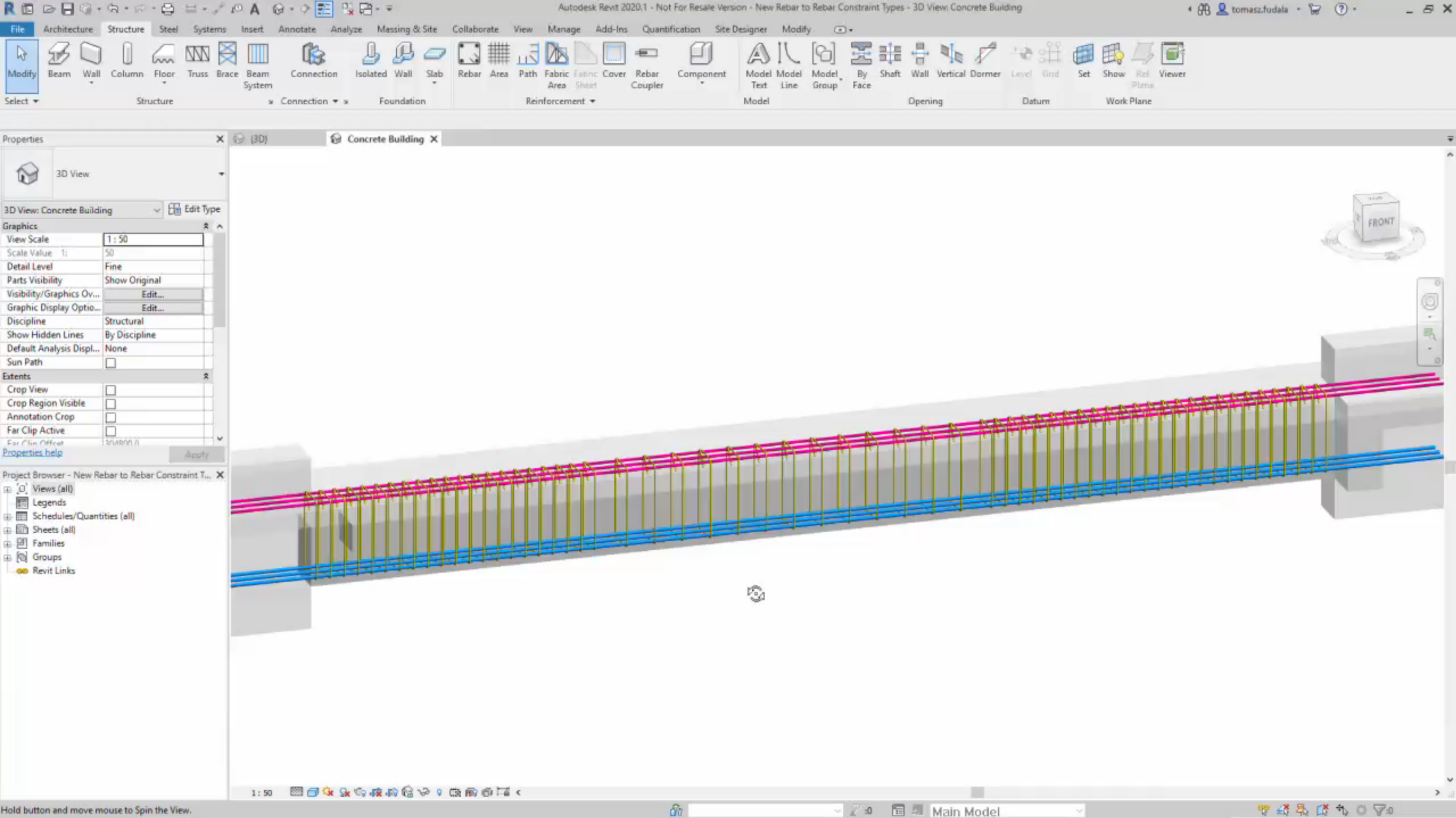
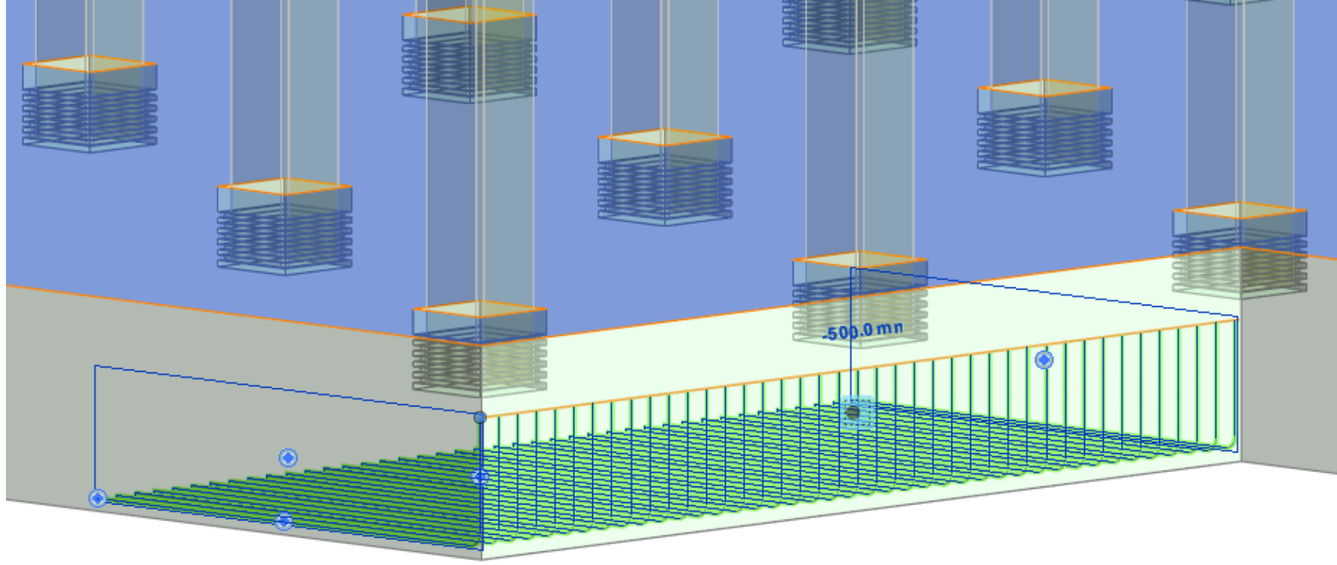

Autodesk Revit 2020.1 - Not For Resale Version - New Rebar to Rebar Constraint Types - 3D View: Concrete Building
tomasz.fudala
File
Architecture
Structure
Steel
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Quantification
Site Designer
Modify
Modify
Beam
Wall
Column
Floor
Truss
Brace
Beam System
Connection
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
Properties
3D View
3D View: Concrete Building
Edit Type
Graphics
View Scale
1 : 50
Scale Value 1:
50
Detail Level
Fine
Parts Visibility
Show Original
Visibility/Graphics Ov...
Edit...
Graphic Display Optio...
Edit...
Discipline
Structural
Show Hidden Lines
By Discipline
Default Analysis Displ...
None
Sun Path
Extents
Crop View
Crop Region Visible
Annotation Crop
Far Clip Active
Properties help
Apply
Project Browser - New Rebar to Rebar Constraint T...
Views (all)
Legends
Schedules/Quantities (all)
Sheets (all)
Families
Groups
Revit Links
{3D}
Concrete Building
FRONT
1 : 50
Hold button and move mouse to Spin the View.
Main Model

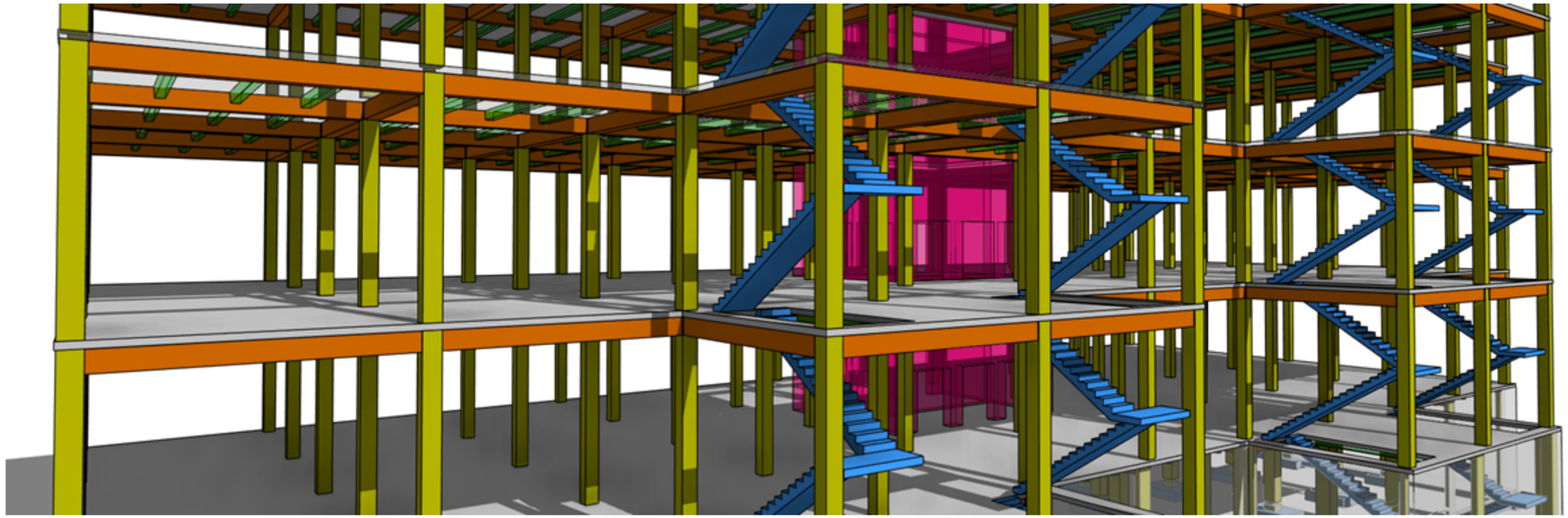
New feature

Autodesk Revit 2020.1

Rebar Constraints Editing Performance Improvement

- Instant rebar constraints editing
- Faster work on large and complex concrete structures





Enhanced user’s performance during rebar detailing

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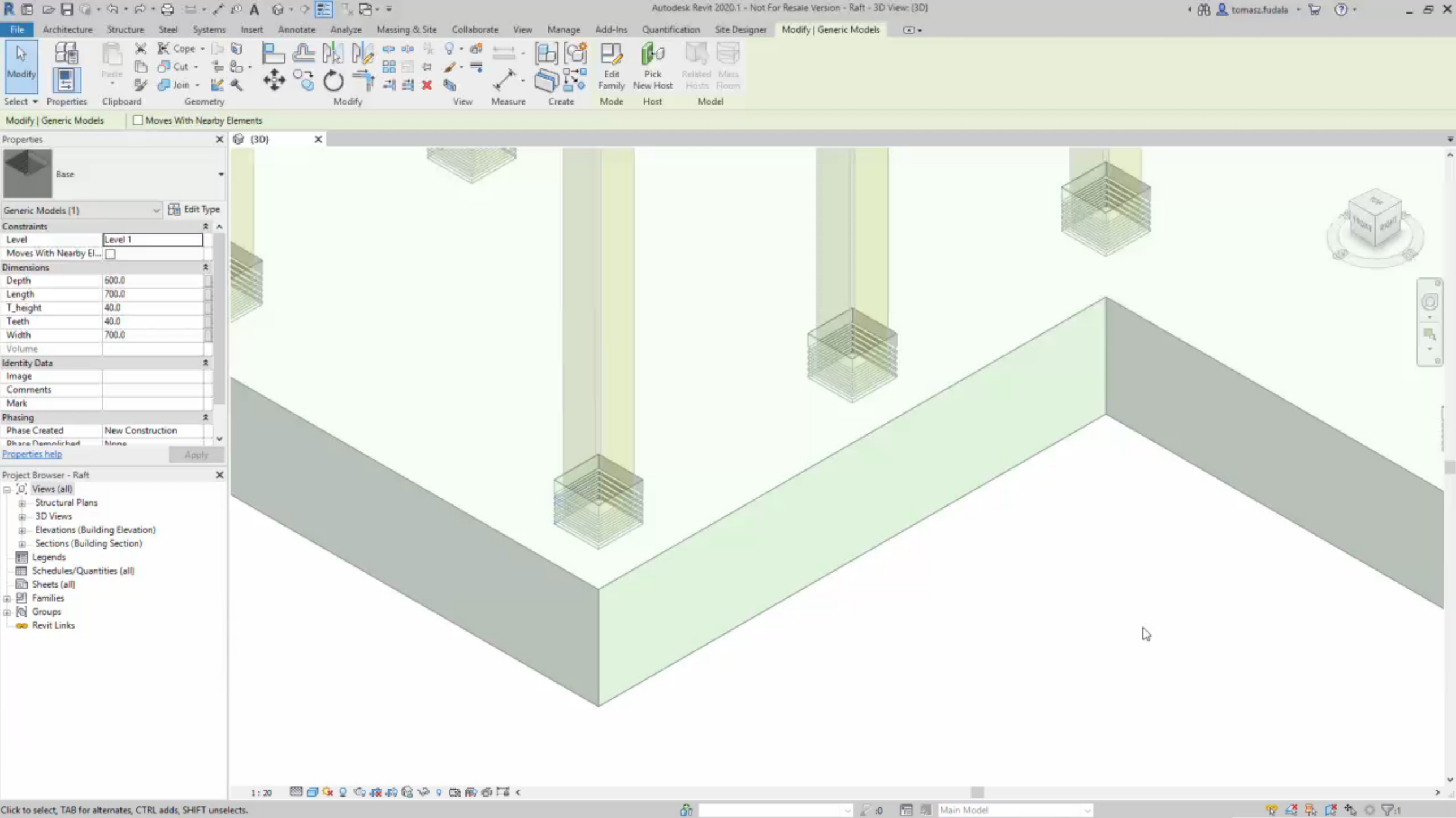
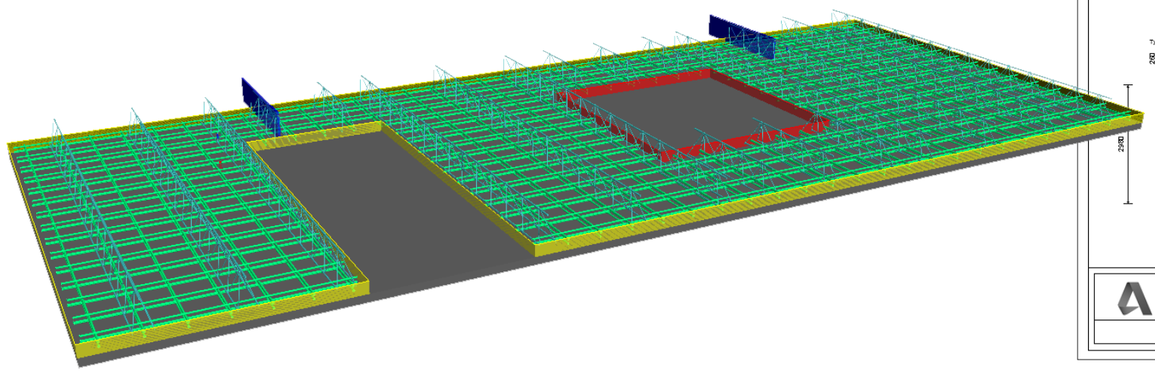

Autodesk Revit 2020.1 - Not For Resale Version - Raft - 3D View: {3D}
tomasz.fudala
File
Architecture
Structure
Steel
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Quantification
Site Designer
Modify | Generic Models
Modify
Select
Properties
Paste
Clipboard
Cope
Cut
Join
Geometry
Modify
View
Measure
Create
Edit Family
Mode
Pick New Host
Host
Related Hosts
Mass Floors
Model
Modify | Generic Models
Moves With Nearby Elements
Properties
Base
Generic Models (1)
Edit Type
Constraints
Level
Level 1
Moves With Nearby El...
Dimensions
Depth
600.0
Length
700.0
T_height
40.0
Teeth
40.0
Width
700.0
Volume
Identity Data
Image
Comments
Mark
Phasing
Phase Created
New Construction
Properties help
Apply
Project Browser - Raft
Views (all)
Structural Plans
3D Views
Elevations (Building Elevation)
Sections (Building Section)
Legends
Schedules/Quantities (all)
Sheets (all)
Families
Groups
Revit Links
{3D}
TOP
FRONT
RIGHT
1 : 20
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.
Main Model

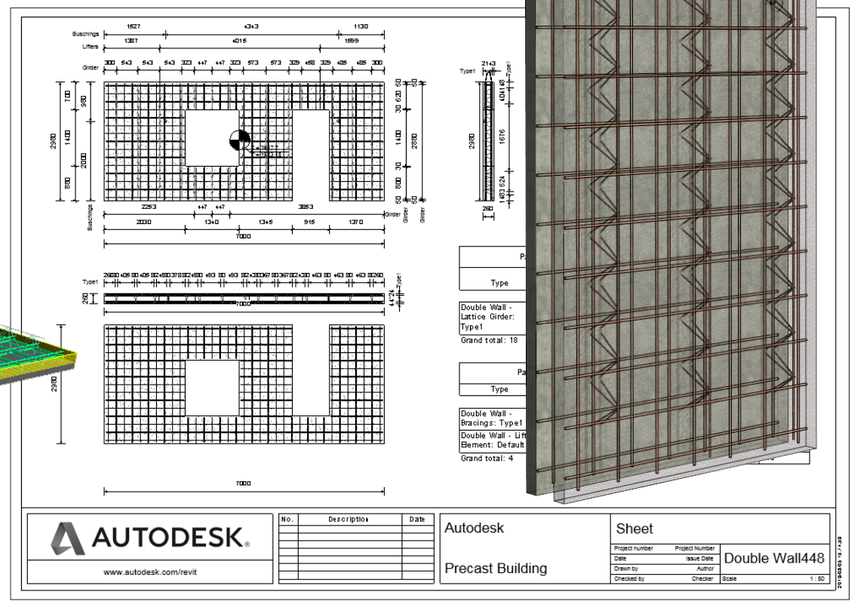
New feature

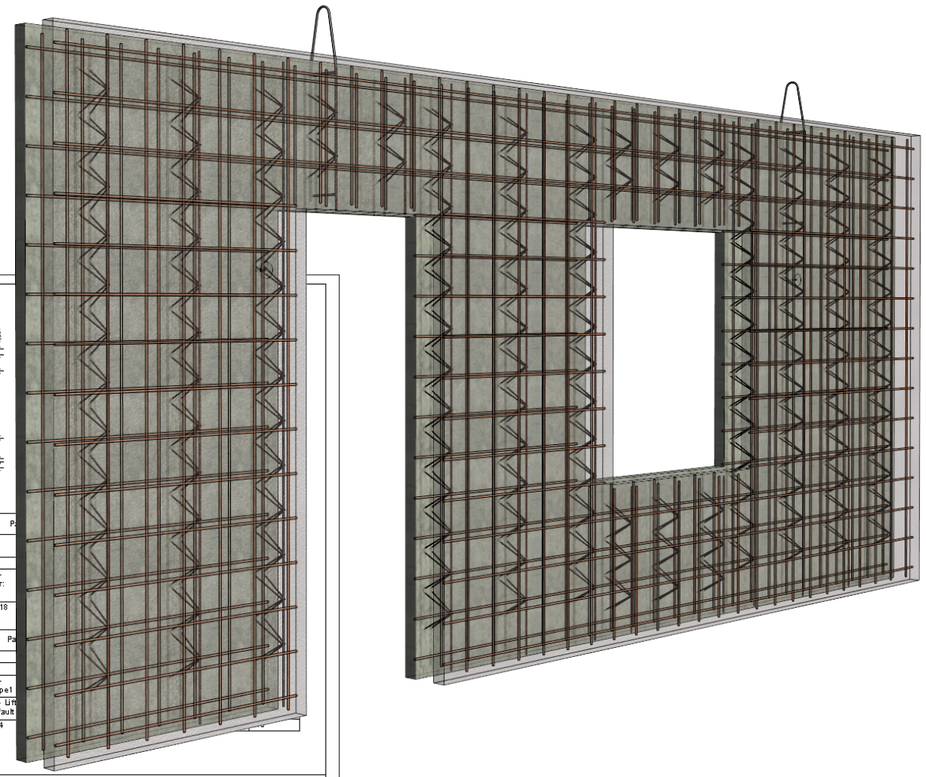
Autodesk Revit 2020.1, Structural Precast Extension for Autodesk Revit 2020.1

Precast Automation for Double Walls

- Perform segmentation
- Add reinforcement
- Shop drawings
- CAM Export Unitechnik & PXML







Enhanced and automated design to fabrication process

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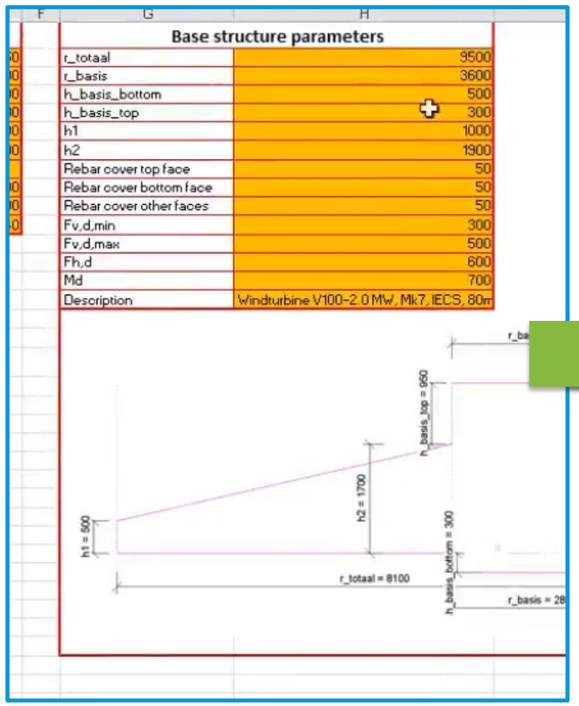
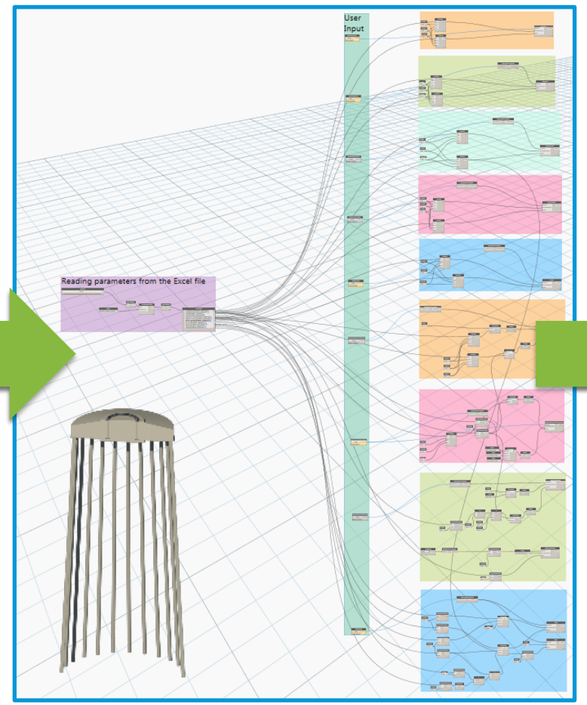
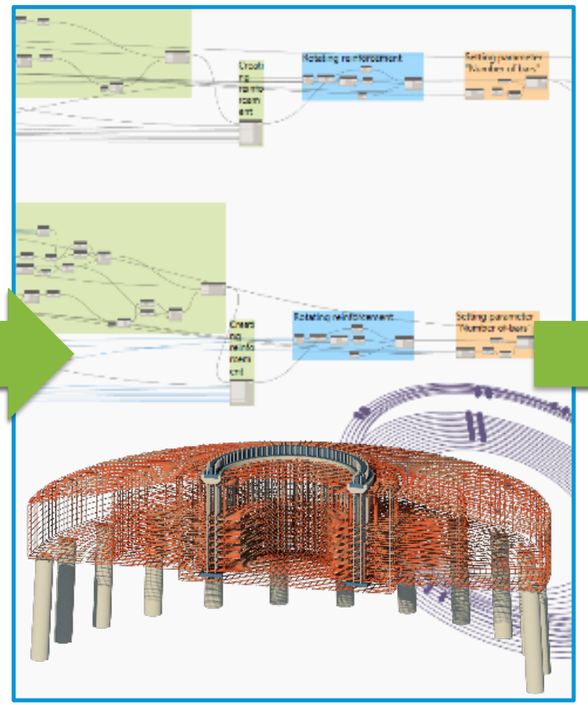
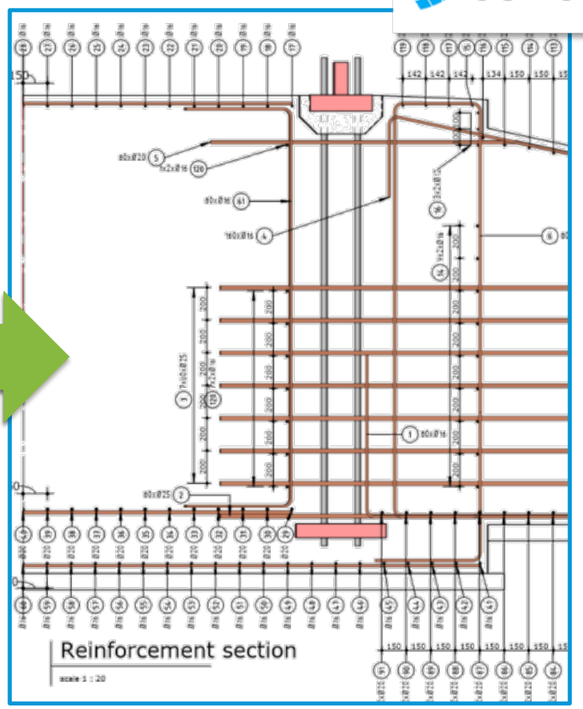
Customer success story

Rebar modeling in Revit with Dynamo – ABT Workflow









Rebar Configuration

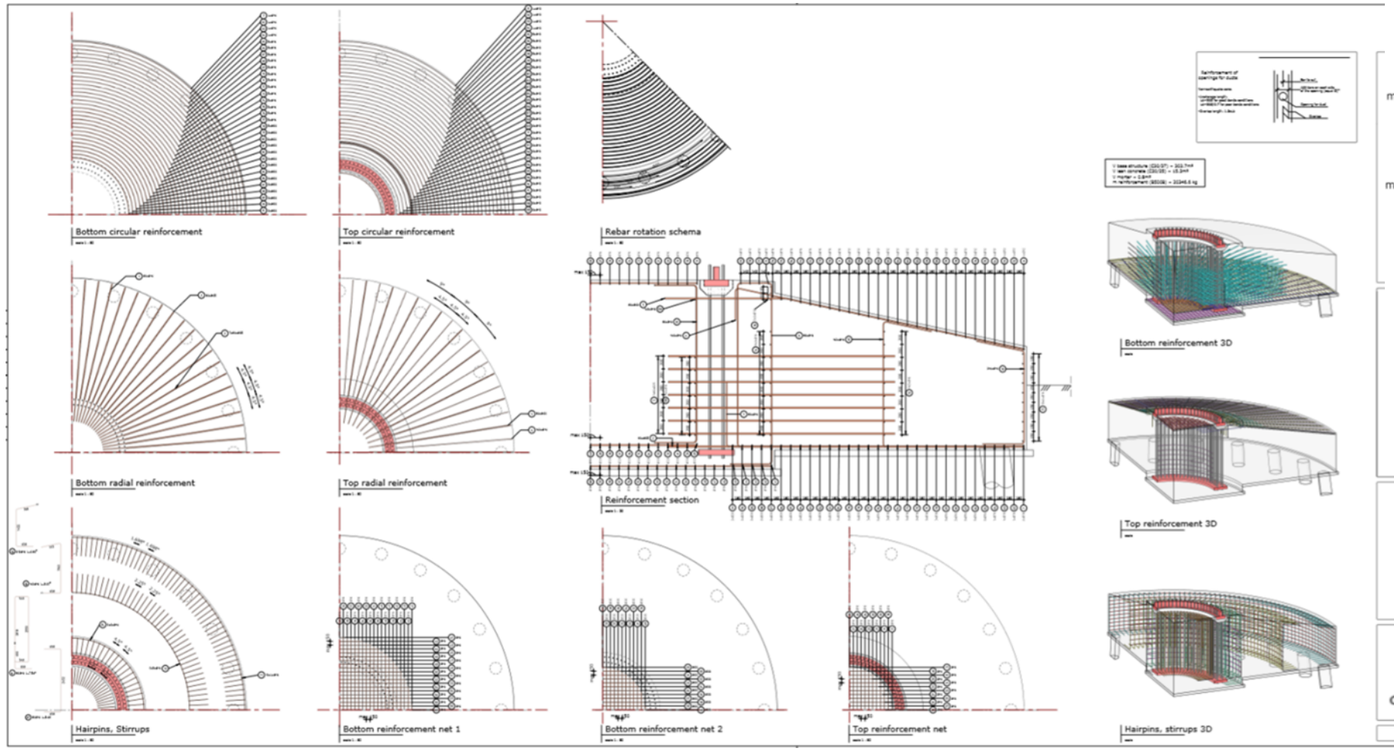
Create initial geometry

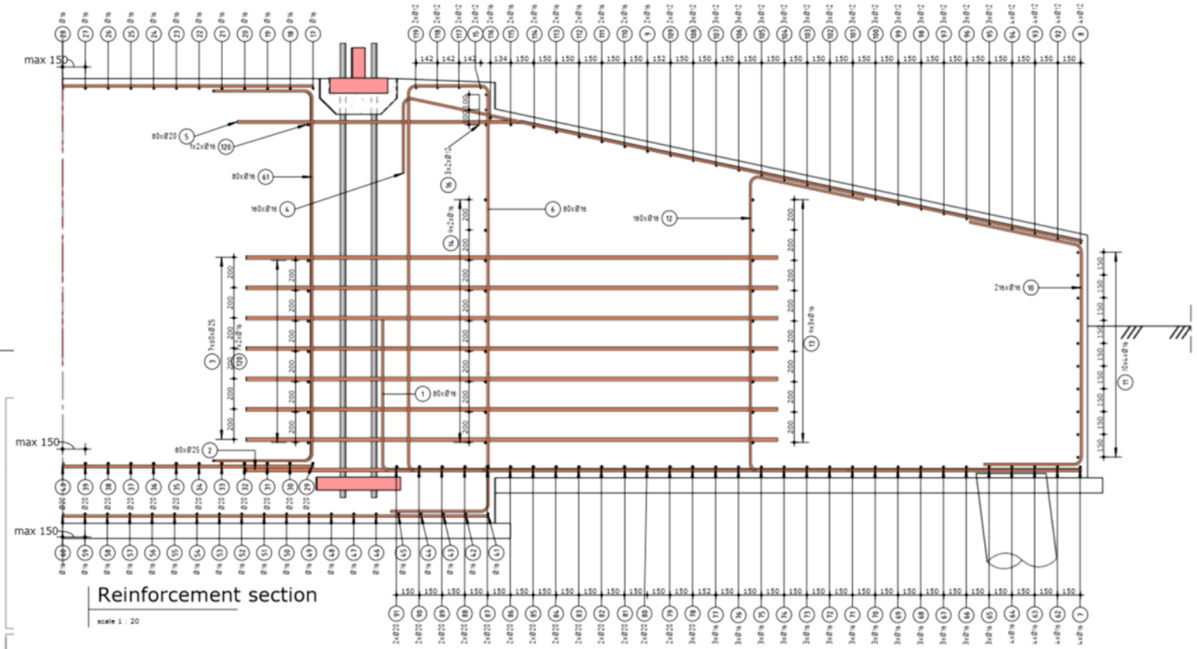
Parametrize geometry and generate rebar

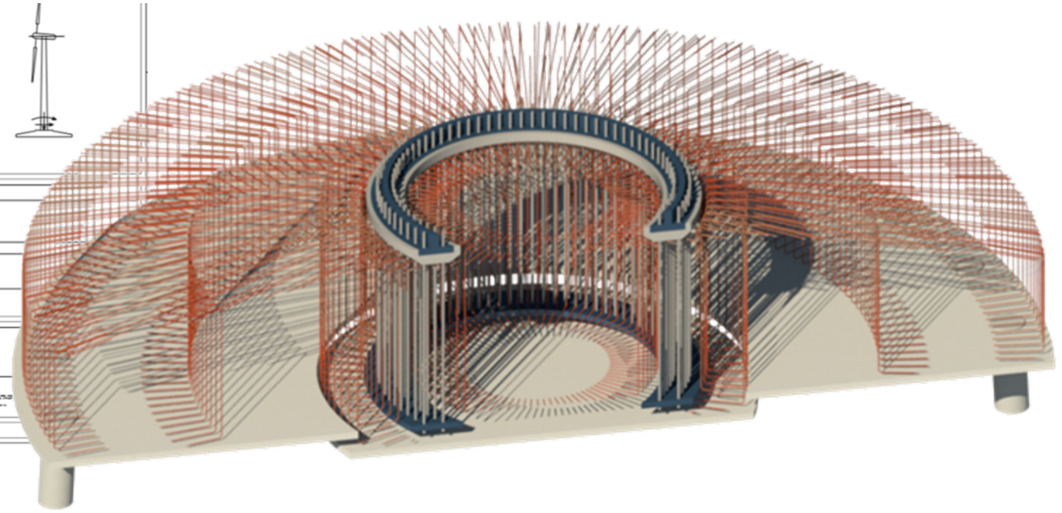
Generate detailed output drawings

Rebar modeling in Revit with Dynamo – Customer Story

Use case by ABT (Netherlands)







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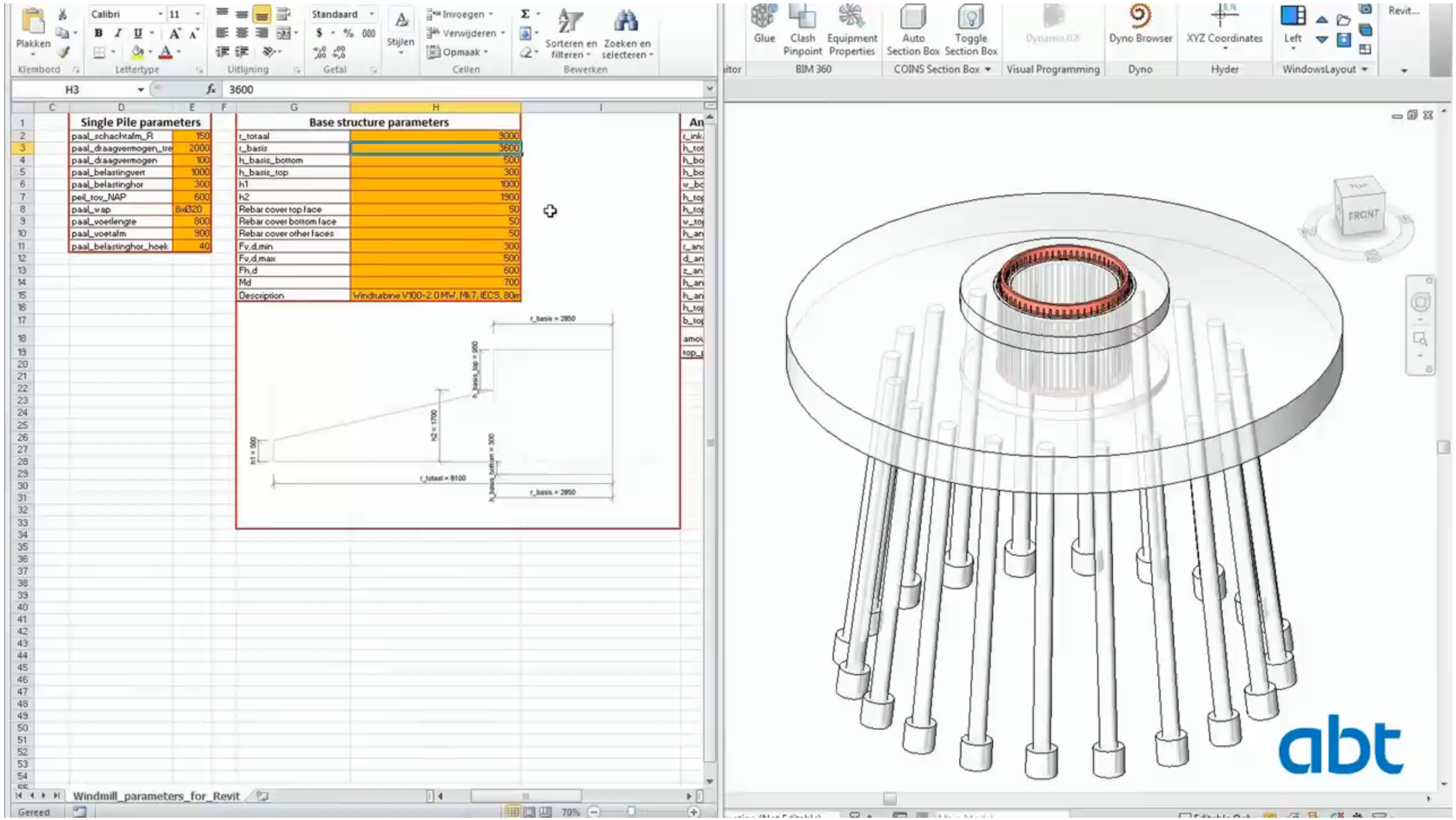
Exemple Client : ABT Reinforcement with Dynamo



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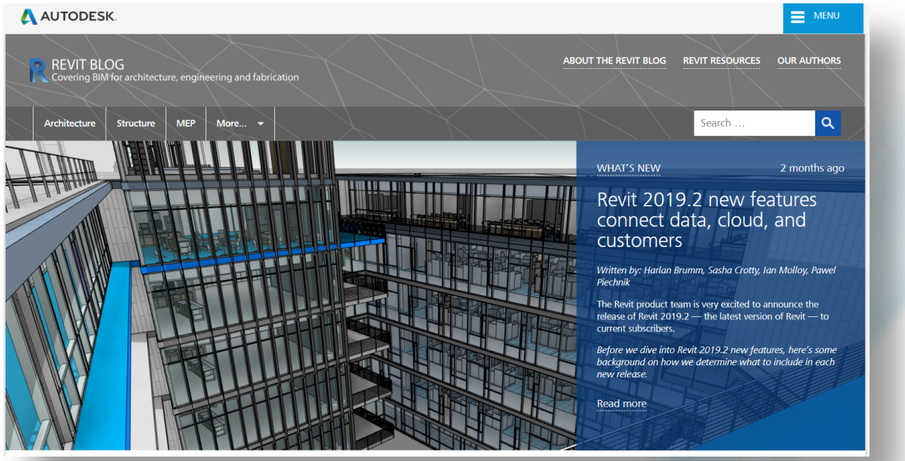
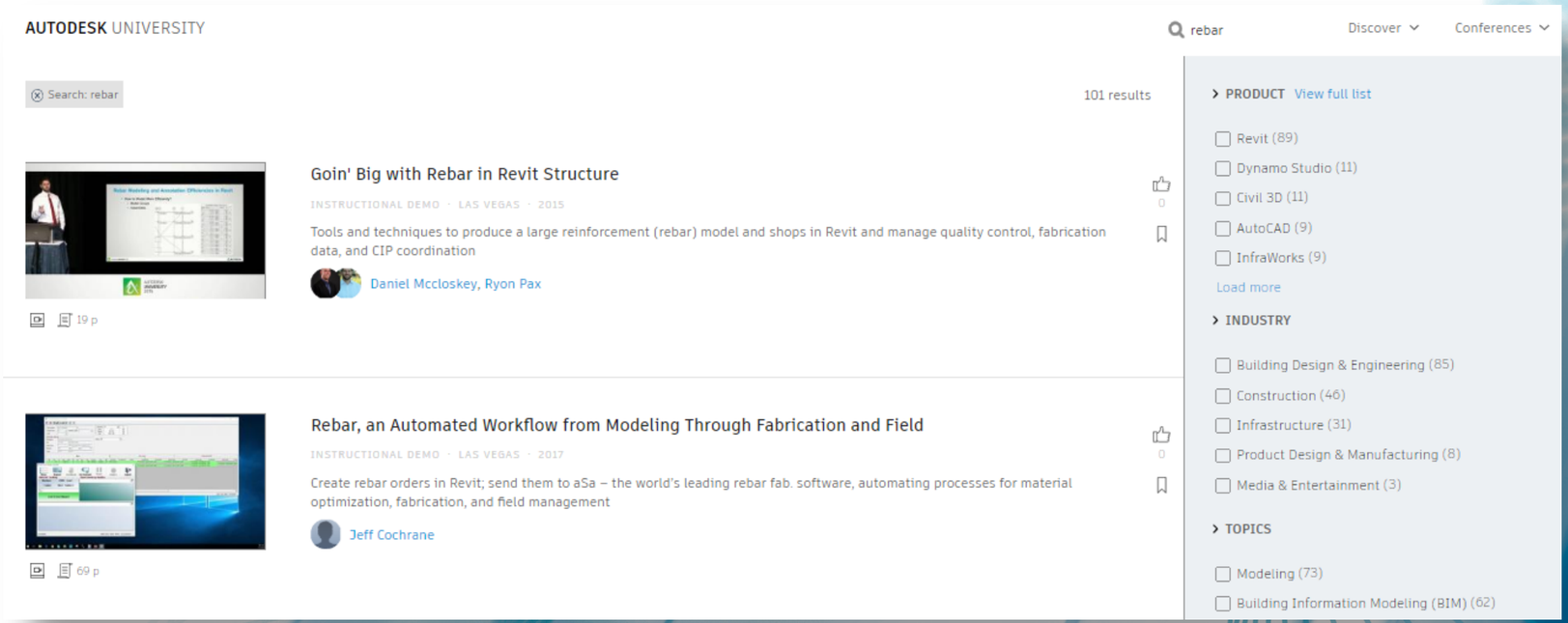
Useful links

- Revit blog:
  https://blogs.autodesk.com/revit/
- Naviate Rebar extension:
  https://www.naviate.com/product/naviate-rebar-extension/p-660
- Autodesk University website – recorded classes:
  https://www.autodesk.com/autodesk-university/au-online?query=rebar





Thank you!

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