Dealing with the Structural Analytical Representation in Revit

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Product Owner

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About the speaker

Catalin Lang

Former Autodesk customer, currently Autodesk employee, working in constructions field for over 19 years, going through several branches of the industry, from junior unskilled worker to formwork specialist, storekeeper, project coordinator, project manager, CAD designer, structural designer. Joined Autodesk since 2014 as Quality Analyst. Currently, Product Owner for one of the teams that develops Revit and Advance Steel structural features.

He is specialized in structural modeling and detailing.

Class Summary

CREATE ANALYTICAL REPRESENTATION OF A STRUCTURAL ELEMENTS IN REVIT

- Set-up Revit Environment
- Create the Structural Elements
- Set-up the Derived Analytical Representation
- Adjust the Position of the Analytical Elements

COMPLETE THE ANALYTICAL MODEL FOR STRUCTURAL ANALYSIS PURPOSE

- Assign Loads

AUTOMATE THE RELATION BETWEEN PHYSICAL AND ANALYTICAL USING DYNAMO

- Verify Analytical Model Consistency
- Adjust the analytical representation using Autodesk Analytical Modeling 2020 Dynamo package

INTEGRATE THE STRUCTURAL ANALYSIS IN THE INTELLIGENT MODELS

- Integrate Structural Analysis Results using Robot Structural Analysis Toolkit

Analytical representation of a structural elements in Revit

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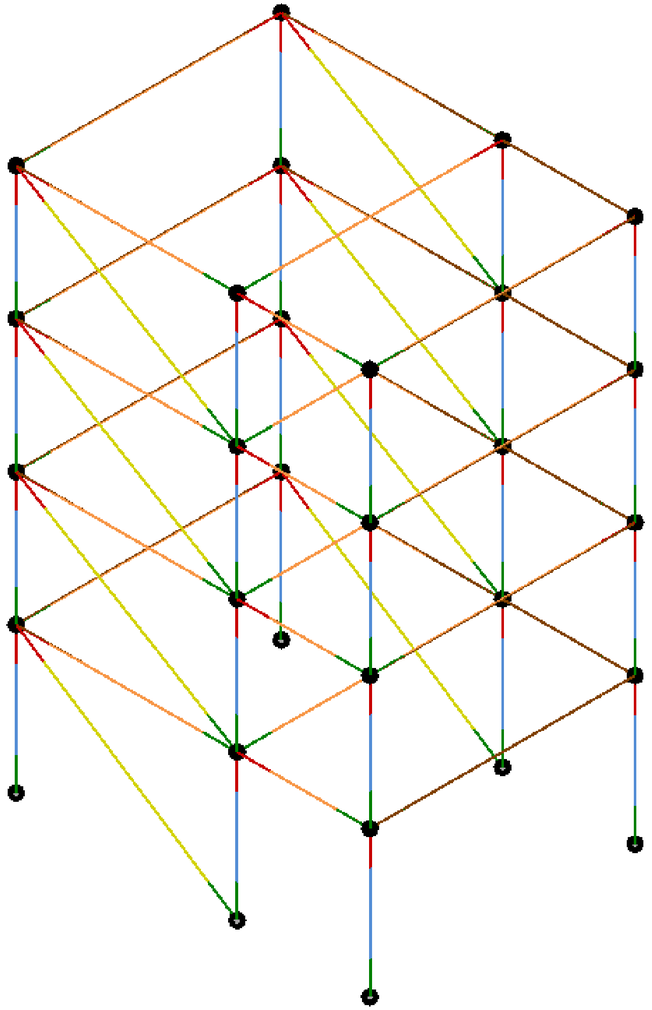
Analytical representation of a structural elements in Revit

- The analytical model is a simplified 3D representation of the structural physical model. It consists of those structural components, geometry, material properties, and loads, that together form an engineering system.

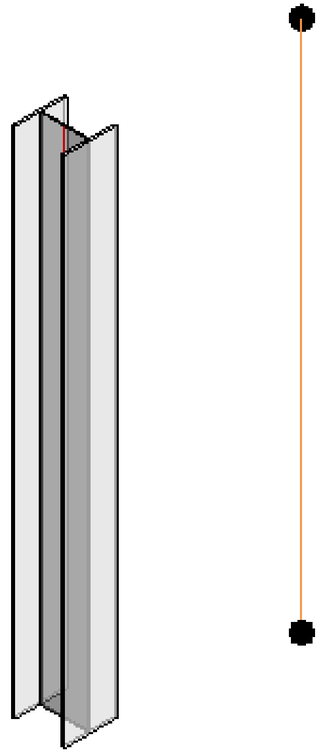
- In Revit software, the analytical model is created automatically as the physical model is built.



Analytical representation of a structural elements in Revit

Analytical Elements Creation

- **In Revit software, the analytical model is created automatically as the physical model is built.**
- **Analytical Elements are derived from the correspondent physical object.**
- **Analytical Elements are in a continuous relation with the correspondent physical objects**
  - Cannot be created without the correspondent physical objects
  - Cannot exist without the correspondent physical objects

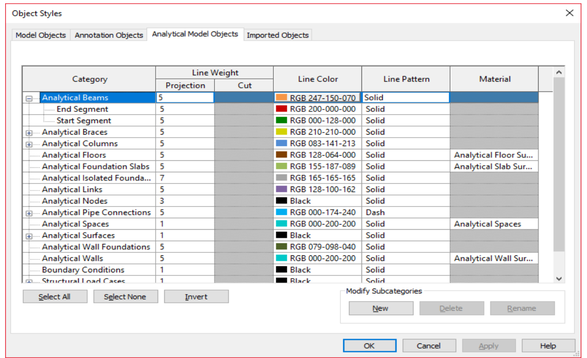


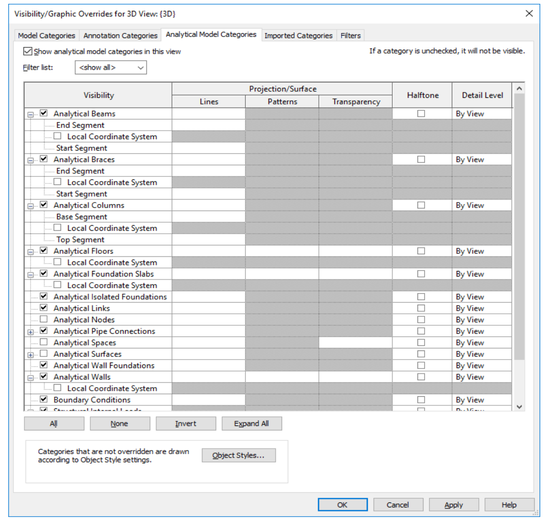
Analytical representation of a structural elements in Revit

Analytical Elements Visibility

- **Analytical element can be enabled/disabled by checking Enable Analytical instance parameter from the Properties Palette.**

- **Analytical element visibility can be controlled from:**
  - **View Control Bar - Show Analytical Model.**
  - **Object Styles in Analytical Model Objects tab.**
  - **Visibility/Graphics Overrides in Analytical Model Categories tab.**





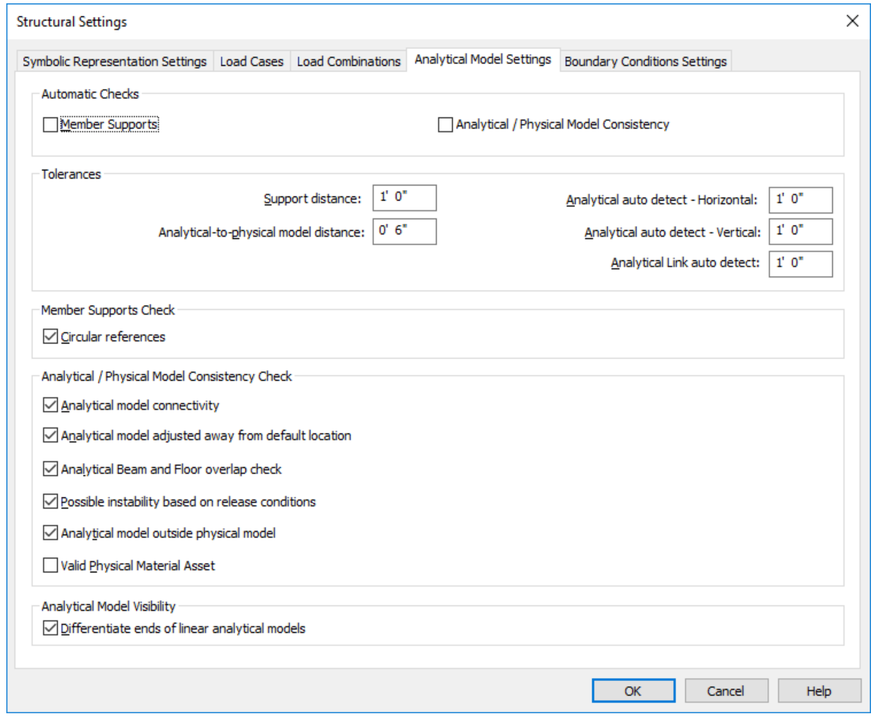
Analytical representation of a structural elements in Revit

Analytical Model Settings

- **The Analytical Model Settings are used to adjust how Revit performs certain tasks on the analytical model.**

- **These are project-specific settings, stored within the project.**

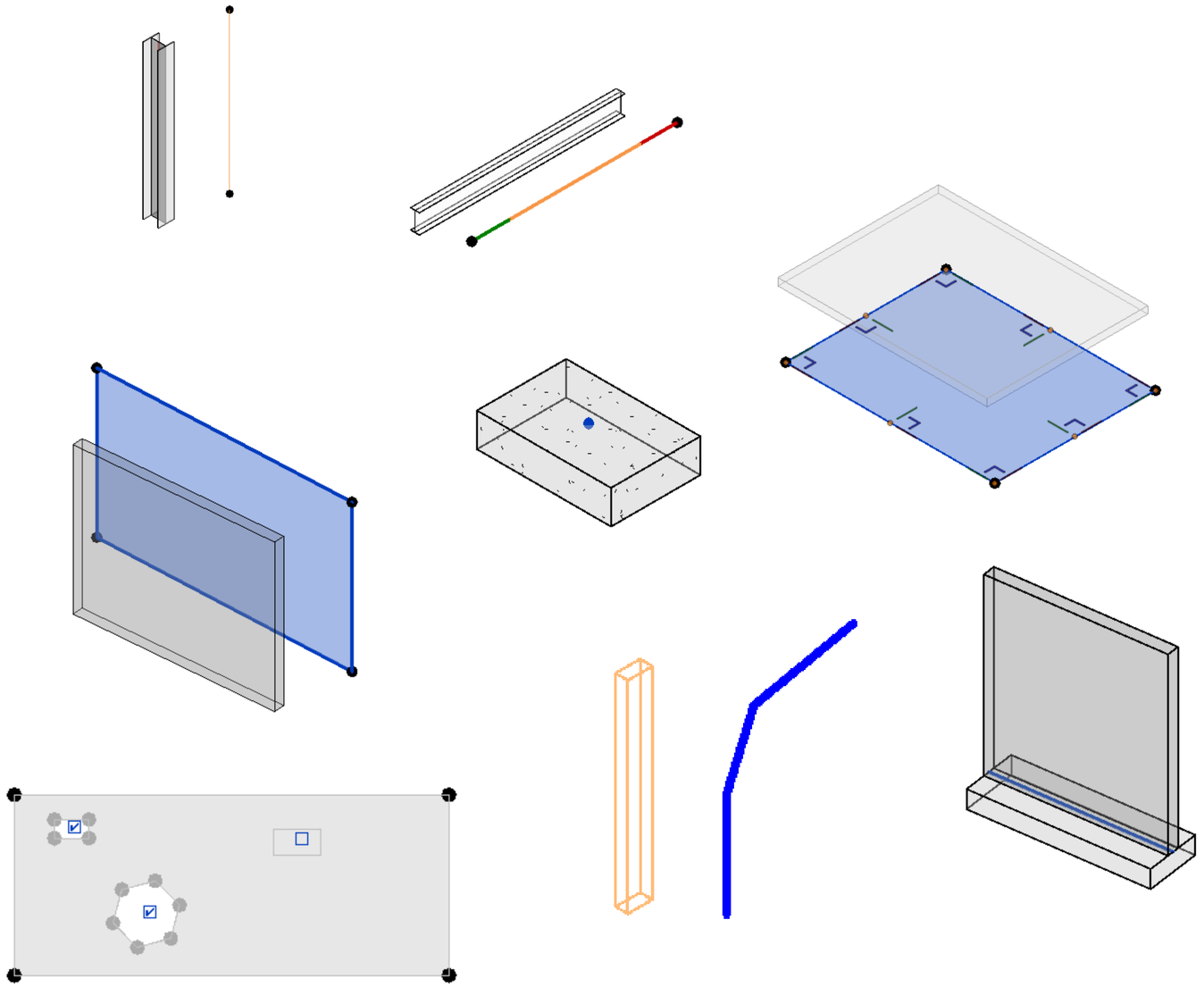
- **Are grouped by:**
  - **Automatic Checks** (Member Supports, Analytical/Physical Model Consistency).
  - **Tolerances** (Support distance, Analytical-to-physical model distance, Auto-detect settings)
  - **Analytical Model Visibility.**



Analytical representation of a structural elements in Revit

Revit Analytical Elements

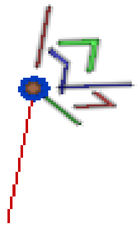
- **Analytical Column**
- **Analytical Beam**
- **Analytical Brace**
- **Analytical Floors**
- **Analytical Walls**
- **Analytical Isolated Foundation**
- **Analytical Wall Foundation**
- **Analytical Foundation Slab**
- **Analytical Line within In-Place Family**
- **Analytical Surface Opening**

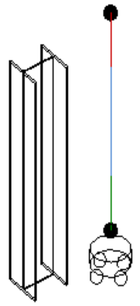


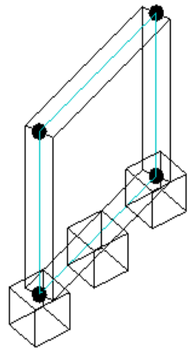
Analytical representation of a structural elements in Revit

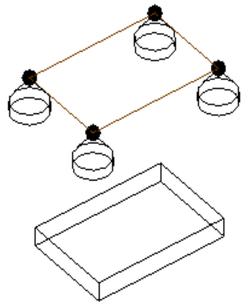
Revit Analytical Elements

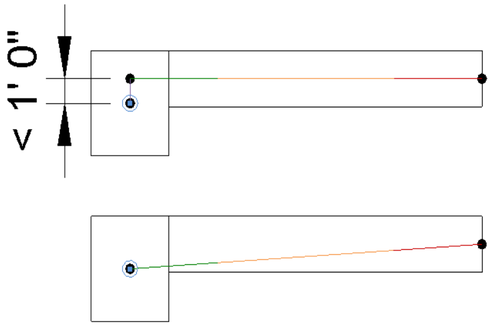
- **Node**
- **Boundary Conditions**
- **Analytical (Rigid) Link**





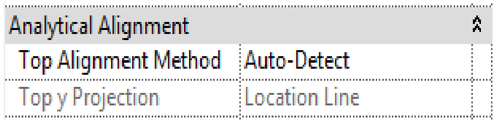




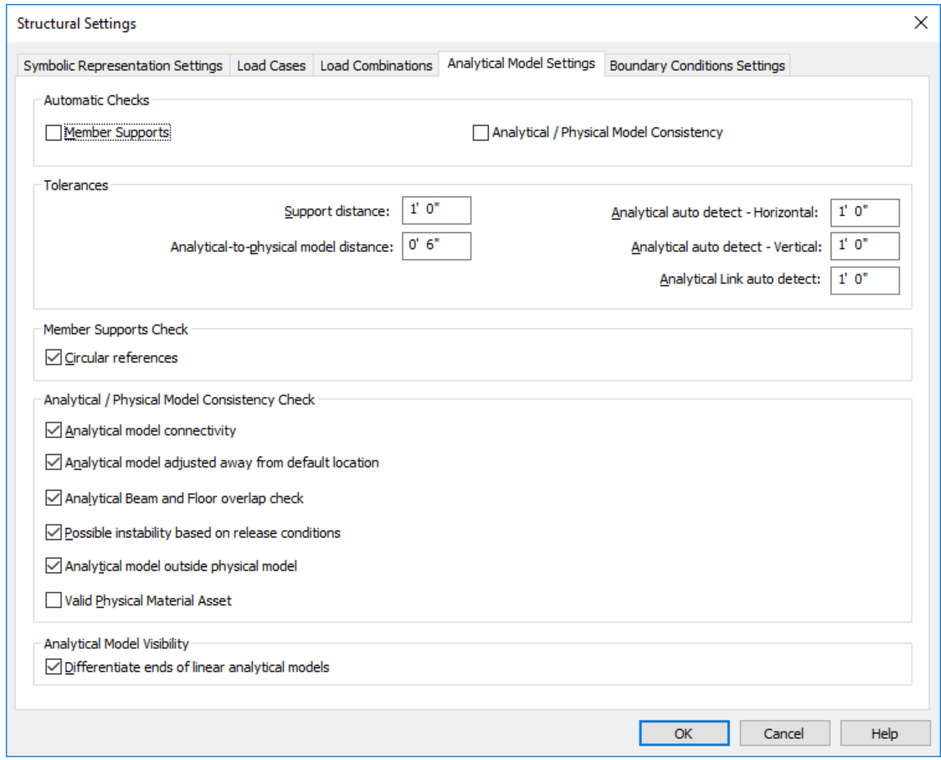


Analytical representation of a structural elements in Revit

Analytical Model Adjustments



- **Auto-Detect Adjustment**
  - Revit can automatically adjust the analytical model, in relation to a neighboring structural element.
- **Projection Adjustment**
  - Projection references are defined as horizontal and vertical in relation to the local coordinate system.
- **Manual Adjustment**



Exercise 1 | Create the Analytical Representation for the Structural Elements of a Steel Structure in Revit

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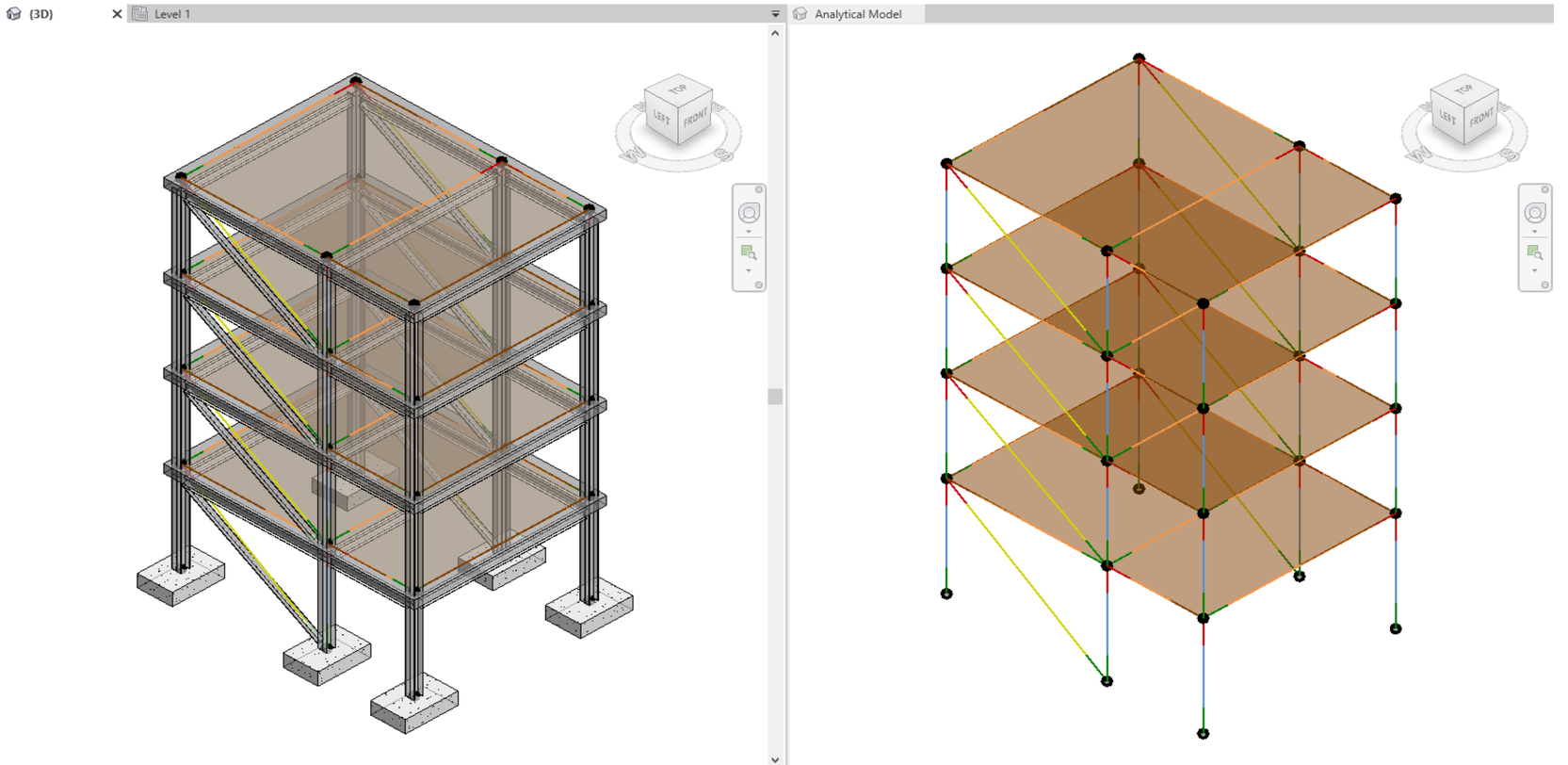
Exercise 1 | Create the Analytical Representation for the Structural Elements of a Steel Structure in Revit

In this exercise, we'll create a structural model while dealing also with the analytical representation of it. We'll create a simple structure with steel frames and concrete decks. In the end the model will be ready to be consumed by structural analysis solvers.

(Handout page 21)

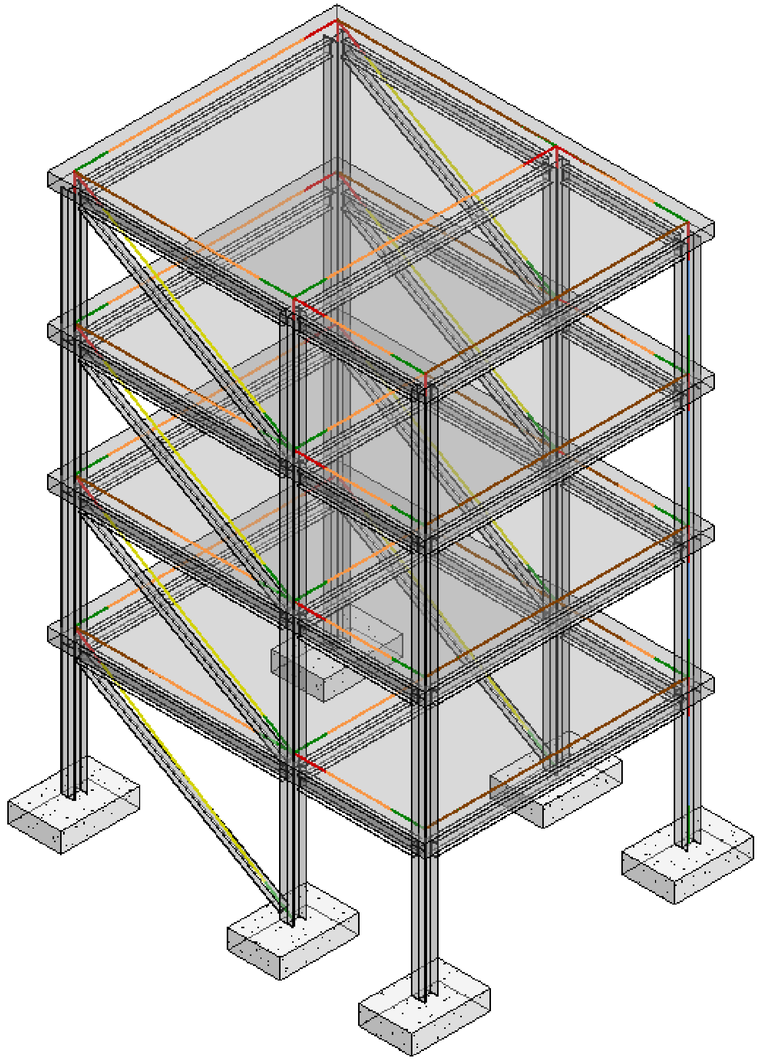


Exercise 1 | Create the Analytical Representation for the Structural Elements of a Steel Structure in Revit

Goal

The goal is not just to create the analytical model.

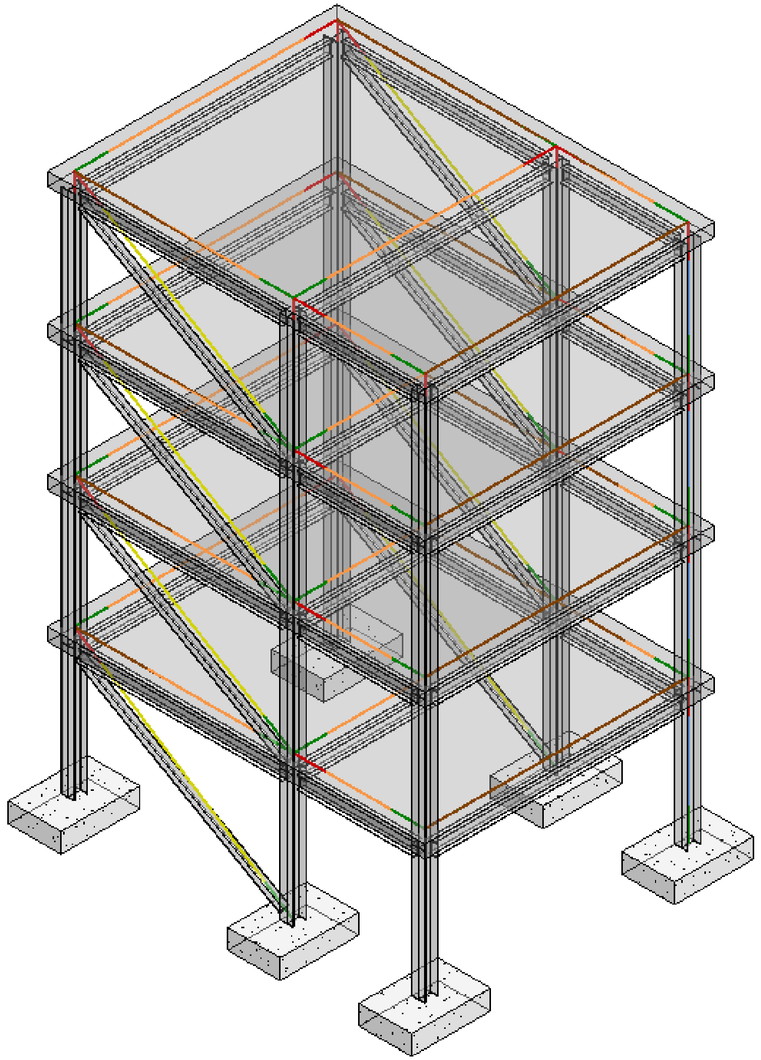
The goal is about creating the analytical representation in the physical model context.



Exercise 1 | Create the Analytical Representation for the Structural Elements of a Steel Structure in Revit

Summary

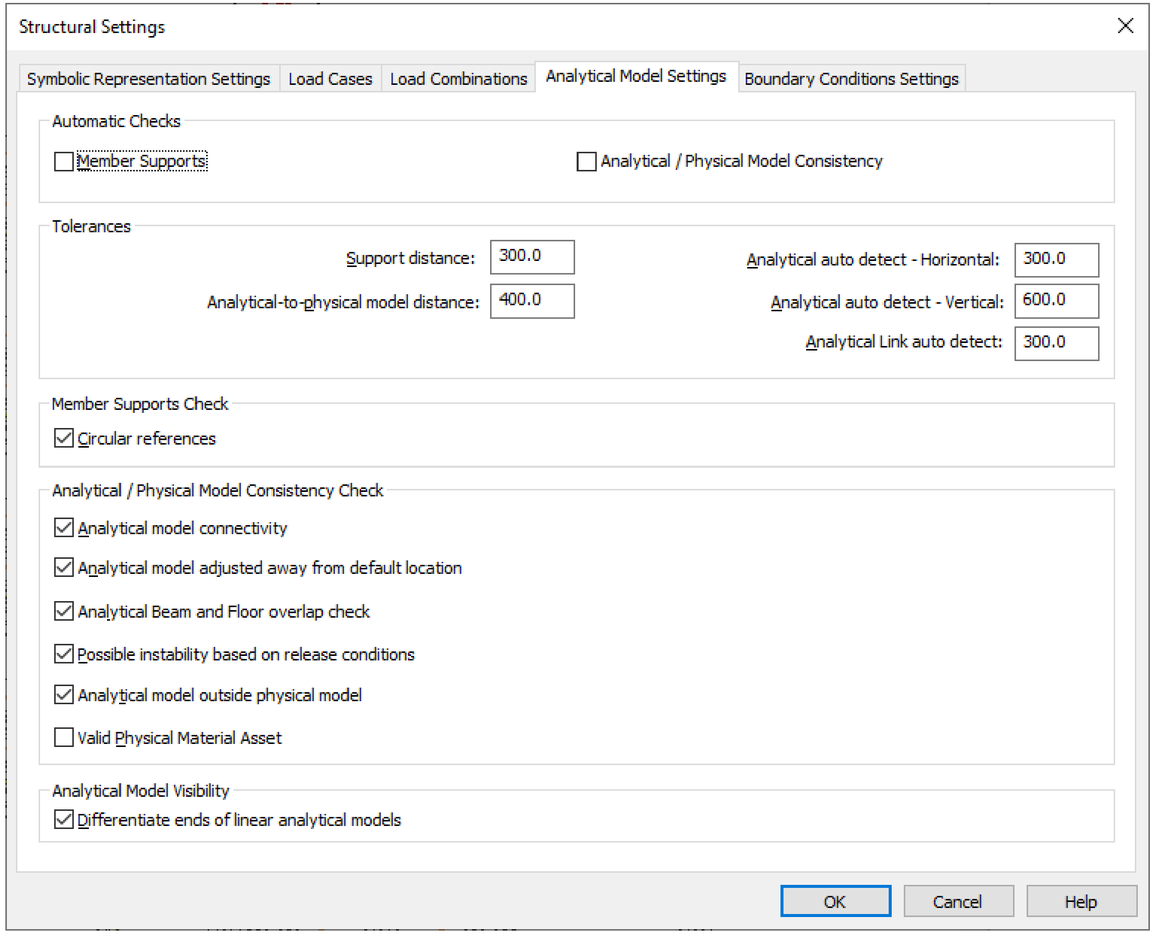
- **Set-up Revit Environment**
- **Create the Structural Elements**
- **Set-up the Derived Analytical Representation**
- **Adjust the Position of the Analytical Elements**
  - Auto-Detect Adjustment
  - Projection Adjustment
  - Manual Adjustment



Exercise 1 | Create the Analytical Representation for the Structural Elements of a Steel Structure in Revit

Set-up Revit Environment

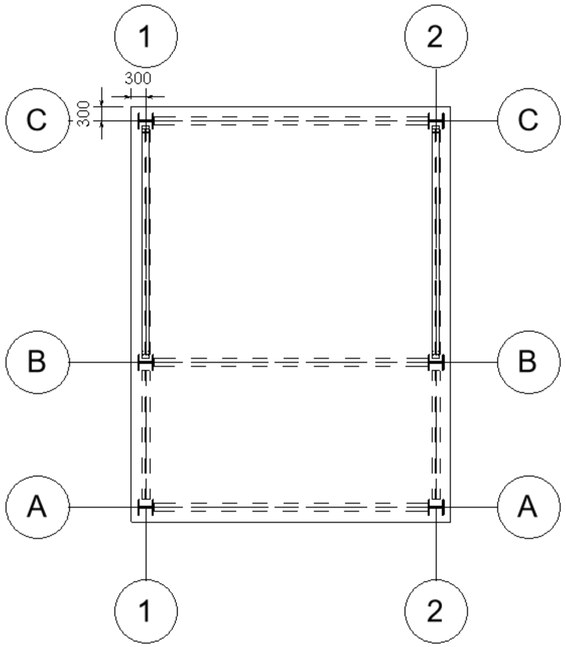
1. Open Exercise_01_StartPoint.rvt
2. Open Level 2 structural view and Analytical Model 3D view
3. Go to View tab Windows panel Tile Views
4. Go to Manage tab Settings panel Structural Settings dialog Analytica Model Settings tab Make sure that:
    - Analytical-to-Physical Model Distance is set to 400mm
    - Analytical Auto-Detect – Horizontal is set to 300mm
    - Analytical Auto-Detect – Vertical is set to 600mm

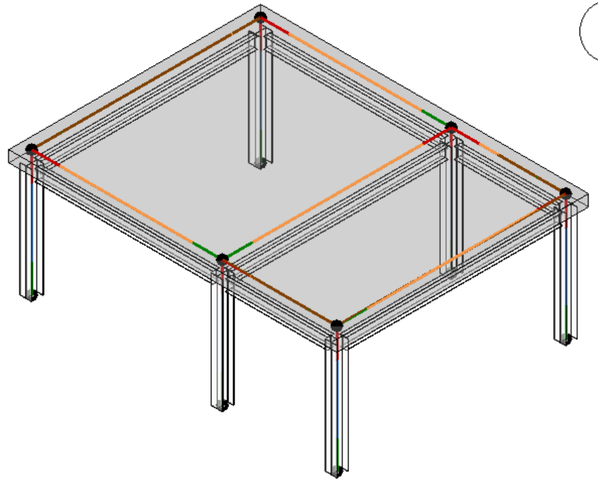


Exercise 1 | Create the Analytical Representation for the Structural Elements of a Steel Structure in Revit

Create the Structural Elements for the First Level

1. Create UC305x305x97 steel columns at the axis intersection.
2. Create the beams between columns. Choose UB305x165x40 section type for the beams.
3. Create a floor at Level 2. Choose Floor Generic 300mm type
   - The floor offsets from the axis will be 300mm.
4. Set the floor’s offset 300mm above Level 2.
5. Set the analytical floor alignment at the top face of the physical floor.
   - Use **Projection Adjustment.**

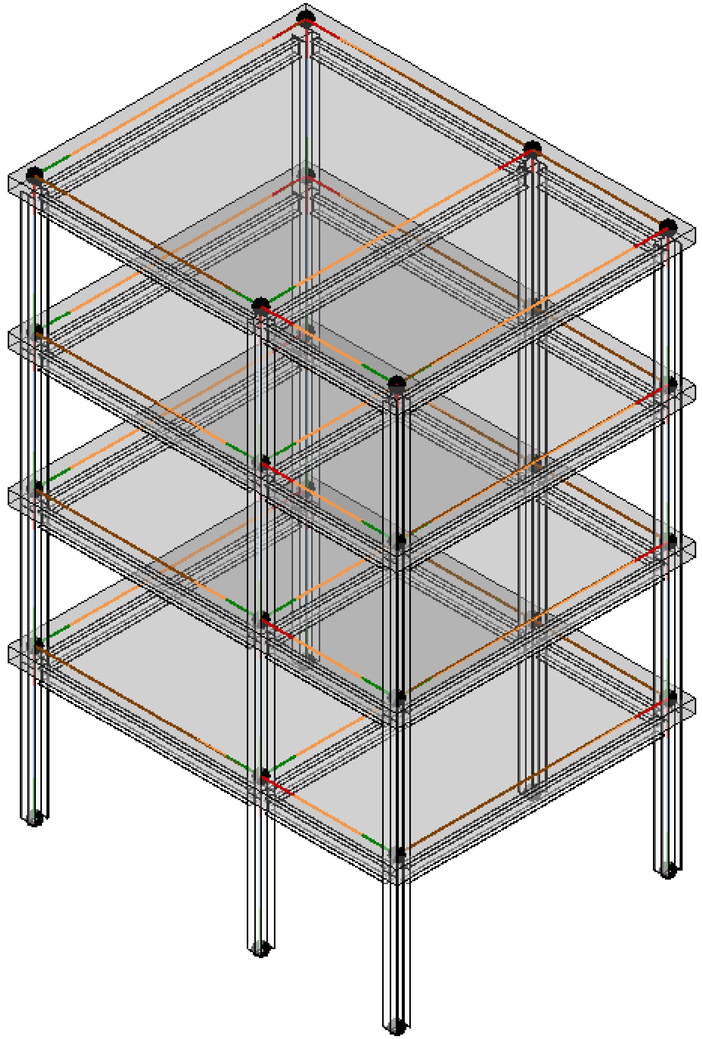




Exercise 1 | Create the Analytical Representation for the Structural Elements of a Steel Structure in Revit

Copy the Elements to the Other Levels

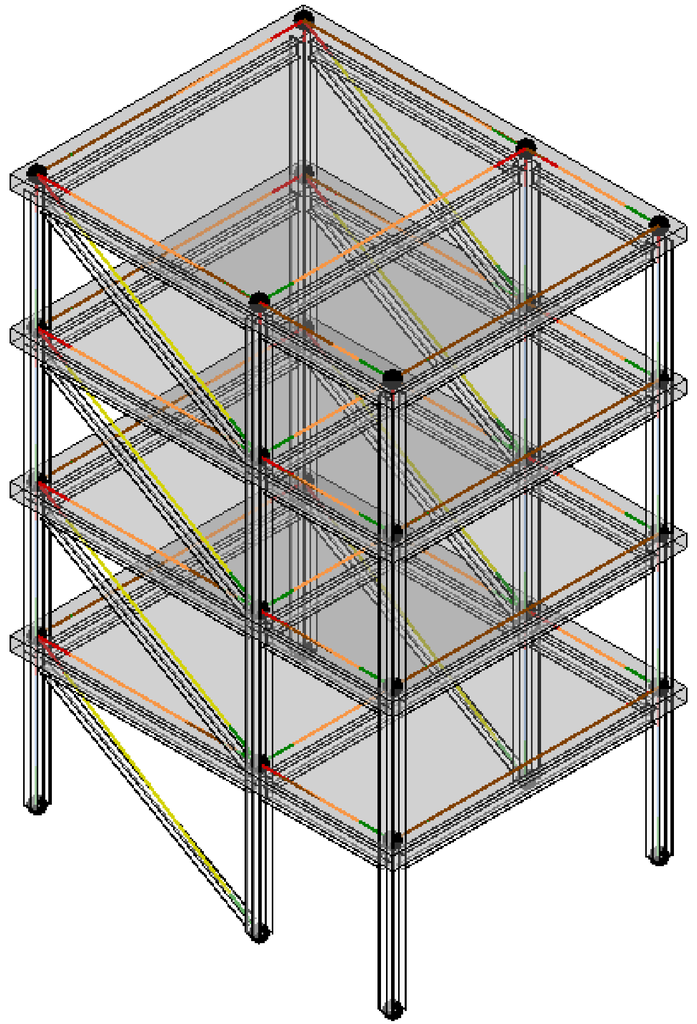
1. Copy the first level elements and to next level.
2. Adjust the analytical columns alignment.
   - Use **Auto-Detect Adjustment**.
3. Copy the elements from Level 3 to Level 4 and Level 5.



Exercise 1 | Create the Analytical Representation for the Structural Elements of a Steel Structure in Revit

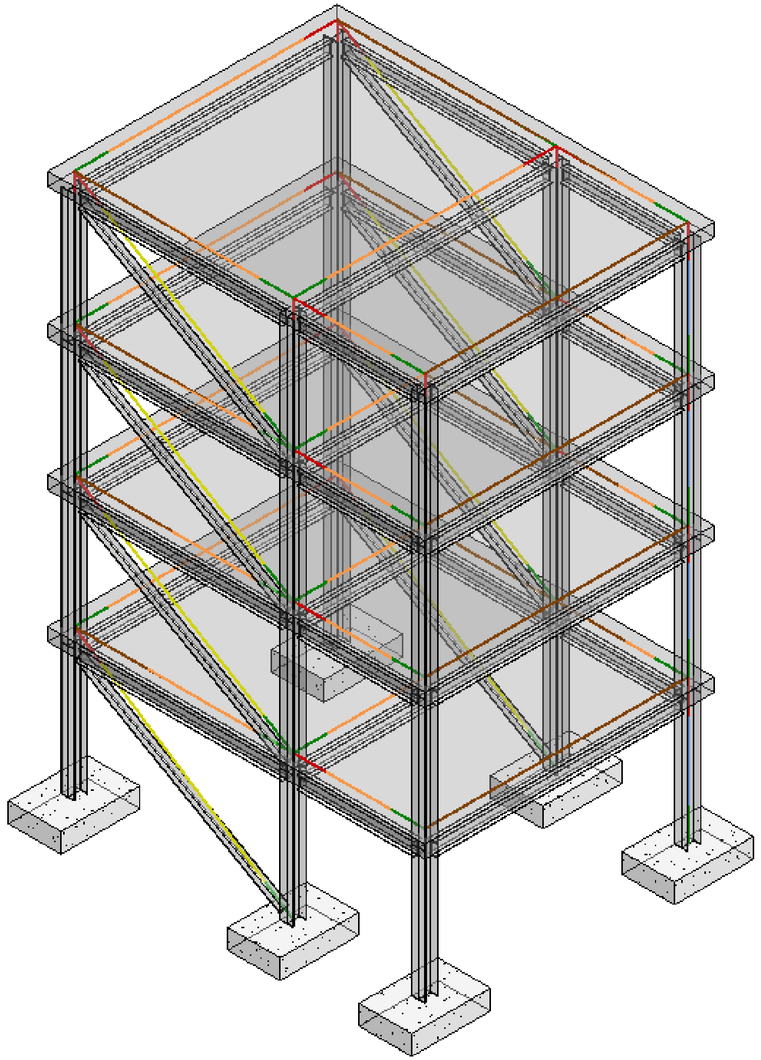
Create Braces

1. Create vertical brace.
2. Copy the created bracing on Level 2.
3. Adjust the Level 2 analytical brace’s position
   - Use **Manual Adjustment**.
4. Copy the braces to Level 3 and Level 4



Exercise 1 | Create the Analytical Representation for the Structural Elements of a Steel Structure in Revit

Create the Isolated Footings for the Columns



Automate the relation between physical and analytical representations using Dynamo

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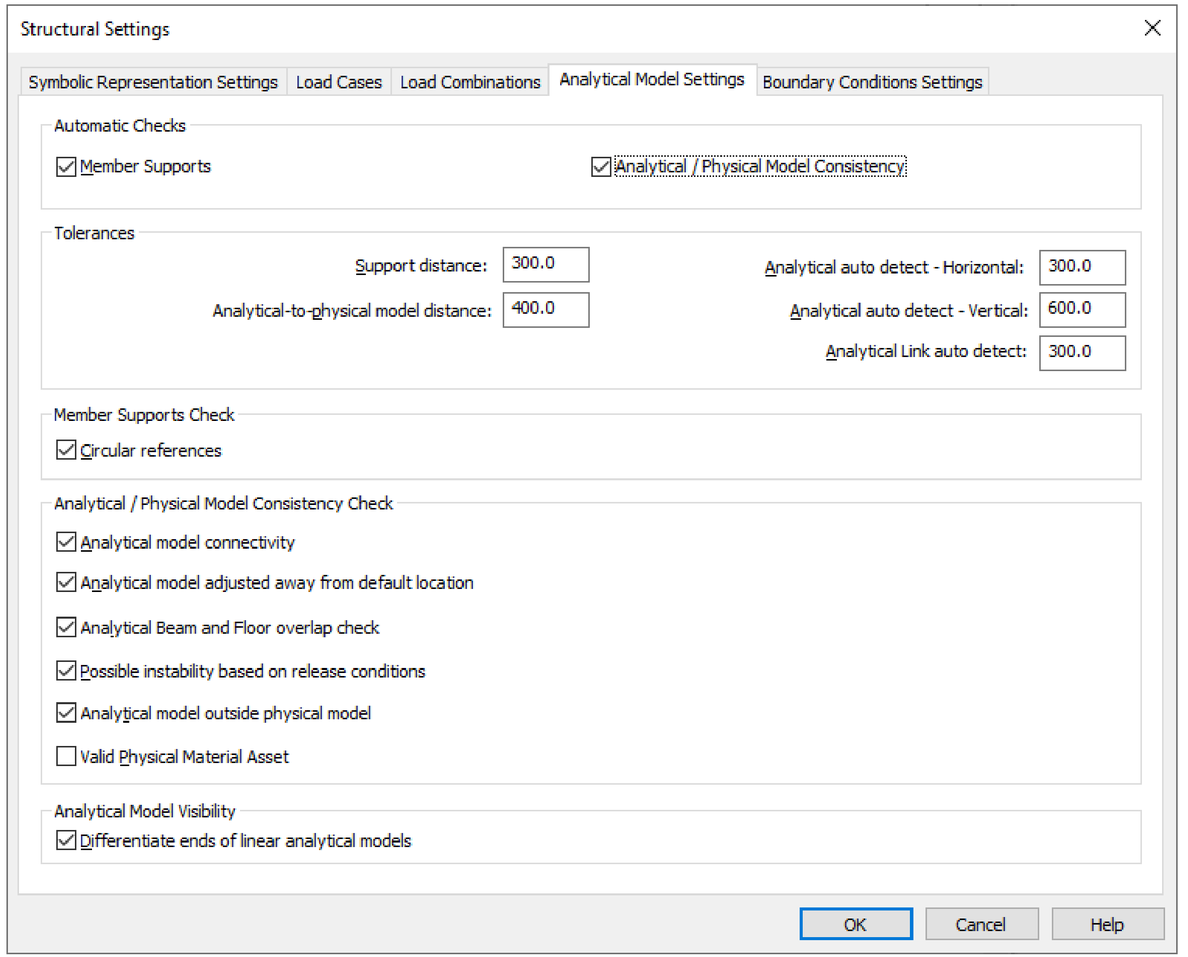
Consistency Checks

Consistency Checks

- **Member Supports**
  - Provides a warning when a member is not supported

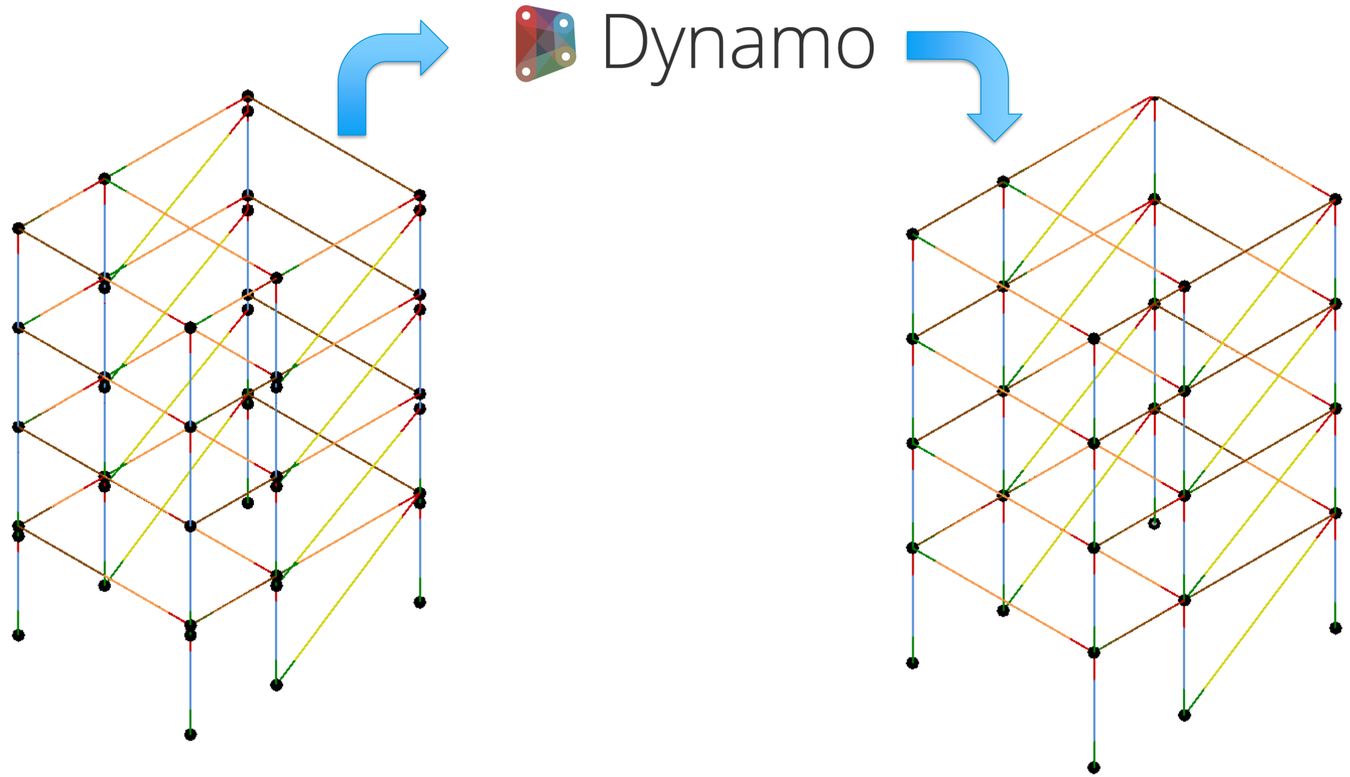
- **Analytical/Physical Model Consistency**
  - unsupported structural elements
  - inconsistencies found within the analytical model
  - inconsistencies between the analytical and physical models
  - analytical elements without a Physical Material Asset assigned.



Automate the relation between physical and analytical representations using Dynamo

The Autodesk Analytical Modeling 2020 Dynamo package helps structural engineers better control and automate the creation and adjustment of analytical models in Revit.

Customizable logic helps you create different rules-based analytical models for diverse types of buildings and multiple analytical model variants for similar building structures, and allows you to use similar patterns across projects.



Exercise 2 | Adjust the Analytical Representation of a Structural Model using Dynamo

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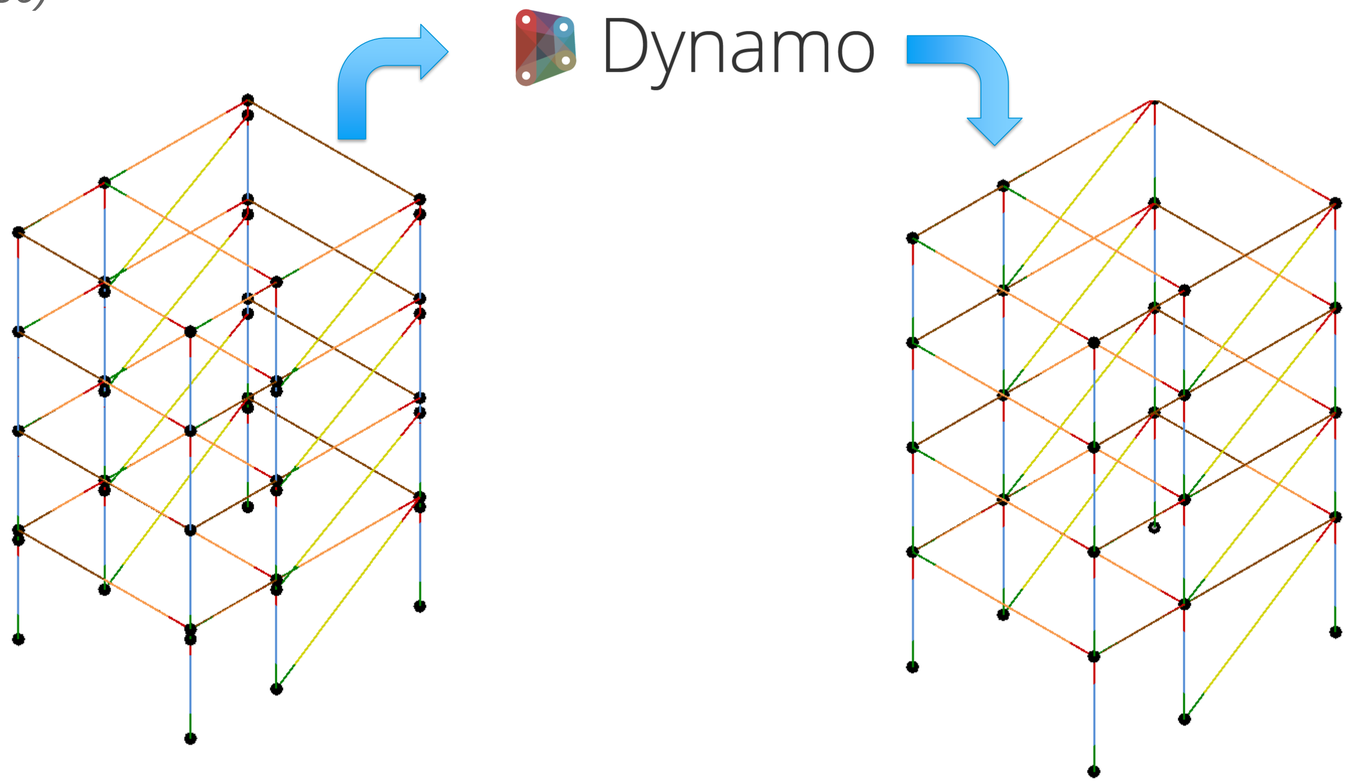
Exercise 2 | Adjust the Analytical Representation of a Structural Model using Dynamo

In this exercise, we'll adjust the analytical representation of the same structure using a Dynamo tool.

Autodesk Analytical Modeling Dynamo package is used to generate a consistent and connected analytical representation that corresponds to the geometric shapes of the model.

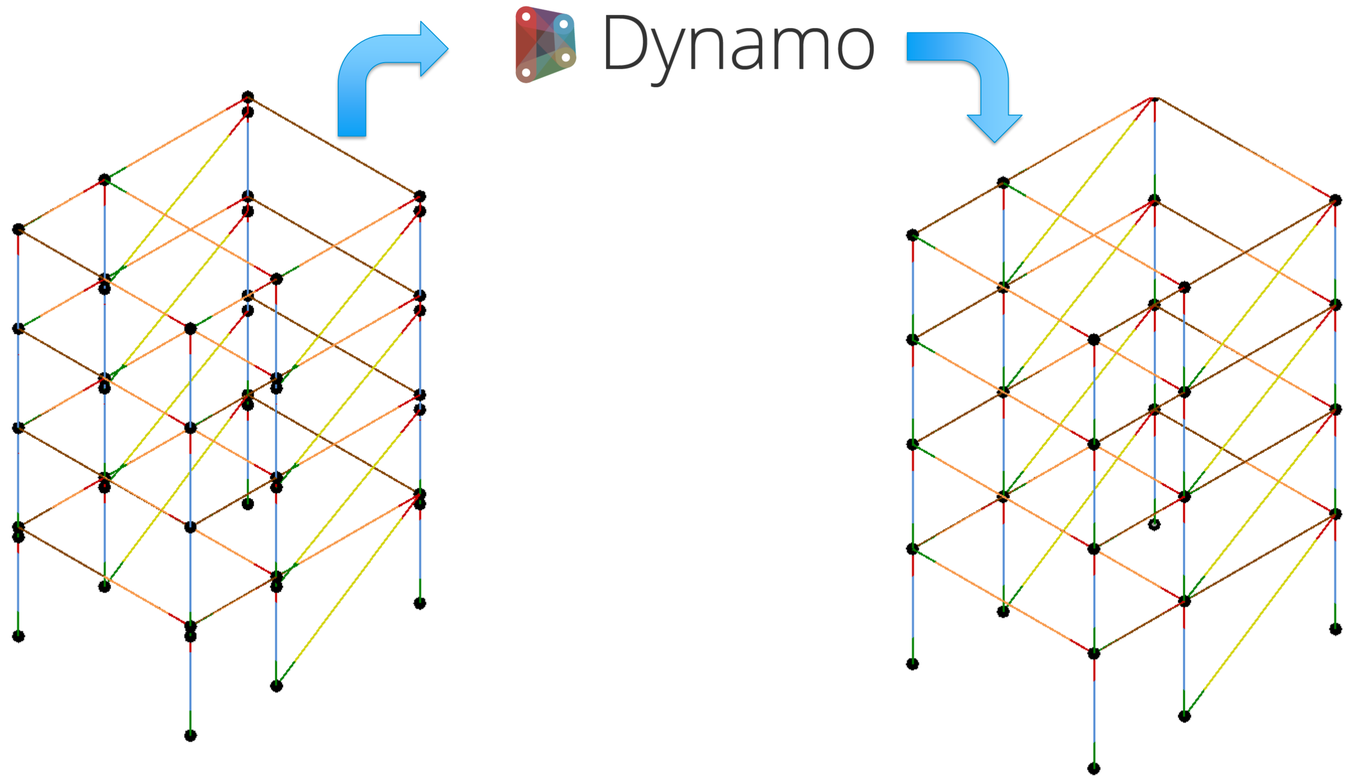
(Handout page 36)



Exercise 2 | Adjust the Analytical Representation of a Structural Model using Dynamo

Goal

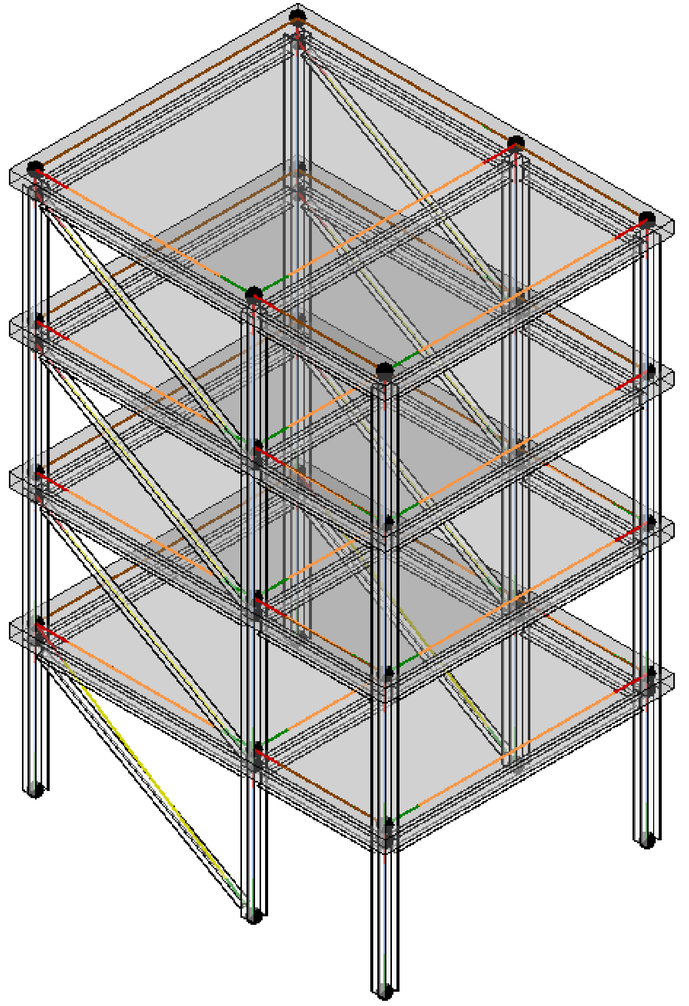
Automate analytical model adjustment.



Exercise 2 | Adjust the Analytical Representation of a Structural Model using Dynamo

Set-up Environment

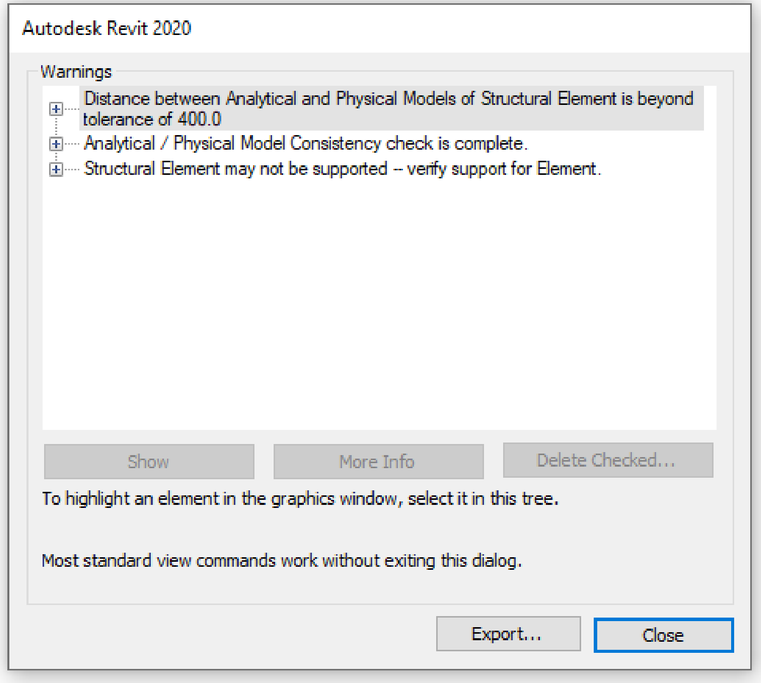
1. Add Autodesk Analytical Modeling 2020 Dynamo package to your collection.
2. Open Exercise_02_StartPoint.rvt.
3. Copy all elements to Level 3, 4 and 5.

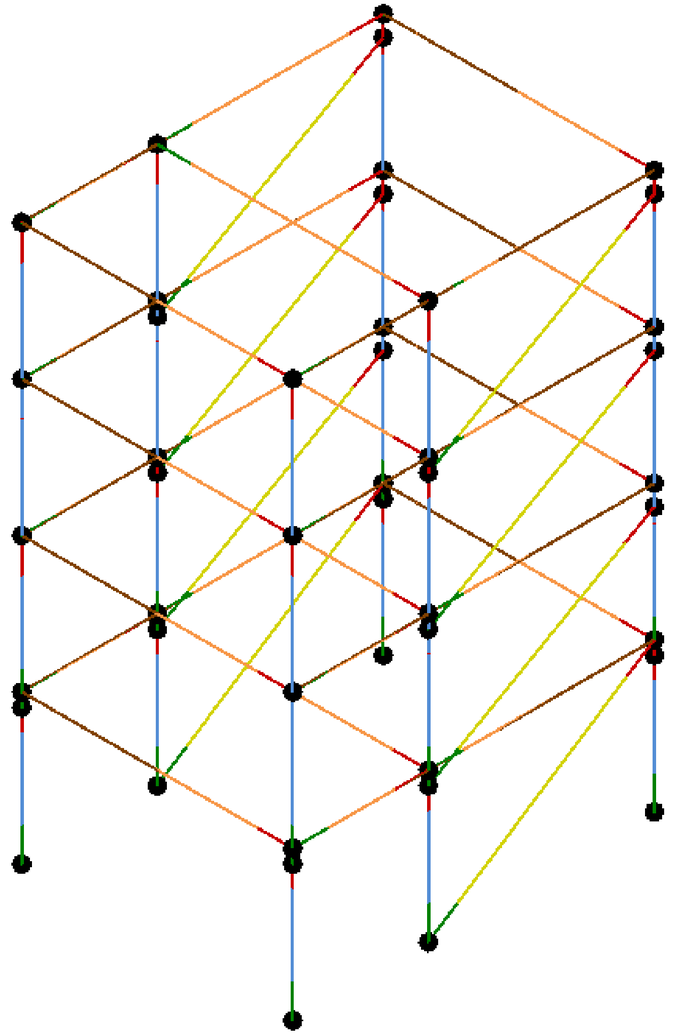


Exercise 2 | Adjust the Analytical Representation of a Structural Model using Dynamo

Verify Analytical Model Consistency

1. Enable the Member Supports and Analytical/Physical Model Consistency automatic checks.
2. Explore the warnings.

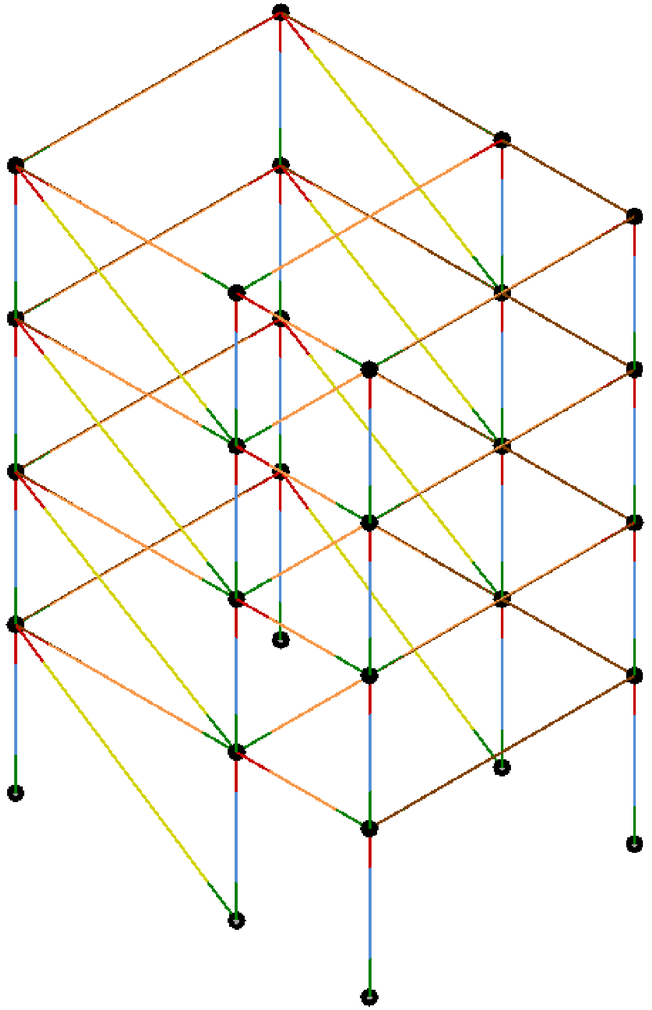




Exercise 2 | Adjust the Analytical Representation of a Structural Model using Dynamo

Adjust the Analytical Representation Using Dynamo

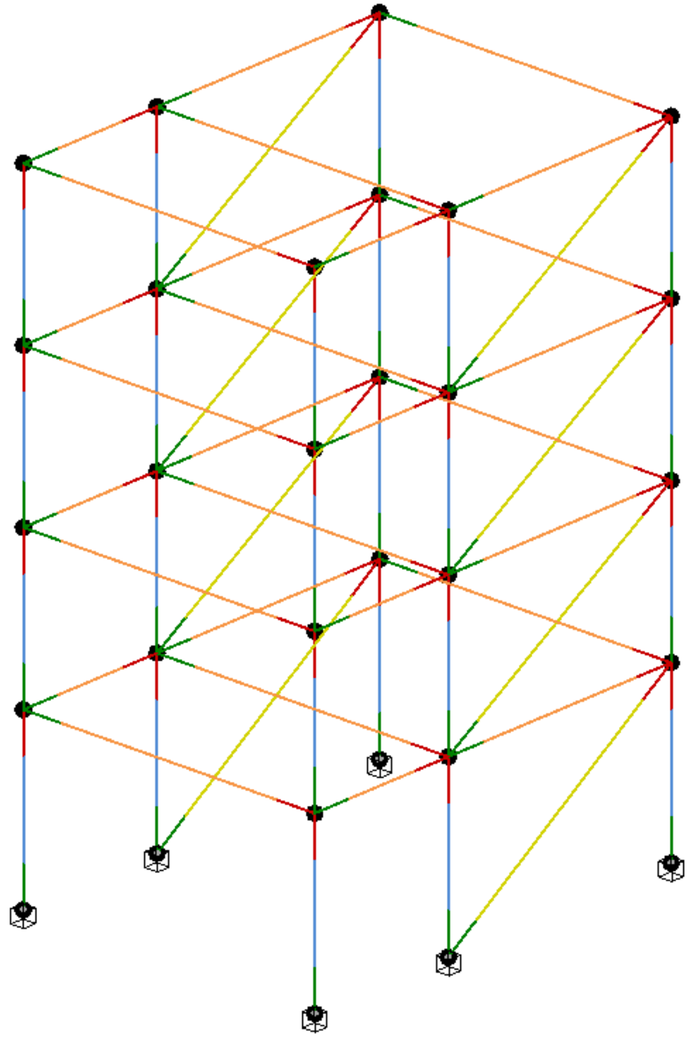
1. Load analytical modeling scripts in Dynamo Player.
2. Using *Adjust the elements between categories* script
   - Select elements
   - Set-up the parameters
     - First Priority Elements: Floors
     - Second Priority Elements: Framings
     - Third Priority Elements: Columns
     - Set Force Tolerance to Change to True
   - Use Relative Tolerance and Set the tolerance to 600mm
3. Run the script to adjust the elements.



Exercise 2 | Adjust the Analytical Representation of a Structural Model using Dynamo

Fix All Warnings

1. Create isolated foundation for columns.
2. Attach boundary conditions for columns support.



Complete the Analytical Model in Revit for Structural Analysis Purpose

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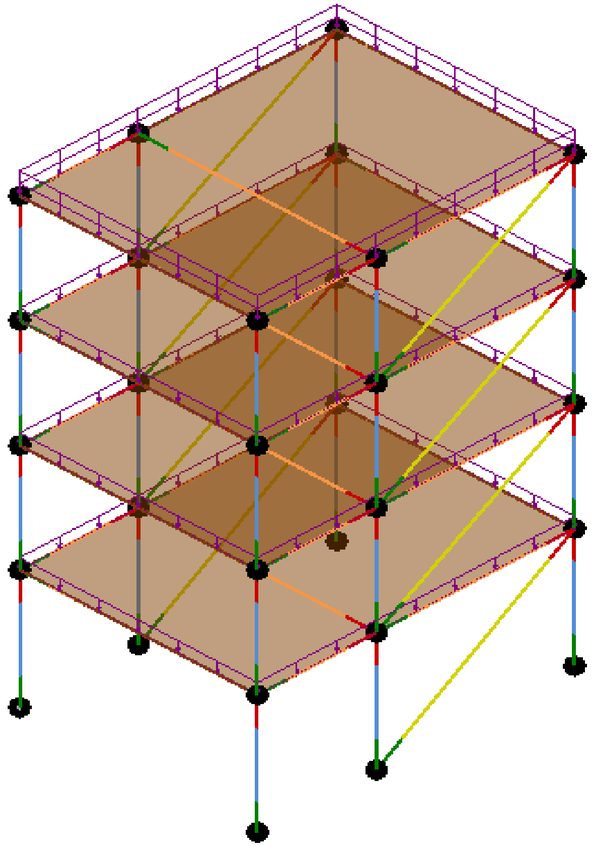
Complete the Analytical Model in Revit for Structural Analysis Purpose

Loads

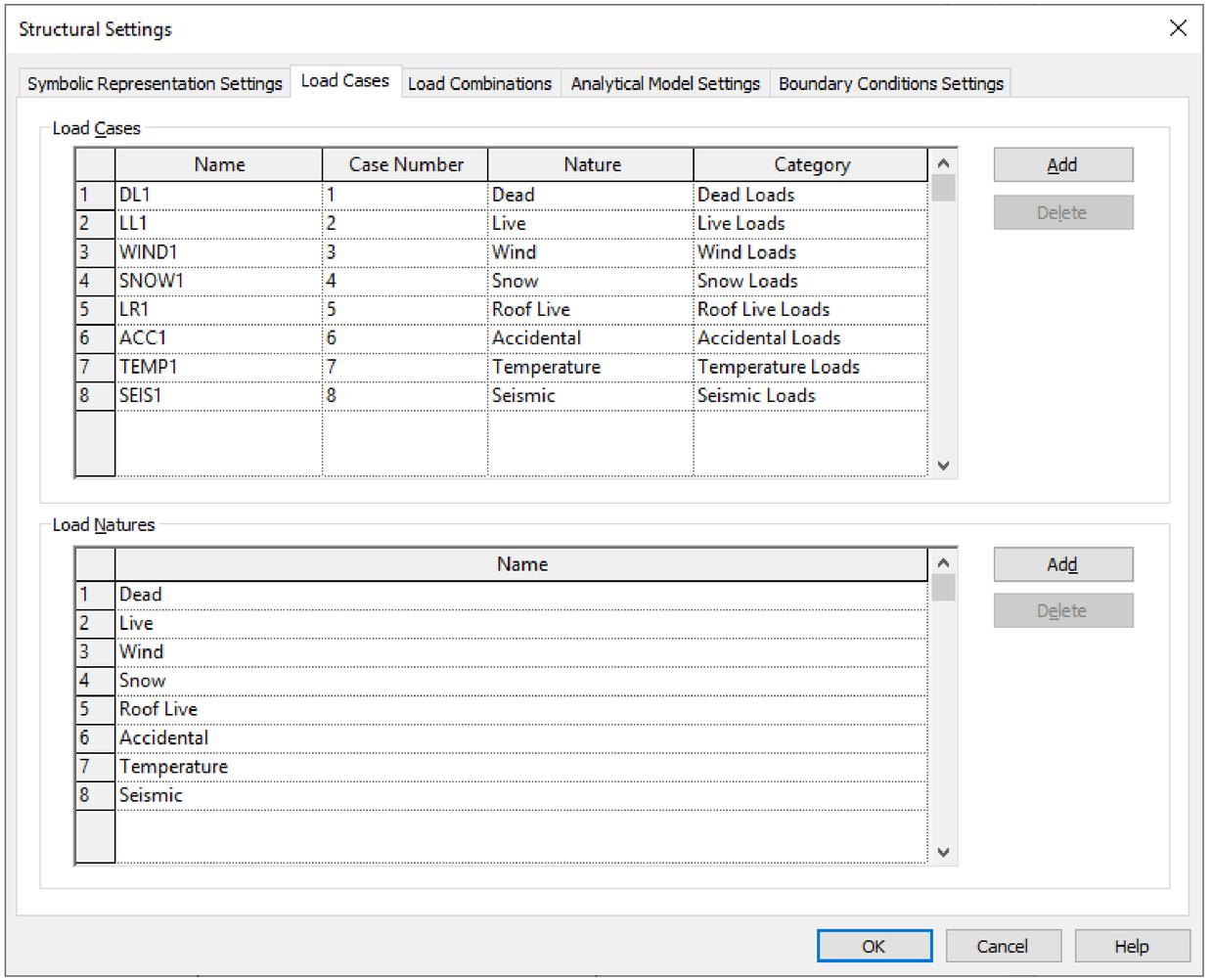
- **Types of Loads**
  - **Un-hosted loads**
    - Point Load
    - Line Load
    - Area Load
  - **Hosted Loads**
    - Hosted Point Load
    - Hosted Line Load
    - Hosted Area Load.



Complete the Analytical Model in Revit for Structural Analysis Purpose

Loads

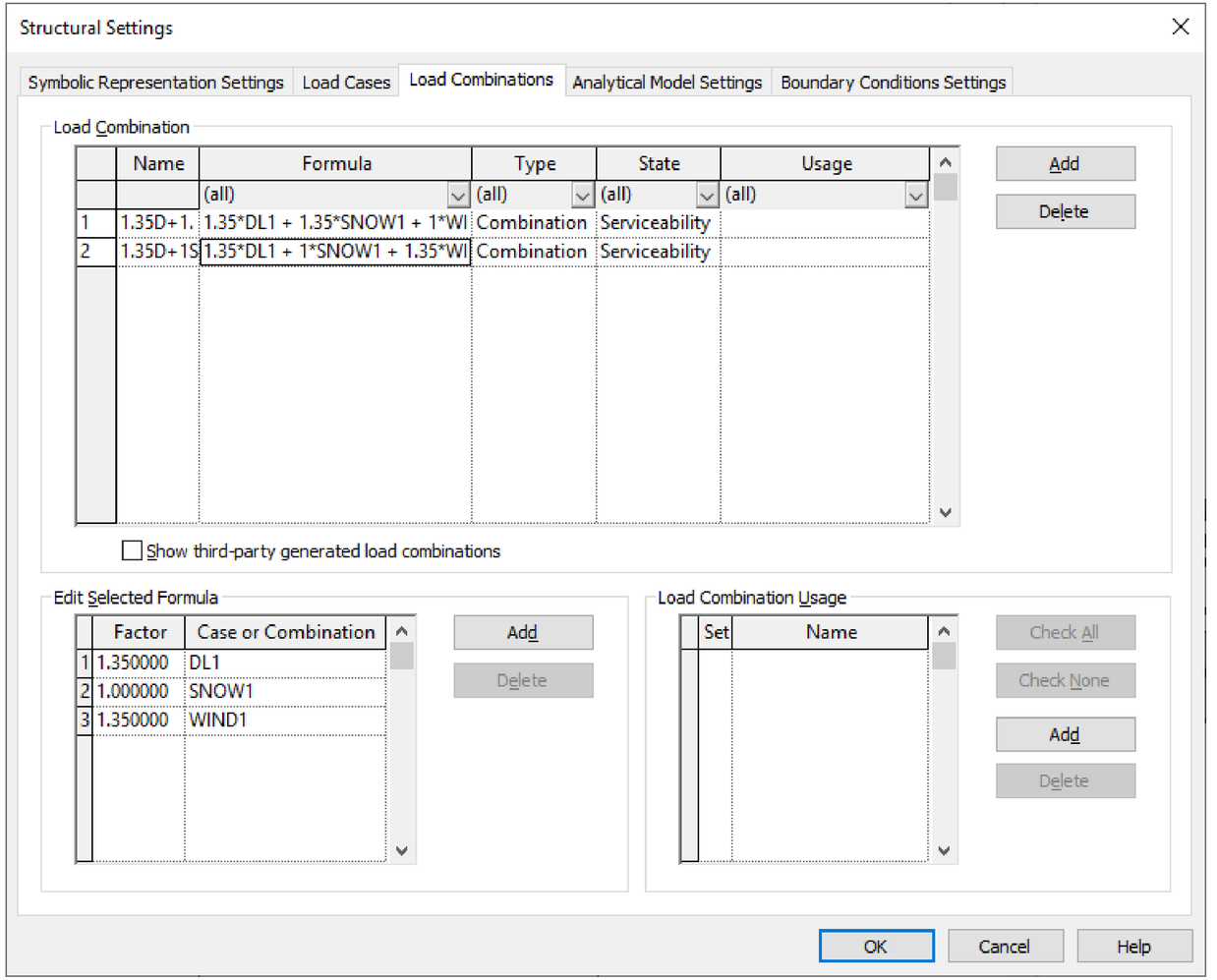
- **Load Nature**
- **Load Cases**



Complete the Analytical Model in Revit for Structural Analysis Purpose

Loads

- **Load Combinations**



Exercise 3 | Complete the Analytical Model in Revit for Structural Analysis Purpose

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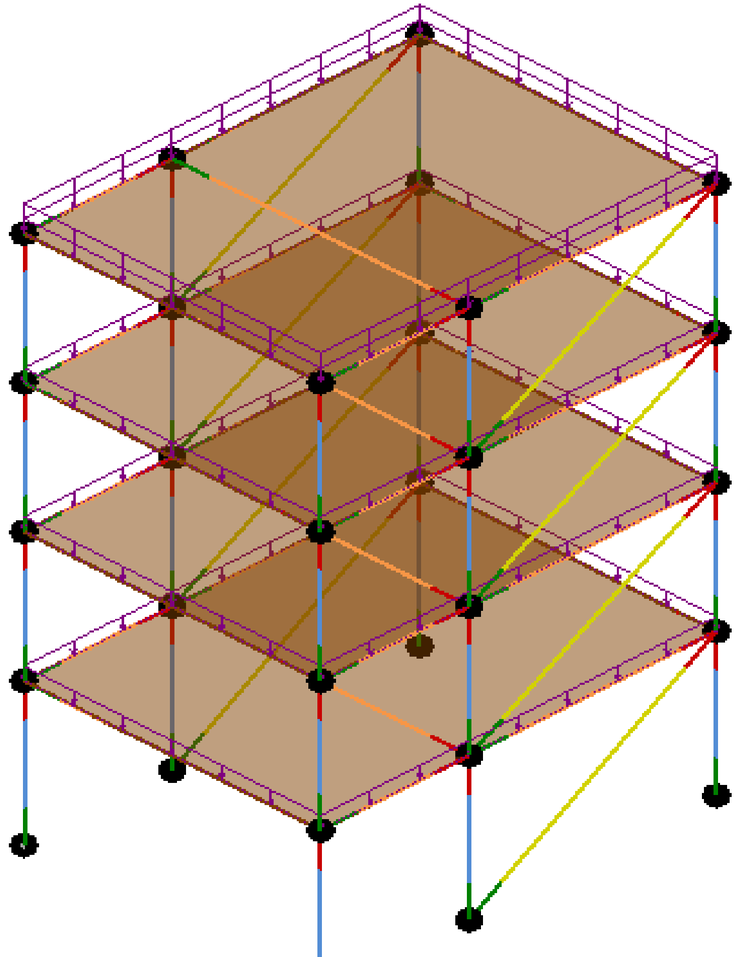
Exercise 3 | Complete the Analytical Model in Revit for Structural Analysis Purpose

In this exercise, we'll define hosted loads to prepare the model for structural analysis.

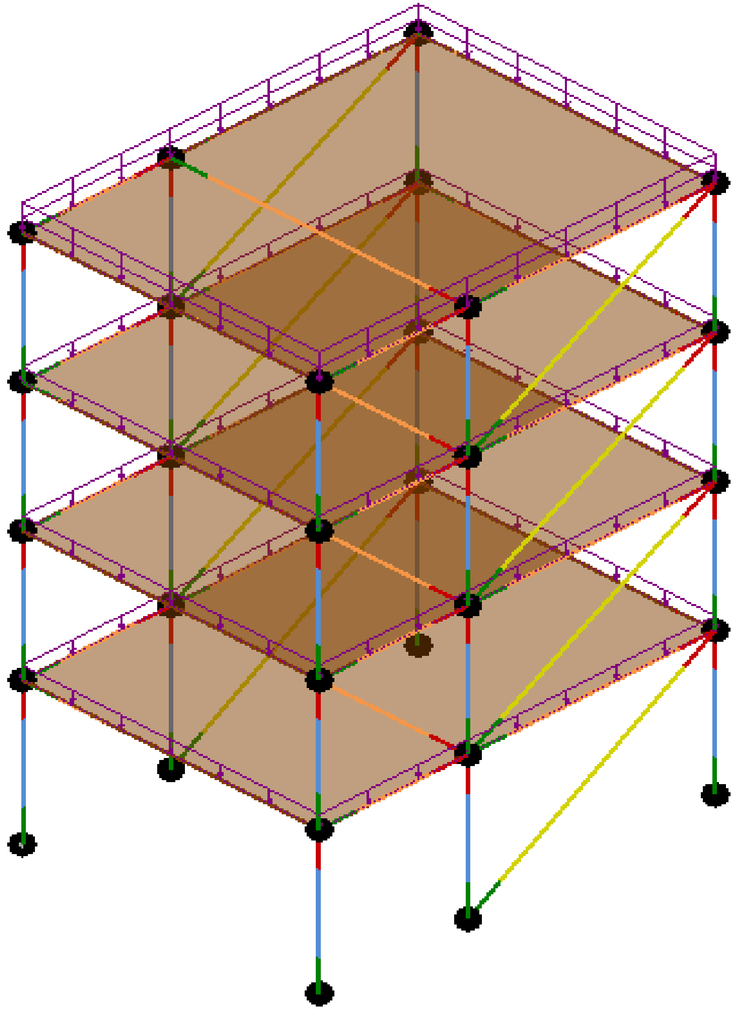
(Handout page 48)



Exercise 3 | Complete the Analytical Model in Revit for Structural Analysis Purpose

Goal

Assign loads to analytical elements.

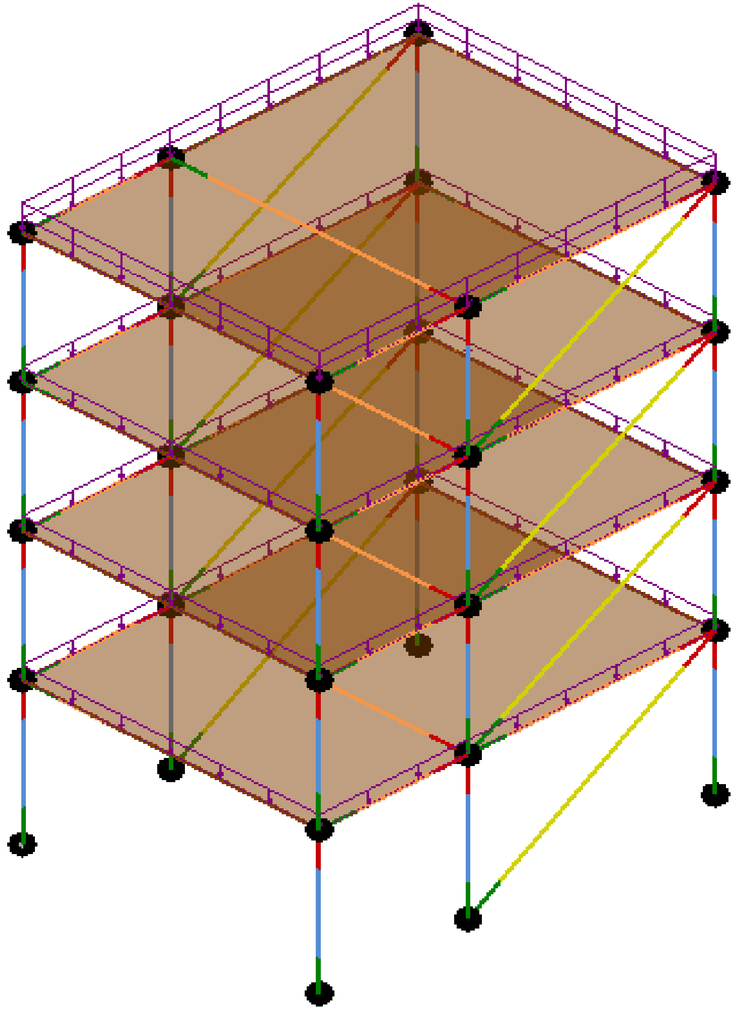


Exercise 3 | Complete the Analytical Model in Revit for Structural Analysis Purpose

Apply Hosted Loads

- Open Exercise_03_01_StartPoint.rvt

1. Apply hosted linear load to top level perimetral beams.
2. Apply hosted area load to all floors.



Integrate Structural Analysis Results in Revit Workflow

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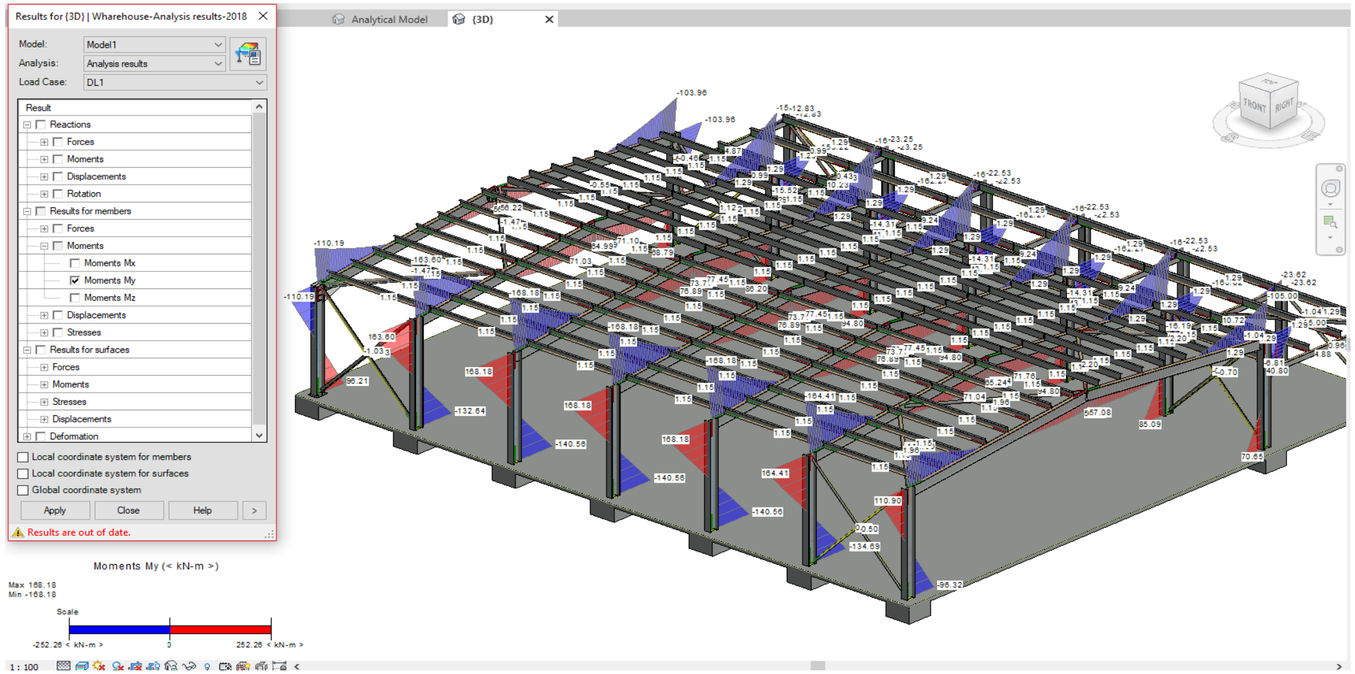
Automate the relation between physical and analytical representations using Dynamo

The Structural Analysis Toolkit for Autodesk® Revit® software is a suite of tools that supports the Building Information Modeling (BIM) process and allows structural engineers to analyze and check your structure from within the Autodesk® Revit® environment.

Using this toolkit structural designers and engineers can optimize their workflows by extending the Revit model to Autodesk® Robot™ Structural Analysis Professional software or supported third party analysis solutions. Once complete, analysis results can be easily stored and explored in the Revit environment.



Exercise 4 | Integrate Structural Analysis Results using Robot Structural Analysis Toolkit

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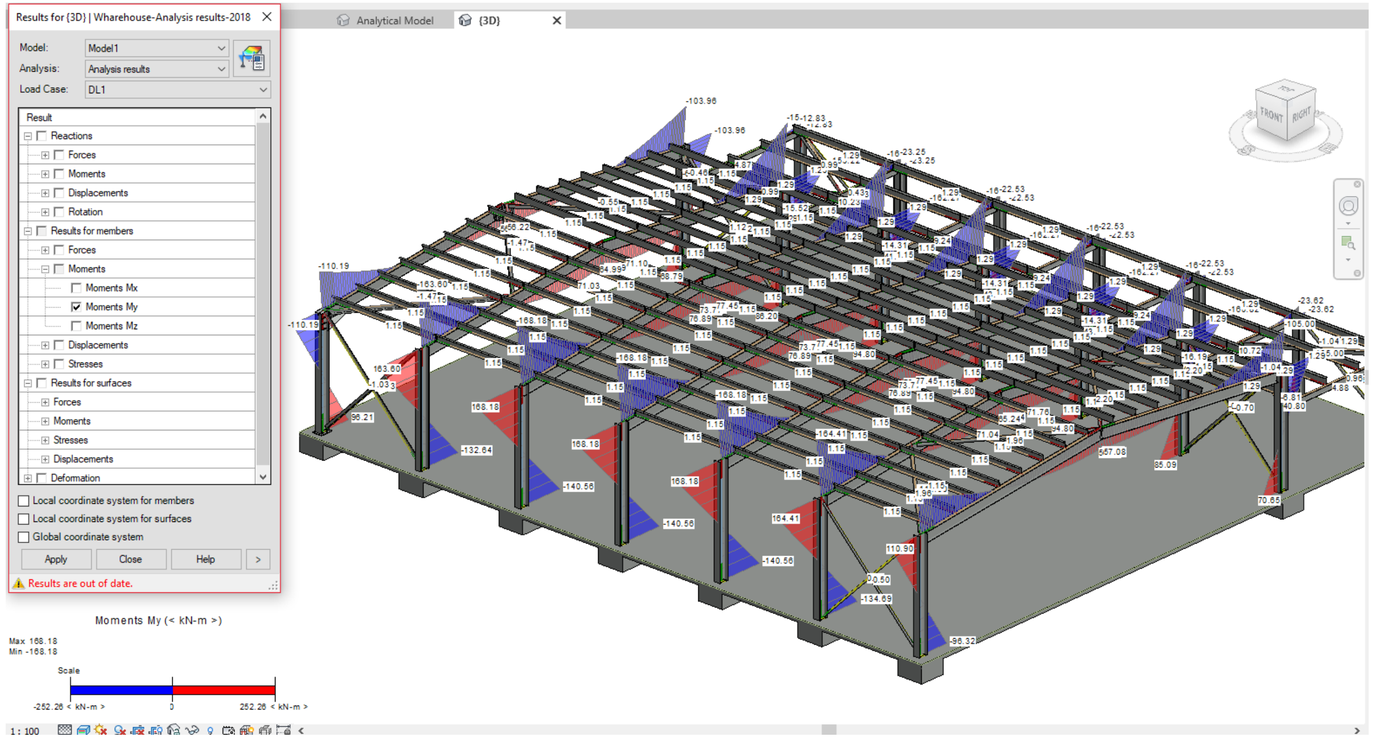
Exercise 4 | Integrate Structural Analysis Results using Robot Structural Analysis Toolkit

In this exercise, we'll explore structural analysis results using a Revit addin – Structural Analysis Toolkit.

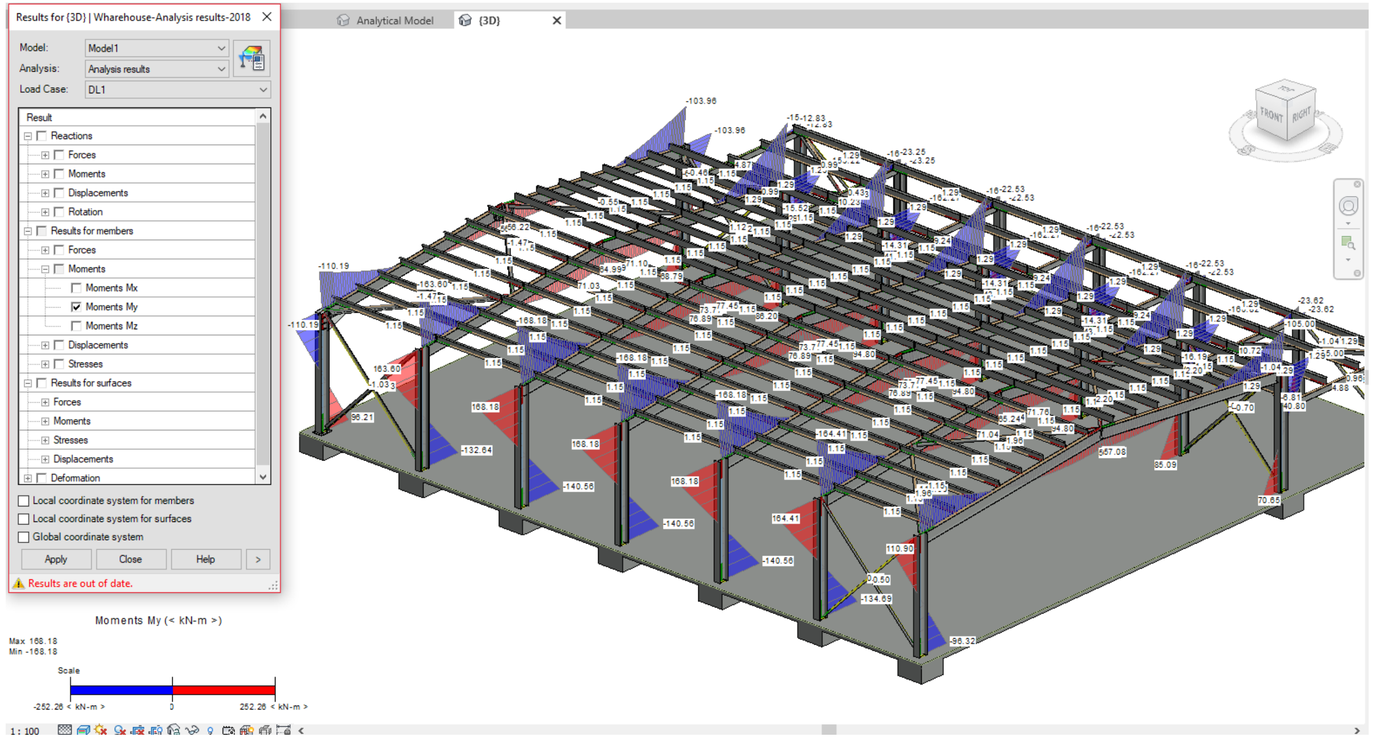
(Handout page 53)



Exercise 4 | Integrate Structural Analysis Results using Robot Structural Analysis Toolkit

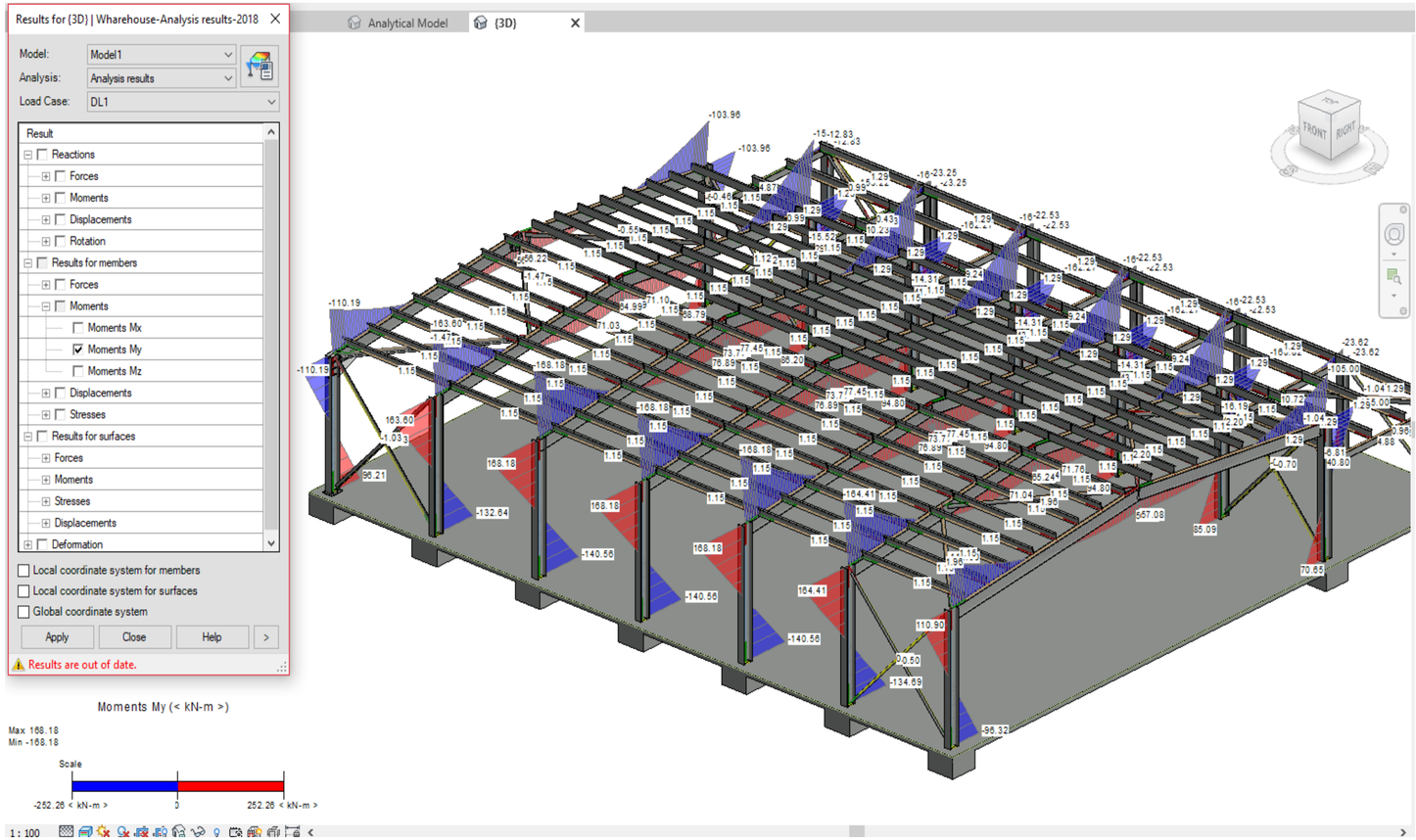
Goal

Explore the structural analysis results in Revit.



Exercise 4 | Integrate Structural Analysis Results using Robot Structural Analysis Toolkit

- Open Exercise_04_StartPoint.rvt
- **Go to Analyze tab > Structural Analysis panel > Result Explorer**
- **Explore the results**



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