ES17637-L: Integrating Structural Design and Analysis: The Basics of a Revit-Robot Workflow

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In this hands-on lab, we will explore the simple, powerful, round-trip workflow between Revit 2017 software and Robot Structural Analysis Professional 2017 software. We'll start with a simple structural model of a building in Revit software, and we'll develop an understanding of the analytical model that Revit software builds concurrently with the creation of structural geometry. We will then explore the Structural Analysis for Revit feature, which enables static and gravity analyses to be performed on the cloud directly from Revit software. Next, we'll push that model into Robot Structural Analysis Professional software to perform a basic analysis and code group-based design. Finally, we'll push the updated geometry from Robot Structural Analysis Professional software back to Revit.
Key learning objectives

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

- Explain the relationship between the physical and analytical models in Revit
- Use the **Structural Analysis for Revit** feature for quick structural checks
- Send models from Revit to **Robot Structural Analysis Pro (RSA)** and back for full-featured analysis
- Perform code group-based design for steel members in **Robot Structural Analysis Pro**
Today’s Agenda
Integrating Structural Design and Analysis

- **Tools and Workflows**
  - What, where, and why
- **Revit**
  - E1: Exploring the analytical model
- **Structural Analysis for Revit**
  - E2: Basic, speedy cloud-based analysis
- **Robot Structural Analysis Pro (RSA)**
  - Key features
  - E3: The round-trip experience!
# Tools by Phase

The Autodesk Structural Toolbox

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**Tools by Phase**

- **Conceptual Design**
- **Structural Design**
- **Coordination, Simulation**
- **Code Checking**
- **Fabrication Model**
- **Shop Drawings**
- **Prefabrication and Production**
- **Installation**

**Tools**

- **Revit**
- **Advance Steel**
- **Structural Analysis for Revit**
- **Robot Structural Analysis Professional**
- **Dynamo**
- **Partner Add-ins, e.g. SOFiSTiK**
- **BIM 360 Team, BIM 360 Docs, Navisworks, BIM 360 Glue**
- **BIM 360 Field, BIM 360 Plan**
Steel Design and Detailing Workflow
Autodesk Revit, Robot, and Advance Steel

Construct Model
Revit, Advance Steel

Perform Analysis
Robot Structural Analysis Pro

Detail Steel Connections
Advance Steel, Revit

Generate Shop Drawings
Advance Steel
Concrete Design and Detailing Workflow
Autodesk Revit and Robot

- Construct Model: Revit
- Add Reinforcement: Revit (+optional add-ins)
- Perform Analysis: Robot Structural Analysis Pro
- Create Assemblies: Revit (+optional add-ins)
- Generate Shop Drawings: Revit (+optional add-ins)
Value: Detailed Modeling

Image courtesy http://vasshaug.net/
Value: Prefabrication
Value: Coordination

Images courtesy ICA
Value: Integration
Autodesk Revit 2017 and 2017.1
New features and enhancements

Architecture/platform enhancements
- Depth cueing
- Improved railing hosts and UI usability
- Autodesk® FormIt® 360 Converter
- Autodesk® Insight 360 integration
- Global parameter enhancements
- Improved software performance
- Autodesk® Raytracer rendering engine
- Text Editor and layout engine
- Calculate in annotation tags
- Dynamo updates and player
- Tangency locks
- Schedule improvements
- LED light fixtures content
- Sketch on level
- Stairs parameters tooltips
- Import 3D shapes (Rhino®/SAT files)
- Work in a perspective view
- Corruption data loss prevention
- High-resolution monitor support
- Autodesk® Collaboration for Revit® sync progress notification

Structural engineering enhancements
- Reinforcement connectors
- Variable rebar distribution
- Graphical rebar constraints management
- Bent fabric sheets reinforcement
- Structural connectivity
- Autodesk® Steel Connections for Revit®
- Split columns and framing elements
- New Steel profiles catalogues
- Improved structural foundations
- AISC connection code checking for steel connections
- New steel shapes content

Mechanical, electrical, and plumbing (MEP) design & fabrication enhancements
- Design to Fabrication
- Optimize lengths
- Short segment optimization
- Route and Fill
- Trim and Extend
- Quick Connect
- Change type
- Slope control
- Fabrication model documentation
- Hanger improvements
- Electrical apparent load calculation options
- Design computation improvements
- Scalability improvements
- Resize connected parts
- Change service
- Exclude FAB parts from Autofill tools
- Add or modify a damper
- Split fabrication elements
- Hanger support rod enhancement
- AWWA valves and pumps content
- Space Naming tool integration
Beyond design and documentation
Autodesk Revit 2017

- The analytical model
  - Revit takes its ‘best guess’ at building an analytical model during design
  - The analytical model can be independently adjusted
  - Revit checks for connectivity and ensures elements are supported

Revit creates and shares detailed element information with structural analysis tools
Exercise 1
Exercise 1
Exploring the analytical model in Revit

1. Open 01 - Simple Building.rvt.
2. Open the View 1 - Analytical view and tile side-by-side with the default 3D view.
3. Select an element in the default 3D view and review its properties. Select the same element in the analytical view and note the differences.
Exercise 1  
Exploring the analytical model in Revit

4. Switch to the Analyze tab.
5. From the Analytical Model Tools panel, open the Structural Settings.
6. Notice the options available here.
7. Close the dialogue box and select the Check Member Supports button. Notice the ‘warning’ that appears.
Structural Analysis for Revit 2017
Cloud-based analysis
Structural Analysis for Revit
Cloud-based analysis
Structural Analysis for Revit
Exercise 2
Exercise 2
Structural Analysis for Revit

1. Open 02 - SAR.rvt and locate the Analyze tab > Structural Analysis panel.

2. Select Analyze in Cloud; configure a static analysis and select Start.*

3. Open your browser and navigate to structuralanalysis360.autodesk.com to view the result.*

*Steps 2-3 require an Autodesk ID with access to SAR and cloud credits. If you don’t have these, don’t worry! You’ll have the opportunity to participate in our next exercise.
Exercise 2
Structural Analysis for Revit

4. In Revit, select **Results Manager** on the **Structural Analysis** panel.
5. Select the AU static analysis that is listed as “in project”.
6. Click the **Explore** button to open the **Results Explorer**.
7. Choose **Results for surfaces** > **Displacements** > **Displacement UZ** and select **Apply** to view results.
Autodesk Robot
Structural Analysis Professional 2017
(aka Robot, RSA)
Top features
Robot Structural Analysis Professional 2017

Collaboration
- Supports efficient BIM workflows
- Interoperability with Revit, Inventor, etc.

Speed
- Auto-meshing (FEA)
- Robust nonlinear and dynamic algorithms
- Over 70 design codes

Versatility
- Flexible, open API
- Covers a broad range of structures
- Localized for global markets
Typical customers
Robot Structural Analysis Professional 2017

- **Spans multiple industries**
  - Structural Engineers
  - Multidisciplinary Engineering Teams
  - Building Product Manufacturers and Fabricators
  - Large Industrial Machinery Providers
  - Oil and Gas / Mining Firms
Analysis of concrete, steel, and timber designs
Robot Structural Analysis Professional 2017

- **Design versatility**
  - Reinforced concrete design module
  - Steel design module
  - Timber design module
Modeling flexibility
Robot Structural Analysis Professional 2017

- Shells, solids, and more
  - 2D and 3D frames and trusses
  - Plates
  - Shells
  - Grillages
  - Plane stress structures
  - Plane deformation structures
  - Axisymmetric structures
  - Volumetric structures
  - Composite beams
Advanced analytical capabilities
Robot Structural Analysis Professional 2017

- Flexibility to meet your needs
  - Advanced finite element auto-meshing
  - Wide range of analysis capabilities
  - Powerful analysis solvers
Advanced analytical capabilities
Robot Structural Analysis Professional 2017

- Linear and non-linear analysis
  - Compression / tension elements
  - Cable elements
  - Non-linear constraints
  - Material plasticity
  - Non-linear hinges
  - 2nd-order effects (non-linear)
  - 3rd-order effects (P-delta)
Advanced analytical capabilities
Robot Structural Analysis Professional 2017

- Dynamic analysis
  - Modal
  - Seismic
  - Spectral
  - Harmonic and FRF
  - Time history (linear and non-linear)
  - Elasto-plastic
  - Pushover
  - Footfall
Advanced analytical capabilities
Robot Structural Analysis Professional 2017

- **Wind load simulation**
  - Simulates the wind flow around a structure
  - Generates wind loads on all surfaces automatically
  - Adjustable wind profile and velocity factor
  - Graphic representation of the virtual wind tunnel
Extensibility
Robot Structural Analysis Professional 2017

- Open, flexible API
  - Custom macros creation
  - Extraction of analysis results
  - Parametric structure creation

- Results Connect
  - Seamlessly access RSA data and results using Microsoft Excel, even without API knowledge

- Dynamo
  - Access the API with powerful visual programming tools
Customer Examples
Robot Structural Analysis Professional 2017
Exercise 3
Exercise 3
Send from Revit to RSA

1. Open 03 - Start.rvt and locate the Analyze tab > Structural Analysis panel.
2. Select Robot Structural Analysis > Robot Structural Analysis Link.
3. Leave default options and select OK. RSA will open and begin importing the Revit model data.
4. Click Yes to the pop-up dialog to view the Events Report.
Exercise 3
Configure the Model Display in RSA

5. If load symbols are not displayed, go to View tab > Display > Loads and toggle Load symbols off and on again, clicking Apply each time.

6. Select OK to exit that dialog.

7. Element visibility may also be controlled using the toolbar at the bottom left edge of the drawing window. Use this toolbar to toggle the display of Section shapes.
Exercise 3
Adjust Analytical Geometry

8. Select the analytical floor at Level 2.
9. In the Properties Inspector at the left side of the screen, change the Calculation model for this floor from Shell to Deck slab (one-way).
10. Repeat for the floor at Level 3.
Exercise 3
Generate Load Case Combinations

11. Select **Loads** tab > **Automatic Combinations** to open the Load Case Code Combinations dialog.
12. Select **Full automatic combinations**, then click **More** to view the combinations in more detail.
13. Select **Generate** to build out the load combinations list.
Exercise 3
Create Finite Element Mesh

14. Click the **Options of FE Mesh Generation** icon to open this toolbar, then choose **Meshing Options** (select **Yes** to the pop-up message).

15. Select **Complex mesh generation (Delaunay)** and set the **Element size** to 2 feet. Select **OK**.

16. Select **Generation of calculation model** to create the FE mesh.

17. Select **Mesh Freeze** to store this mesh; then close the toolbar.
Exercise 3
Perform Analysis

18. Time for analysis! If you’ve gotten lost along the way, open 04 – Analysis.rtd to catch up.

19. Go to Analysis tab > Analysis Types to open this menu. Observe additional capabilities under the New and Parameters buttons.

20. Select Calculations to run the analysis. A green light at the bottom of the screen indicates that current results are available.
Exercise 3
View Results

21. Select **Results** tab > **Maps** to open this dialog.
22. Select the **z** direction for **Displacements – u,w** and select **Apply**.
23. Note the color mapping in RSA is similar to the results previously explored in Revit.
24. Deselect the **z** checkbox and select **Apply** again to remove the map.
Exercise 3
Configure Code Group for Design

25. For this step, let’s change our RSA layout. Locate the **Layouts** toolbar and change from **Geometry** to **Steel/Aluminum Design**.

26. Proceed to the **Groups** tab of the **Definitions** dialog. Click **New** to create a new code group and enter members **104 to 123** in the **Member list**.

27. Select **Save**.
Exercise 3
Perform Code Group Design with Optimization

28. Proceed to the **Calculations** dialog and select the **Code group design** option. Enter 1 or use the **List** button to find and select group 1.

29. Select **Optimization** and check the **Weight** option. Select OK to close this dialog. *If you’re behind, open 05 – Design.rtd to catch up.*

30. Select **Calculations** to perform code group design for the selected settings.
Exercise 3
Select Optimal Sections

31. The **Code Group Design** module highlights the optimal section for the group (W 8x24 here). Click on the icon next to this section to view results; select **OK** to return.

32. In the **Code Group Design** dialog, select **Change all** to resize the sections. **Close** the dialog and **Cancel** saving the calculation results.
Exercise 3
Update the Revit Model

33. Return to Revit. As before, select Robot Structural Analysis > Robot Structural Analysis Link.
34. Choose Update model and click OK. You can also choose Update from the intermediate file and select 06 – Update.rtd. Ignore the events report.
35. Open the {3D} view, hide the top floor slab, and select an interior beam to confirm its new size.
You did it!
Q&A
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