Advanced Modeling in Autodesk® Revit® Structure

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SD33-1  Achieve the most critical modeling tasks in Revit Structure. Use the family editor to create additional structural components. From steel to concrete structures, learn how building information modeling will increase your competitive edge.

About the Speaker:
Marie joined Autodesk in 2005 as the technical marketing manager Structural Solutions in the Building Solutions division. She is responsible for supporting the worldwide launch and market entry for Autodesk Revit Structure, the first Autodesk product for the structural engineering market. Marie has a Master's degree in Structural Engineering and over ten years of experience designing structures, and marketing and selling structural engineering software. She has trained and taught hundreds of engineers on structural analysis and design software.
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Structural Modeling Examples

Note on families
Families are like libraries where you can store object properties with various powerful parameters, so structural components can be reused with new parameters in new projects.

In Revit Structure, we have 3 types of families.

1. Structural elements like walls, floors, ramps, etc… are “system” families in Revit Structure. They are built in place. You can only change their parameters using the element properties.

2. The other elements like columns, beams, footings are “standard” families. Standard families are stored in the Library and can be loaded into Structural templates and projects. Structural elements can be edited directly in the family editor.

   The family editor is for standard families, it’s a tool to allow the creation of any new and custom structural components.

   The standard families are meant to be reused from one project to another (like existing beams and columns).

3. The “in-place” families are project specific and are not meant to be reused in other projects.

Curved beams

Use in-place family. From the modeling design bar, Create new.
Select the structural framing category and name accordingly.

Use a Solid Sweep, load a profile, like W shape.
Sketch the path of the arc beam.

Analytical model line can be added to the family if the engineer needs to send the model to analysis software.

Note: Similar modeling technique can be used for project specific trusses.
Stepped footing

If you want to change the default representation of stepped footing with slope at bottom, one option is to create a new in-place foundation with the proper shape.

This allows you to have the 3D model and all related views in synch, instead of just adjusting the detail section view with drafting tools like detail lines.

- Add a reference plane called “wall center”
- Align/lock concrete walls to the reference plane
- Create/structural foundations, use the reference plane

- Sketch the solid extrusion
- Add equal constraints between “Wall Center” plane and the foundation boundaries

![Diagram showing equal constraints between Wall Center plane and foundation boundaries.](image)

- Add width parameter
- Flex the foundation to make sure it stays centered to the wall
- This new foundation can also be scheduled

**Concrete precast walls**

When you have 2 walls, close to each other like tilt-up concrete panels, Revit Structure will merge basic walls into one single.

You need to use a curtain wall element to be able to keep them separate.

![Curtain wall element in Revit Structure.](image)

Create the curtain wall from the Architectural design bar.

In curtain wall properties, make sure you select a bearing usage.

In type properties, you can layout vertical panels only.

Apply concrete properties to the associated glazed panels.
If the concrete panels do not show up in your views, change the discipline to “coordination”.

**Tapered beam and tapered column**

- Open existing W shape and rename
- Delete existing geometry and angle parameter
- Layout additional reference planes and parameters for taper
- Create additional types and flex
- Create new blend, attached to correct reference planes

- Assign proper visibility settings for medium and fine
- Flex
- Modify coarse section model lines
- Flex
- Test in project

Use “cut geometry” tool to clean column and beam intersection.
Light gauge joist

Revit Structure does not provide out-of-the-box cold form sections. This example shows how to create a joist beam type J (from MarinoWare, light weight steel framing systems).

- Create new profile for Light Gauge Joist
- Modify existing beam for new Light Gauge Joist Beam, rename
- Load profile, replace existing profile with new profile in medium sweep definition

- Delete extra geometry fine visibility and old profiles
- Rename existing parameters to match Light Gauge Joist parameters required
- Map profile parameter to Beam parameters
- Create additional types and flex
- Modify the sweep level of detail to include Fine
- Modify course section model lines
- Flex
- Test in project
Opening in beam for MEP equipment

- Edit the beam family
- Assign reference planes and parameters
- Create void extrusion, attached to correct reference planes
- Create additional types and flex

The beam section can then be used for a typical detail (section and elevation showing plates to reinforce opening).

**Bar joists systems - K, LH and DLH series – Change example**

These components come directly out-of-the-box. You can still edit them in the family editor when necessary. For example, you want wants only one of the ends to extend out a certain distance.
This can be done with a simply change to the family:

- Make a separate parameter for each end so the extensions could be different
- Rename the parameters to Extension - Start and Extension - End for clarity.
- Open concrete column family
- Add reference planes
- Select solid extrusion
- Sketch the corbel in Front elevation
- Lock to reference planes
- Assign dimension parameters to the corbel and lock
- Add a new type
- Flex to test
- Use align tool to align corbel to faces of columns
- Add a parameter for vertical position
- Test family type
- Uncheck visible in properties
- Use button to associate family parameter
- Add visibility parameter
- Load family to project
- Test
- Use architectural design tool: Ramp
- Set ramp properties to 24' width, 1' thickness and 1:10 slope, change maximum inclined length to 500'
- Create an arc run
- Make sure you turn visibility of ramps and railing ON
- Edit Railing
- Define rail structure and baluster placement (if needed)

- Rail Structure: create a new profile for the concrete barrier

- Also choose profile for top rail
Test your baluster properties.

You can remove from the railing, both top rail and baluster, in order to keep just the concrete profile, or if the ramp is directly connected to circular walls.

- Copy ramp onto levels, attach other structural elements
Useful Tips

- Use structural templates
- Set-up levels first
- Use grids for relationships between objects
- Use the space bar to orient columns when placing them
- Use the tab key to select objects more precisely
- Use and name reference planes (sloped beams, sloped beam system, families)
- Use 3D section box in complex geometry situation, use the View > Orient > To other view
- Use the shaft tool for opening throughout your structural model
- Save time with keyboard shortcuts VV, ZA, AL, CP, DI, BM, CL etc...

Family Tips

- Reference Planes, Reference Planes, Reference Planes:
  Reference planes have the highest priority of attachment making them the most stable
- Pin existing template reference planes Center L/R & F/B:
  Keep the insertion point orientation from moving
- Use align tool to attach geometry to reference planes:
  To minimize selection errors
- Use Tab to select

Process Order:

- Plan: Determine how this family will be parametric
- Layout reference planes: Relating to placement and planed parameters
- Add parameters
- Add 2 or more types: With enough parametric difference to test the geometry within reason
- Flex types (testing procedure): Cycle through family types to find constraint and other errors
- Add a single level of geometry: Attach geometry to reference planes (not other geometry)
- Repeat Flex procedure for each level of geometry added to catch error early.
- Test in project environment (create testing project)
  1. Create a project file with some predefined elements you expect to interact with (Wall, columns, beams)
  2. Duplicate levels of multiple Detail Levels
  3. Add a predefined section, framing elevation
  4. Test multiple types
  5. Verify in multiple levels of detail, section views, elevations...etc.
Appendix: Best Practices on Families

Areas to remember:

1. Settings / family category and settings for family based settings
   - Always Vertical
   - Symbol Representation (where is the course representation controlled)
     - From Family (generated and controlled family side mostly)
     - From Project Settings (generated and controlled project side)
   - Structural Material Type
     - Adds the correct material related parameters in the project
   - Always Export As Geometry (for ADT export)
   - Shared
   - Others depending on category

2. View Specific Display & Detail Levels
   - 3D objects display in 3D views and selected view orientations
   - At selected detail levels
   - On a per object bases

3. Reference plane strength, snapping and shape handles
   - Named – first in Snap behavior
   - Strong – same as Named
   - Weak – second in Snap behavior
   - No Reference – no snapping and no shape handles
4. Category cutting (see help: Cut or Not Cut in Plan Views)

5. Instance vs. Type in formulas
   - Can’t have instance parameters defined in a formula of a type parameter

6. Associate parameters button in nested families

7. Don’t dimension objects inside a sketch and then constrain the object outside the sketch...all in or all out...

Performance:
- Avoid over use of voids
- Avoid using too many formulas
- Avoid arrays and formulas
- Always test in project environment
- Use symbolic lines instead of geometry in plan views

Warnings:
- Constraints not satisfied
- Circular chain reference