

# Engineered Parametric Project

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## Class summary

This session will share a recent project that incorporates custom families into an early design project intended for use as a decision-making tool. The families essentially engineer themselves and update themselves in real-time. The elements are also scheduled to approximate construction cost. This session will show both how the custom families were created and how the project was modeled.

# Learning Objectives

1. Learn how to incorporate engineering into structural families
2. Discuss challenges of building a parametric project
3. Learn how to manipulate schedules to calculate cost
4. Discover an option for a design aid that can be created for clients, contractors, etc.

# Introduction

- Fully parametric model – updates engineering, sizes, etc.
- Visualize impact of various design decisions
- Rough construction costs
- Easily manipulated by client (owner of big box stores)

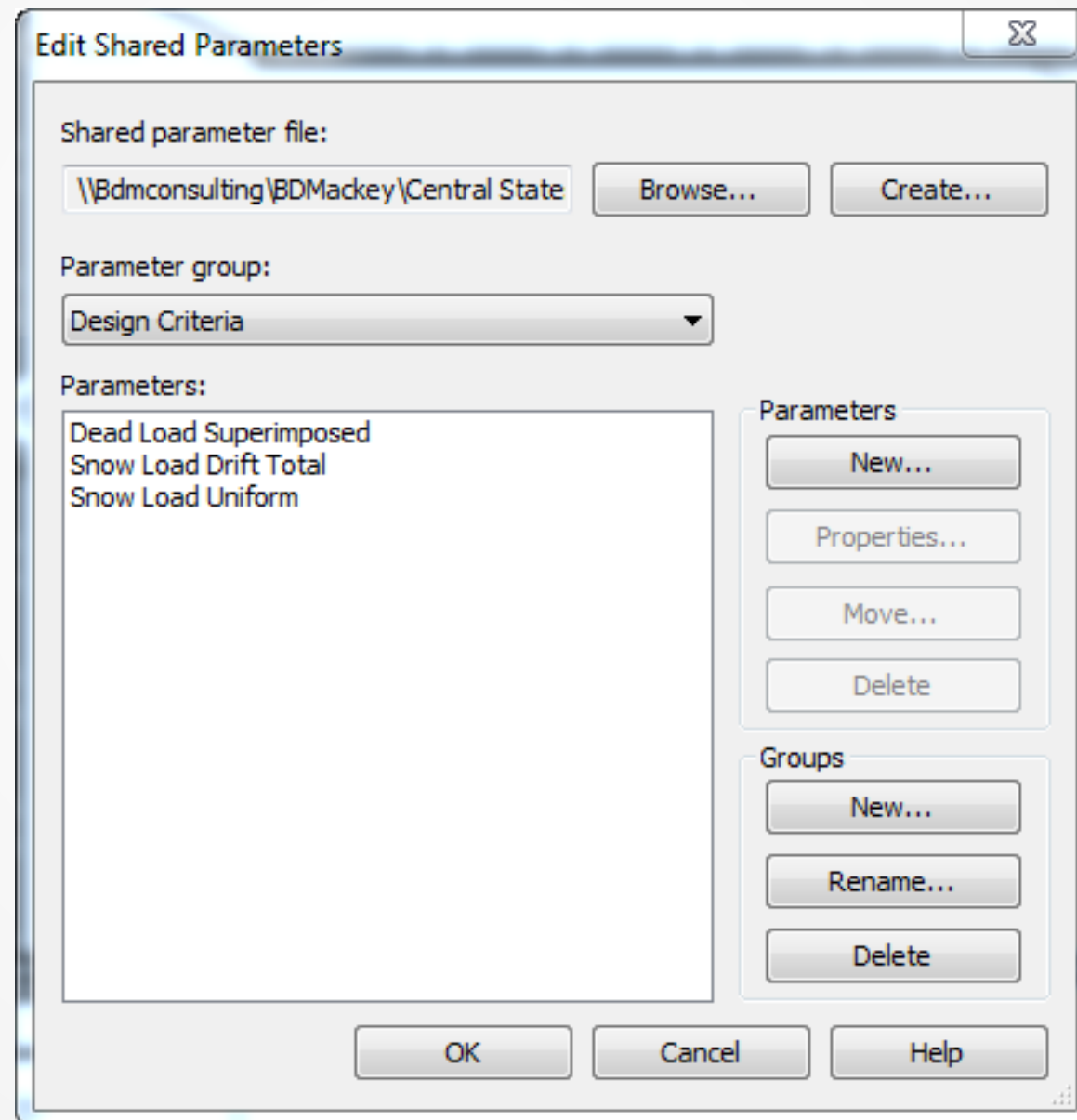
# Constraints

- 5-bays in N/S direction, 8-bays in E/W direction
- N/S bay lengths and joist spacing not variable
- E/W bay lengths and joist spacing are variable
- N/S walls variable heights, north always 4'-0" shorter than south
- Drifted snow load at south wall only
- Parapet height not variable
- CMU exterior walls w/concrete stem walls and strip footings
- Steel joists and joist girders with metal deck roof
- HSS columns with pad footings
- 4" concrete slab on grade
- Superimposed dead load, live load, and snow load not variable

# Building the Families

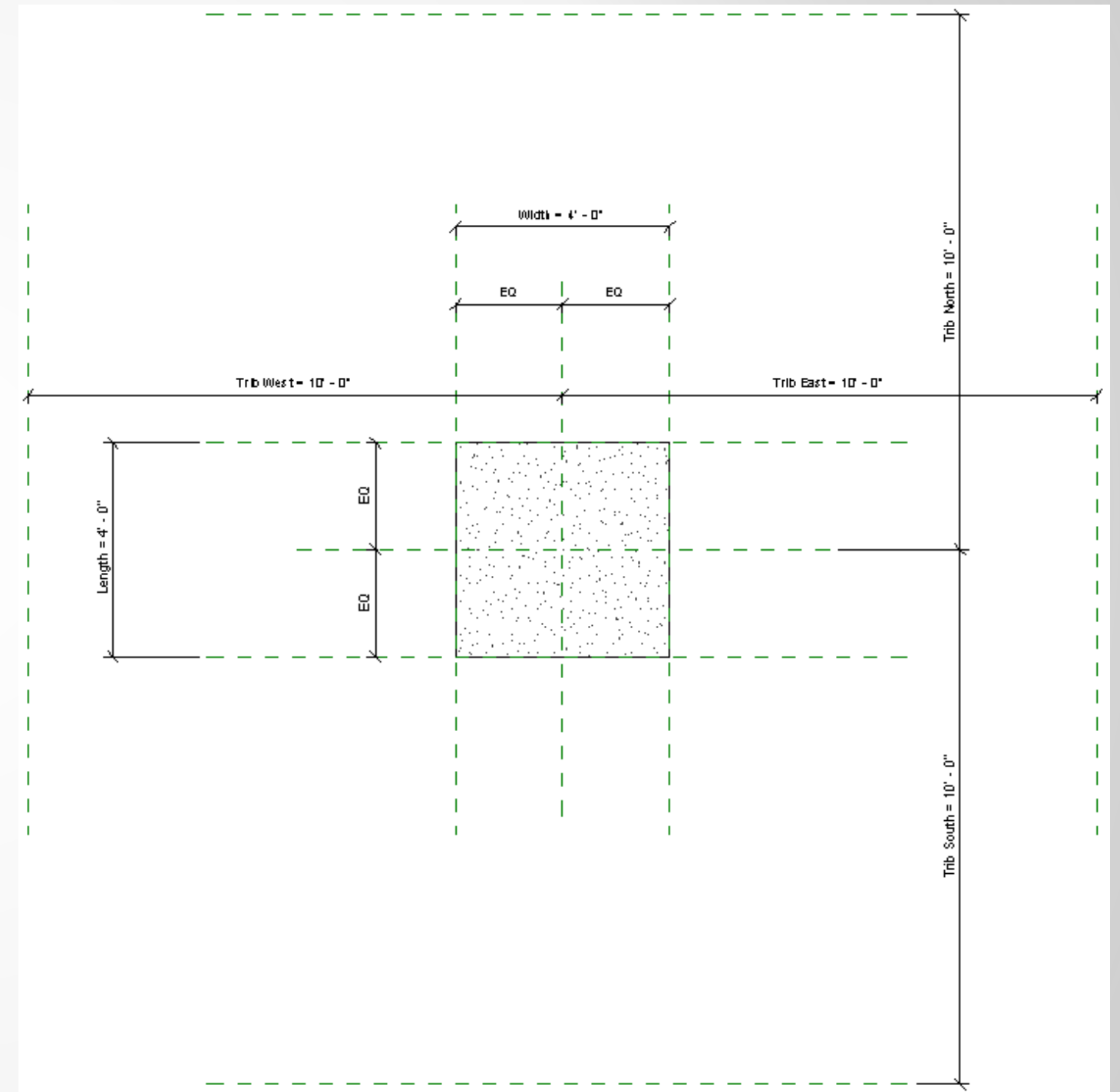
# Shared Parameters

- Loads to be used in many families
- Instance tag text



# The Footings

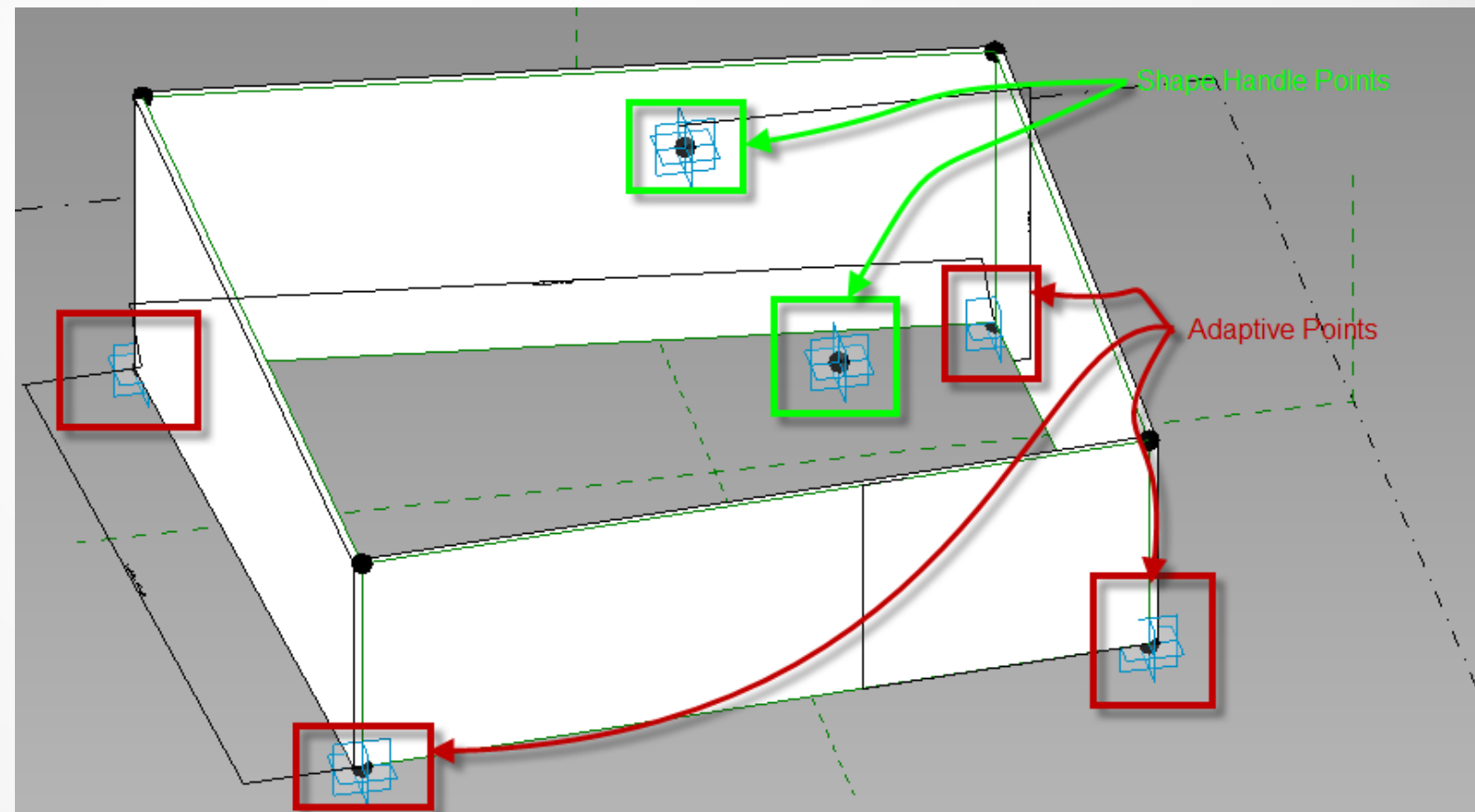
- Tributary area
- 3 types for different locations/loading scenarios and thicknesses
- Required area calculated based on load demand
- Geometry updates





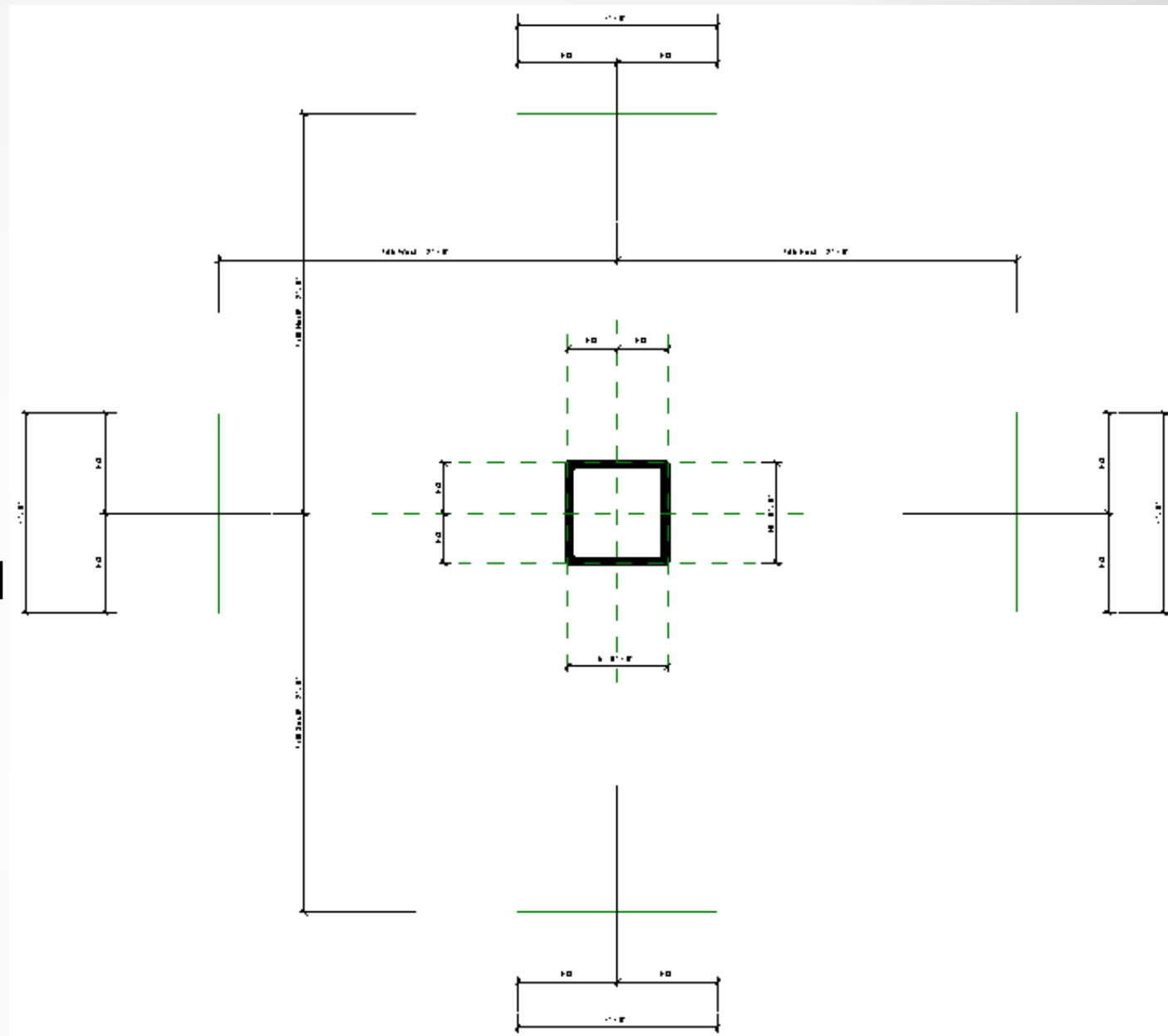
# The Walls

- Adaptive Component – 4 adaptive points and 2 shape handle points
- Variable thickness, heights, plan size/shape
- Areas calculated in family
- One element in project



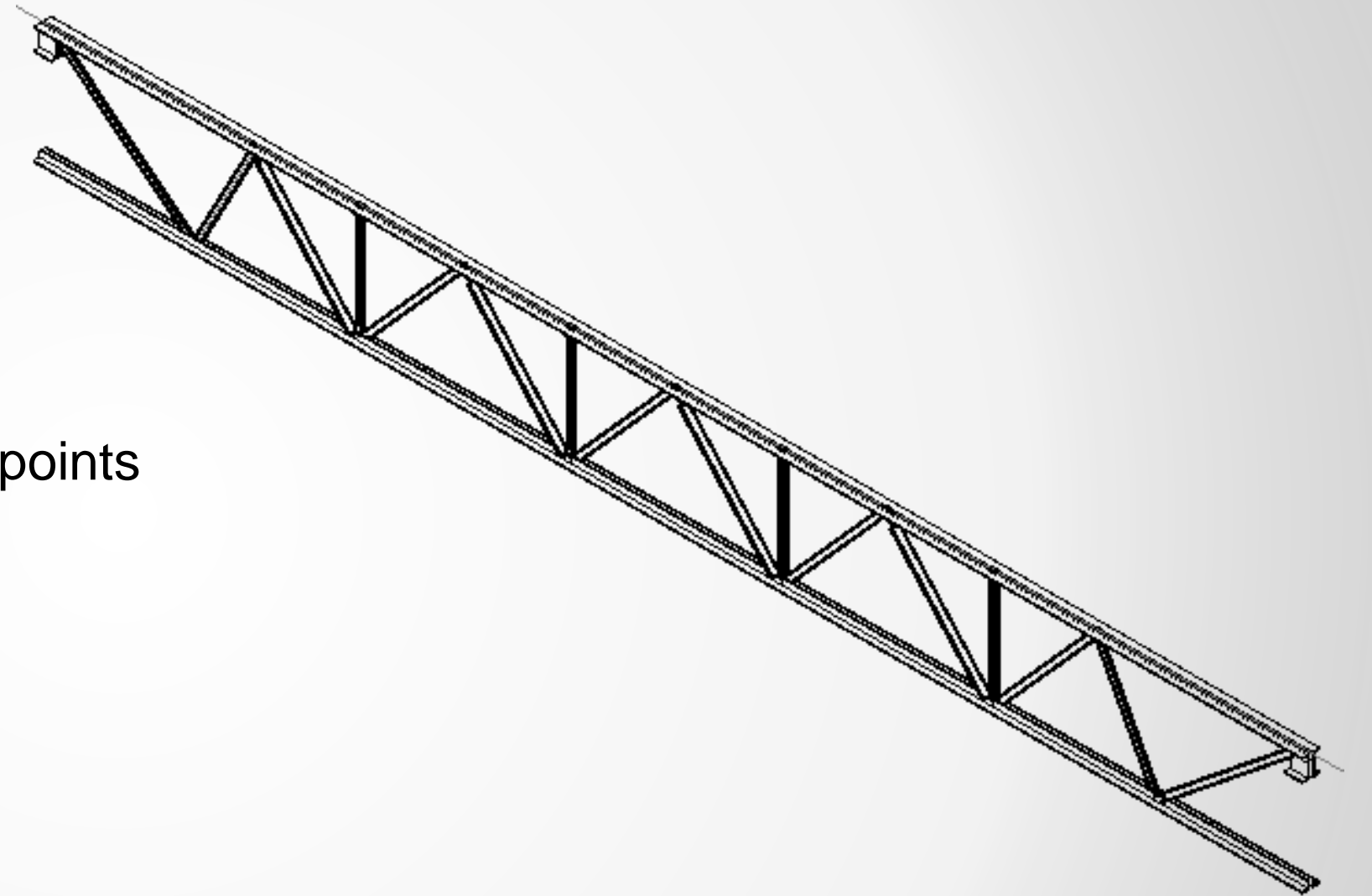
# The Columns

- Tributary area
- Reporting parameter for height
- Six HSS sizes pre-selected
- Member selected based on calculated load
- Geometry updates



# The Joist Girders

- Tributary area
- Two possible lengths, constant depth
- Two types for two loading scenarios
- Weight derived from calculated loads at panel points
- Geometry updates



# The Joists

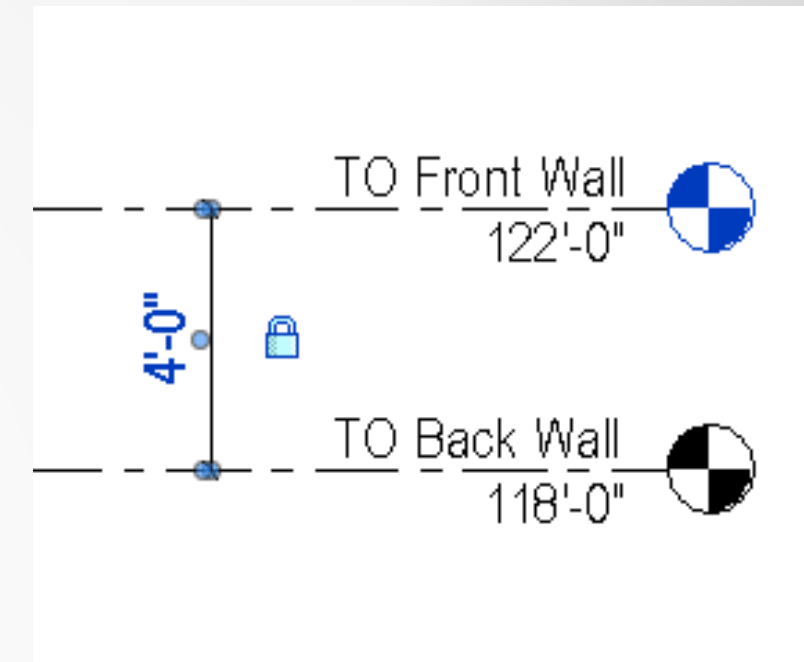
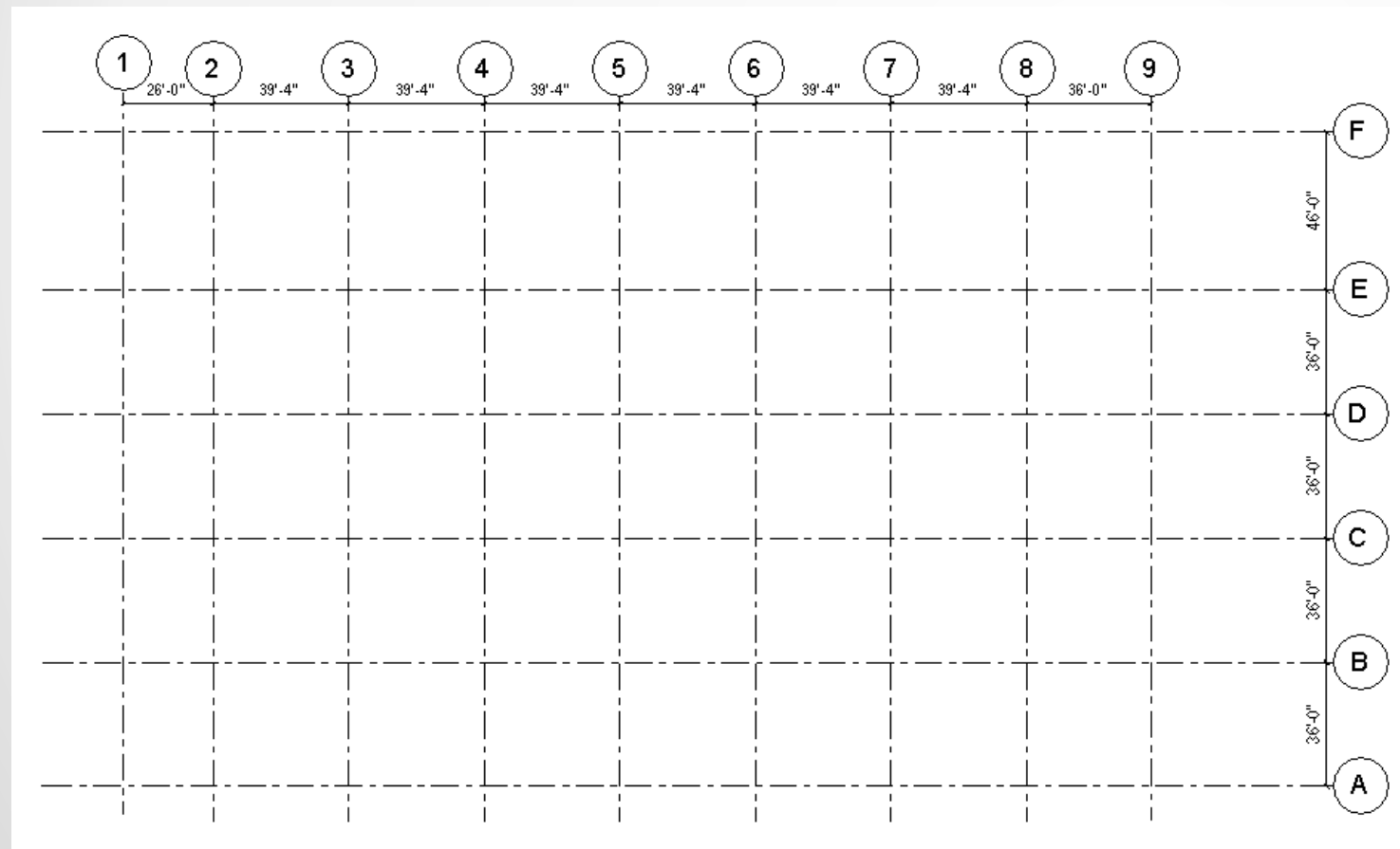
- Regular spacing, so consistent loading – Two loading scenarios
- Size dependent on length
- Six possible joists pre-selected
- Geometry updates
- Web members deleted for performance



# Building the Model

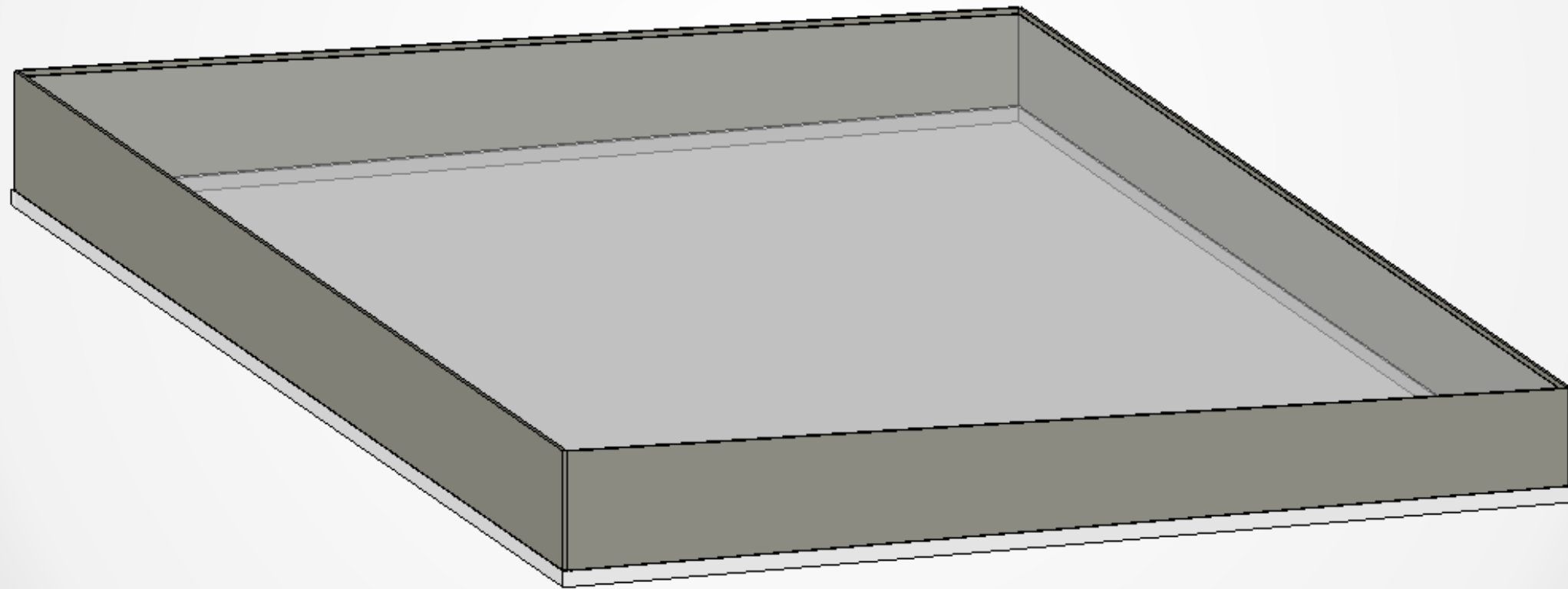
# Grids and Levels

- N/S grid spacing variable
- E/W grid spacing constant
- Level heights variable
- Front wall always 4' taller than back wall



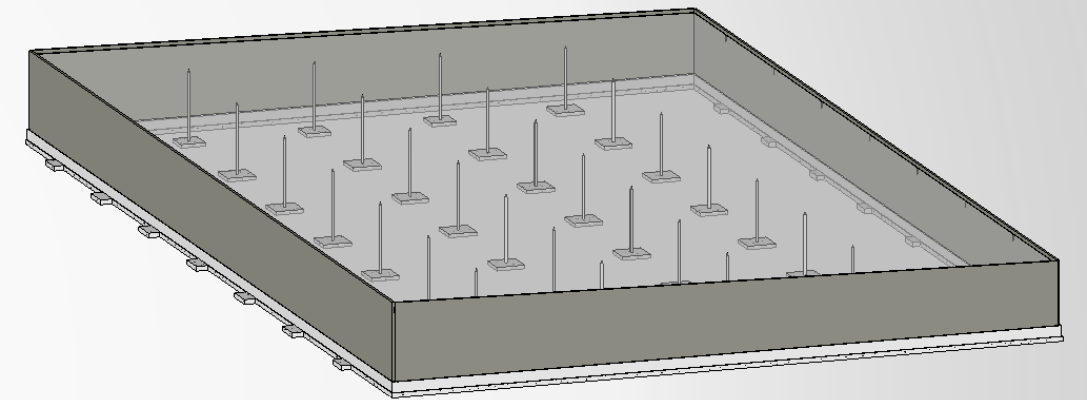
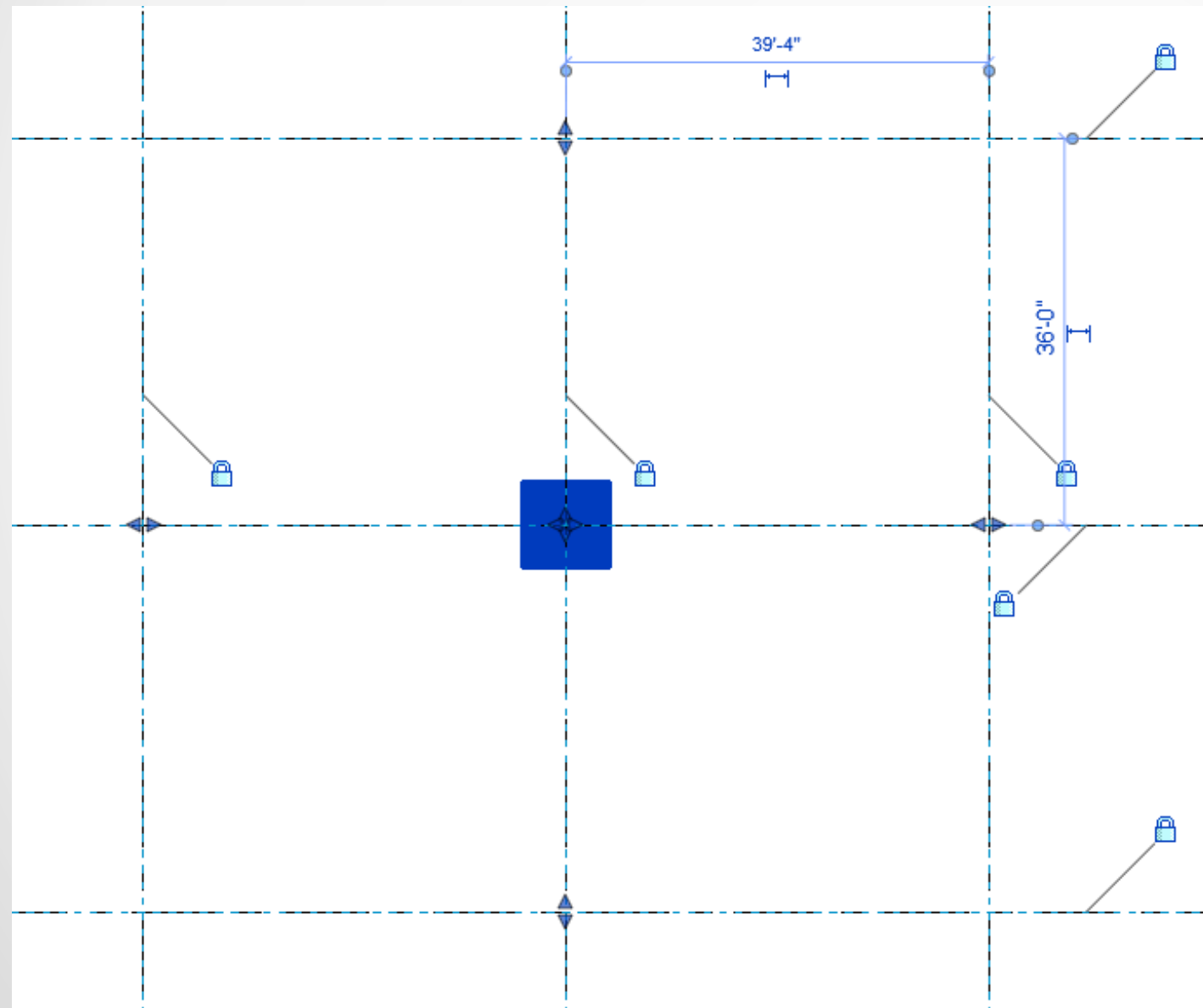
# Stem Walls, Strip Footings, Walls

- Stem walls and strip footing out-of-the box
- Associated with grids and levels
- Wall associated to stem wall and levels



# Columns and Pad Footings

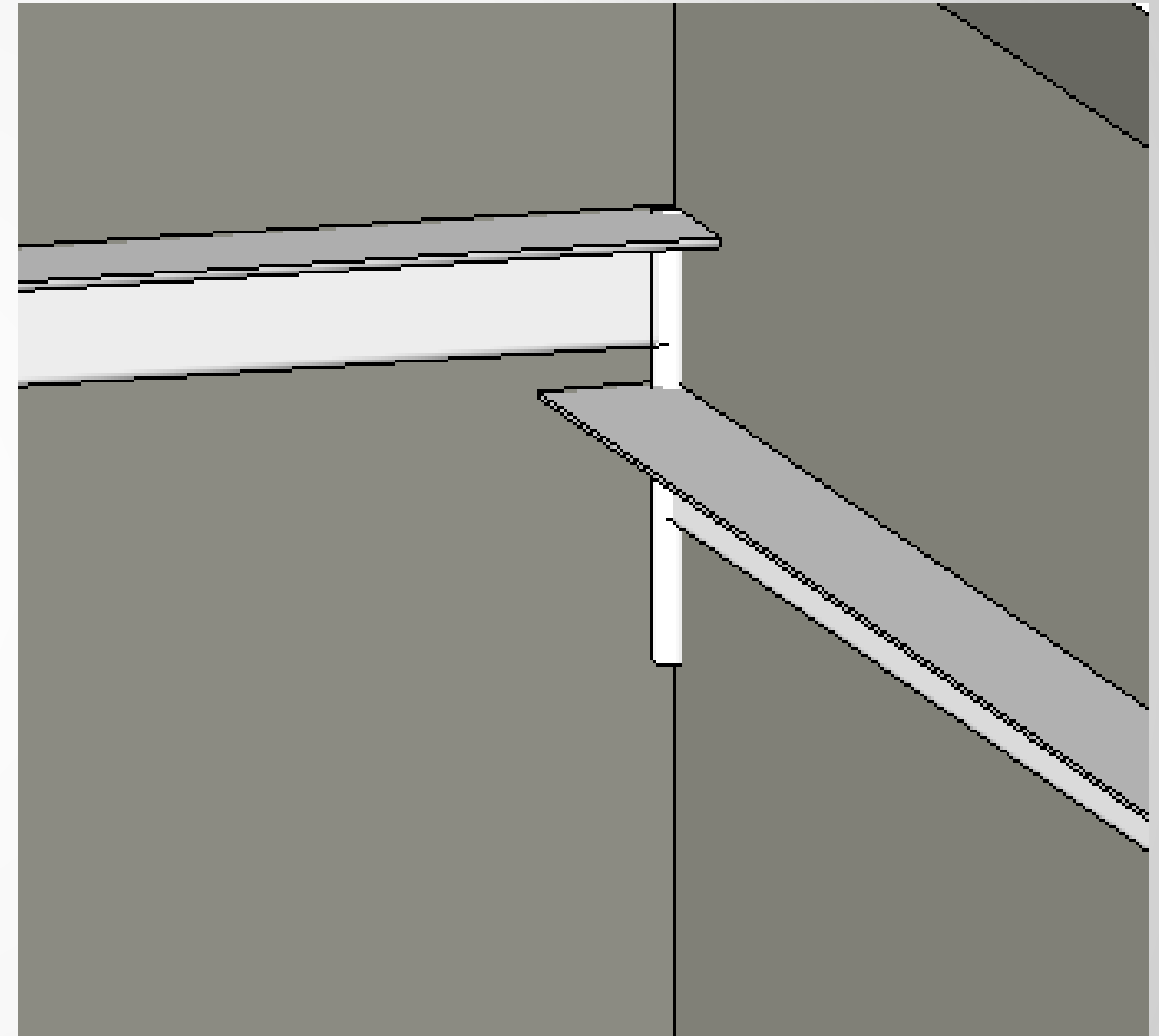
- Tributary references locked to grids
- Associated to host, base and top levels





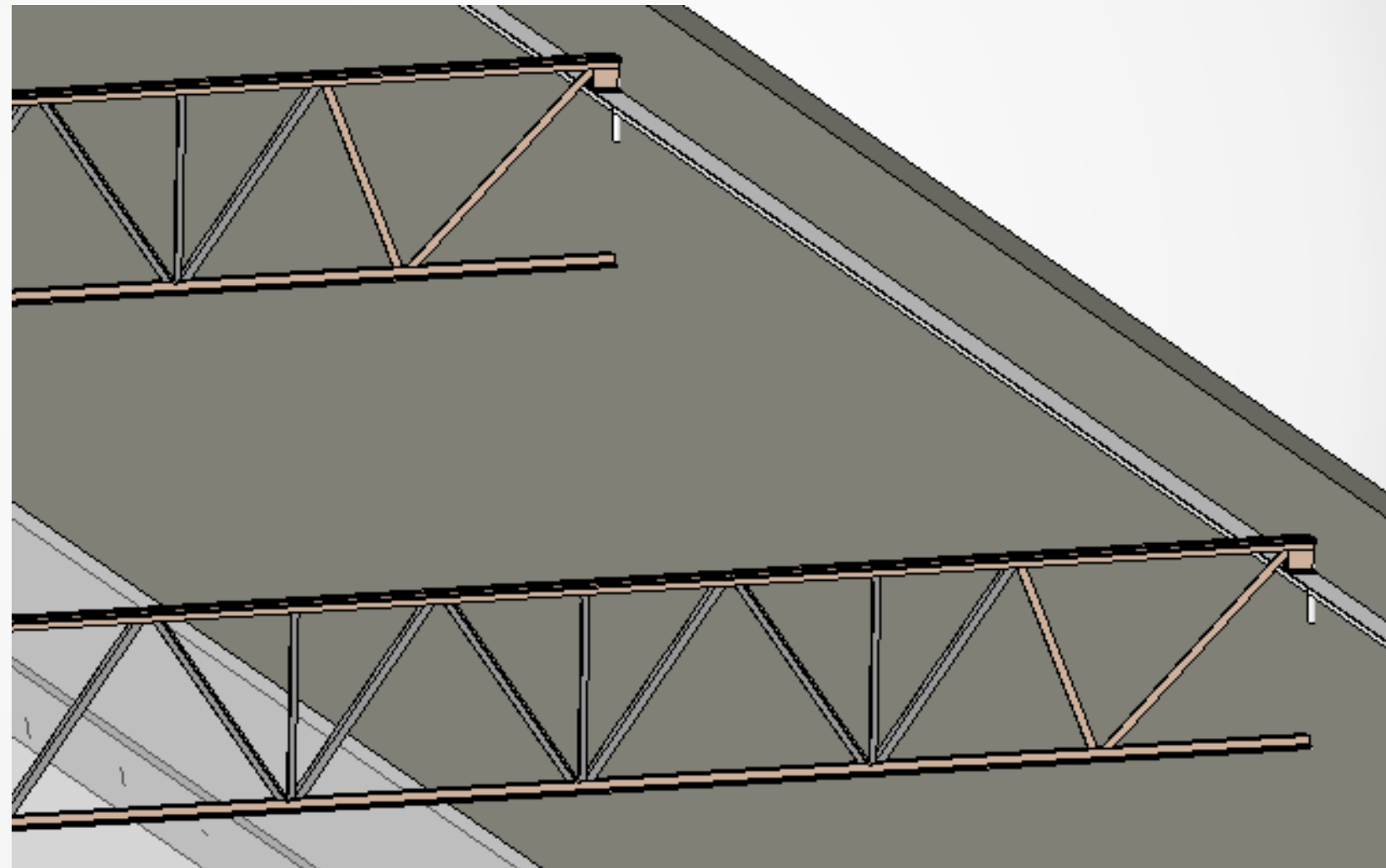
# Ledger Angles

- Length difficult to make parametric
- Elevation, especially of the sloping angles difficult to control
- Variation in required seat depths also a challenge
- “Fake columns”



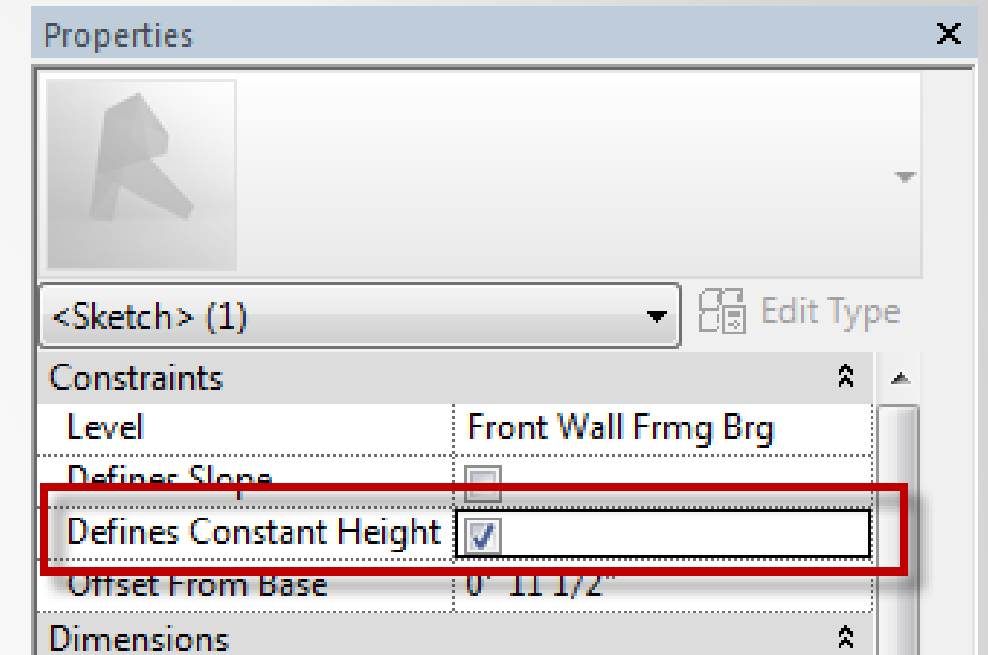
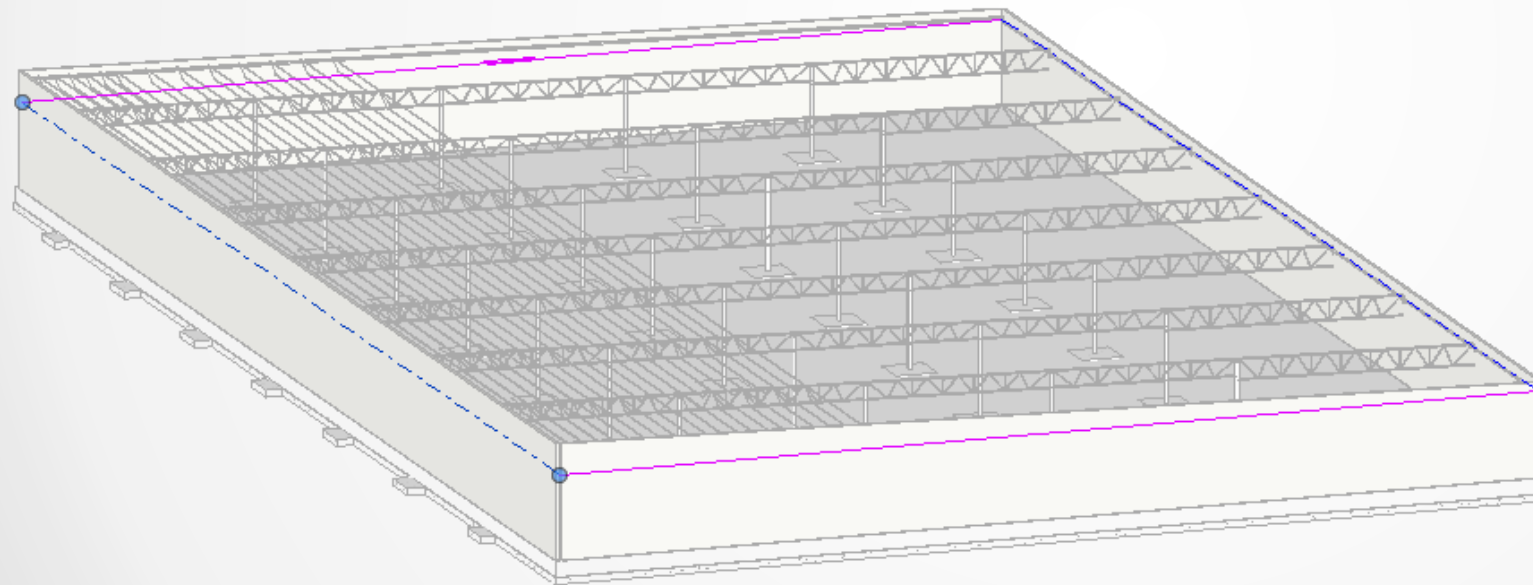
# Joist Girders

- Elevation and location a challenge
- Tributary references made columns large so hard to snap framing to columns
- “Fake columns” used again



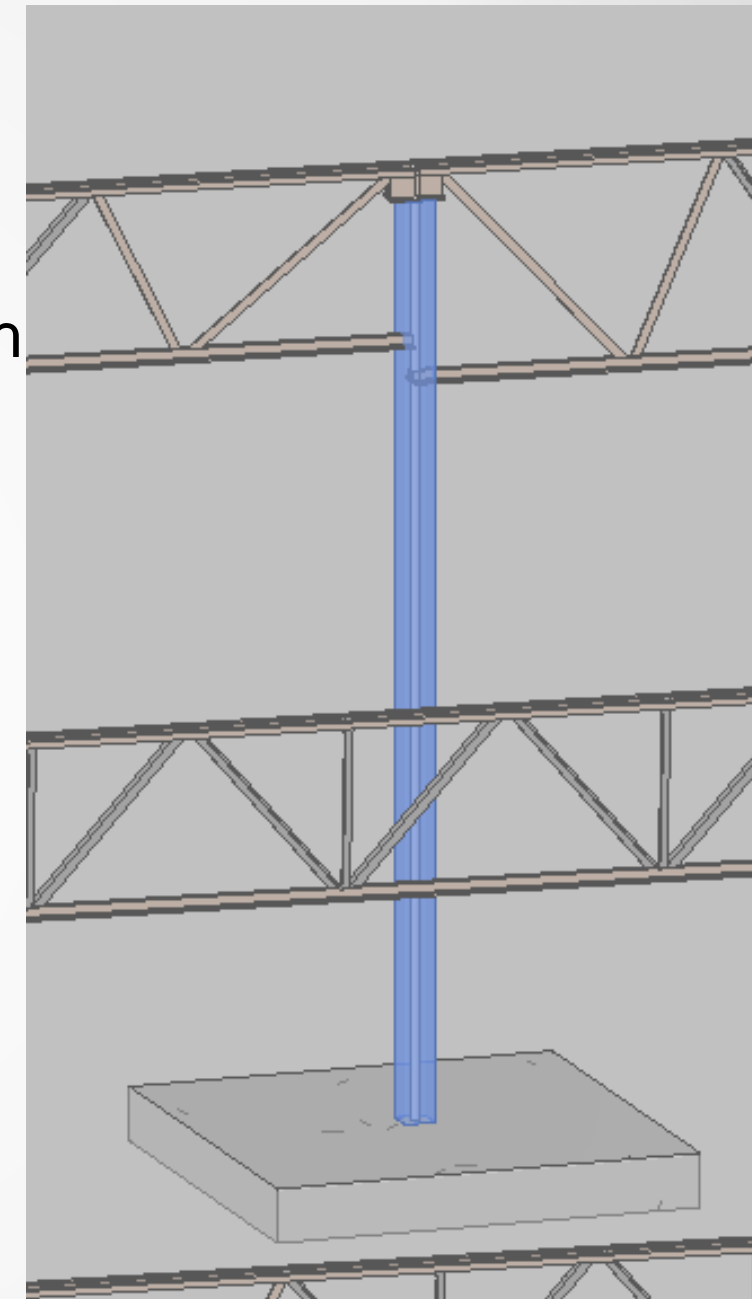
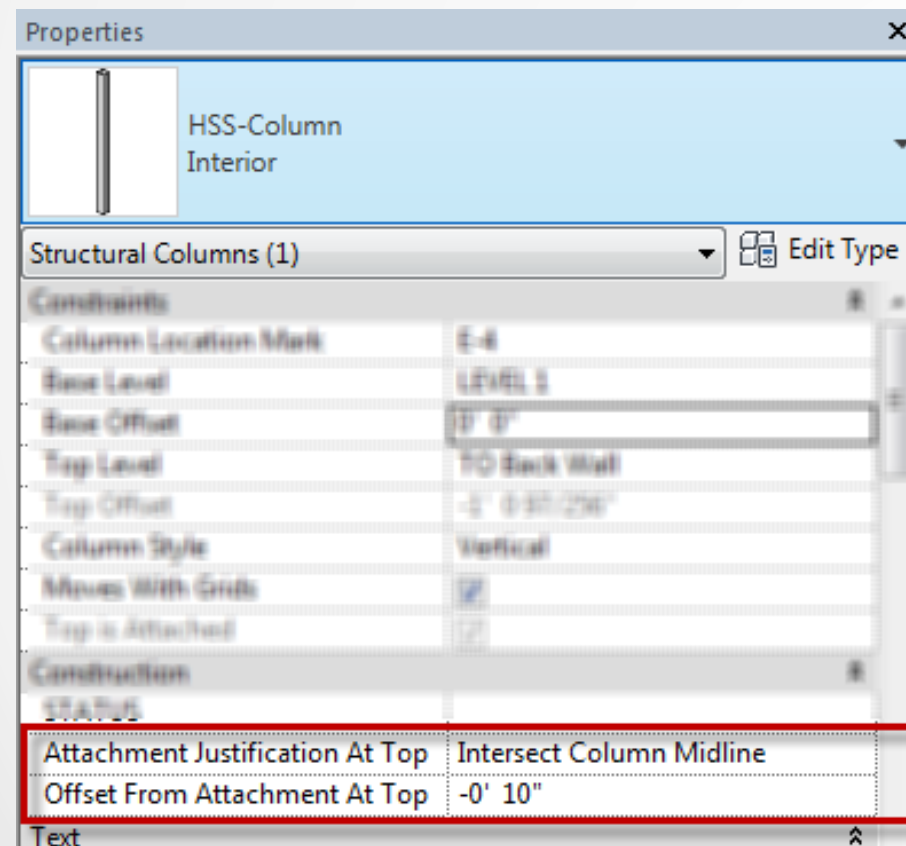
# Roof

- “Pick Supports” and Defines Constant Height” options used
- Out-of-the-box metal deck



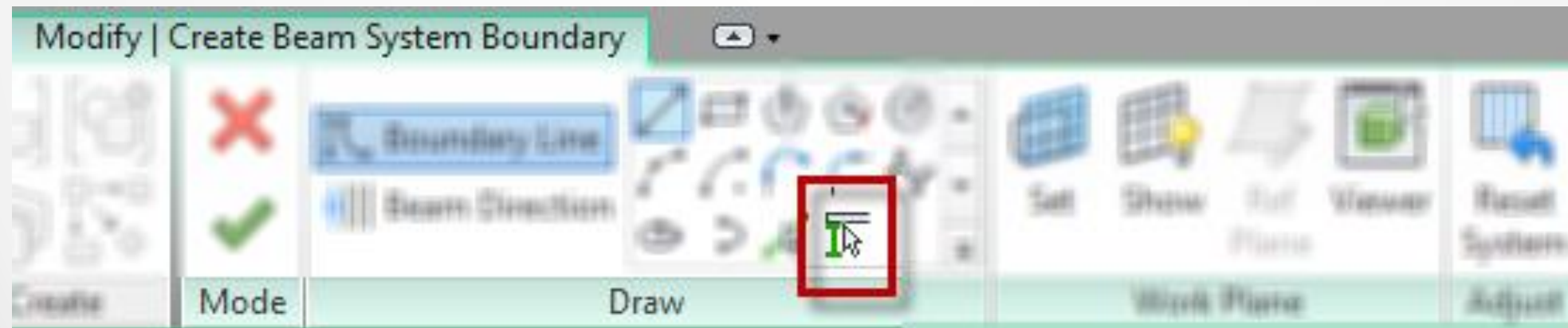
# Attaching Columns

- Columns attached to roof
- Offsets for framing accuracy and joist seats
- Tributary references made columns large, important to have attached



# Joists

- Beam systems with “pick supports” as well as single members
- Most difficult
- Iterative process with other members and locking tributary references
- Seems unstable



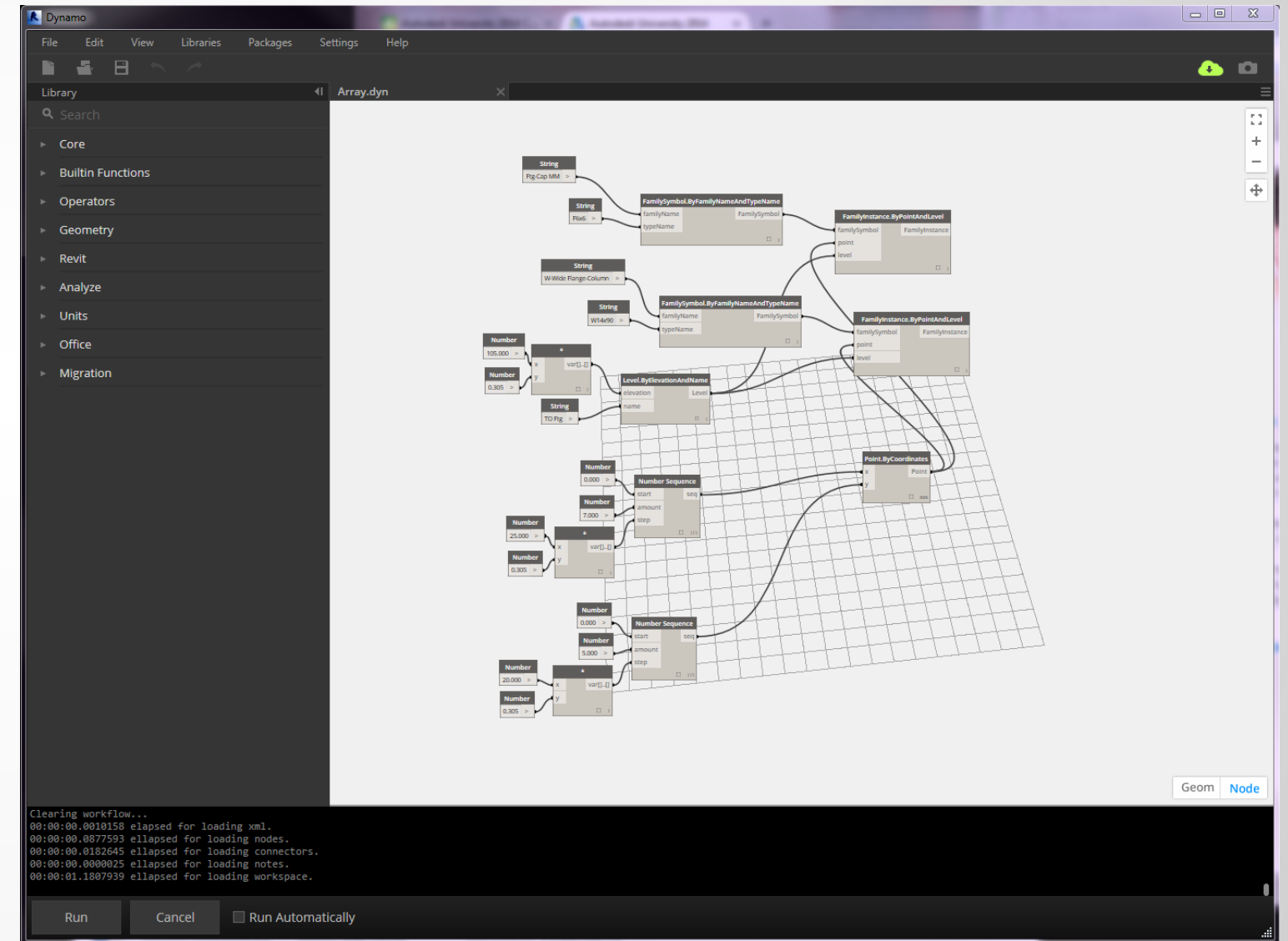
# Schedule

- Multi-Category w/totals
- Costs estimated from RS Means and from industry contacts/estimates
- Additional manually entered parameters: length/weight/volume calculations, unit costs, calculated costs
- Cost modifier parameter for fine-tuning
- Filter to remove “fake columns”

Material Costs														
Material	Family	Type	Unit Cost 1	Unit Cost 2	8in CMU Tot Area	10in CMU Tot Area	Material: Area	Material: Volume	Tons	Cost Per Area	Cost Per Volume	Cost Per Weight	Total Cost	Cost Modifier
Concrete - Cast-in-Place Concrete	Basic Wall	1'-0" Conc	\$300.00				2940 SF	2940.00 CF	0.0	No	Yes	No	\$32,667	1
Concrete - Cast-in-Place Concrete	Floor	SO G4A	\$250.00				56620 SF	18873.33 CF	0.0	No	Yes	No	\$174,753	1
Concrete - Cast-in-Place Concrete	Ftg	Exterior	\$390.00				728 SF	336.00 CF	0.0	No	Yes	No	\$4,853	1
Concrete - Cast-in-Place Concrete	Ftg	Front Wall	\$390.00				1124 SF	557.33 CF	0.0	No	Yes	No	\$8,050	1
Concrete - Cast-in-Place Concrete	Ftg	Interior	\$390.00				4378 SF	1747.00 CF	0.0	No	Yes	No	\$25,234	1
Concrete - Cast-in-Place Concrete	Wall Foundation	18" Exterior	\$300.00				5081 SF	1768.00 CF	0.0	No	Yes	No	\$19,644	1
Concrete Masonry Units	Walls	Walls	\$11.15	\$13.10	12964 SF	6556 SF	40489 SF	13496.00 CF	0.0	Yes	No	No	\$230,432	1
Metal - Steel - ASTM A36	Floor	1.5B	\$1.75				56633 SF	7079.07 CF	0.0	Yes	No	Yes	\$99,107	1
Metal - Steel - ASTM A36	L-Angle	L6X6X1/2	\$2,000.00				1900 SF	38.61 CF	9.6	No	No	Yes	\$22,958	1.2
Metal - Steel - ASTM A500 - Grade B - Rectangular and Square	HSS-Column	Interior	\$2,000.00				2009 SF	23.50 CF	6.0	No	No	Yes	\$14,503	1.2
Steel - ASTM A36 (36 ksi)	Joist Girder	Front Bay	\$2,500.00				910 SF	21.25 CF	18.0	No	No	Yes	\$44,968	1
Steel - ASTM A36 (36 ksi)	Joist Girder	Typ Girder	\$2,500.00				3877 SF	92.47 CF	24.8	No	No	Yes	\$61,923	1
Steel - ASTM A36 (36 ksi)	K-Series Bar Joist Light	Joist	\$2,200.00				5915 SF	55.20 CF	20.8	No	No	Yes	\$119,878	2.6154
													182603 SF 47027.76 CF 79.2	\$858,972

# Conclusion and What's Next?

- Has “wow” factor but pushing Revit to the limits of what it is intended to do
- Definite limitations in Revit, had to operate within various constraints
- Unstable model, difficult to create
- Definite potential
- ...Dynamo...??



# Questions/Discussion?

Remember to fill out your surveys! Thank You!



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