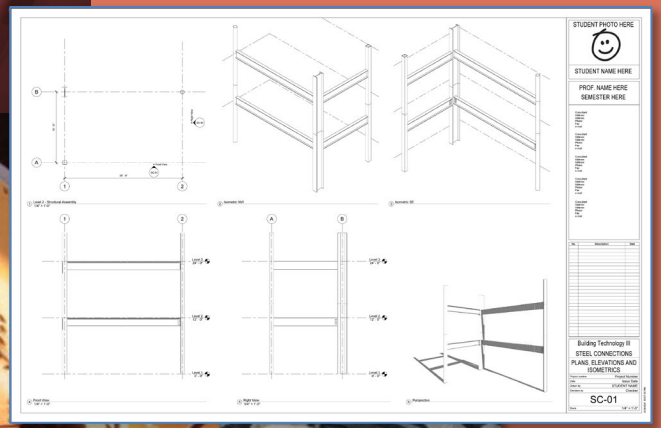
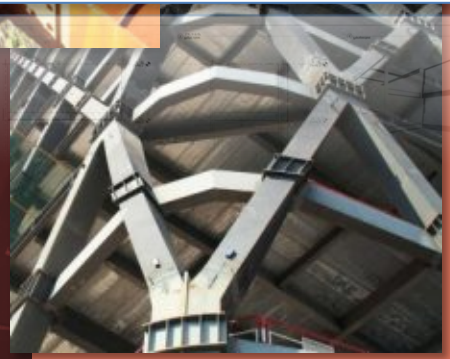
ARCH 2431
Building Technology III
Steel Assembly & Building Information Modeling (BIM) with Revit





Steel Connections Series

- #1 Introduction to Columns & Beams
- #2 Column Base Plates
- #3 Photos & Videos – Connections & Fasteners
- #4 Concrete footing to baseplate connection
- #5 Fin & Splice Plates – Notched Beams
- #6 Diagonal Bracing

Prof. Paul C. King, Course Coordinator Pking@CityTech.Cuny.Edu
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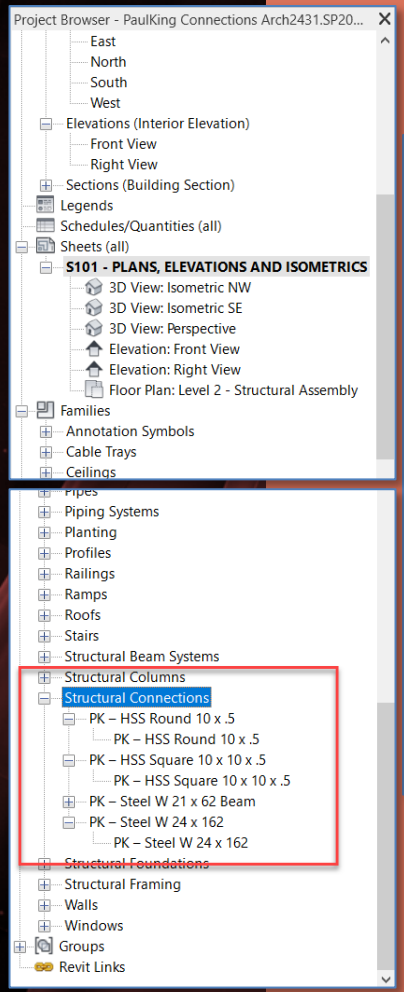
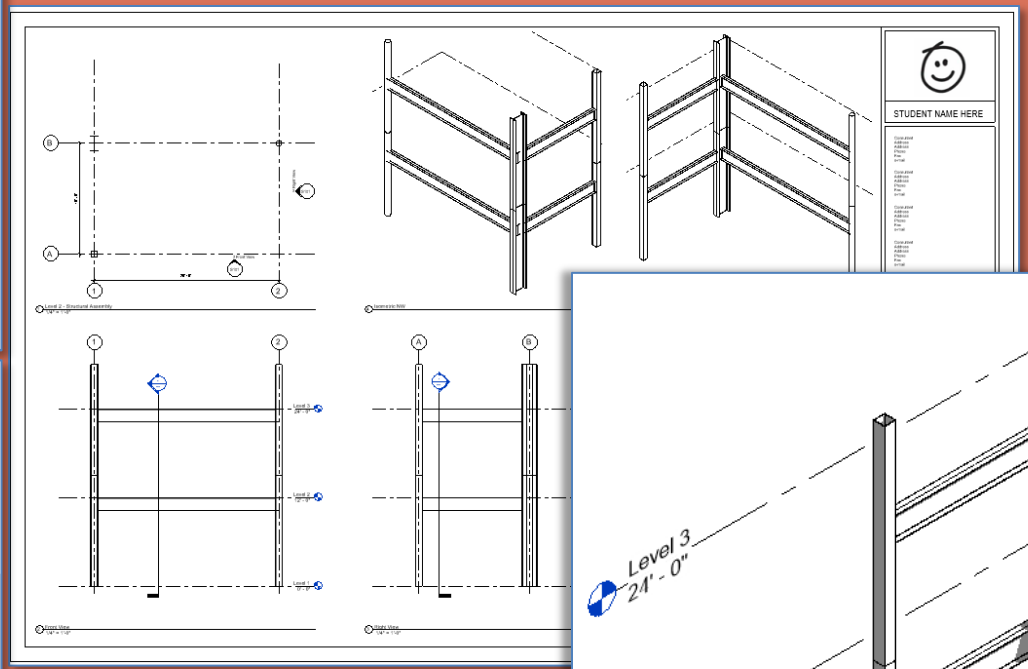
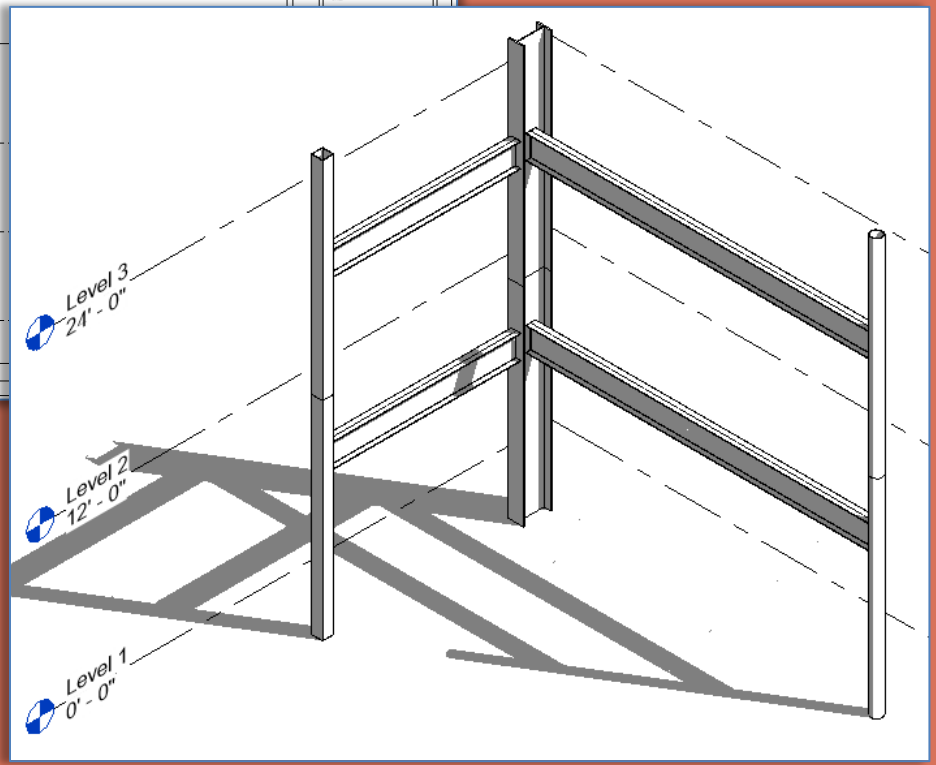
Prof. Justin Sherman Jsherman@CityTech.Cuny.Edu
Prof. Jieun Yang Jyang@CityTech.Cuny.Edu

Introduction to Steel Connections





- *22 X 34 Sheet*
- *Coordinated Views & Isometrics*



- *Levels & Grids*
- *3 Column Types*
  - *Wide Flange*
  - *Round*
  - *Square*
- *Beams*

Building Technology III

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- Assignment Description
- New Project File
  - Levels
  - Grids
  - Dimensions
- New 3D Family
- W 24 x 162 column
  - Reference Planes
  - Parameters
  - Extrusion
  - Height Parameters
  - Family Category
- Load into Project
- New 3D Families
  - HSS Pipe Column
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Introduction to Steel Connections Assignment

Creating 3D families build the 3D Revit model described in the assignment.

These 3d Families will be assembled in a project file named as follows:

FirstLastName-Connections-AR2431-SP20-Professor.rvt

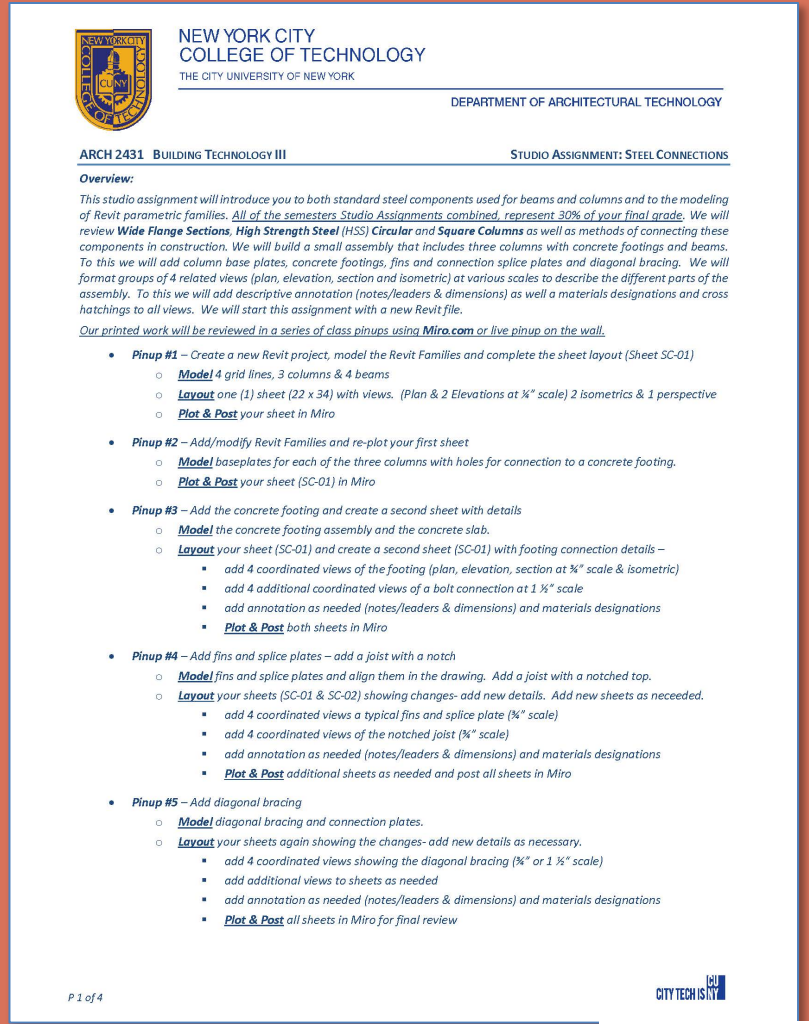
As specified create families using modifiable parameters.

Format the assembly on a 22 x 34" titleblock. As before be certain your photo and name is on each sheet.

Create additional sets of coordinated views of assembly connections at enlarged scale along with an isometric.

Add annotation (notes and leaders) dimensions and detail items as necessary to clarify the details.

Review class readings and conduct additional research as needed to complete the assignment.



NEW YORK CITY COLLEGE OF TECHNOLOGY
THE CITY UNIVERSITY OF NEW YORK
DEPARTMENT OF ARCHITECTURAL TECHNOLOGY

ARCH 2431 BUILDING TECHNOLOGY III — **STUDIO ASSIGNMENT: STEEL CONNECTIONS**

Overview:

*This studio assignment will introduce you to both standard steel components used for beams and columns and to the modeling of Revit parametric families. All of the semesters Studio Assignments combined, represent 30% of your final grade. We will review **Wide Flange Sections**, **High Strength Steel** (HSS) **Circular** and **Square Columns** as well as methods of connecting these components in construction. We will build a small assembly that includes three columns with concrete footings and beams. To this we will add column base plates, concrete footings, fins and connection splice plates and diagonal bracing. We will format groups of 4 related views (plan, elevation, section and isometric) at various scales to describe the different parts of the assembly. To this we will add descriptive annotation (notes/leaders & dimensions) as well a materials designations and cross hatchings to all views. We will start this assignment with a new Revit file.*

*Our printed work will be reviewed in a series of class pinups using **Miro.com** or live pinup on the wall.*

- ***Pinup #1** – Create a new Revit project, model the Revit Families and complete the sheet layout (Sheet SC-01)*
  - ***Model** 4 grid lines, 3 columns & 4 beams*
  - ***Layout** one (1) sheet (22 x 34) with views. (Plan & 2 Elevations at ¾" scale) 2 isometrics & 1 perspective*
  - ***Plot & Post** your sheet in Miro*
- ***Pinup #2** – Add/modify Revit Families and re-plot your first sheet*
  - ***Model** baseplates for each of the three columns with holes for connection to a concrete footing.*
  - ***Plot & Post** your sheet (SC-01) in Miro*
- ***Pinup #3** – Add the concrete footing and create a second sheet with details*
  - ***Model** the concrete footing assembly and the concrete slab.*
  - ***Layout** your sheet (SC-01) and create a second sheet (SC-01) with footing connection details –*
    - *add 4 coordinated views of the footing (plan, elevation, section at ¾" scale & isometric)*
    - *add 4 additional coordinated views of a bolt connection at 1 ½" scale*
    - *add annotation as needed (notes/leaders & dimensions) and materials designations*
    - ***Plot & Post** both sheets in Miro*
- ***Pinup #4** – Add fins and splice plates – add a joist with a notch*
  - ***Model** fins and splice plates and align them in the drawing. Add a joist with a notched top.*
  - ***Layout** your sheets (SC-01 & SC-02) showing changes- add new details. Add new sheets as neceeded.*
    - *add 4 coordinated views a typical fins and splice plate (¾" scale)*
    - *add 4 coordinated views of the notched joist (¾" scale)*
    - *add annotation as needed (notes/leaders & dimensions) and materials designations*
    - ***Plot & Post** additional sheets as needed and post all sheets in Miro*
- ***Pinup #5** – Add diagonal bracing*
  - ***Model** diagonal bracing and connection plates.*
  - ***Layout** your sheets again showing the changes- add new details as necessary.*
    - *add 4 coordinated views showing the diagonal bracing (¾" or 1 ½" scale)*
    - *add additional views to sheets as needed*
    - *add annotation as needed (notes/leaders & dimensions) and materials designations*
    - ***Plot & Post** all sheets in Miro for final review*

P 1 of 4

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Introduction to Steel Connections Assignment

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  - Height Parameters
  - Family Category
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  - Formula Parameter
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Building Technology III

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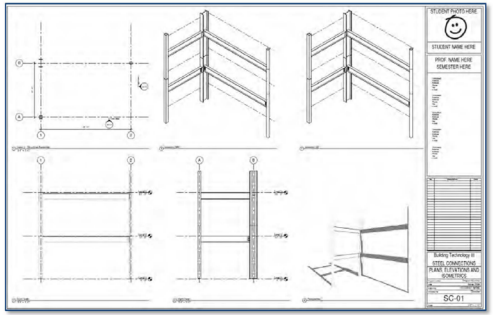
Instructions and Lectures:

- *Detailed sequential instructions are provided in a series of tutorials that are posted on the course OpenLab website.*



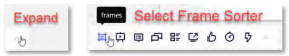
Sample sheet from Pinup #1

Revit Specific Tasks:

- ***Customize the titleblock**. Using a 22 x 34 titleblock – make a copy of this family and add course and individual information to the titleblock. You may have to adjust locations of lines, etc.*
- ***Add Personal Information** – Remove the Autodesk Logo in the top right corner of the title block and add a recognizable portrait photo of yourself to the sheet. Below this add your name. Make sure it is large enough to be legible. If your name is long, it can be on two lines. You may have to adjust lines on the titleblock for it to fit.*
- ***Add Class Information** – Add the Course Number & Name (ARCH 2431 Building Technology III) using the "Owner" and "Project" fields. Add the Professors Name (Prof. King, etc.) and the semester (Fall 2020) below your name.*
- ***Add Sheet information** – For each sheet, add a sheet number and a title. For the date drawn add the deadline date.*
- ***Duplicating views** – Since we have multiple pinups, you may need to include the same view on more than one sheet. To do this you will need to "duplicate" the view. Review the duplicate options. (with detailing, as a dependent)*
- ***Dimension and Text Styles** – Notes and dimensions text, should be 1/8" tall. Create new styles as needed.*
- ***Project Browser Cleanup** - When you create new views either using duplicate or creating new views as callouts, sections or elevations, be certain to rename these views appropriately.*
- ***Revit File Name** – Each of you must rename your Revit file in the format (Firstname.LastName ARCH2431 Steel Connections Semester-Professor.rvt) File name for a student named Louis Sullivan in Prof. King's Fall 2020 class would be (**Louis.Sullivan ARCH2431 Steel Connections FA20-King.rvt**)*

MIRO & Pinups -

- *We will be conducting "virtual pinups", using a shared pinup board hosted on **Miro.com**. We may also conduct a live pinup in the classroom. You will not be required to create an account to work with Miro. The pinup space will be provided for you with a single frame for each of you. You will need to rename this frame to claim your pinup space and you will duplicate and place each additional sheet below, creating a vertical column of sheets for each student.*
- *To post your work in Miro - print each sheet from Revit to a separate PDF and then paste it onto the frame.*
- *MIRO Frames listing – as you add new sheets you will need to create or copy a frame. Rename and re-sort the order your own frames, so they are always in order. It helps to name your slides sequentially. King-01, King-02, etc.*



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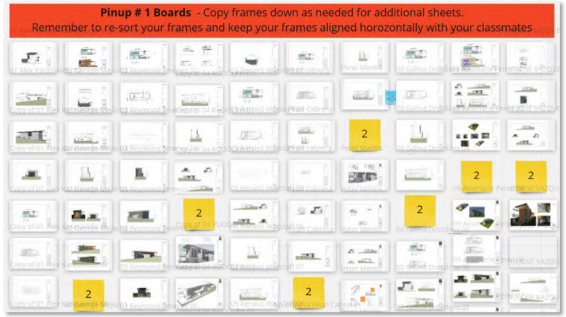
Sample Miro.com Pinup Board



Grading & Rubric:

- ***Grading**: Pinups # 1, #2, #3 & #4 will be given a preliminary grades (A/B/C/D). Pinup #5 will be given a final grade and will count most toward your overall semester grade.*
- ***Rubric:** Assignments will be graded on the following criteria. Additional criteria may be given during discussions.*
  - *Completeness of submission & deadlines. Proper file name, sheet name/number and format of titleblock*
  - *Good sheet layout & appropriate views. Coordinated sets of four (4) views are best. (Plan, two Elevations or an Elevation & Section and an Isometric). Scales for the group of four typically match.*
  - *Annotation & appropriate scale of views. Use a scale that clearly represents the information and allows for proper annotation to be added including, hatch patterns, detail items, notes/leaders & dimensions.*
  - *Formatting and organization – Are the sheets laid out well, organized and numbered properly? Do views align, is there limited wasted (white) space? Are detail views numbered sequentially?*
  - *Level of detail – Do the studies show enough to explain the construction? This requires that drawings exist at multiple scales (½" or ¾") with a second set of callout details at larger scales. (1 ½", 3" or 6")*
  - *Demonstration of the mastery of the Revit software. Good control over views, proper organization of project browser, creation and organization of sheets with title blocks, proper printing to PDF, etc.*
  - *Oral Presentation – Students ability to describe what has been drawn.*

Archive Submission:

- *In addition to class Miro pinup boards, each student will need to post the completed final assignment in blackboard. For this submission, you must combine the individual PDF files into a single PDF and then upload this to the proper directory in blackboard. You must also include your Revit file. All of your Revit family files are embedded in your main project file and should not be uploaded separately as part of this submission.*
- ***Proper naming conventions** – For your final submissions your PDF and your Revit files must be properly named, or you will not receive full credit.*
- ***Meet all deadlines** – do not be late!*
- *Failure to submit the archive file on a timely basis may lower your grade.*
  - ***Pinup #5** – Final pinup of steel connections assembly*

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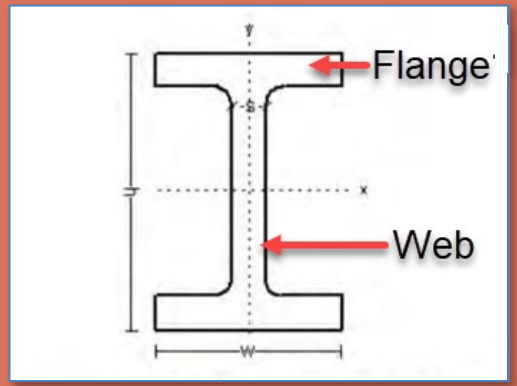
Introduction to Steel Connections Assignment

Reference sheet of standard dimensions for
Wide Flange Sections

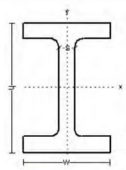
- Depth (h)
- Width (w)
- Web thickness (t_w)
- Flange Thickness (t_f)
- Sectional Area (sq inches)
- Weight (lbs. per linear foot)



Reference Materials:

American Wide Flange Beams - W Beam

Dimensions of American Wide Flange Beams ASTM A6 - Imperial units



Properties in imperial units of American Wide Flange Beams according ASTM A6 are indicated below.

- American Wide Flange Beams according ASTM A6 - **Metric units**

For the Column use W 24 x 162 and for the Beam use @ 21 x 62

Designation	Dimensions						Static Parameters			
							Moment of Inertia		Elastic Section Modulus	
Imperial (in x lb/ft)	Depth h (in)	Width w (in)	Web Thickness t_w (in)	Flange Thickness t_f (in)	Sectional Area (in^2)	Weight (lb/ft)	I_x (in^4)	I_y (in^4)	W_x (in^3)	W_y (in^3)
W 27 x 178	27.8	14.09	0.725	1.190	52.3	178	6990	555	502	78.8
W 27 x 161	27.6	14.02	0.660	1.080	47.4	161	6280	497	455	70.9
W 27 x 146	27.4	14	0.605	0.975	42.9	146	5630	443	411	63.5
W 27 x 114	27.3	10.07	0.570	0.930	33.5	114	4090	159	299	31.5
W 27 x 102	27.1	10.02	0.515	0.830	30.0	102	3620	139	267	27.8
W 27 x 94	26.9	10	0.490	0.745	27.7	94	3270	124	243	24.8
W 27 x 84	26.7	9.96	0.460	0.640	24.8	84	2850	106	213	21.2
W 24 x 162	25	13	0.705	1.220	47.7	162	5170	443	414	68.4
W 24 x 146	24.7	12.9	0.650	1.090	43.0	146	4580	391	371	60.5
W 24 x 131	24.5	12.9	0.605	0.960	38.5	131	4020	340	329	53.0
W 24 x 117	24.3	12.8	0.55	0.850	34.4	117	3540	297	291	46.5
W 24 x 104	24.1	12.75	0.500	0.750	30.6	104	3100	259	258	40.7
W 24 x 94	24.1	9.07	0.515	0.875	27.7	94	2700	109	222	24.0
W 24 x 84	24.1	9.02	0.470	0.770	24.7	84	2370	94.4	196	20.9
W 24 x 76	23.9	9	0.440	0.680	22.4	76	2100	82.5	176	18.4
W 24 x 68	23.7	8.97	0.415	0.585	20.1	68	1830	70.4	154	15.7
W 24 x 62	23.7	7.04	0.430	0.590	18.2	62	1550	34.5	131	9.8
W 24 x 55	23.6	7.01	0.395	0.505	16.2	55	1350	29.1	114	8.3
W 21 x 147	22.1	12.51	0.720	1.150	43.2	147	3630	376	329	60.1
W 21 x 132	21.8	12.44	0.650	1.035	38.8	132	3220	333	295	53.5
W 21 x 122	21.7	12.39	0.600	0.960	35.9	122	2960	305	273	49.2
W 21 x 111	21.5	12.34	0.550	0.875	32.7	111	2670	274	249	44.5
W 21 x 101	21.4	12.29	0.500	0.800	29.8	101	2420	248	227	40.3
W 21 x 93	21.6	8.42	0.580	0.930	27.3	93	2070	92.9	192	22.1
W 21 x 83	21.4	8.36	0.515	0.835	24.3	83	1830	81.4	171	19.5
W 21 x 73	21.2	8.3	0.455	0.740	21.5	73	1600	70.6	151	17.0
W 21 x 68	21.1	8.27	0.430	0.685	20.0	68	1480	64.7	140	15.7
W 21 x 62	21	8.24	0.400	0.615	18.3	62	1330	57.5	127	13.9
W 21 x 57	21.1	6.56	0.405	0.650	16.7	57	1170	30.6	111	9.4
W 21 x 50	20.8	6.53	0.380	0.535	14.7	50	984	24.9	94.5	7.6
W 21 x 44	20.7	6.5	0.350	0.450	13.0	44	843	20.7	81.6	6.4

Sources of Information:

- https://www.engineeringtoolbox.com/american-wide-flange-steel-beams-d_1319.html
- Additional Reference for steel components: http://products.ansteel.com/category/steel?

CITY TECH IS CUNY

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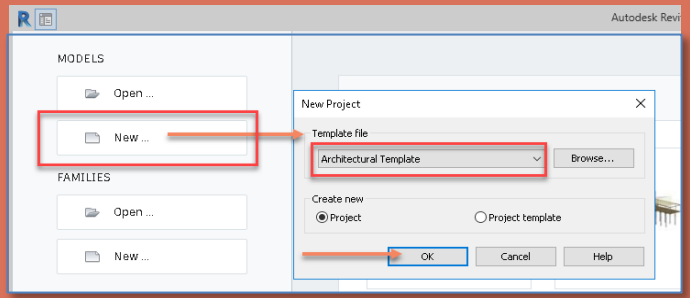
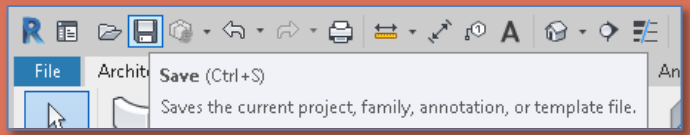
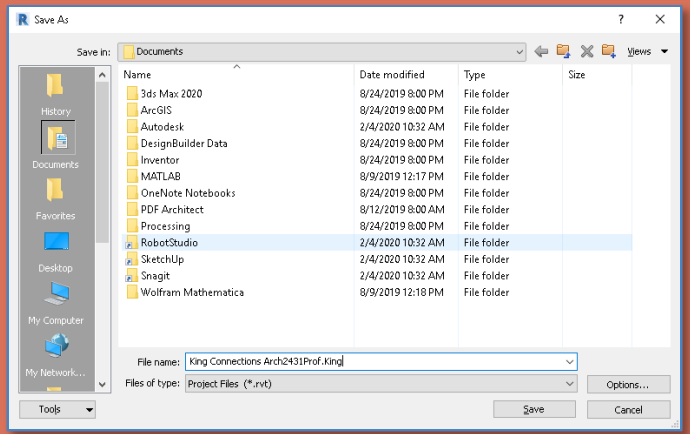
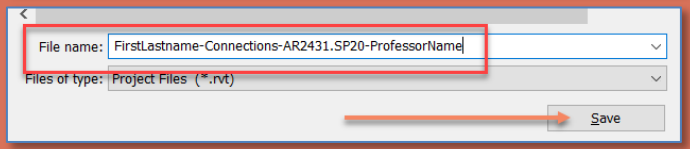
Creating a New Project File









- **Create a new Project File**
  - Architectural Template or Imperial-Architectural Template
- **Save and Name the File**
  - *Create a working directory for all your project and family files – stay organized!*
- **Select an appropriate directory**
  - *(do not work from your USB! This will cause all backup files to be saved there and fill up your drive and potentially crash the program.)*
- **Name the file as follows:**
  - *FirstLastname-Connections-AR2431.SP20-ProfessorName.rvt*

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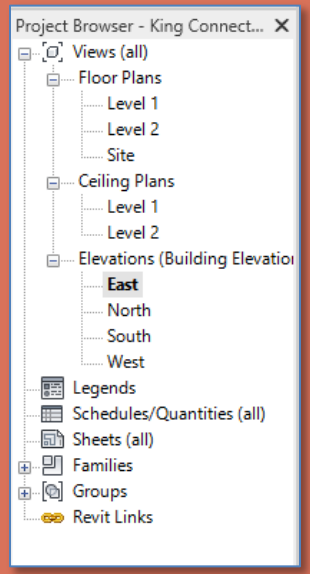
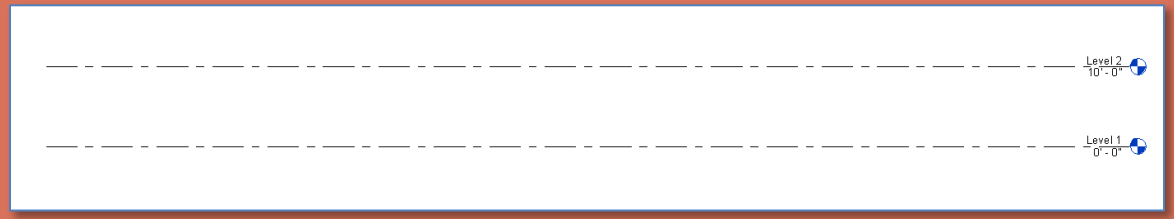
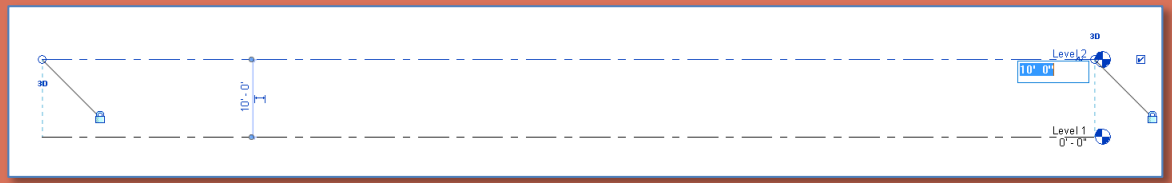
Modify Level 2 elevation from 10 to 12 feet



- **Project Browser**
  - Select the East Elevation



- **Select Level 2**
  - Highlight the Elevation [10’-0”]



  - Change the Elevation to [12’-0”]

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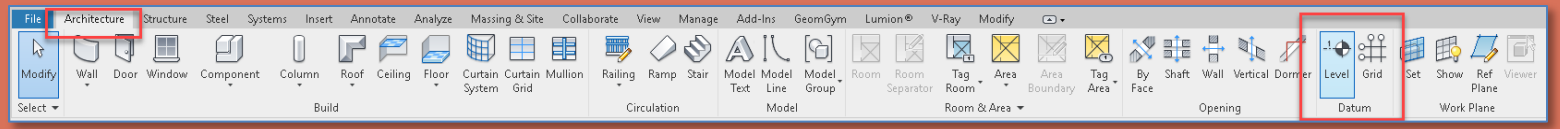
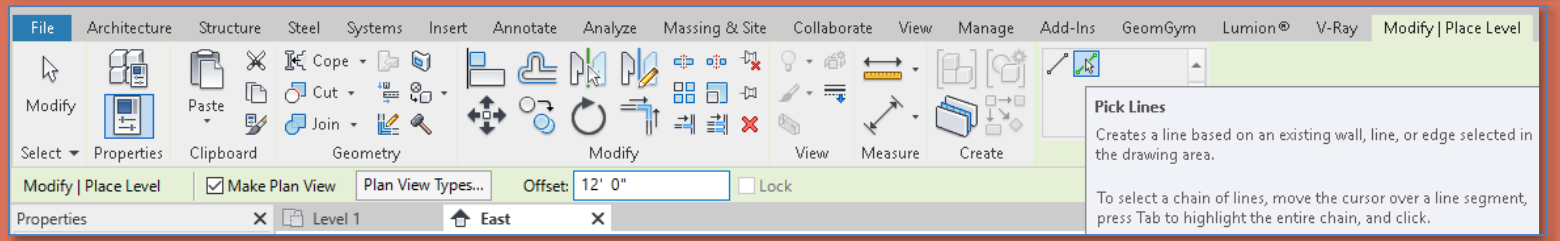
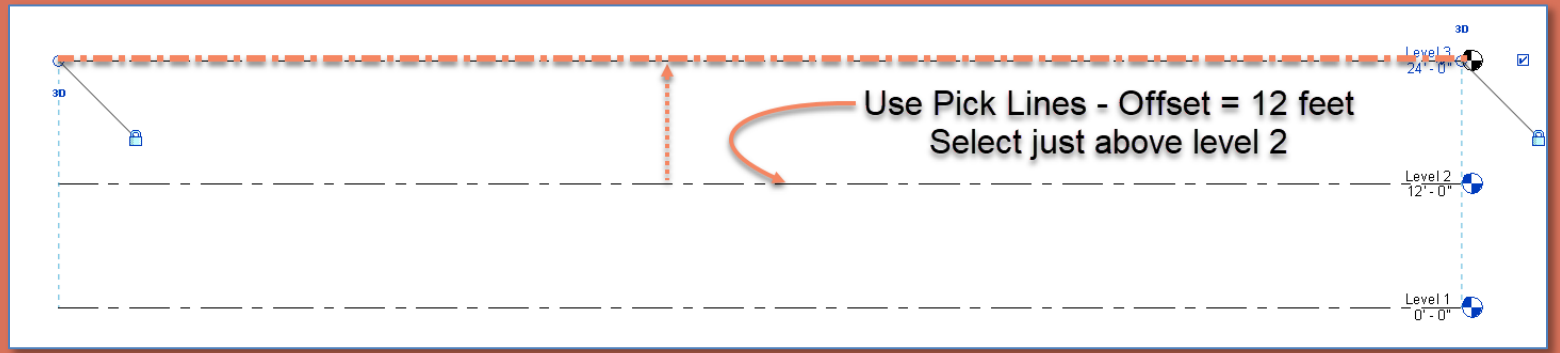
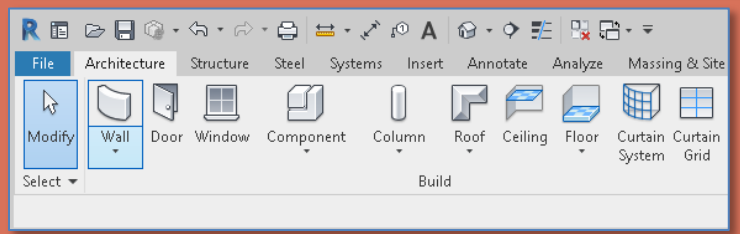
Add Level 3





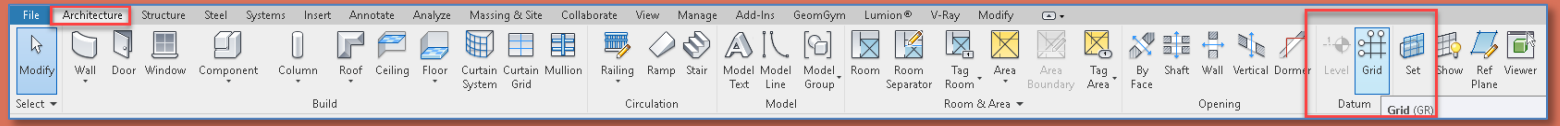


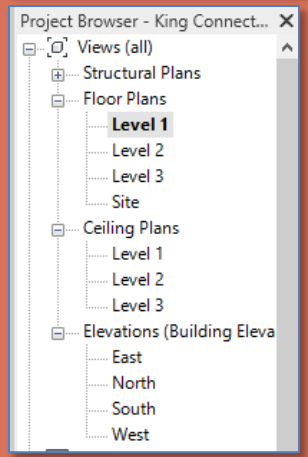


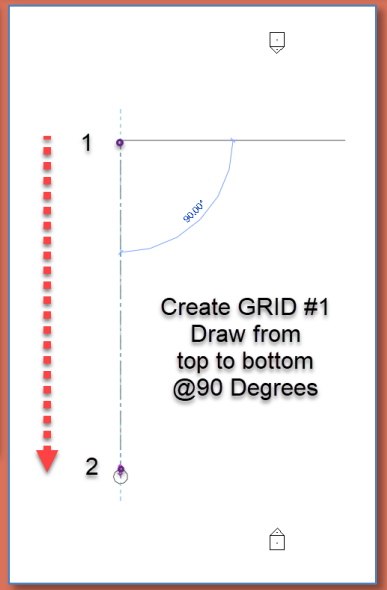
- **Architecture Ribbon**
  - Activate **East** view then select **Level**
  - Method = **Pick Lines**
- Set **Offset** to 12’-0” & [Yes] **Make Plan View**
  - Move cursor just above Level 2
  - Select and Level 3 will be created
- Select the **Modify** Button to end command

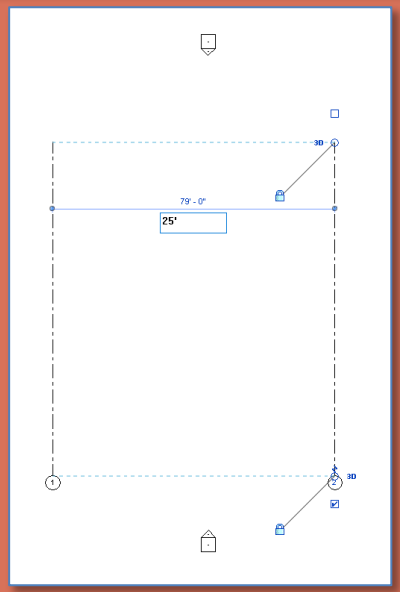
- Assignment Description
- New Project File
  - Levels
  - Grids
  - Dimensions
- New 3D Family
- W 24 x 162 column
  - Reference Planes
  - Parameters
  - Extrusion
  - Height Parameters
  - Family Category
- Load into Project
- New 3D Families
  - HSS Pipe Column
  - Formula Parameter
  - HSS Square Column
  - W 21 x 162 Beam
  - Place Beam
  - Snap, Align & Copy
  - Modify Round Column Family
- Project File Sheet

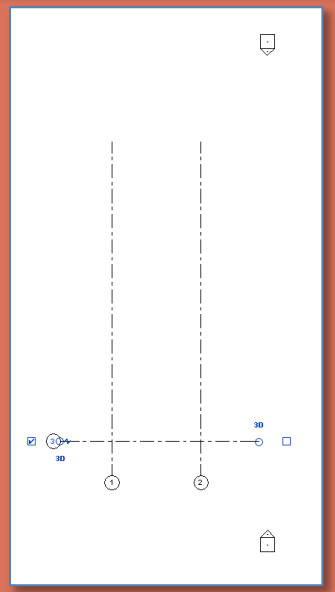
Add Column Grids on Level 1

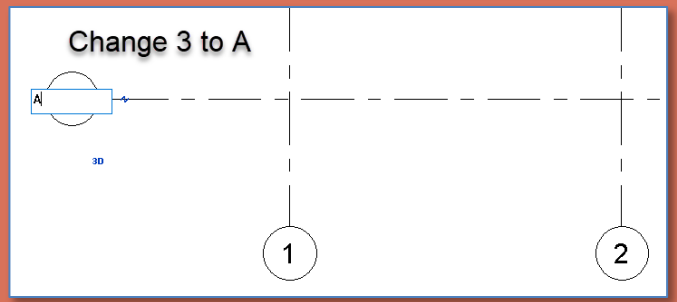








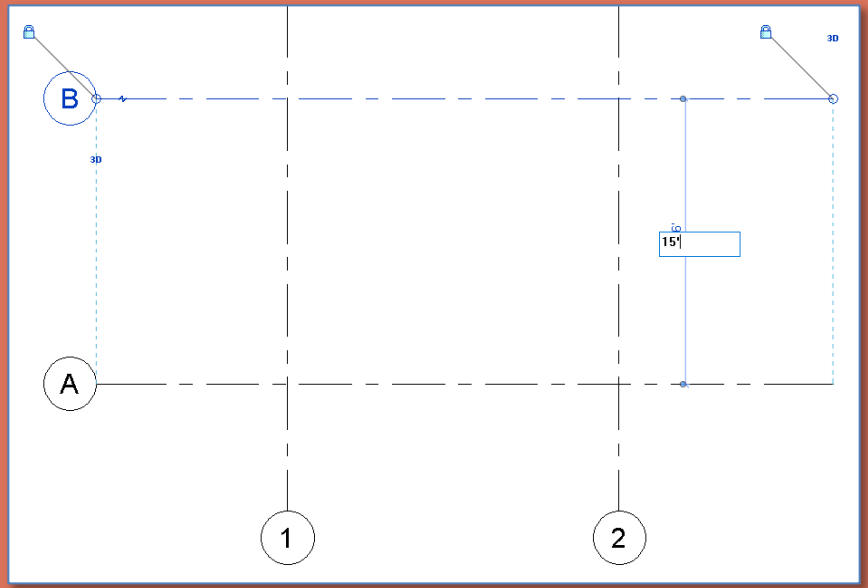


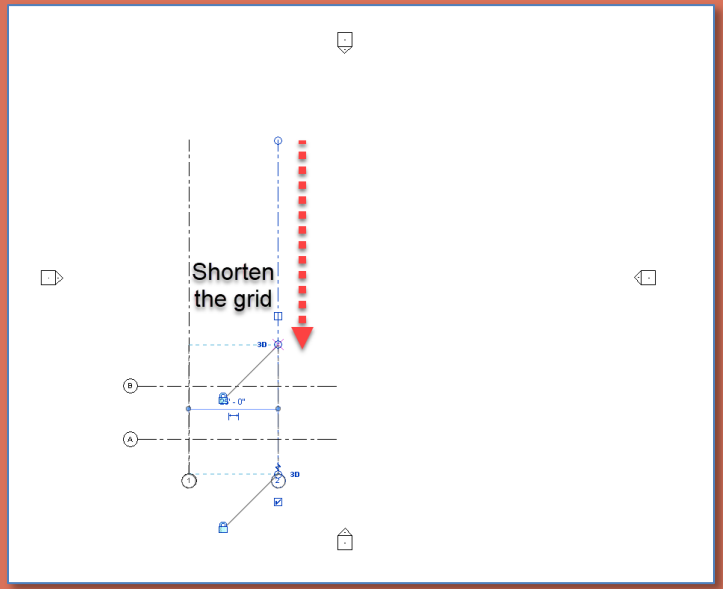


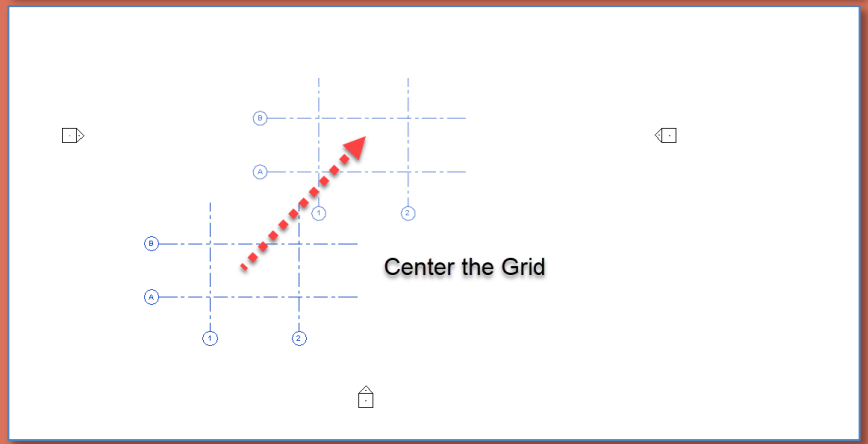
- **Set Level 1 as the current view**
  - Architecture Ribbon > Grid
- Draw Vertical Grid 1 from top to bottom
- Draw Vertical Grid 2 from top to bottom
  - Modify Spacing to 25 feet
- Draw Horizontal Grid (will be numbered 3)
  - Change Name from 3 to A

- Assignment Description
- New Project File
  - Levels
  - Grids
  - Dimensions
- New 3D Family
- W 24 x 162 column
  - Reference Planes
  - Parameters
  - Extrusion
  - Height Parameters
  - Family Category
- Load into Project
- New 3D Families
  - HSS Pipe Column
  - Formula Parameter
  - HSS Square Column
  - W 21 x 162 Beam
  - Place Beam
  - Snap, Align & Copy
  - Modify Round Column Family
- Project File Sheet

Add Column Grids on Level 1







- Draw Grid Line B
  - Set Spacing to 15’-0”
- Shorten the Grid Lines
- Move & Center the Grid
  - Select Grid & Drag

- Assignment Description
- New Project File
  - Levels
  - Grids
  - Dimensions
- New 3D Family
- W 24 x 162 column
  - Reference Planes
  - Parameters
  - Extrusion
  - Height Parameters
  - Family Category
- Load into Project
- New 3D Families
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  - HSS Square Column
  - W 21 x 162 Beam
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  - Snap, Align & Copy
  - Modify Round Column Family
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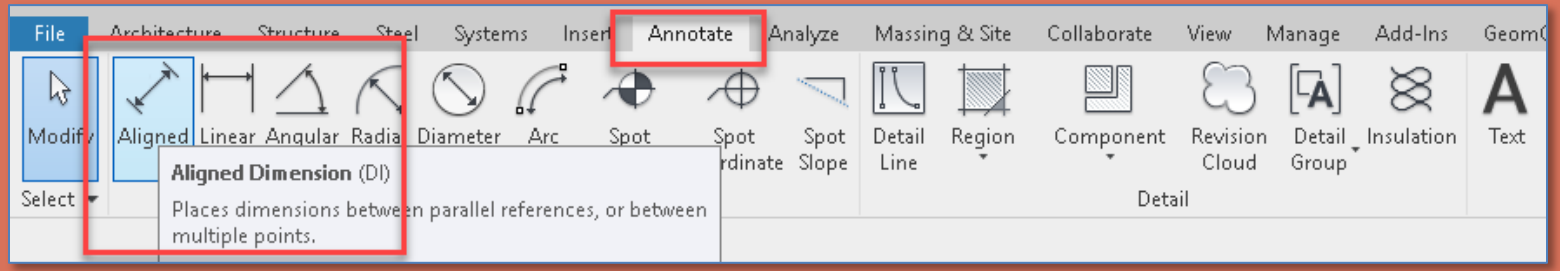
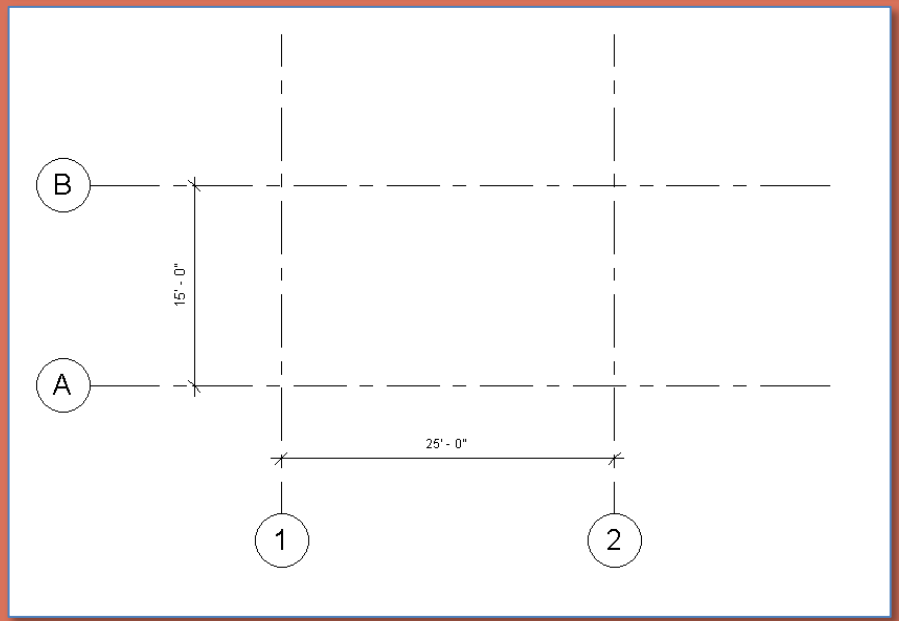
Add Dimensions





- **Annotate Ribbon**
  - Aligned Dimension
- Add vertical dimension
- Add Horizontal Dimension

- Assignment Description
- New Project File
  - Levels
  - Grids
  - Dimensions
- New 3D Family
- W 24 x 162 column
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  - W 21 x 162 Beam
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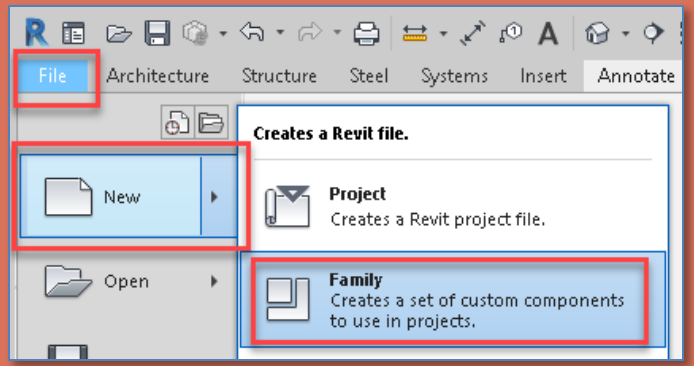
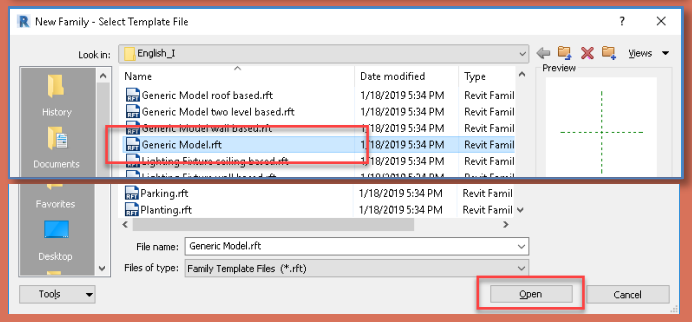
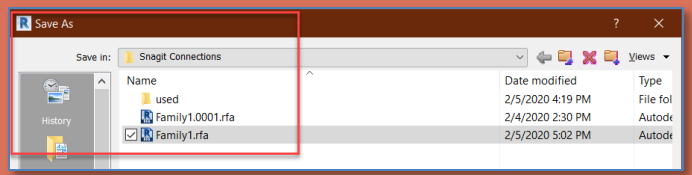
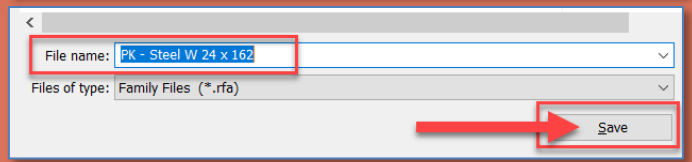
Creating a new 3D Family File

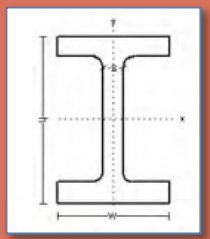








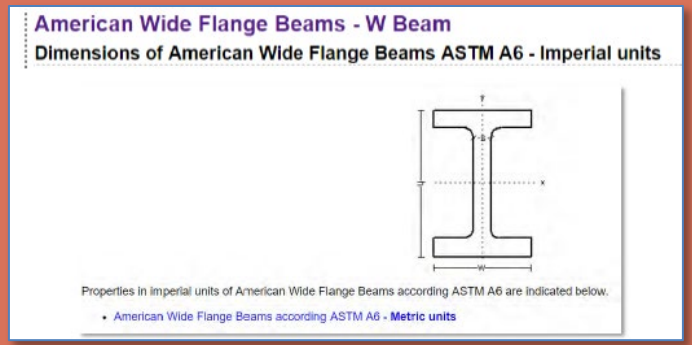
- We will repeat this for each component of the Steel Connection Assembly
- **Create a new Family**
  - File > New > Family *(English Imperial)*
  - Generic Model Template
- **Save and Name the File**
- **Select an appropriate directory**
- **Name the file as follows:**
  - *Initials- Description*
  - *PK – Steel W 24 x 162*



Designation	Dimensions					
Imperial *(in x lb/ft)*	Depth h *(in)*	Width w *(in)*	Web Thickness t_w *(in)*	Flange Thickness t_f *(in)*	Sectional Area *(in^2)*	Weight *(lb/ft)*
W 24 x 162	25	13	0.705	1.220	47.7	162
W 24 x 146	24.7	12.9	0.650	1.090	43.0	146

- Assignment Description
- New Project File
  - Levels
  - Grids
  - Dimensions
- New 3D Family
- W 24 x 162 column
  - Reference Planes
  - Parameters
  - Extrusion
  - Height Parameters
  - Family Category
- Load into Project
- New 3D Families
  - HSS Pipe Column
  - Formula Parameter
  - HSS Square Column
  - W 21 x 162 Beam
  - Place Beam
  - Snap, Align & Copy
  - Modify Round Column Family
- Project File Sheet

Wide Flange W 24 x 162



American Wide Flange Beams - W Beam

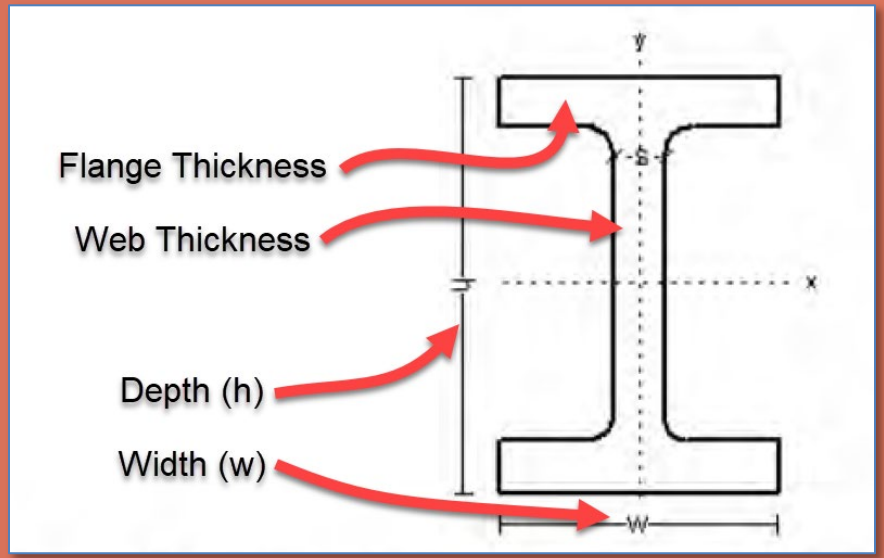
Dimensions of American Wide Flange Beams ASTM A6 - Imperial units

Properties in imperial units of American Wide Flange Beams according ASTM A6 are indicated below.

- American Wide Flange Beams according ASTM A6 - **Metric units**

- *W 24 x 162*
  - *Depth (h) = 25”*
  - *Width (w) = 13”*
  - *Web Thickness = .705”*
  - *Flange Thickness = 1.220”*

Designation	Dimensions					
Imperial (in x lb/ft)	Depth h (in)	Width w (in)	Web Thickness t_w (in)	Flange Thickness t_f (in)	Sectional Area (in^2)	Weight (lb/ft)
W 27 x 178	27.8	14.09	0.725	1.190	52.3	178
W 27 x 161	27.6	14.02	0.660	1.080	47.4	161
W 27 x 146	27.4	14	0.605	0.975	42.9	146
W 27 x 114	27.3	10.07	0.570	0.930	33.5	114
W 27 x 102	27.1	10.02	0.515	0.830	30.0	102
W 27 x 94	26.9	10	0.490	0.745	27.7	94
W 27 x 84	26.7	9.96	0.460	0.640	24.8	84
W 24 x 162	25	13	0.705	1.220	47.7	162
W 24 x 146	24.7	12.9	0.650	1.090	43.0	146



Source of Information:
https://www.engineeringtoolbox.com/american-wide-flange-steel-beams-d_1319.html

Additional Reference for steel components:
http://products.anssteel.com/category/steel?

W 24 x 162	25	13	0.705	1.220	47.7	162
W 24 x 146	24.7	12.9	0.650	1.090	43.0	146

Steel Connections Introduction

- Assignment Description
- New Project File
  - Levels
  - Grids
  - Dimensions
- New 3D Family
- W 24 x 162 column
  - Reference Planes
  - Parameters
  - Extrusion
  - Height Parameters
  - Family Category
- Load into Project
- New 3D Families
  - HSS Pipe Column
  - Formula Parameter
  - HSS Square Column
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  - Place Beam
  - Snap, Align & Copy
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- Project File Sheet

Building Technology III

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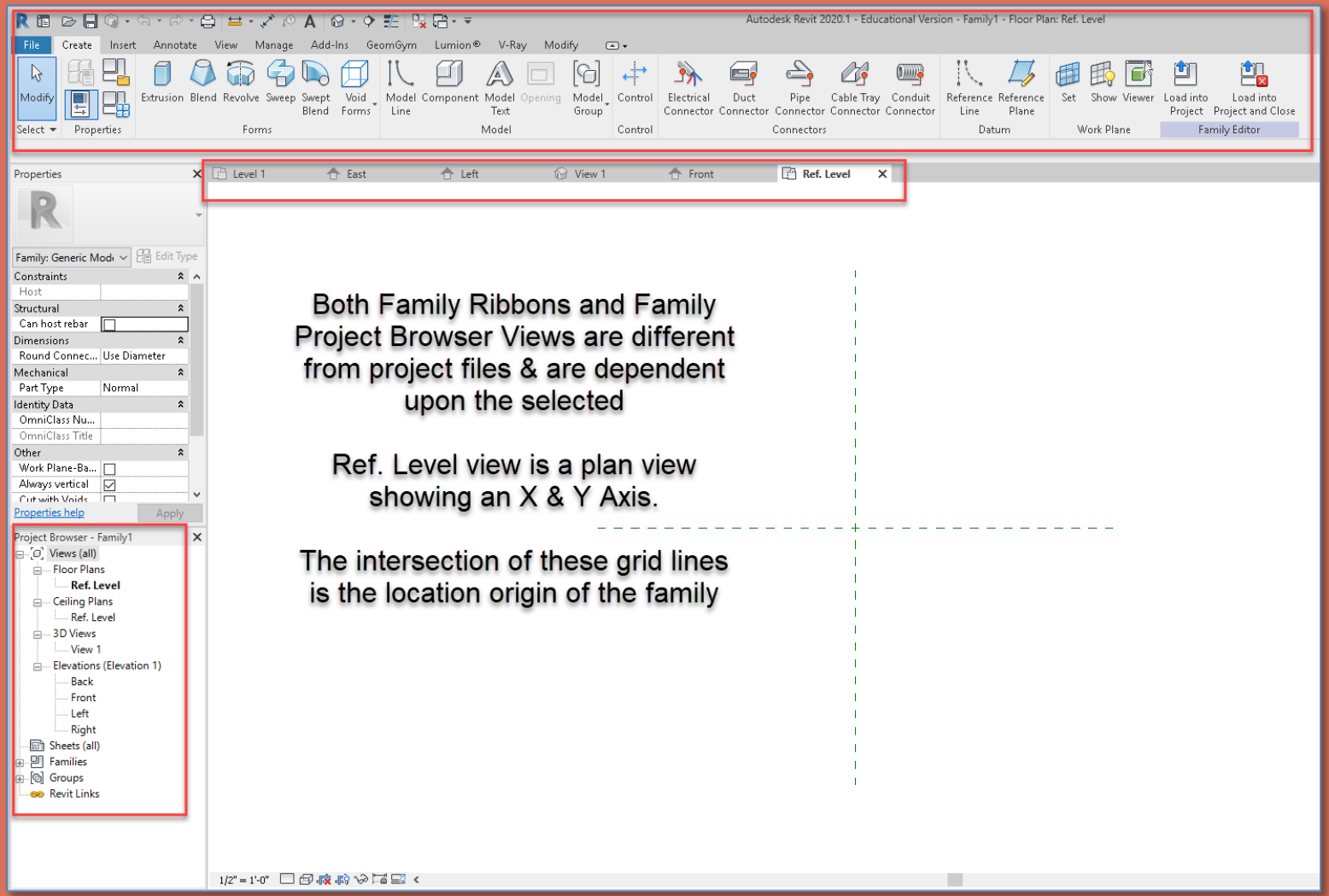
Family Ribbons and Project Browser Views



- Assignment Description
- New Project File
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  - Grids
  - Dimensions
- New 3D Family
- W 24 x 162 column
  - Reference Planes
  - Parameters
  - Extrusion
  - Height Parameters
  - Family Category
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- New 3D Families
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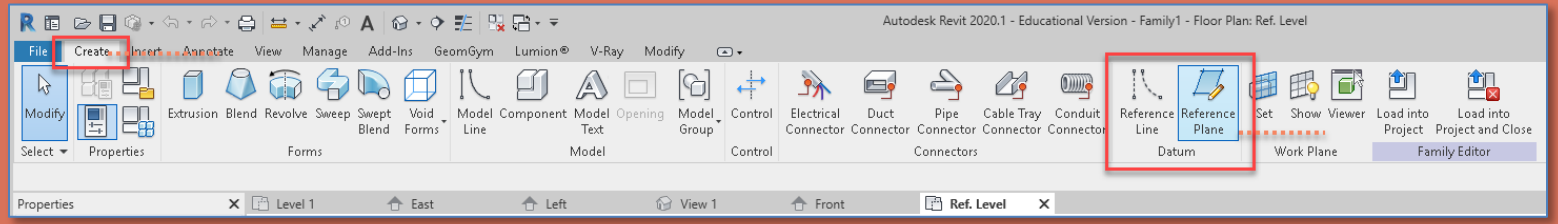
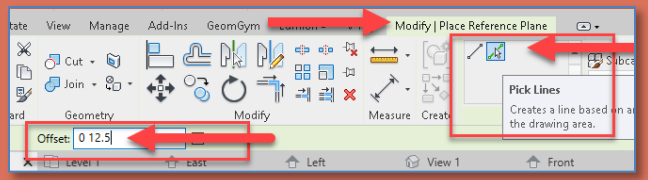
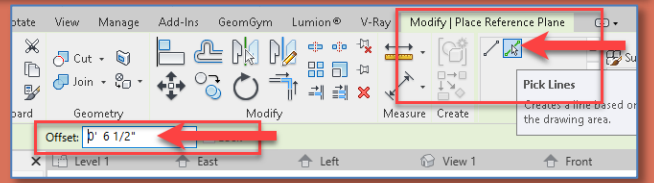
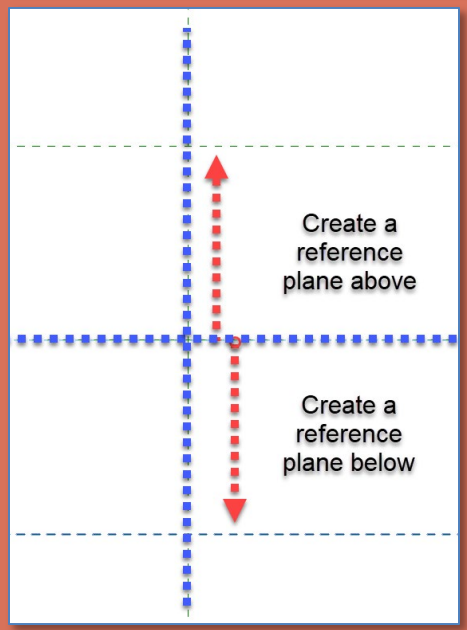
Add Reference Planes for the Depth & Width



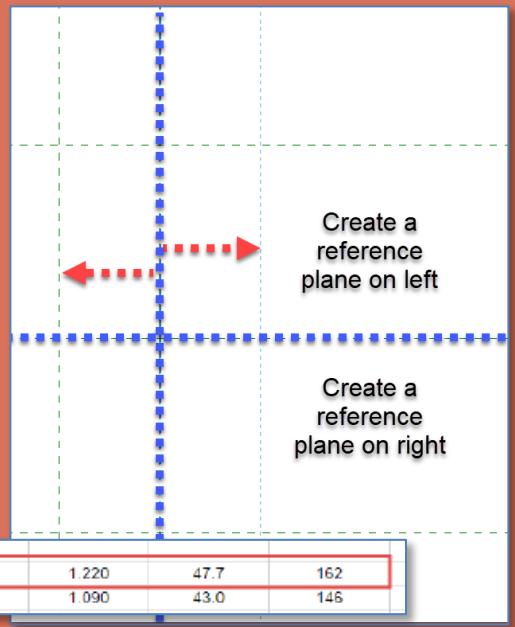


- ***W 24 x 162***
- *Depth (h) = 25”*
- *Width (w) = 13”*





- **Create Ribbon**
  - Reference Plane
- **Depth pick lines**
  Offset (25/2 = 12.5”)
  - Add two
- **Width pick lines**
  Offset (13/2 = 6.5 “)
  - Add two



W 24 x 162	25	13	0.705	1.220	47.7	162
W 24 x 146	24.7	12.9	0.650	1.090	43.0	146

- Assignment Description
- New Project File
  - Levels
  - Grids
  - Dimensions
- New 3D Family
- W 24 x 162 column
  - Reference Planes
  - Parameters
  - Extrusion
  - Height Parameters
  - Family Category
- Load into Project
- New 3D Families
  - HSS Pipe Column
  - Formula Parameter
  - HSS Square Column
  - W 21 x 162 Beam
  - Place Beam
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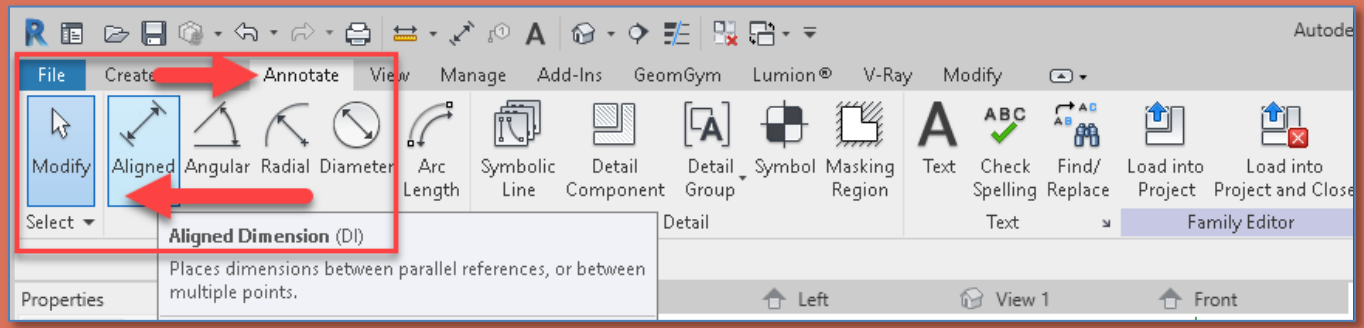
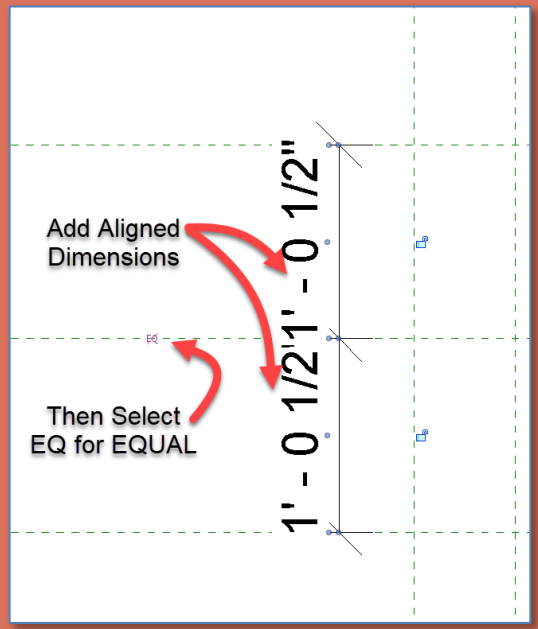
- Project File Sheet

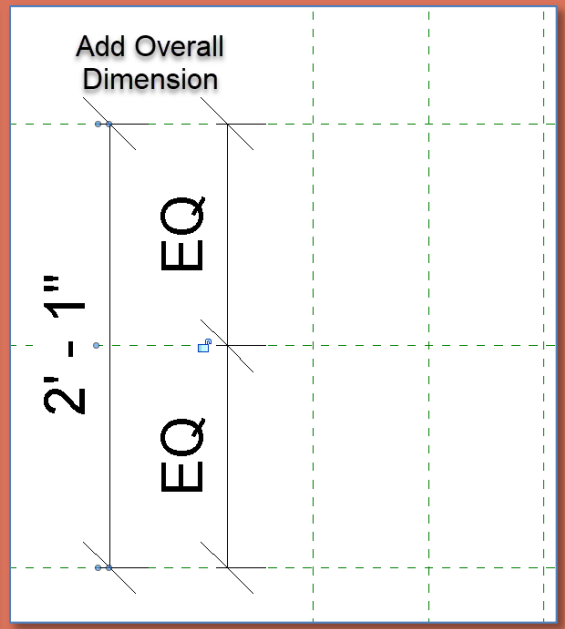
Add Dimensions & define adjustable Parameters

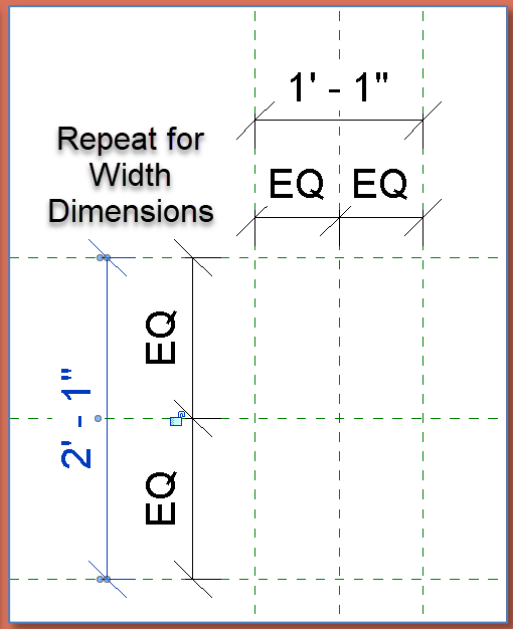


- *W 24 x 162*
- *Depth (h) = 25”*
- *Width (w) = 15”*

- **Annotate > Aligned** (Add two dimensions then EQ) Then Overall & Repeat

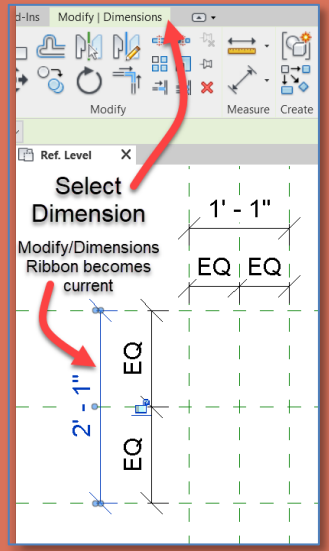


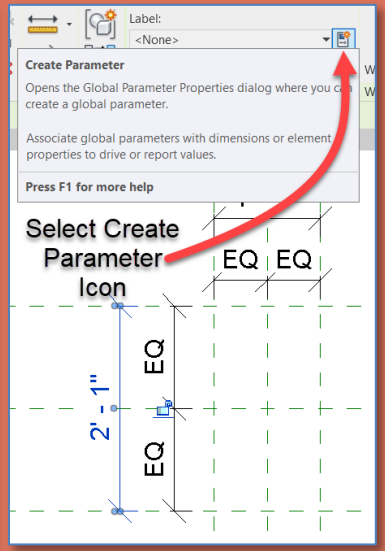


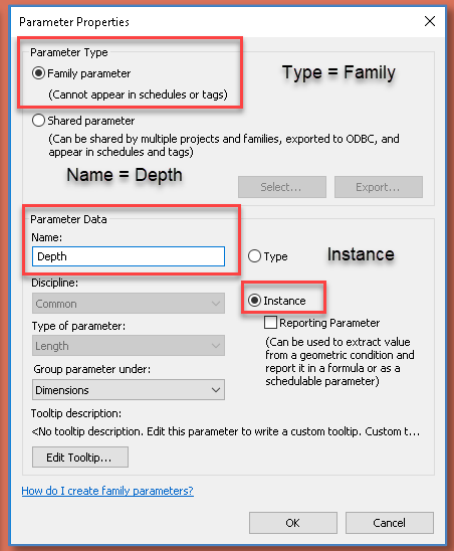


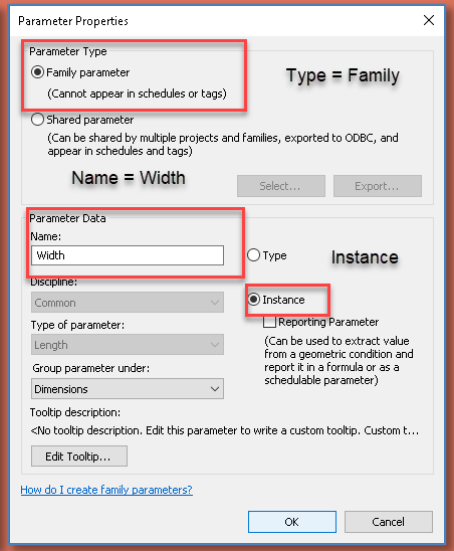
- Assignment Description
- New Project File
  - Levels
  - Grids
  - Dimensions
- New 3D Family
- W 24 x 162 column
  - Reference Planes
  - Parameters
  - Extrusion
  - Height Parameters
  - Family Category
- Load into Project
- New 3D Families
  - HSS Pipe Column
  - Formula Parameter
  - HSS Square Column
  - W 21 x 162 Beam
  - Place Beam
  - Snap, Align & Copy
  - Modify Round Column Family
- Project File Sheet

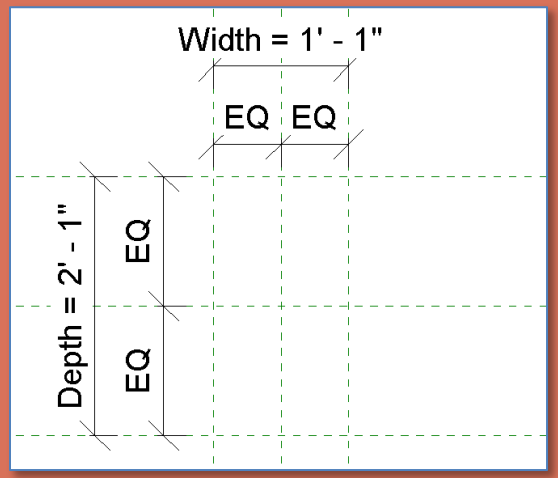
Add Dimensions & define adjustable Parameters









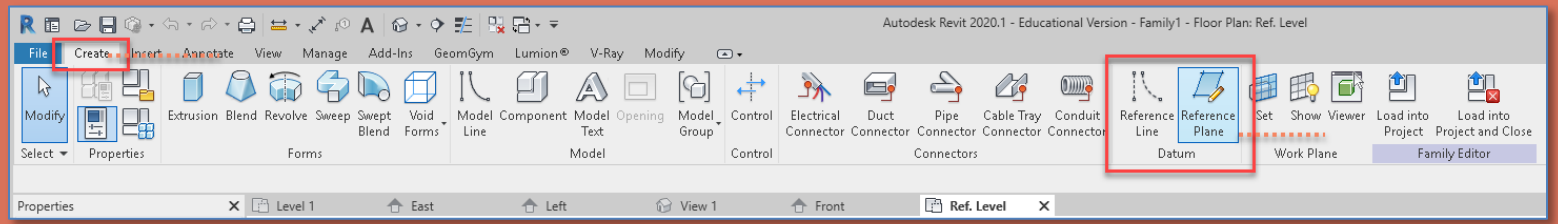


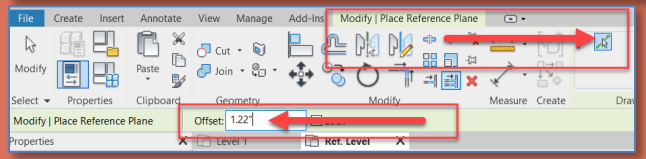
- **Select Depth (2'-1'') > Create Parameter**
  - Type = Family
  - Name = Depth
  - Instance
- **Select Width (1'-1'') > Create Parameter**
  - Type = Family
  - Name = Width
  - Instance

- ***W 24 x 162***
- *Depth (h) = 25"*
- *Width (w) = 15"*

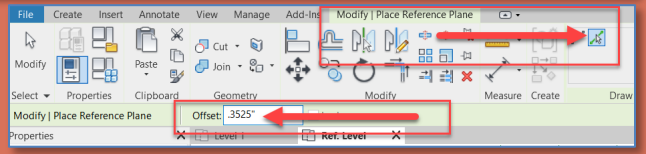
- Assignment Description
- New Project File
  - Levels
  - Grids
  - Dimensions
- New 3D Family
- W 24 x 162 column
  - Reference Planes
  - Parameters
  - Extrusion
  - Height Parameters
  - Family Category
- Load into Project
- New 3D Families
  - HSS Pipe Column
  - Formula Parameter
  - HSS Square Column
  - W 21 x 162 Beam
  - Place Beam
  - Snap, Align & Copy
  - Modify Round Column Family
- Project File Sheet

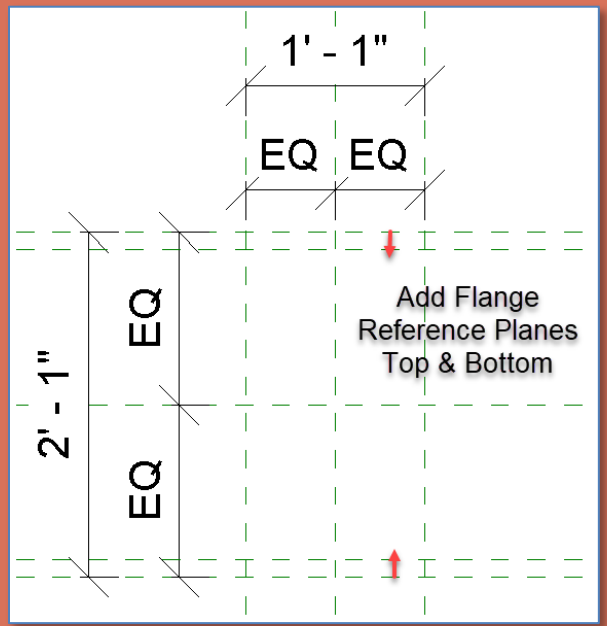
Add Reference Planes for Web & Flange



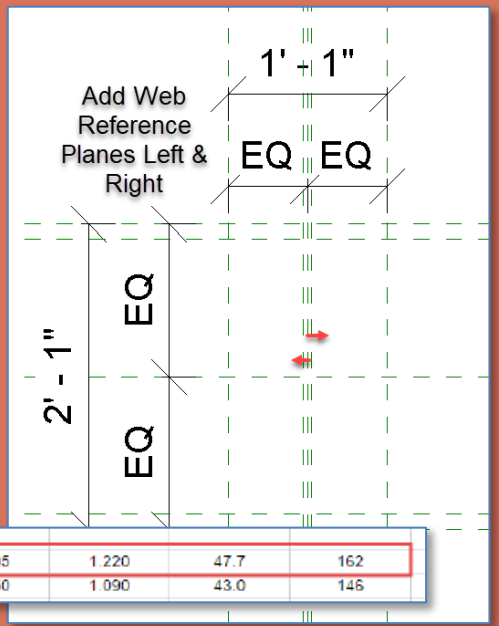


- *W 24 x 162*
  - *Web Thickness = .705”*
  - *Flange Thickness = 1.220”*





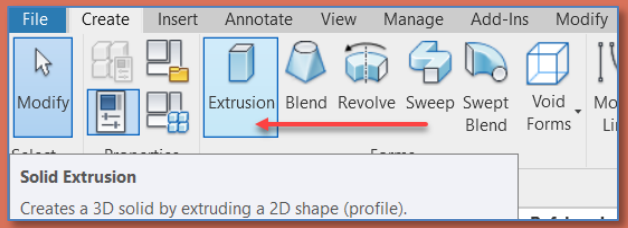
- **Create Ribbon > Reference Plane**
- Flange pick lines Offset (1.22”)
  - Add both top and bottom
- Web pick lines Offset (.705/2 = .3525”)
  - Add two left and right



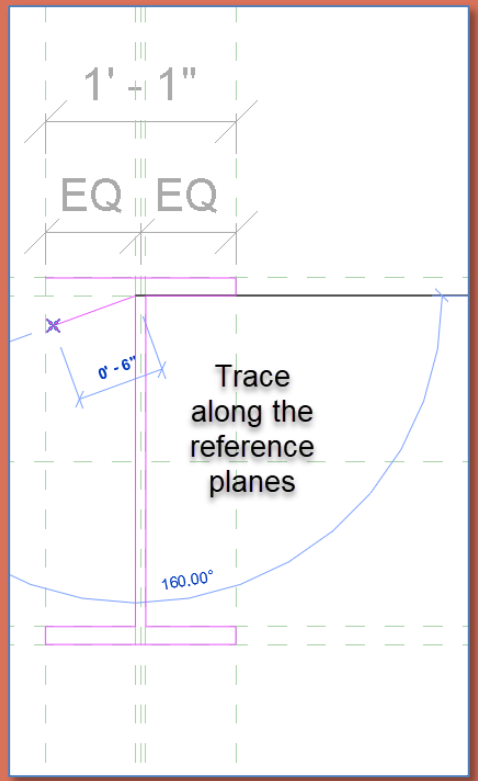
W 24 x 162	25	13	0.705	1.220	47.7	162
W 24 x 146	24.7	12.9	0.650	1.090	43.0	146

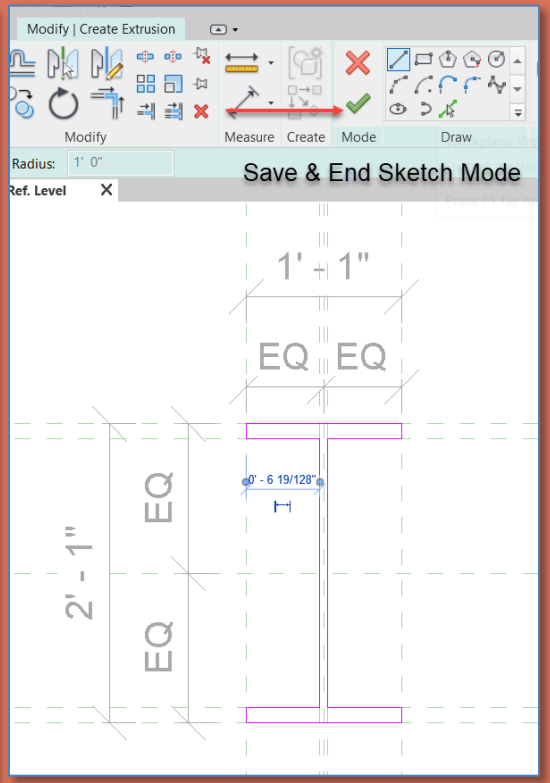
- Assignment Description
- New Project File
  - Levels
  - Grids
  - Dimensions
- New 3D Family
- W 24 x 162 column
  - Reference Planes
  - Parameters
  - Extrusion
  - Height Parameters
  - Family Category
- Load into Project
- New 3D Families
  - HSS Pipe Column
  - Formula Parameter
  - HSS Square Column
  - W 21 x 162 Beam
  - Place Beam
  - Snap, Align & Copy
  - Modify Round Column Family
- Project File Sheet

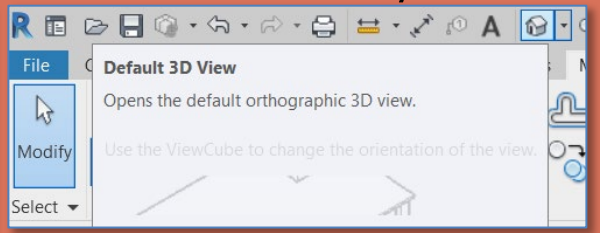
Create the Extrusion

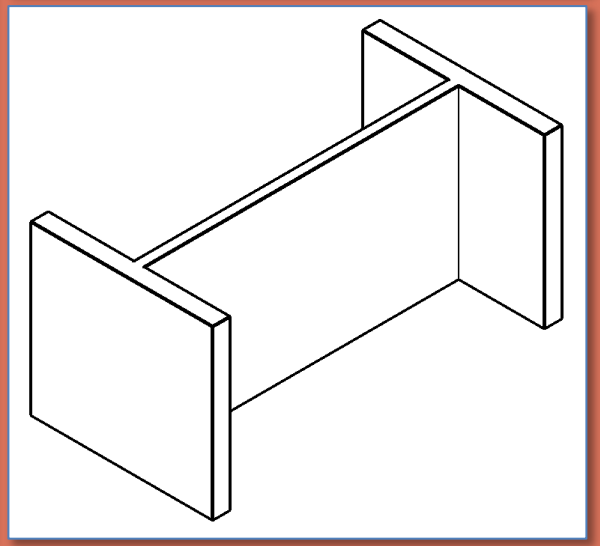


- **Create Ribbon > Extrusion (Solid)**
  - Lines (trace the shape using reference planes)
  - Green Check (Save and end Sketch Mode)
  - Default 3D View
  - *Remember to lock lines to reference planes*









- Assignment Description
- New Project File
  - Levels
  - Grids
  - Dimensions
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  - Parameters
  - Extrusion
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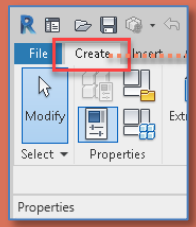
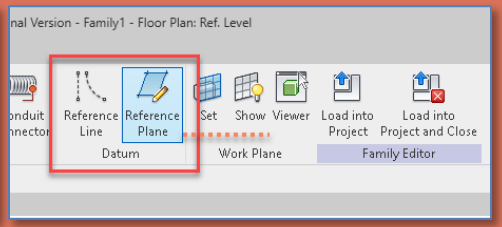
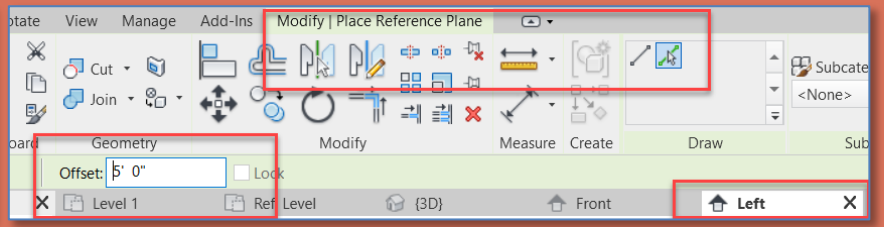
- Project File Sheet

Add Reference Plane for Height & Lock Top & Bottom

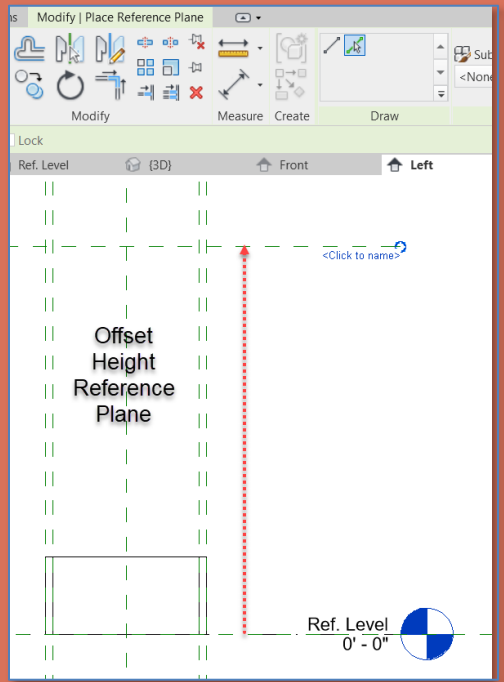


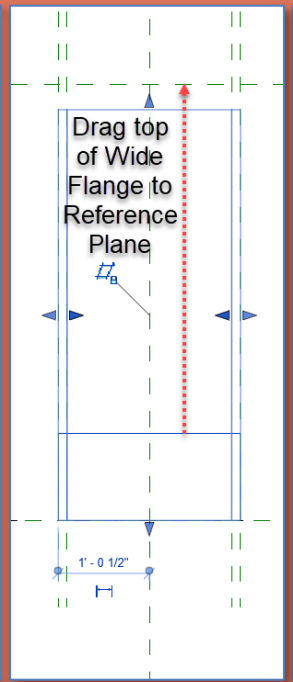


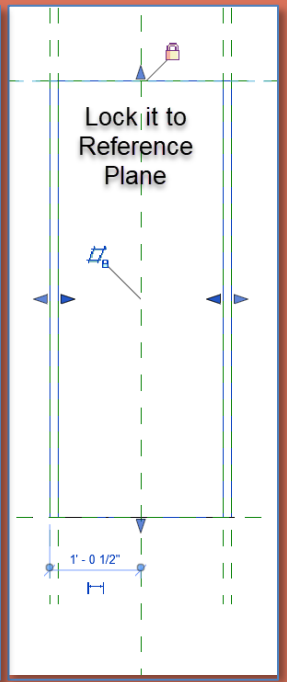


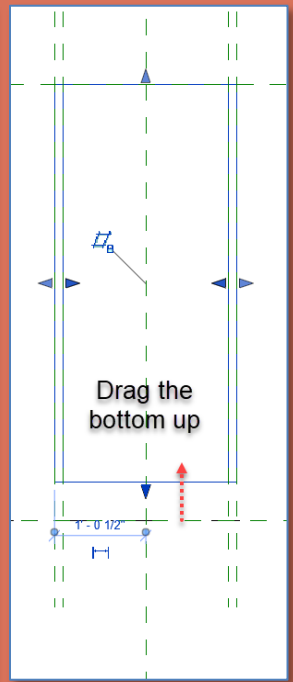
- **Left View> Create > Reference Plane**
- Pick Lines (offset 5’-0”)

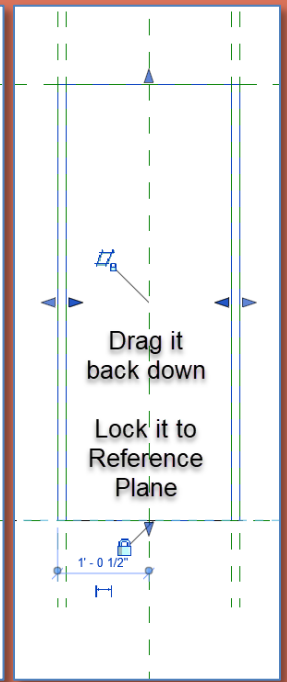
- Drag top to reference plane and lock it
- Drag bottom up then back don and lock it











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  - Extrusion
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  - HSS Square Column
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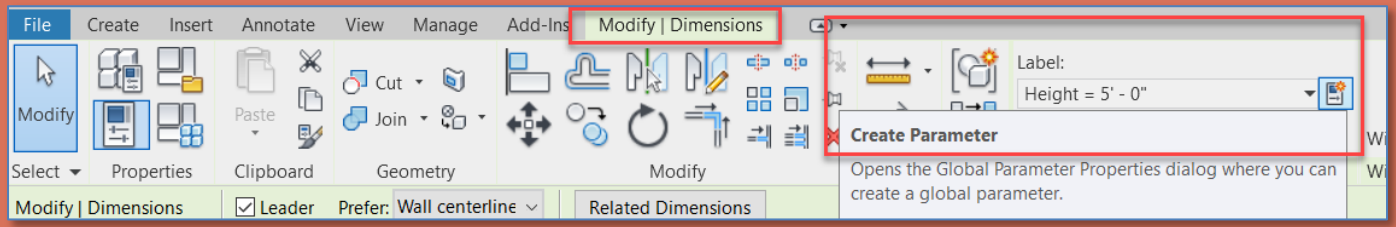
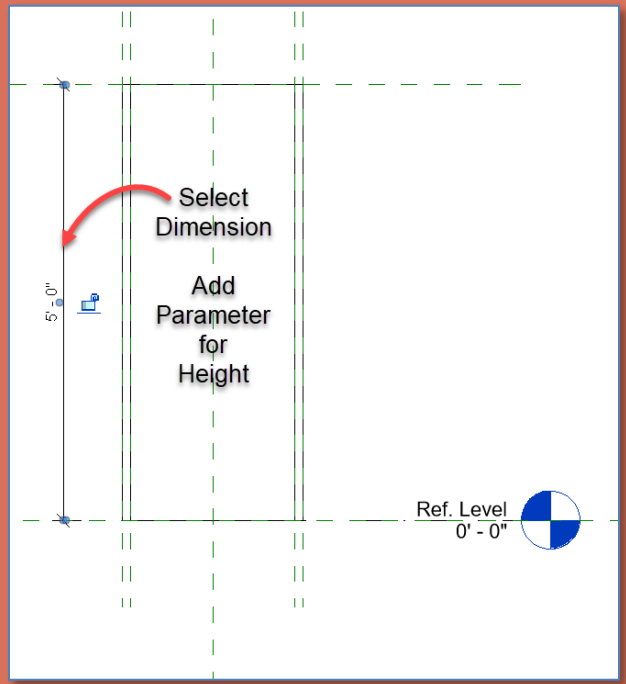
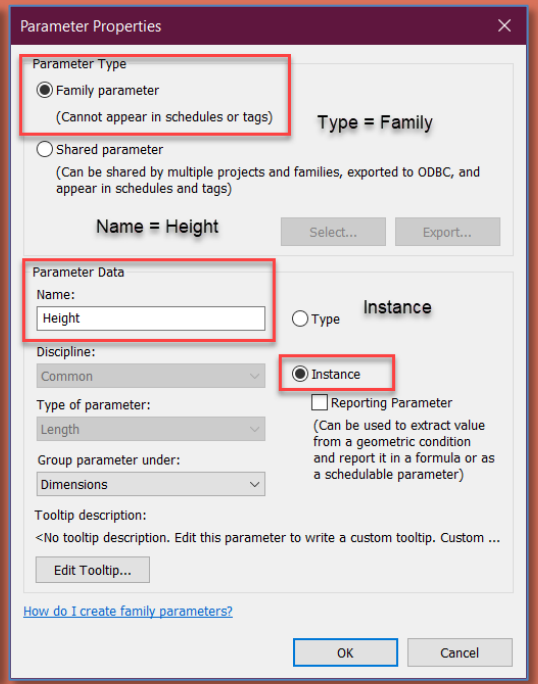
- Project File Sheet

Add Dimension and Parameter for Height







- **Select Dimension**
- **Create Parameter**
  - Type = Family
  - Name = Height
  - Instance

- Assignment Description
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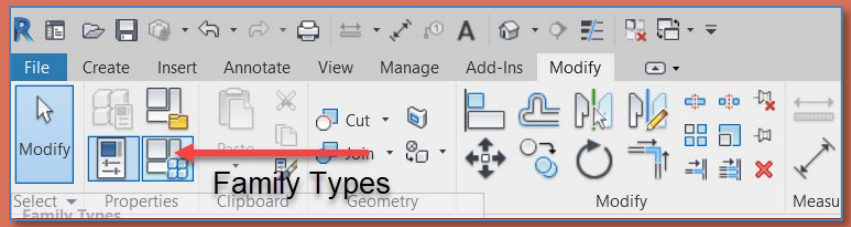
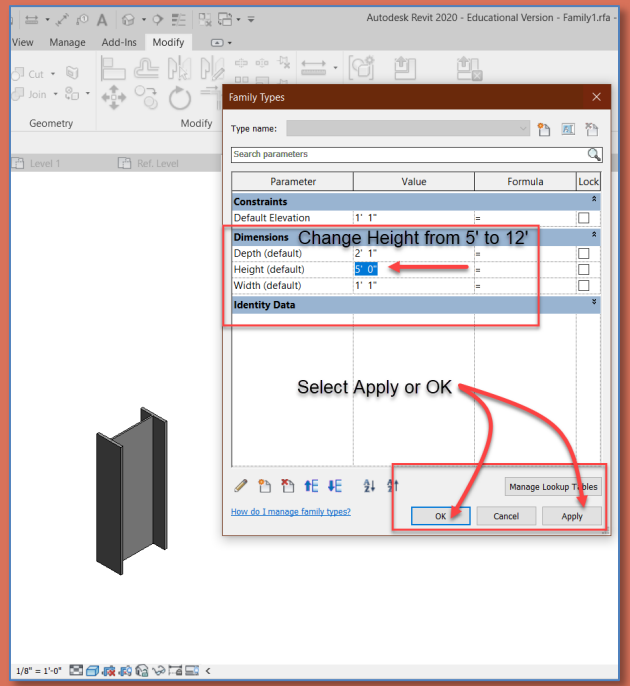
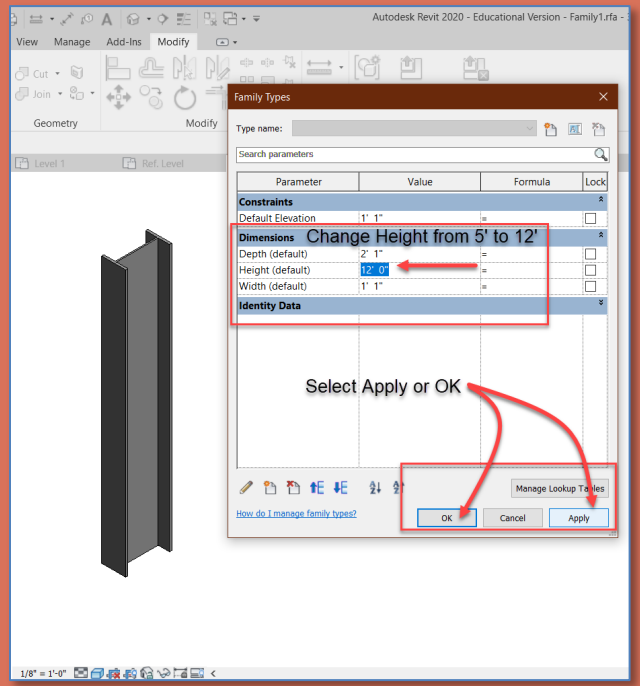
Using Parameters to Control the 3D extrusion



- **Properties > Family Type**
  - Notice the list of parameters
- **Change Height from 5’ to 12’**
  - Notice the 3D model updates





- Assignment Description
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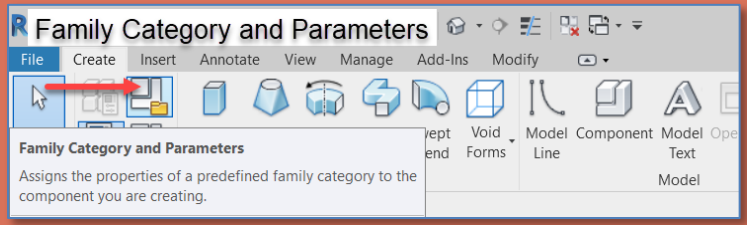
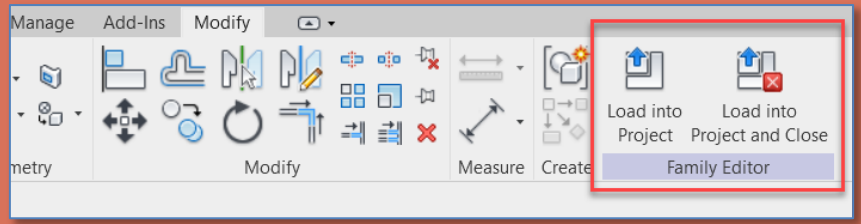
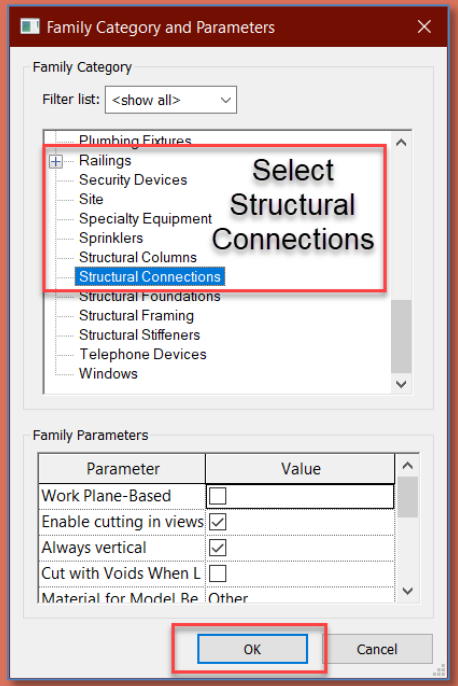
Set Family Category to Structural Connections

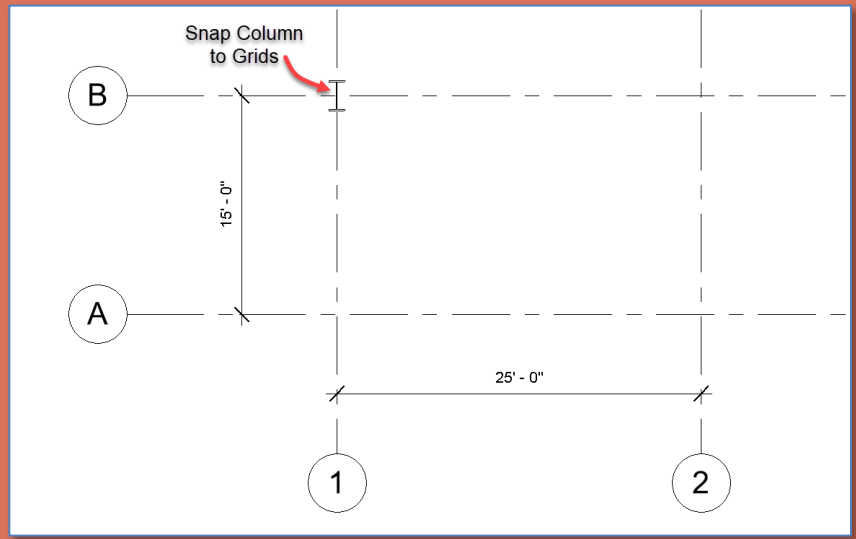






- *Family Category & Parameters*
- *Select Structural Connections*
- *Save the file*
- *Load into Project*
- *Snap to Column Grids B & 1*

- **Save your family (your working directory)**
- **Be good about appropriate names for family files**
- **Load into Project**
  - (family file remains open)
- **Load into Project and Close**
  - (family file will close)
- The family is saved inside the project file



- Assignment Description
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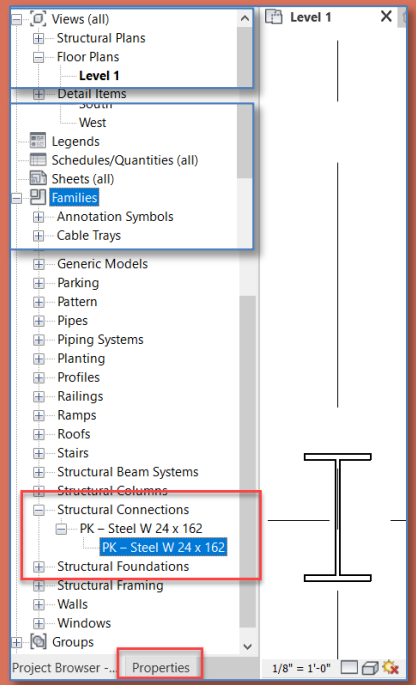
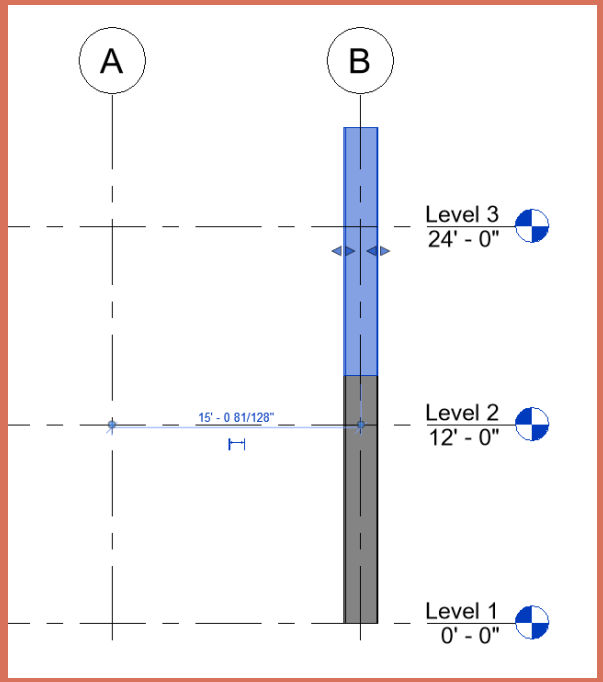
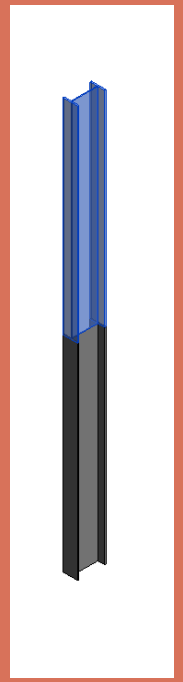
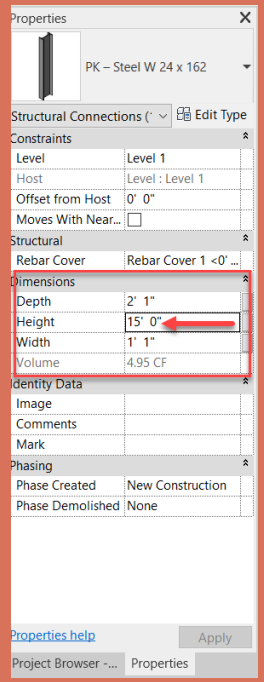
Look under Family Category for Structural Connections

- In the ***project browser*** the family will show in the category "Structural Connections"
- To create additional copies either copy the one already in the project or drag it from the project browser into the project
- Modify the height of the first column to 15'-0" (12' for the Level + an extra 3 feet)
- Make a copy 15 feet above the first column









HSS High Strength Steel Pipe Columns

Steel Pipe Columns - Allowable Loads

Allowable concentric loads for steel pipe columns

Sponsored Links

The tables bellows indicates allowable concentric loads for steel pipe columns:

Standard Steel Pipe

Nominal Pipe Diameter *(inches)*	Wall Thickness *(inches)* (mm)	Effective Length of Column *(feet)* (m)							
		6	8	10	12	14	16	18	20
		Allowable Concentric Loads *(10^3 lbf)* (kN)							
3	0.216	38	34	28	22	16	12	10	
3 1/2	0.226	48	44	38	32	25	19	15	12
4	0.237	59	54	49	43	36	29	23	19
5	0.257	83	78	73	68	61	55	47	39
6	0.280	110	106	101	95	89	82	75	67

Extra Strong Steel Pipe

Nominal Pipe Diameter *(inches)*	Wall Thickness *(inches)* (mm)	Effective Length of Column *(feet)* (m)							
		6	8	10	12	14	16	18	20
		Allowable Concentric Loads *(10^3 lbf)* (kN)							
3	0.300	52	45	37	28	21	16	12	

- *For Round Column HSS 10* *Outside Diameter 10" Thickness = .5"*

8	0.500	259	251	243	234	224	214	203	191
10	0.500	332	325	318	309	301	291	281	271
12	0.500	400	394	387	379	371	363	353	344

Note that the effective column length depends on the column configuration. The values above is valid for columns with rotation free and translation fixed in both ends.

Source of Information: https://www.engineeringtoolbox.com/american-wide-flange-steel-beams-d_1319.html

Additional Reference for steel components: http://products.anssteel.com/category/steel?

- Assignment Description
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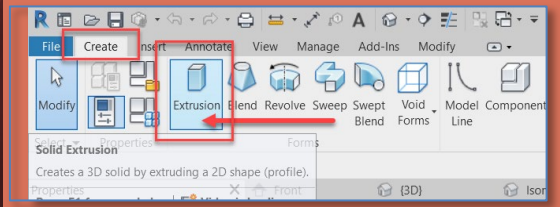
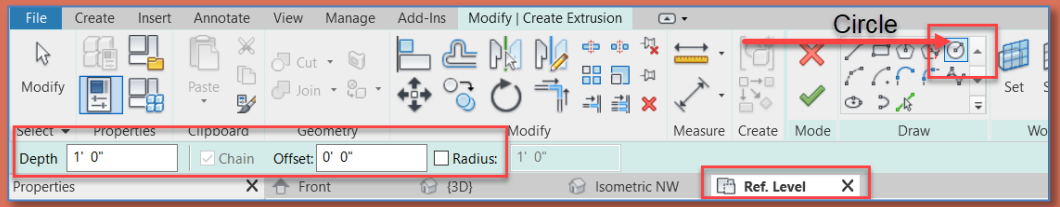
HSS High Strength Steel Pipe Columns (Create)

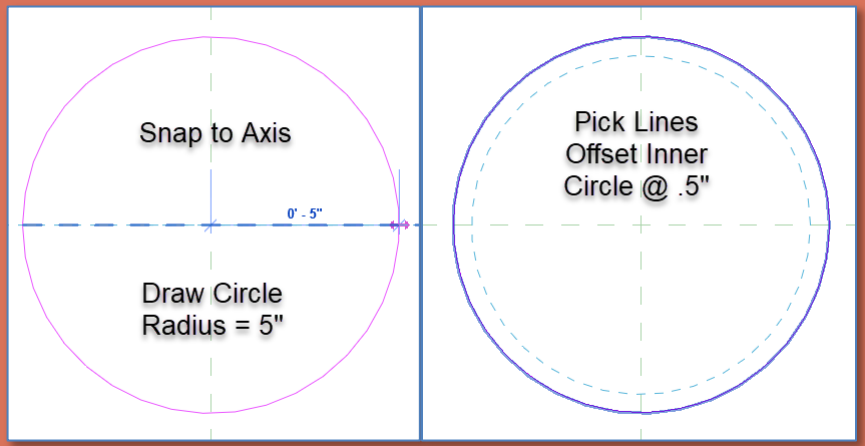
- *For Round Column HSS 10* Outside Diameter 10" Thickness = .5"

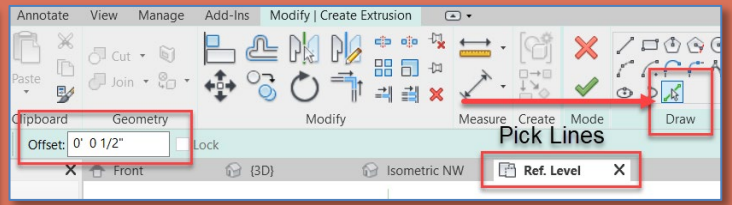
8	0.500	259	251	243	234	224	214	203	191
10	0.500	332	325	318	309	301	291	281	271
12	0.500	400	394	387	379	371	363	353	344

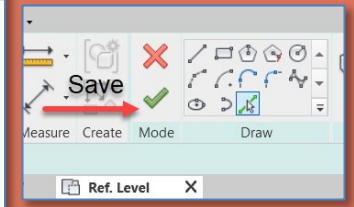
- *New > Family > Generic Model* *Save_as Initials-HSS-Round 10 x .5*
- *Create > Extrusion > Circle (radius 5") > Pick Lines (.5")*

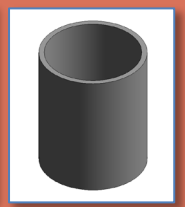












Set Family Category to Structural Connections

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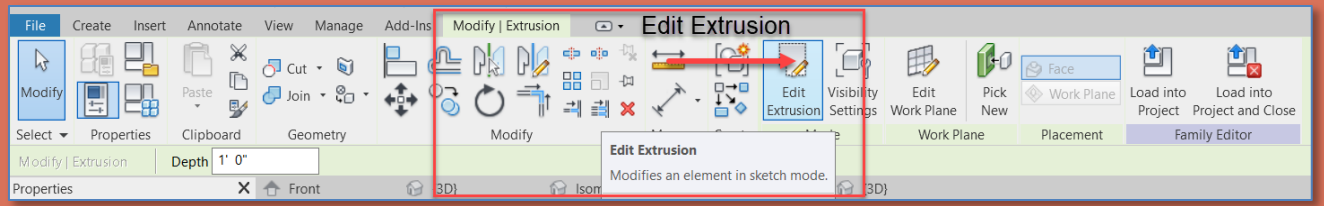
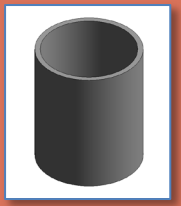
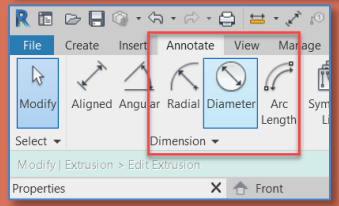
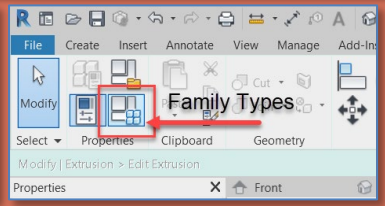
HSS High Strength Steel Pipe Columns (Parameters)

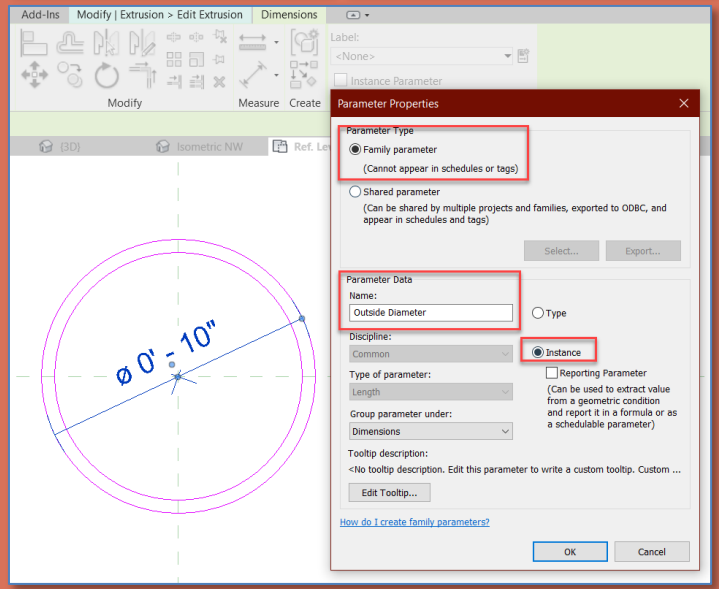


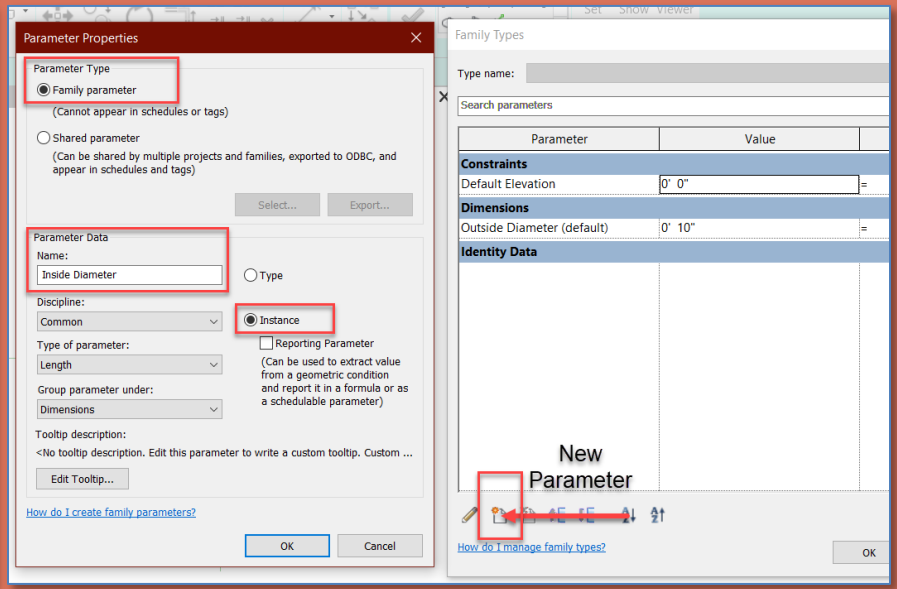






- *Edit Extrusion > Annotate > Diameter*
- *Add Parameter (Outside Diameter)*
- *Family Type > New Parameter (Inside Diameter)*





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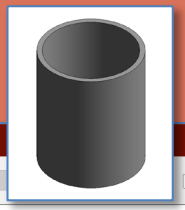
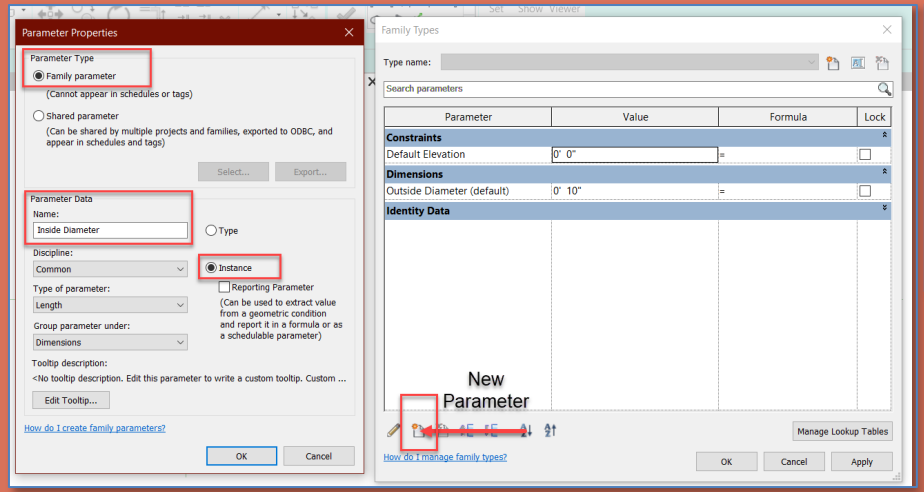
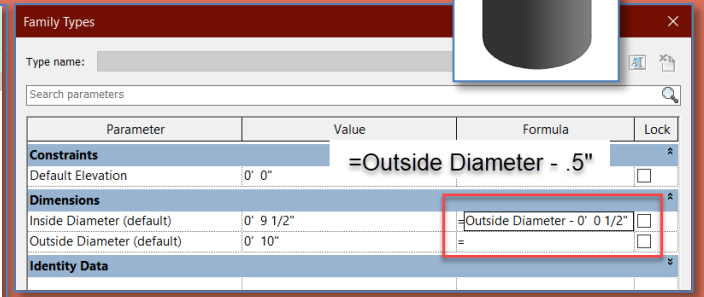
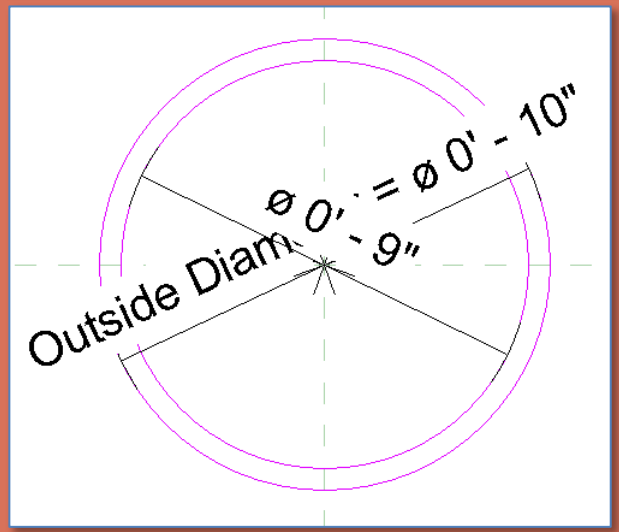
Add Formula to Parameter

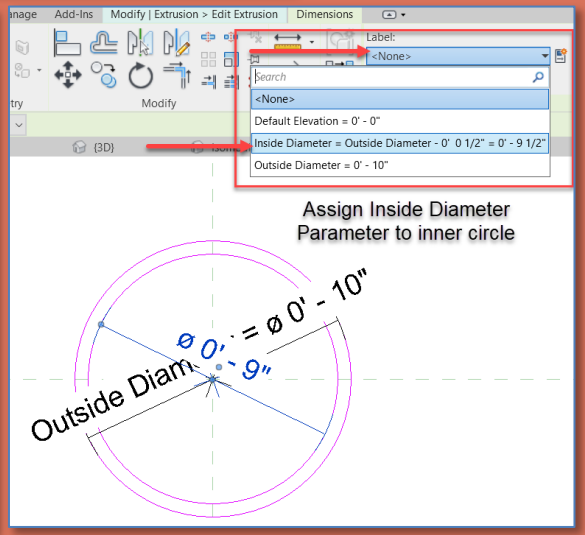




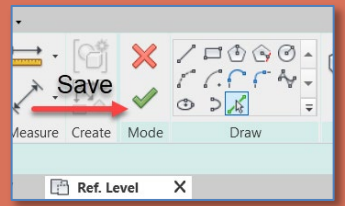


- *Inner circle is dependent on outer*
- *= Outside Diameter - .5”*
- *Annotate > Diameter (inner circle)*
- *Assign Parameter to Inner Circle Diameter*





- *Add additional reference plane and parameter to control the height*
- *Save and Load into Project file*



HSS Square Hollow Structural Sections

Square Hollow Structural Sections - HSS

Weight, cross sectional area, moments of inertia - Imperial units

- *1 in = 25.4 mm*

Nominal Size 3)	Weight	Wall Thickness	b/t 1)	h/t 1)	Cross Sectional Area 2)	I 1)	S 1)	r 1)	Z 1)	Torsional Stiffness Constant J	Torsional Shear Constant C	Surface Area
(in x in x in)	*(lb_f/ft)*	*(in)*	-	-	*(in^2)*	*(in^4)*	*(in^3)*	*(in)*	*(in^3)*	*(in^4)*	*(in^3)*	*(ft^2/ft)*
32 x 32 x 5/8	259.83	0.625	48.2	48.2	76.4	12300	771	12.7	890	19700	1230	10.34
32 x 32 x 1/2	210.72	0.500	61.0	61.0	61.9	10100	634	12.8	727	15900	991	10.45
32 x 32 x 3/8	159.37	0.375	82.3	82.3	46.8	7750	485	12.9	553	12000	750	10.51
30 x 30 x 5/8	242.82	0.625	45.0	45.0	71.4	10100	673	11.9	778	16200	1070	9.68
30 x 30 x 1/2	197.11	0.500	57.0	57.0	57.9	8320	555	12.0	637	13000	869	9.79
30 x 30 x 3/8	149.16	0.375	77.0	77.0	43.8	6370	424	12.1	485	9870	658	9.84

- *For Square Column 10 x 10 x .5* Outside Dimension 10" x 10" Thickness 0.5"

12 x 12 x 3/8	58.10	0.349	31.4	31.4	16.0	357	59.5	4.73	69.2	561	94.6	3.90
12 x 12 x 5/16	48.86	0.291	38.2	38.2	13.4	304	50.7	4.76	58.6	474	79.7	3.92
12 x 12 x 1/4	39.43	0.233	48.5	48.5	10.8	248	41.4	4.79	47.6	384	64.5	3.93
10 x 10 x 5/8	76.33	0.581	14.2	14.2	21.0	304	60.8	3.80	73.2	498	102	3.17
10 x 10 x 1/2	62.46	0.465	18.5	18.5	17.2	256	51.2	3.86	60.7	412	84.2	3.20
10 x 10 x 3/8	47.90	0.349	25.7	25.7	13.2	202	40.4	3.92	47.2	320	64.8	3.23
10 x 10 x 5/16	40.35	0.291	31.4	31.4	11.1	172	34.5	3.94	40.1	271	54.8	3.25
10 x 10 x 1/4	32.63	0.233	39.9	39.9	8.96	141	28.3	3.97	32.7	220	44.4	3.27
10 x 10 x 3/16	24.73	0.174	54.5	54.5	6.76	108	21.6	4.00	24.8	167	33.6	3.28
9 x 9 x 1/2	55.66	0.465	16.4	16.4	15.3	182	40.6	3.45	48.4	296	67.4	2.87
9 x 9 x 3/8	42.70	0.349	22.8	22.8	11.8	145	32.2	3.51	37.8	231	53.1	2.90

Source of Information: https://www.engineeringtoolbox.com/american-wide-flange-steel-beams-d_1319.html

Additional Reference for steel components: http://products.anssteel.com/category/steel?

- Assignment Description
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  - Grids
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- W 24 x 162 column
  - Reference Planes
  - Parameters
  - Extrusion
  - Height Parameters
  - Family Category
- Load into Project
- New 3D Families
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  - Formula Parameter
  - HSS Square Column
  - W 21 x 162 Beam
  - Place Beam
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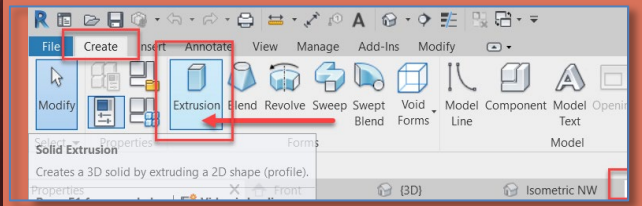
  - Modify Round Column Family
- Project File Sheet

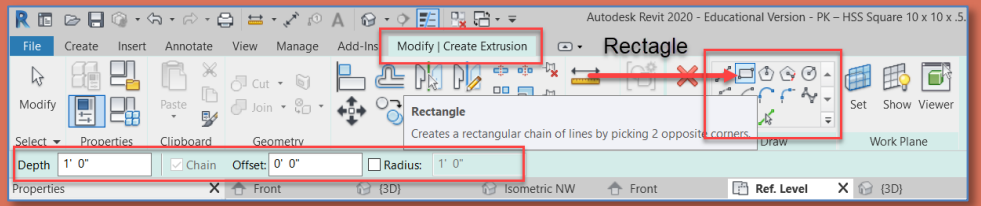
HSS Square Hollow Structural Columns (Create)

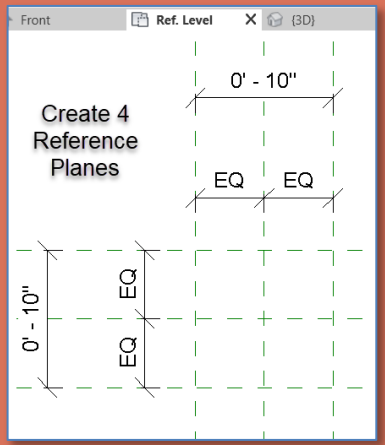
- *For Square Column 10 x 10 x .5* Outside Dimension 10" x 10" Thickness 0.5"

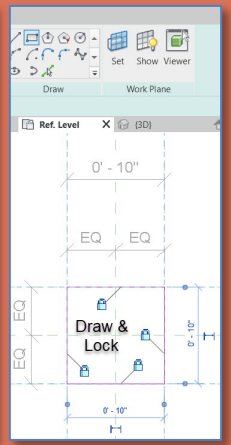
10 x 10 x 5/8	76.33	0.581	14.2	14.2	21.0	304	60.8	3.80	73.2	498	102	3.17
10 x 10 x 1/2	62.46	0.465	18.5	18.5	17.2	256	51.2	3.86	60.7	412	84.2	3.20
10 x 10 x 3/8	47.90	0.349	25.7	25.7	13.2	202	40.4	3.92	47.2	320	64.8	3.23

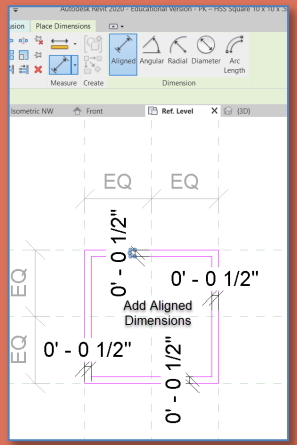
- *New > Family > Generic Model Save_as Initials-HSS-Square 10 x10x.5*
- *Create > Extrusion > Rectangle (10x10") >Rectangle Offset .5"*

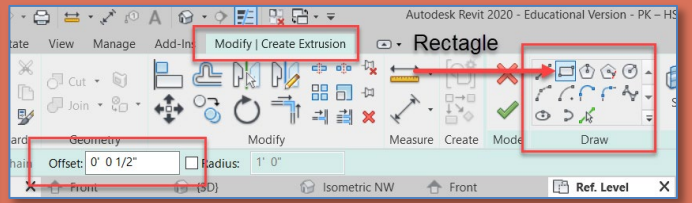




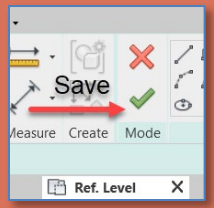


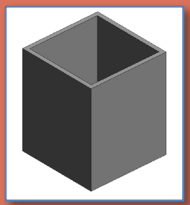






- *Draw & Lock to Reference Planes*
- *Add aligned dimension for inner rectangle*





- Assignment Description
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  - Extrusion
  - Height Parameters
  - Family Category
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  - Formula Parameter
  - HSS Square Column
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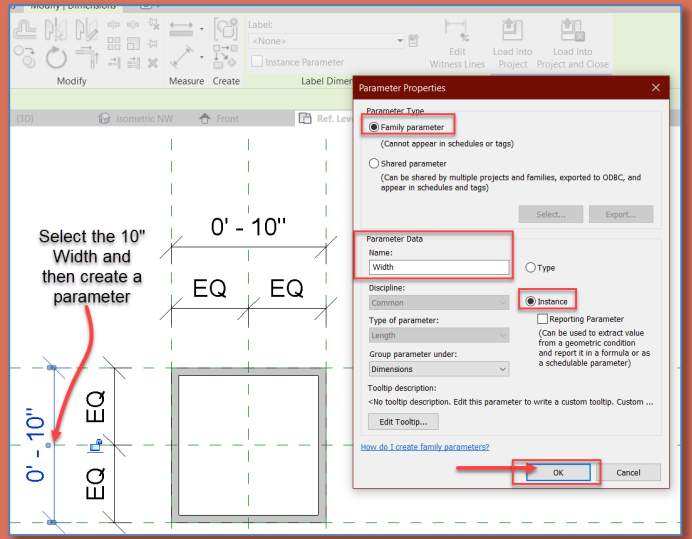
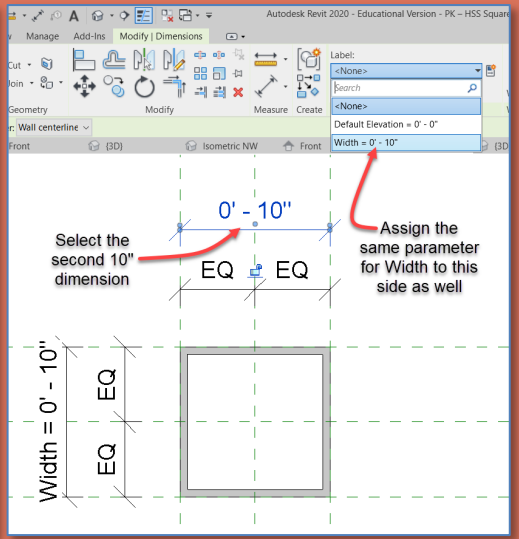
  - Modify Round Column Family
- Project File Sheet

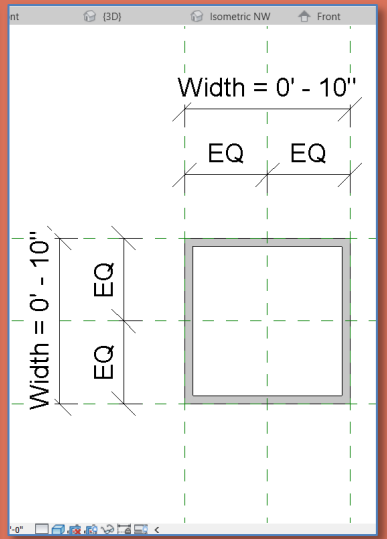
HSS Square Hollow Structural Columns (Parameters)

- *For Square Column 10 x 10 x .5 Outside Dimension 10" x 10" Thickness 0.5"*

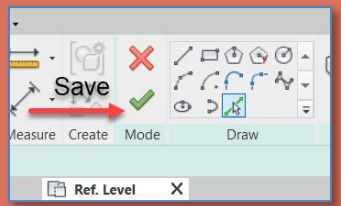
- *Select one of the 10" dimensions > Create Parameter (Width, Instance)*
- *Select the second 10" dimension > assign the same parameter*

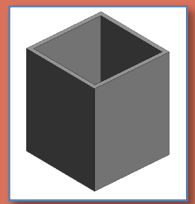






- *Add additional reference plane and parameter to control the height*
- *Set Height to 12'*
- *Save and Load into Project file*





Set Family Category to Structural Connections

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Create the W 21 x 62 Beam (use front view)

For the Column use W 24 x 162 and for the Beam use @ 21 x 62

Designation	Dimensions						Static Parameters			
							Moment of Inertia		Elastic Section Modulus	
Imperial *(in x lb/ft)*	Depth h *(in)*	Width w *(in)*	Web Thickness t_w *(in)*	Flange Thickness t_f *(in)*	Sectional Area *(in^2)*	Weight *(lb/ft)*	I_x *(in^4)*	I_y *(in^4)*	W_x *(in^3)*	W_y *(in^3)*
W 27 x 178	27.8	14.09	0.725	1.190	52.3	178	6990	555	502	78.8

- *For Column W 24 x 162* Depth = 25" Width = 13" Web = 0.4" Flange = 1.22"

W 27 x 84	26.7	9.96	0.460	0.640	24.8	84	2850	106	213	21.2
W 24 x 162	25	13	0.705	1.220	47.7	162	5170	443	414	68.4
W 24 x 146	24.7	12.9	0.650	1.090	43.0	146	4580	391	371	60.5
W 24 x 131	24.5	12.9	0.605	0.960	38.5	131	4020	340	329	53.0
W 24 x 117	24.3	12.8	0.55	0.850	34.4	117	3540	297	291	46.5
W 24 x 104	24.1	12.75	0.500	0.750	30.6	104	3100	259	258	40.7

- *For Beam W 21 x 62* Depth = 21" Width = 8.24" Web = 0.4" Flange = .615"

W 21 x 68	21.1	8.27	0.430	0.685	20.0	68	1480	64.7	140	15.7
W 21 x 62	21	8.24	0.400	0.615	18.3	62	1330	57.5	127	13.9
W 21 x 57	21.1	6.56	0.405	0.650	16.7	57	1170	30.6	111	9.4
W 21 x 50	20.8	6.53	0.380	0.535	14.7	50	984	24.9	94.5	7.6
W 21 x 44	20.7	6.5	0.350	0.450	13.0	44	843	20.7	81.6	6.4

Source of Information: https://www.engineeringtoolbox.com/american-wide-flange-steel-beams-d_1319.html

Additional Reference for steel components: http://products.anssteel.com/category/steel?

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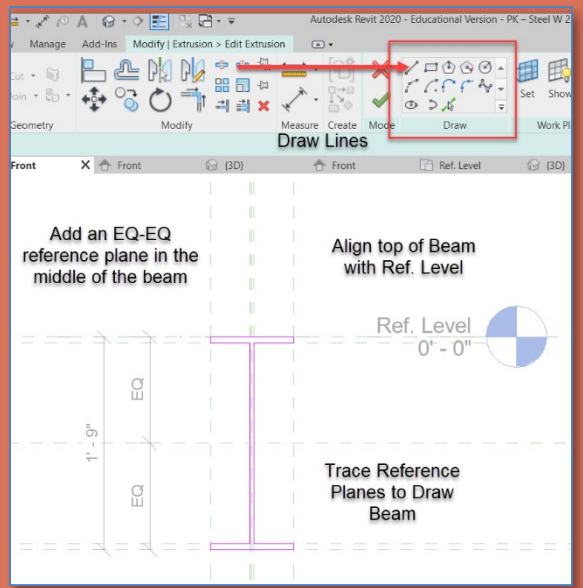
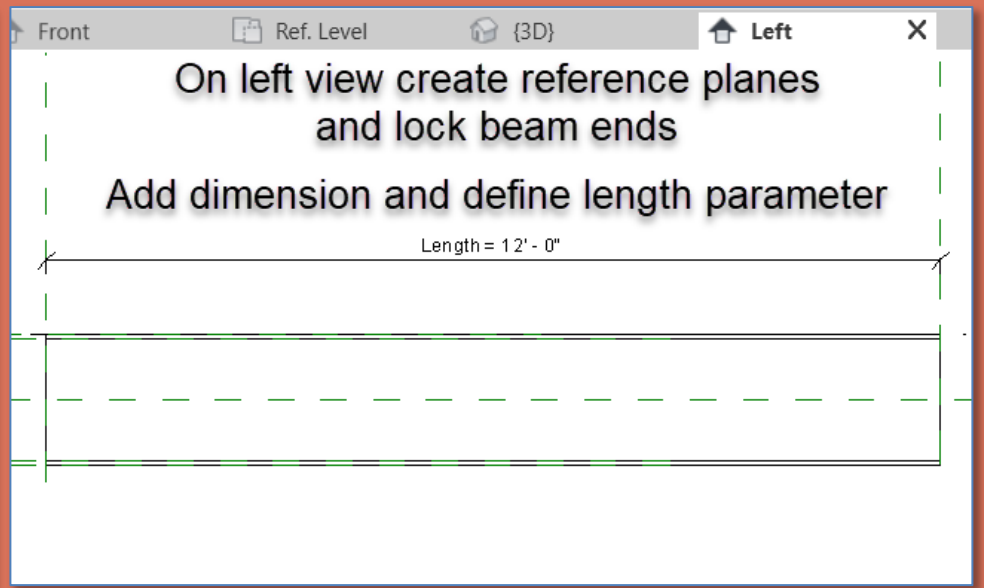
Create the Beams (use front view)

- *For Beam W 21 x 62 Depth = 21" Width = 8.24" Web = 0.4" Flange = .615"*

W 21 x 68	21.1	8.27	0.430	0.685	20.0	68	1480	64.7	140	15.7
W 21 x 62	21	8.24	0.400	0.615	18.3	62	1330	57.5	127	13.9
W 21 x 57	21.1	6.56	0.405	0.650	16.7	57	1170	30.6	111	9.4
W 21 x 50	20.8	6.53	0.380	0.535	14.7	50	984	24.9	94.5	7.6
W 21 x 44	20.7	6.5	0.350	0.450	13.0	44	843	20.7	81.6	6.4

- *New > Family > Generic Model* *Save_as Initials-Steel Beam W 21x62*
- *Draw from front view – align top of beam with ref. level*
- *Add Reference Plans same as for W 24 x 162 column – add extra plane at center of beam*
- *Create > Extrusion > Lines*
- *Add reference planes, add dimension and define parameter for length*
- *Save and Load into Project File*





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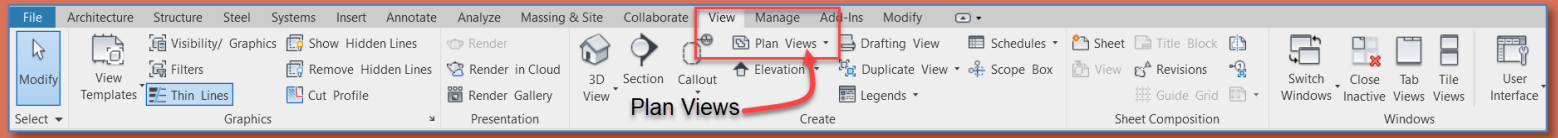
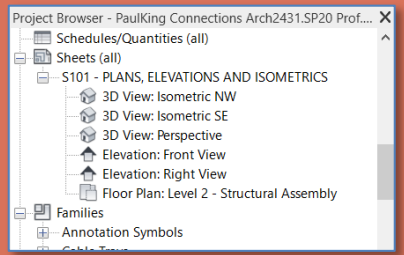
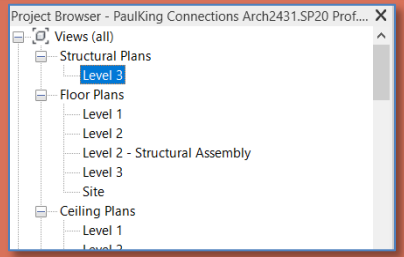
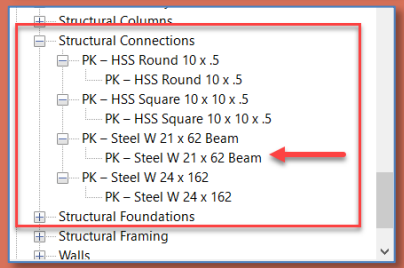
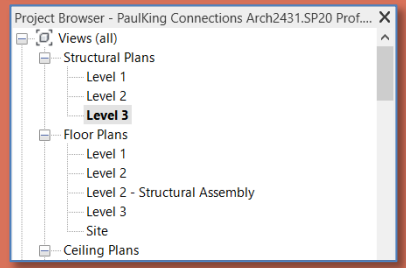
To Place the Beams & Add Structural Plan Views

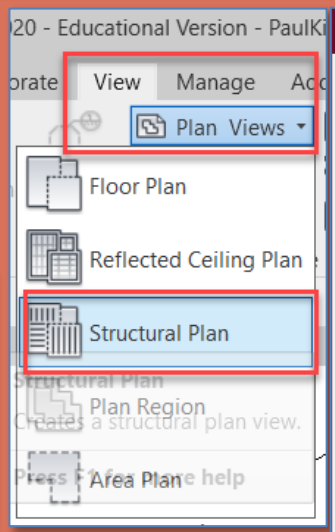


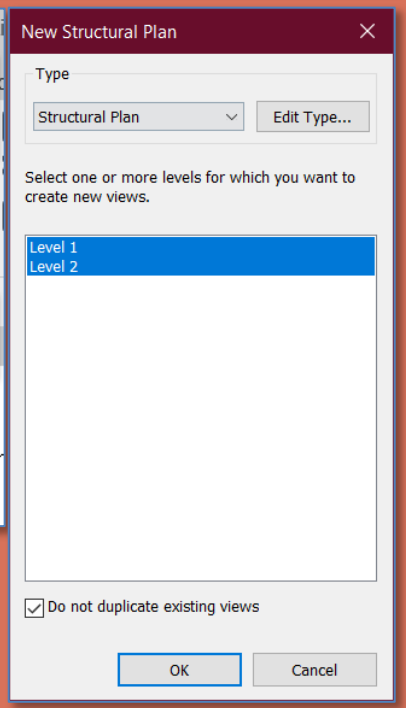












- *Review the project browser*
- *The families we created are located under "structural connections"*
- *A structural plan only exists for Level 3, the new level we added to the project file*

- *Add the missing structural views as follows:*
- ***View Ribbon > Plan Views > Structural Plan***
- *Select Level 1 & Level 2 > OK*
- *The new structural levels will show in the project browser*
- *Make Level 3 Structural the current view*

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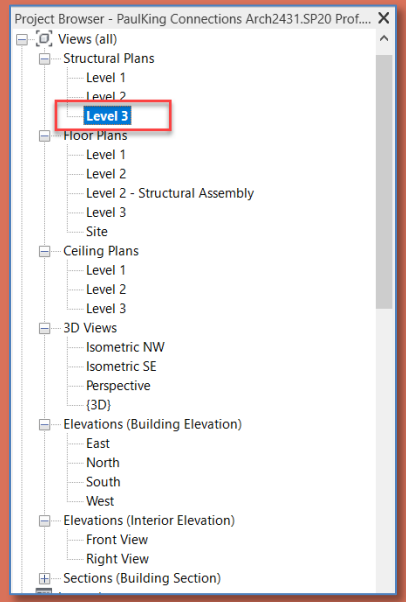
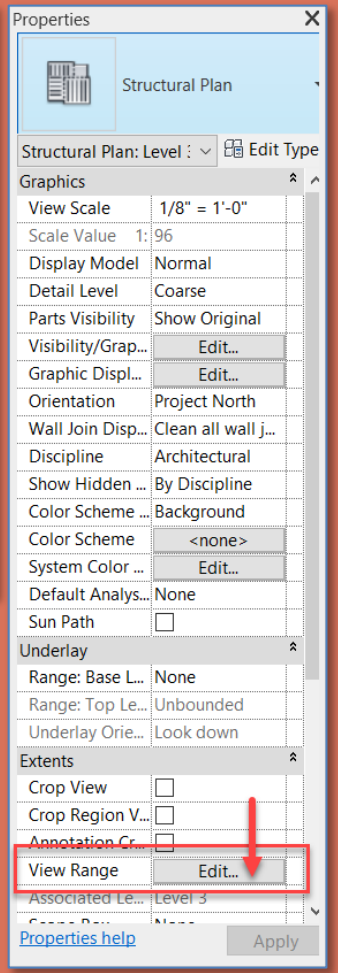
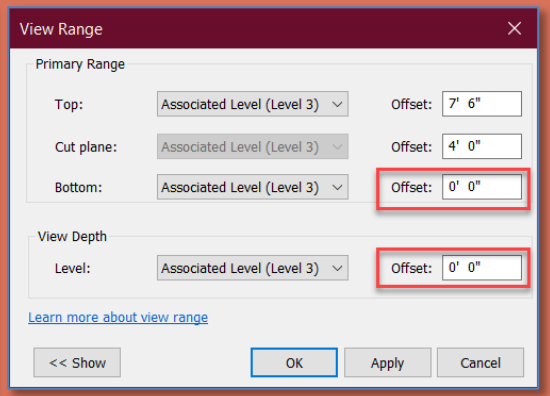
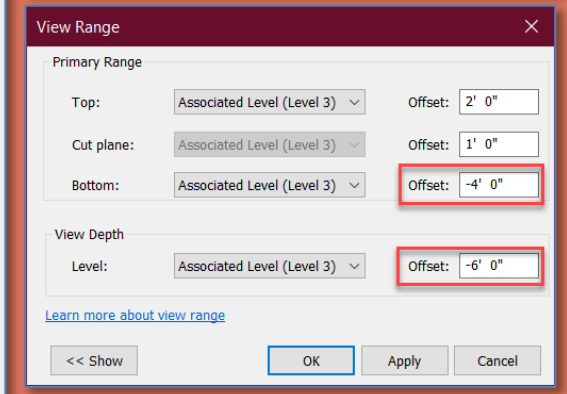
Compare Floor Plans vs Structural Plans









- *From the project browser compare the "view range" properties of a plan view vs a structural view*

- *View Range Floor Plan*
- *Bottom and View Depth Offsets are 0*

- *View Range Structural Plan*
- *Bottom Offset -4'0"*
- *View Depth Offset -6'-0"*

- *We will work from the structural views – as they allow us to see below the selected level. Remember beams are below the floor.*

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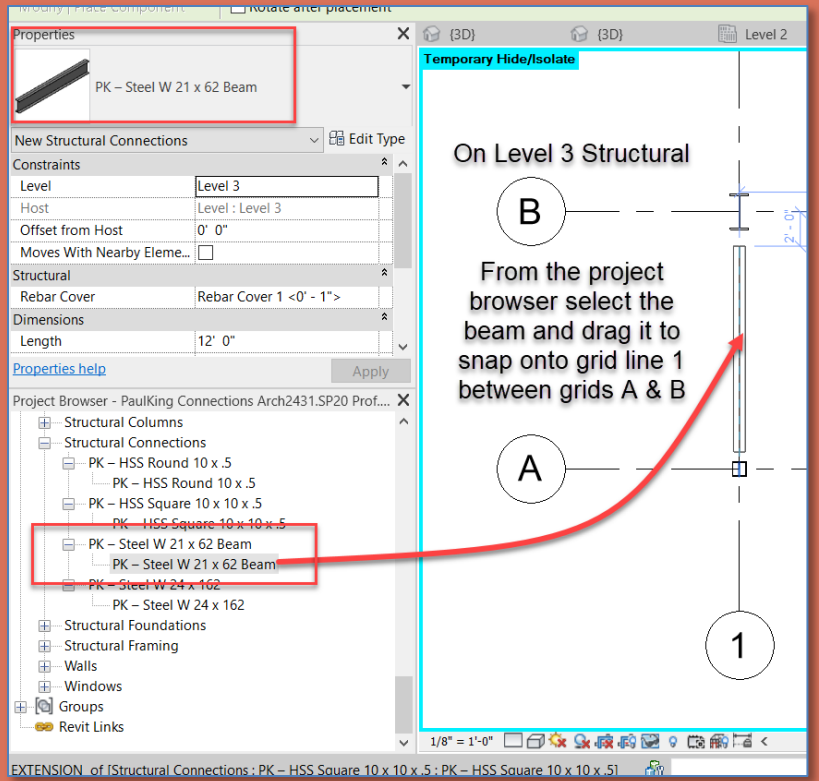
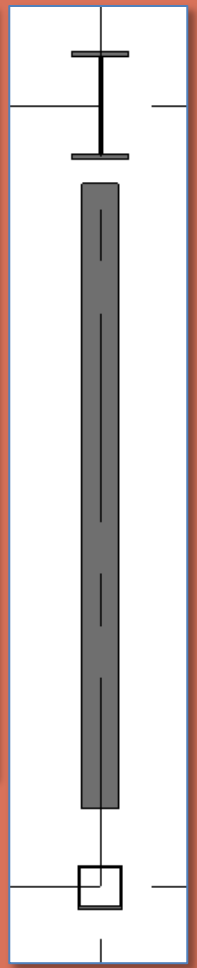
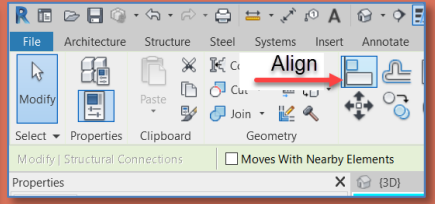
  - Place Beam
  - Snap, Align & Copy
  - Modify Round Column Family
- Project File Sheet

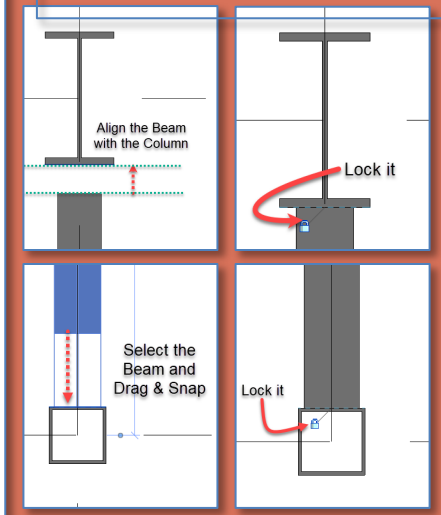
Add the Beams to Level 3 – Grid Line 1 (A to B)







- *Align and snap the end of the beam to the column at Grid B*

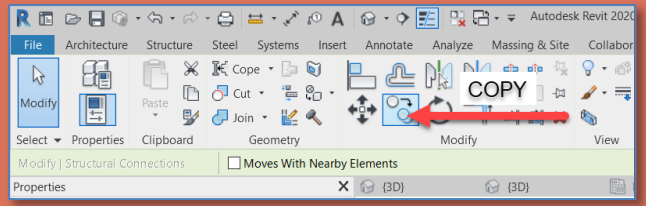


- *From the project browser select the beam and drag it to snap onto <u>Grid line 1 between Grids A & B</u>*

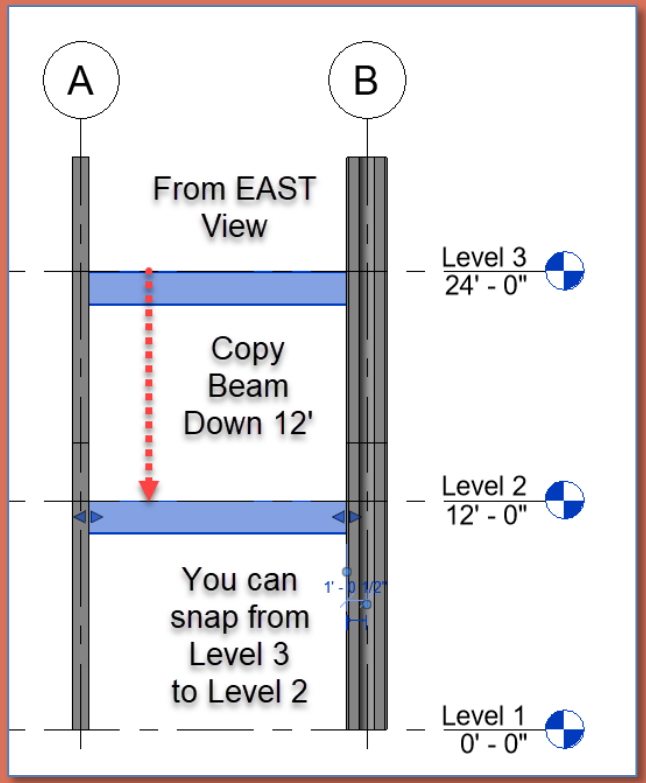
- *Select and drag the other end and snap to the column at Grid A*

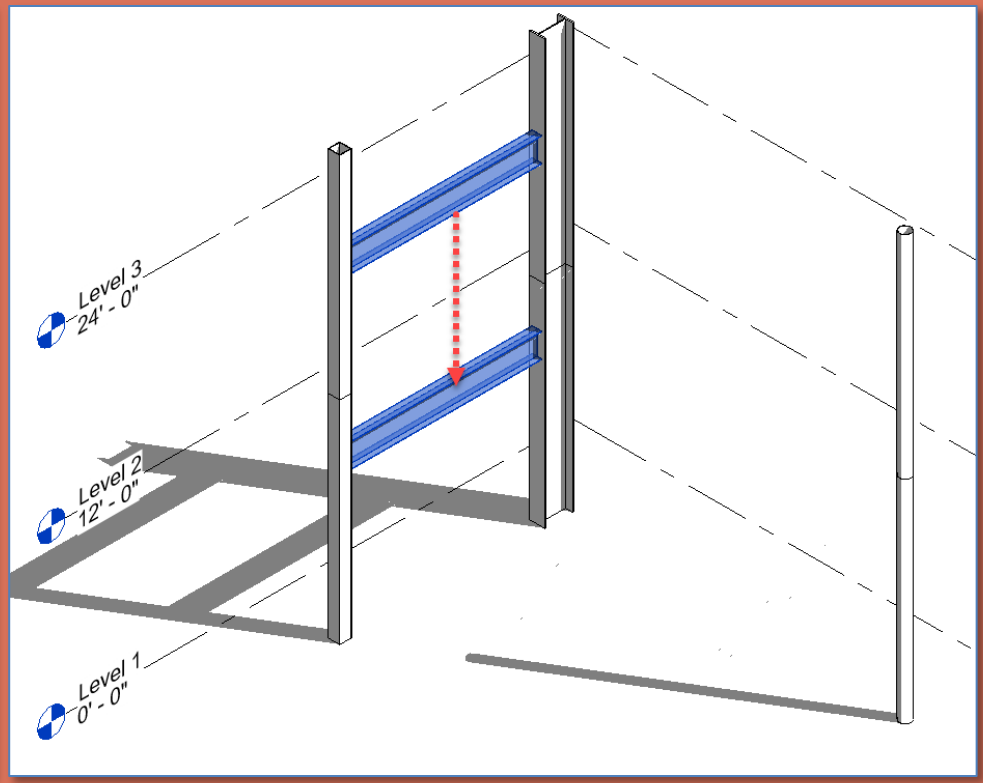
- Assignment Description
- New Project File
  - Levels
  - Grids
  - Dimensions
- New 3D Family
- W 24 x 162 column
  - Reference Planes
  - Parameters
  - Extrusion
  - Height Parameters
  - Family Category
- Load into Project
- New 3D Families
  - HSS Pipe Column
  - Formula Parameter
  - HSS Square Column
  - W 21 x 162 Beam
  - Place Beam
  - Snap, Align & Copy
  - Modify Round Column Family
- Project File Sheet

Add the Beams to Level 3



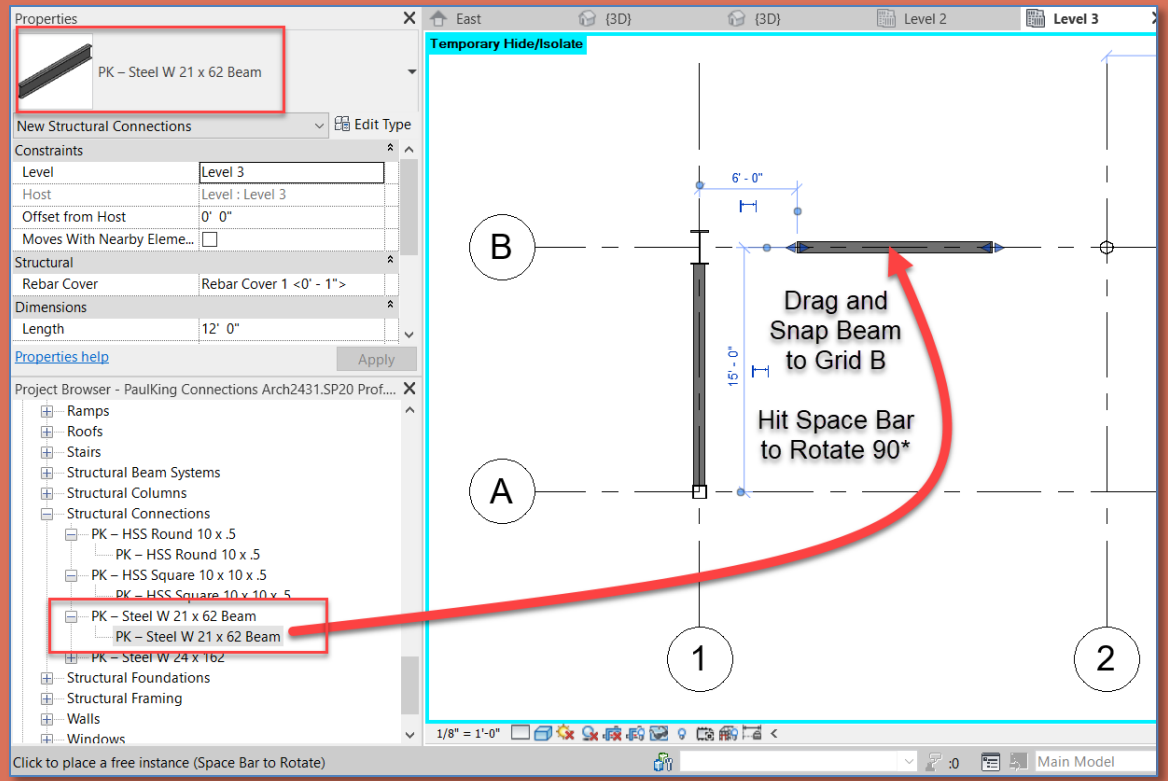
- Set ***EAST*** as the current View
- Select the ***Beam on Level 3***
- ***Copy*** it down to ***Level 2***

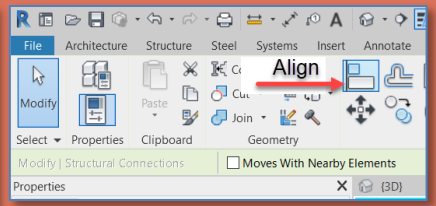




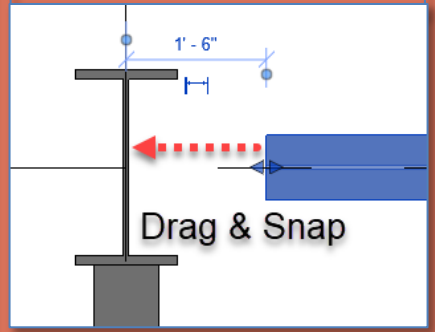
- Assignment Description
- New Project File
  - Levels
  - Grids
  - Dimensions
- New 3D Family
- W 24 x 162 column
  - Reference Planes
  - Parameters
  - Extrusion
  - Height Parameters
  - Family Category
- Load into Project
- New 3D Families
  - HSS Pipe Column
  - Formula Parameter
  - HSS Square Column
  - W 21 x 162 Beam
  - Place Beam
  - Snap, Align & Copy
  - Modify Round Column Family
- Project File Sheet

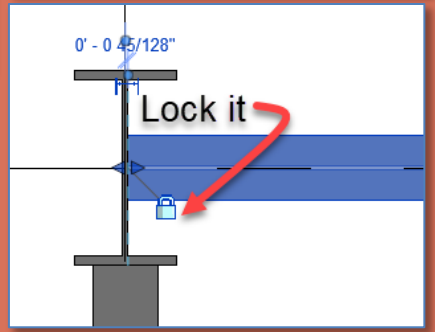
Add the Beams to Level 3 – Grid Line B (1 to 2)





- *Align and Snap the end of the beam to the column at Grid 1*

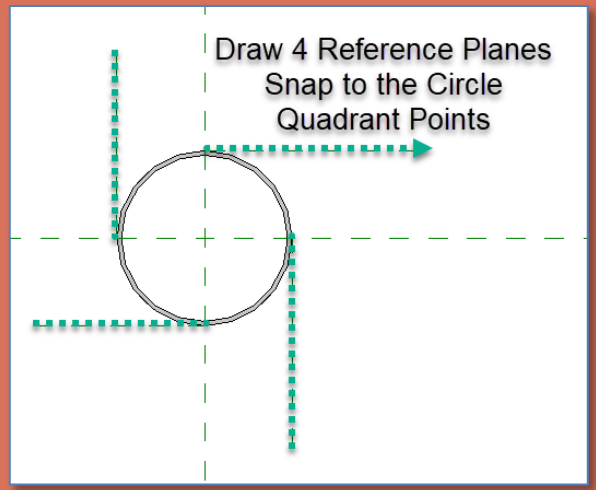


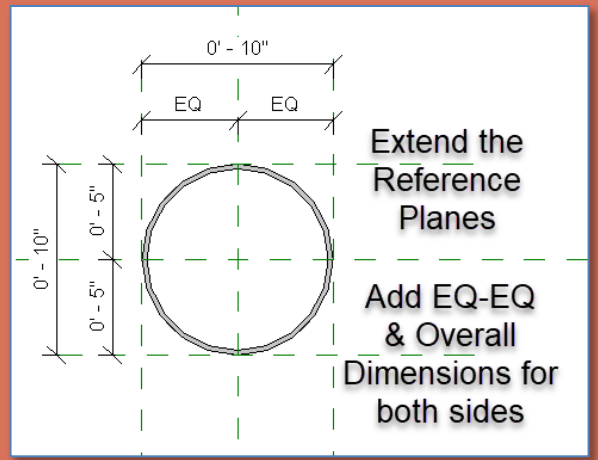


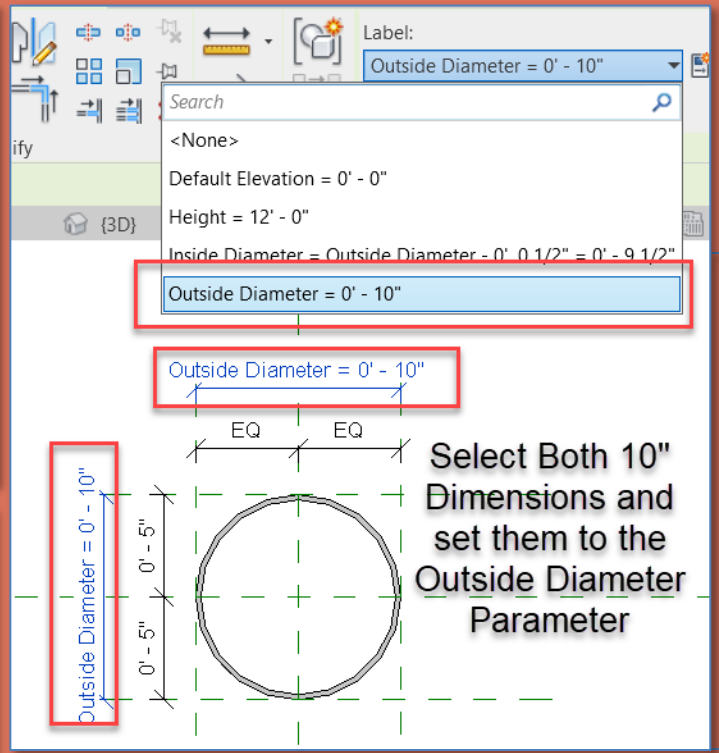
- *We will not be able to snap to the round column without first modifying the column family to include reference planes for snapping*

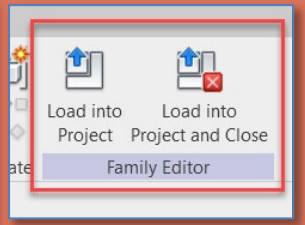
- Assignment Description
- New Project File
  - Levels
  - Grids
  - Dimensions
- New 3D Family
- W 24 x 162 column
  - Reference Planes
  - Parameters
  - Extrusion
  - Height Parameters
  - Family Category
- Load into Project
- New 3D Families
  - HSS Pipe Column
  - Formula Parameter
  - HSS Square Column
  - W 21 x 162 Beam
  - Place Beam
  - Snap, Align & Copy
  - Modify Round Column Family
- Project File Sheet

Edit the Column Family (PK – HSS Round 10 x .5)









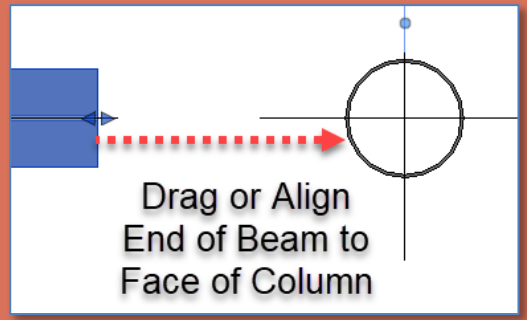
*The single parameter **Outside Diameter** will control the **column size** & the **distance between the reference planes** and by formula the **inside diameter.***

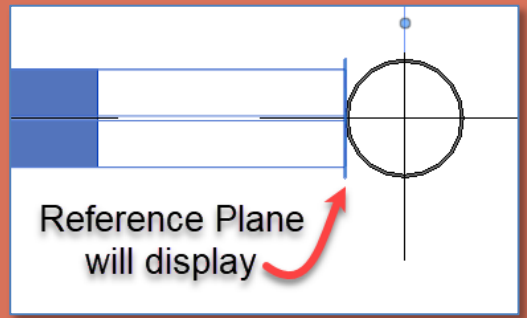
- *Draw **4 Reference Planes** snapping to quadrant points*
- ***Extend** the reference planes and **add dimensions***
- *Assign the **Outside Diameter Parameter** to the two overall dimensions*
- ***Load into Project***

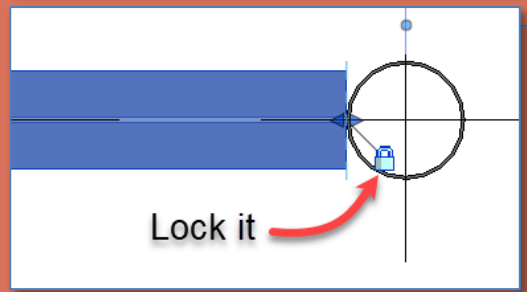
→ Overwrite the existing version and its parameter values

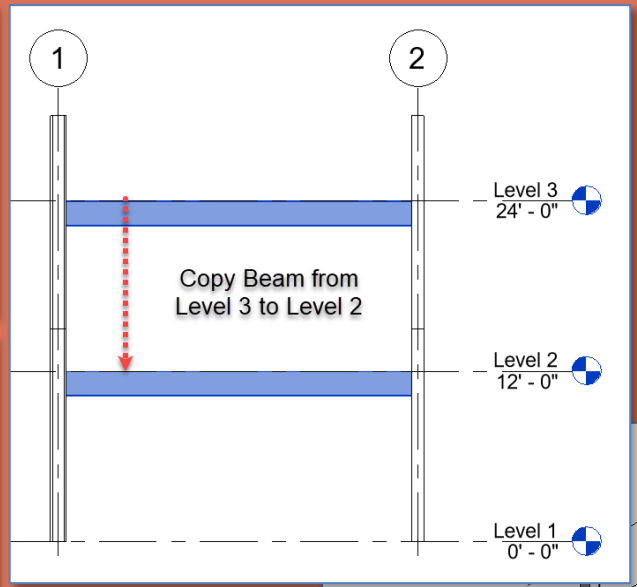
- Assignment Description
- New Project File
  - Levels
  - Grids
  - Dimensions
- New 3D Family
- W 24 x 162 column
  - Reference Planes
  - Parameters
  - Extrusion
  - Height Parameters
  - Family Category
- Load into Project
- New 3D Families
  - HSS Pipe Column
  - Formula Parameter
  - HSS Square Column
  - W 21 x 162 Beam
  - Place Beam
  - Snap, Align & Copy
  - Modify Round Column Family
- Project File Sheet

Align the end of the Beam to the Column

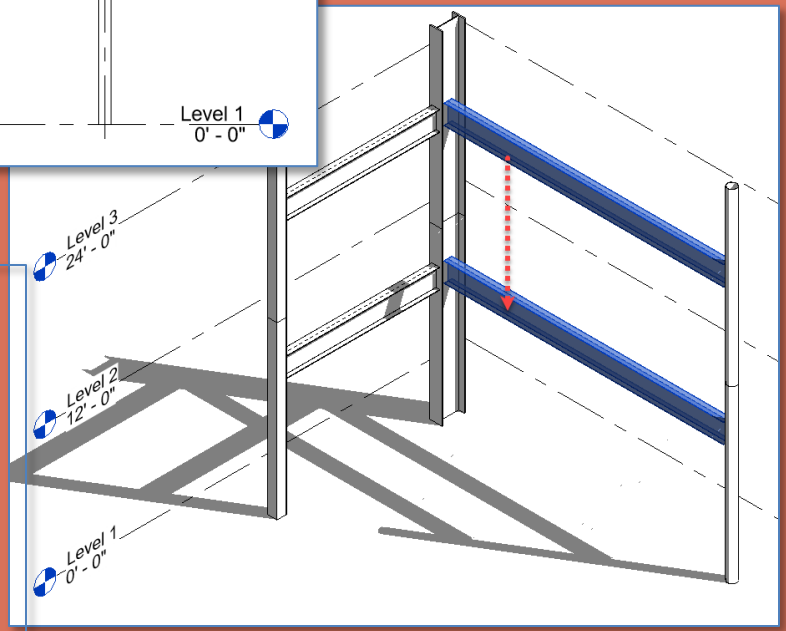








- *Copy the Beam from Level 3 down to Level 2*



- *Drag or Align the end of Beam to Face of Column*
- ***Lock it***

- Assignment Description
- New Project File
  - Levels
  - Grids
  - Dimensions
- New 3D Family
- W 24 x 162 column
  - Reference Planes
  - Parameters
  - Extrusion
  - Height Parameters
  - Family Category
- Load into Project
- New 3D Families
  - HSS Pipe Column
  - Formula Parameter
  - HSS Square Column
  - W 21 x 162 Beam
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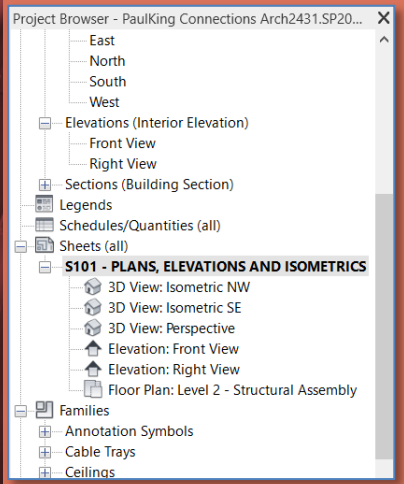
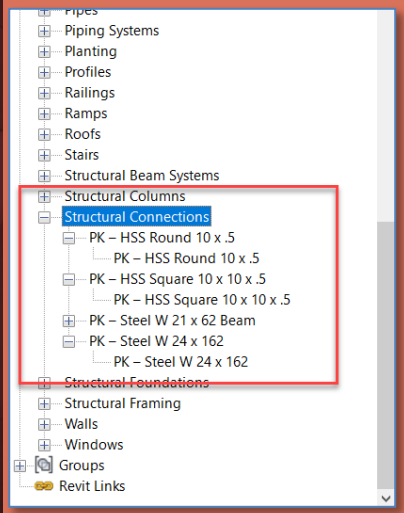
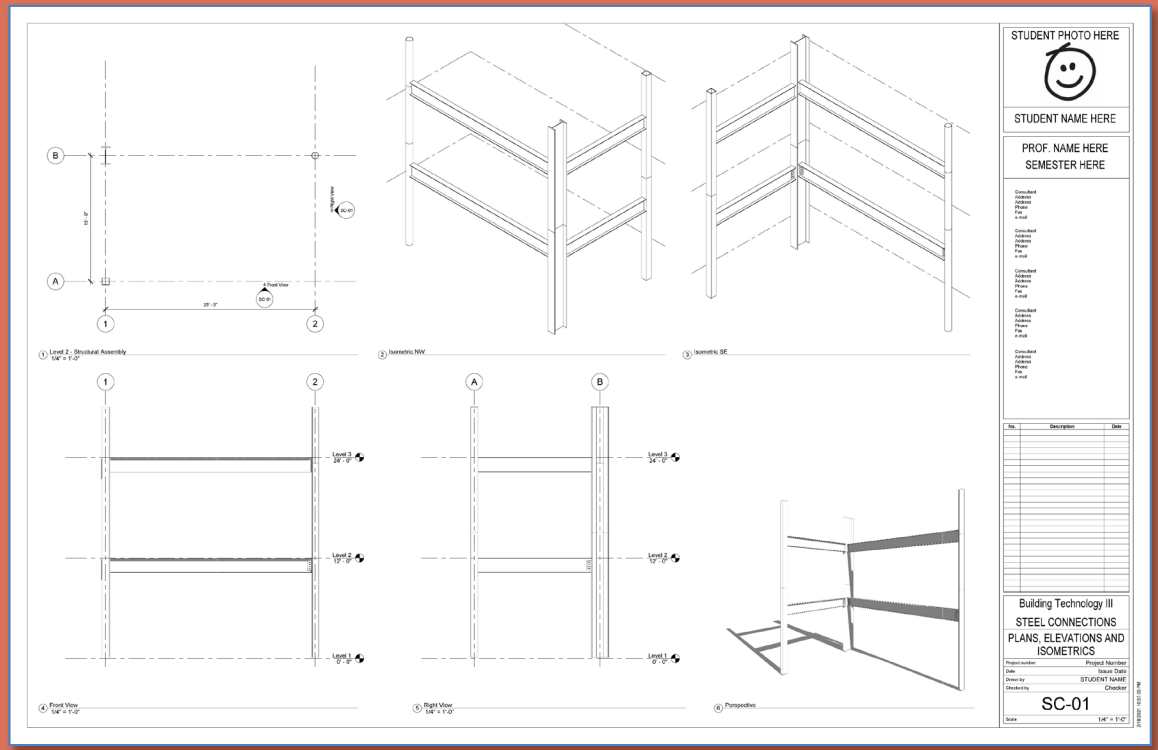
Sheet layout 22 x 34 SC-01







- ¼" Scale Views
- Plan View
- Front Elevation
- Side Elevation
- NW Isometric
- SE Isometric
- Perspective w/Shadows


That's all Folks!