AUTODESK UNIVERSITY 2013

Creating Steel Fabrication Friendly Families and Schedules with Autodesk® Revit® Structure

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SE3048-L Once you have mastered the day-to-day use of Autodesk Revit Structure, you must continue to push the boundaries toward enhanced integration for construction purposes. One of the most commonly used materials in a structural engineer's arsenal is structural steel. In this hands-on lab, we focus on using the information contained within Revit and the information we can derive from within custom family content to create enhanced structural steel schedules. This class is about the use of shared parameters and custom families to facilitate greater symmetry with steel fabricators through the use of smarter families and schedules.

Learning Objectives

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

- Use shared parameters to make smarter families and schedules
- Create a parametric steel plate family and detailed geometrical schedule
- Use parameters and calculated values for steel quantity takeoffs
- Create a steel takeoff schedule

About the Speaker

Tina is a Senior Structural Technologist and the BIM Leader for Herold Engineering in Victoria, BC. Tina is a lead Revit Structure modeler, producing construction documents in Revit since 2006. Tina creates and maintains all Revit standards and content as well as providing on-going internal Revit training. She is responsible for the development of long term goals and strategies for the structural discipline and the overall BIM planning for the company. Tina is also chair of the BIMbc Victoria Revit Users Group.
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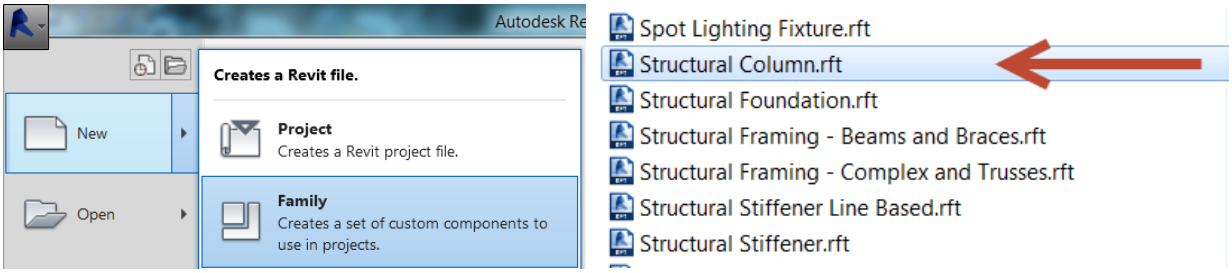
Section 1: Create a Steel Base Plate Family

In this section you will create a rectangular steel base plate family complete with shared parameters.

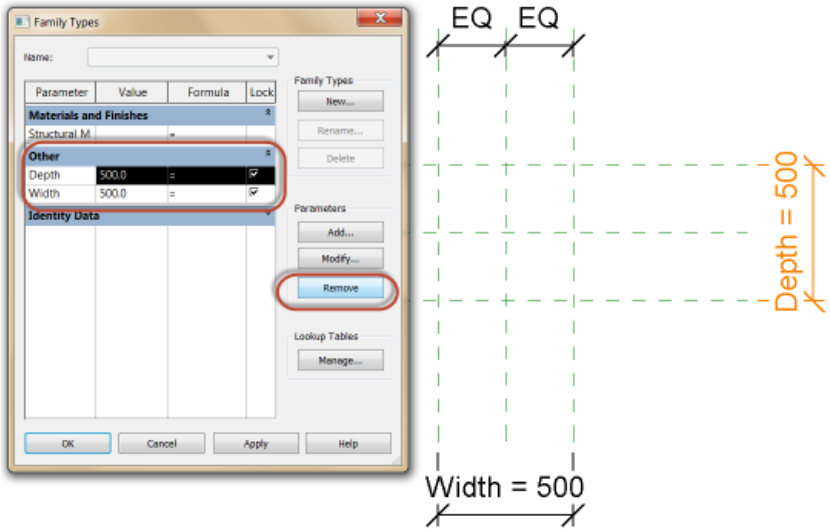
1. ***Open Autodesk® Revit® 2014 and open the file SE3048-L Family Testing Project in the session folder C:\DataSets\Tuesday\SE3048-L.***

2. ***Start a new Structural Column Family using the default <u>imperial</u> family template.***



TIP: Use the structural column family template instead of the generic model face based template for your custom base plate family. This will allow easier placement of the base plate to the column, priority graphical representation in the plans, and each base plate will also appear and can be tagged within the graphical column schedule.

NOTE: If using the metric structural column family template, this template includes Depth and Width parameters and related dimensions that need to be deleted prior to beginning this exercise.



3. ***Save the new family as BasePlate_4bolt.rfa to C:Datasets\|Tuesday\|SE3048-L***

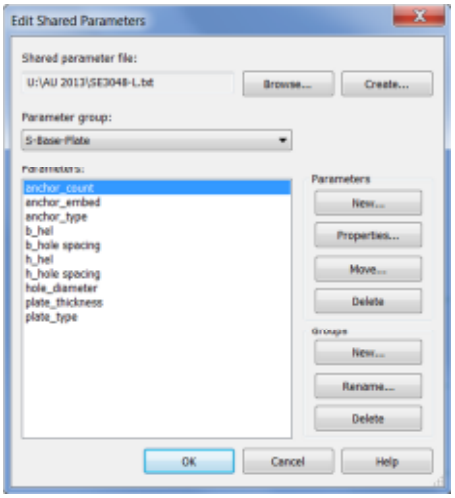
4. ***From the Manage Tab, select Shared Parameters***
Load the file SE3048-L.txt in the session folder C:\DataSets\Tuesday\SE3048-L

5. ***In the Shared Parameters dialog box, create a new Group named S-Base Plate***

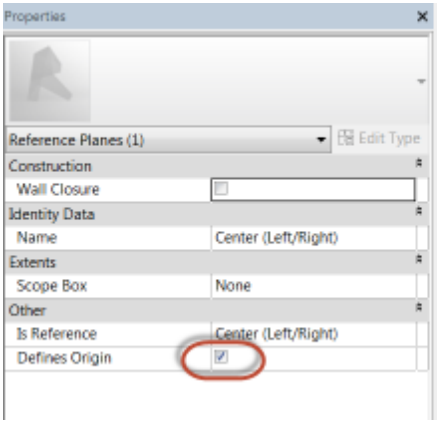
> **TIP:** Use a discipline prefix descriptor for parameter groups within a multi-discipline shared parameter file.

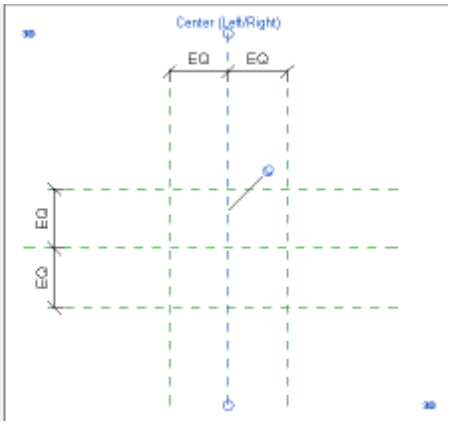
6. ***The following parameters have been created within the group S-Base Plate:***
****Note: Use your company abbreviation where hel* is indicated.***

Name	Discipline	Type of Parameter
b_hel*	Common	Length
h_hel*	Common	Length
b_hole spacing	Common	Length
h_hole spacing	Common	Length
hole_diameter	Common	Length
plate_thickness	Common	Length
anchor_embed	Common	Length
anchor_count	Common	Text
anchor_type	Common	Text
plate_type	Common	Text



7. ***Select the Center (Left/Right) reference plane and check: Defines Origin. Then repeat this for the Center (Front/ Back) reference plane.***

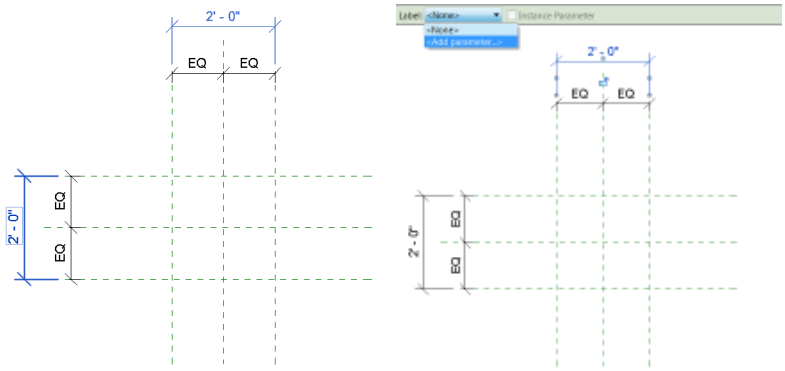




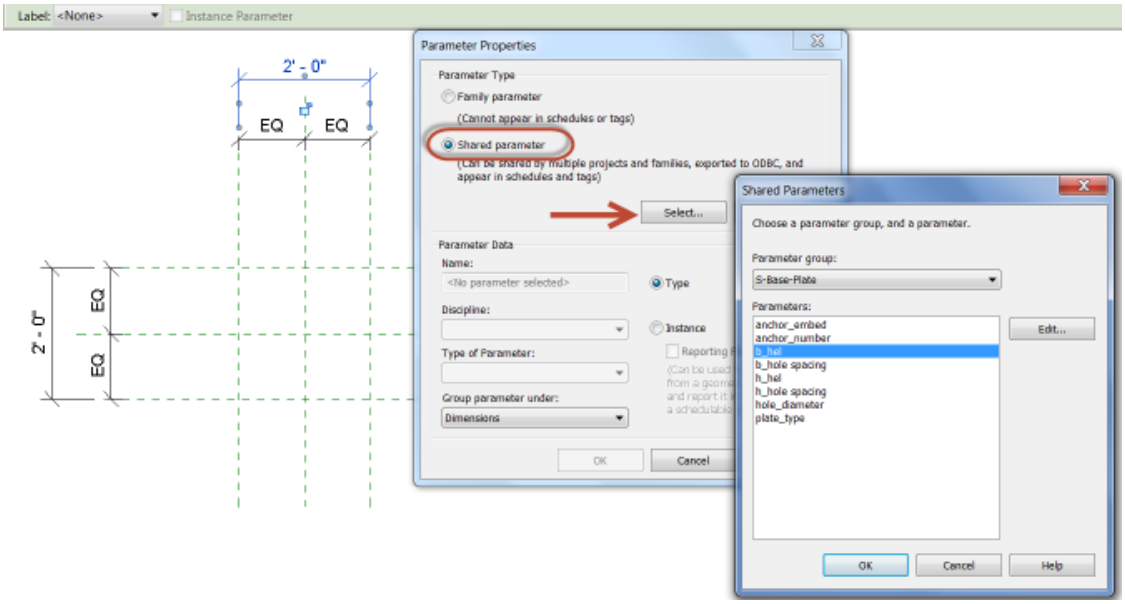
NOTE: While the Defines Origin is not required to constrain the geometry of the symmetrical base plate family we are about to create, it is necessary when creating base plates which are not symmetrical. This base plate family can be used as a template for further base plate configurations and in order for the base plate to show up in identical locations with the columns in the graphical column schedule all offset base plates must be created such that their origin point is center of column.

For further on this see the NOTES section on Graphical Column Schedules.

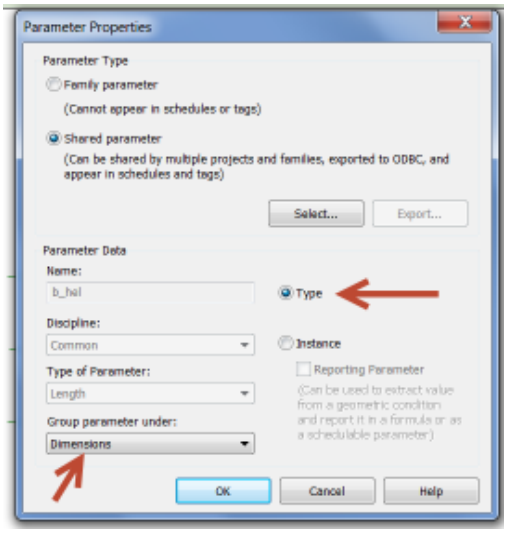
8. ***Add dimensions to the right and left, back and front reference planes already within the base family. This first set of dimensions will be equality constrained dimensions. To create equality constraints click the first reference plane, the center plane, then the opposite side all in one operation of the dimension command. Then Select the right / left dimension and under label choose Add Parameter.***

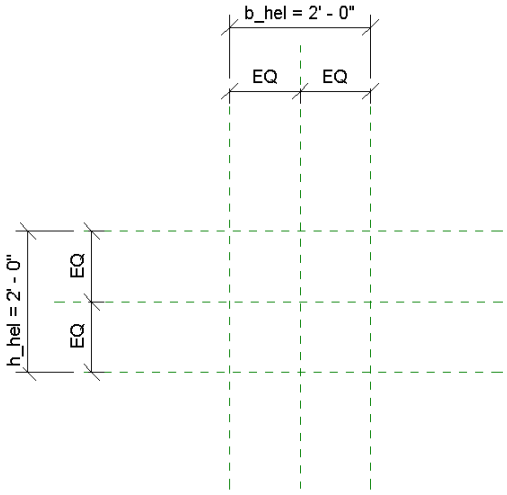


9. ***Select Shared Parameter, and Select b_hel from the Shared Parameter list.***



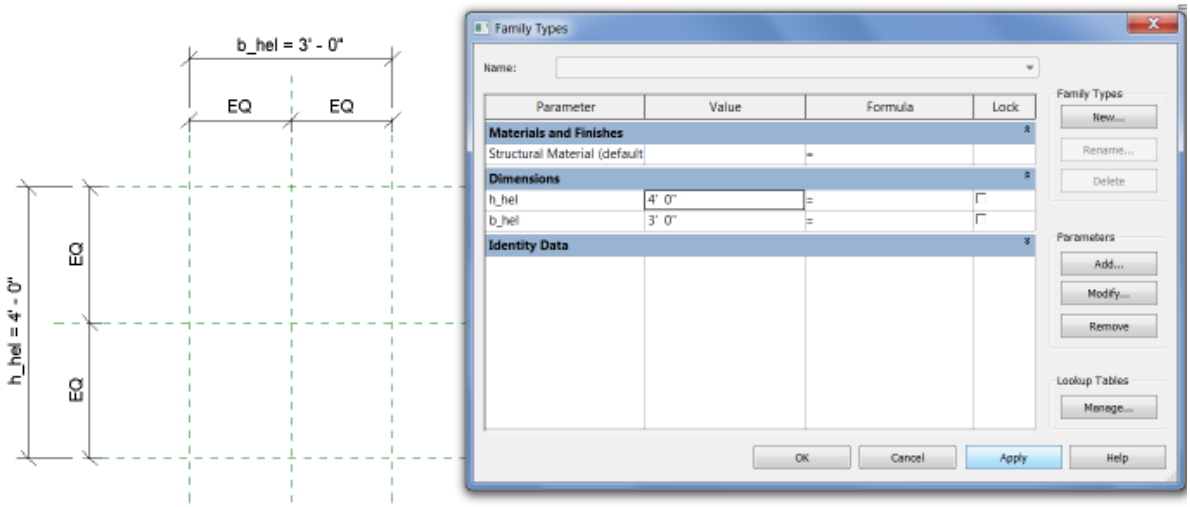
Within the Parameter Properties box you can now choose whether the parameter will be a type or instance property, and where you'd like the parameter grouped.
The width parameter, b_hel will be a type parameter and located within the dimensions grouping in Type Properties dialogue box.



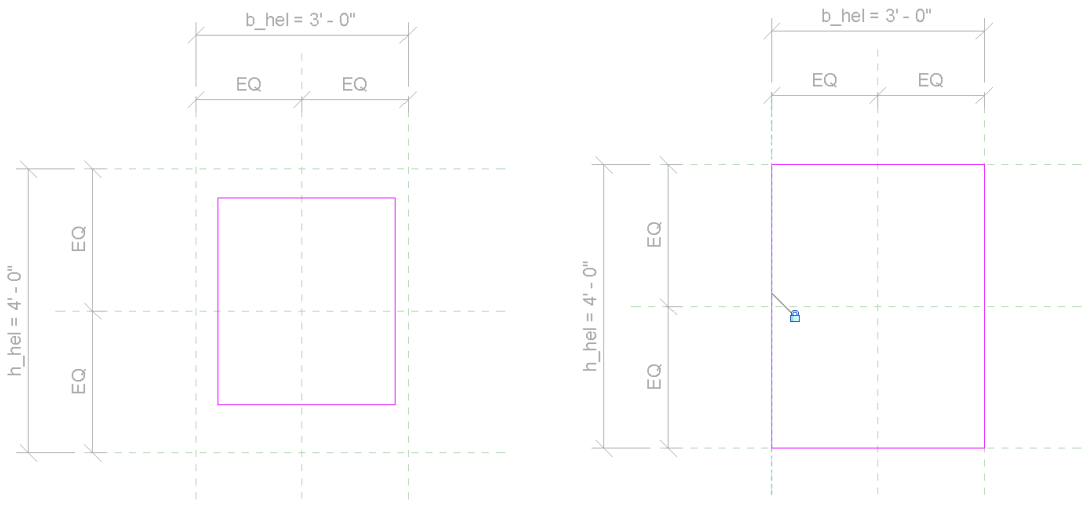


10. Repeat Step 9 and add the length parameter, h_hel to the family.

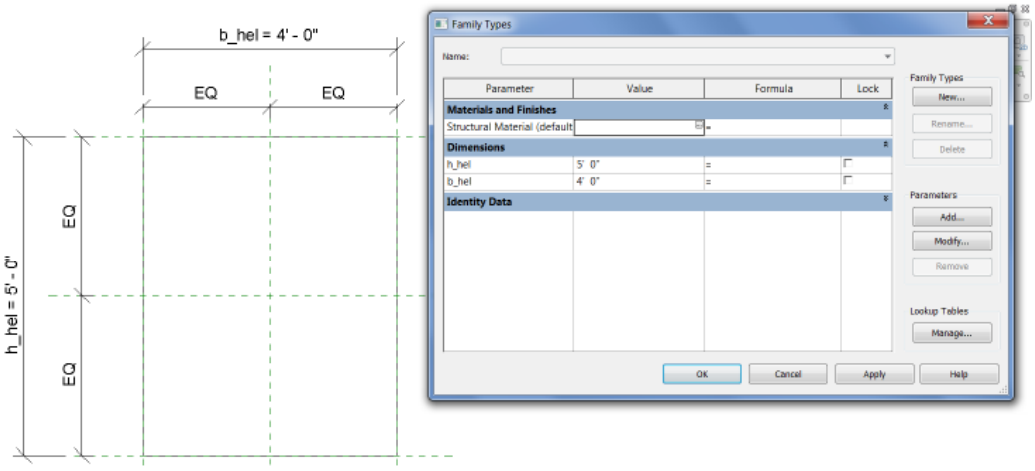
11. Flex the family.
From the Properties Panel, select Family Types. In the family types dialogue box change the h_hel and b_hel values and confirm that the reference planes move accordingly.



12. Select the Create Tab, choose the Forms Panel - Extrusion
In sketch mode, draw a rectangle.
Align and lock the sides of the rectangle to the right, left, back and front reference planes. Then select Finish Edit Mode.

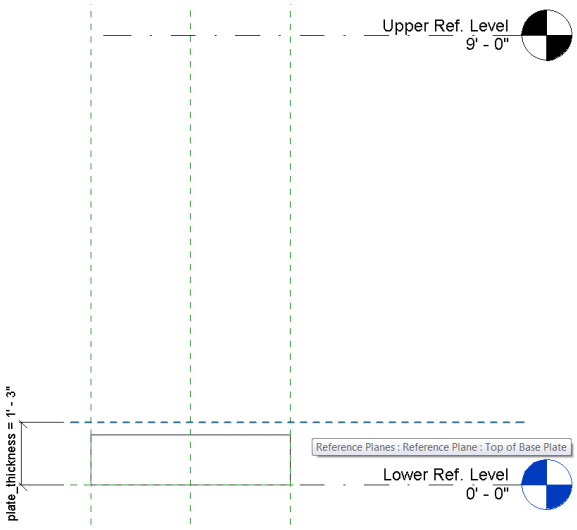


13. Flex the family.
From the Properties Panel, select Family Types. In the family types dialogue box change the h_hel and b_hel values and confirm that the extrusion moves accordingly.



14. Open the Front Elevation. Add a reference plane above and parallel to the Lower Ref Level. Name the reference plane: Top of Base Plate. Add a dimension from the Lower Ref Level to the Top of Base Plate reference plane. As per step 9, label and add the

shared parameter plate_thickness as a type parameter grouped under dimensions to this dimension.



15. Flex the family.

From the Properties Panel, select Family Types. In the family types dialogue box change the plate_thickness value and confirm that the reference plane moves accordingly.

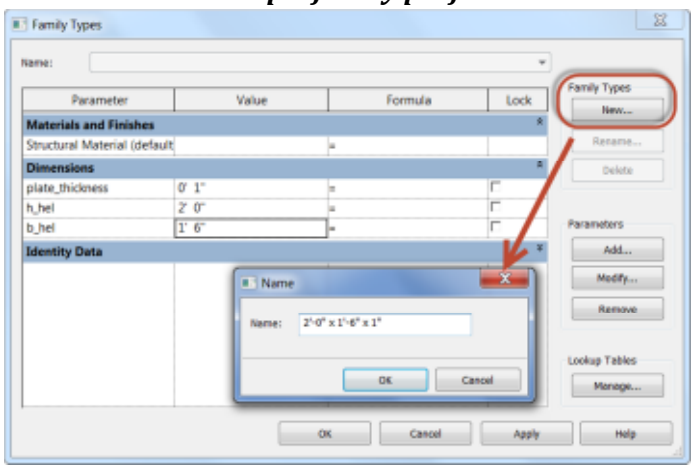
16. Align and lock the top of the extrusion to the Top of Base Plate reference plane.

17. Flex the family.

From the Properties Panel, select Family Types. In the family types dialogue box change the plate_thickness value and confirm that the extrusion moves accordingly.

18. Create a Base Plate Type.

In the family type dialogue box create at least one default plate type. Additional types will be created on a project by project basis.

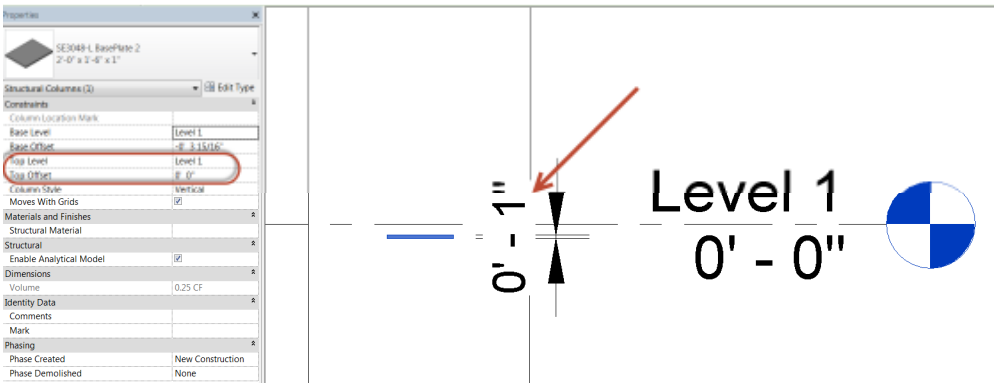


19. Test the family.

Load the Base Plate family into the SE3048-L Family Testing Project (this is the out of the box Structural Analysis Template saved as a project) and check all the type properties for the desired results.

> **TIP:** Test all your families and any downloaded content within a family testing project created from your company template before loading it into any project.

Open the Level 1 plan view and place a base plate. Note that the Top Level and Offset parameters are redundant because the extrusion is locked to the Top of Base Plate reference plane and the plate_thickness parameter is used to control the extrusion for each type. Elevation of the base plate is controlled by the Base Level and Base Offset parameters.

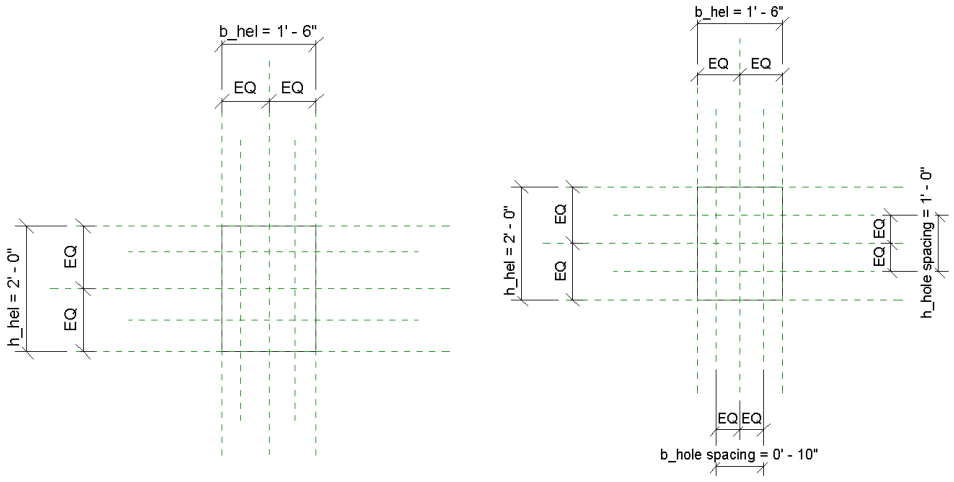


Note: the alignment of the plate in elevation. The extrusion extends up from the Base Level elevation. This is my preference and you can adjust the extrusion settings to suit your work flow standards.

Section 2: Adding Bolt Holes to the Steel Base Plate Family

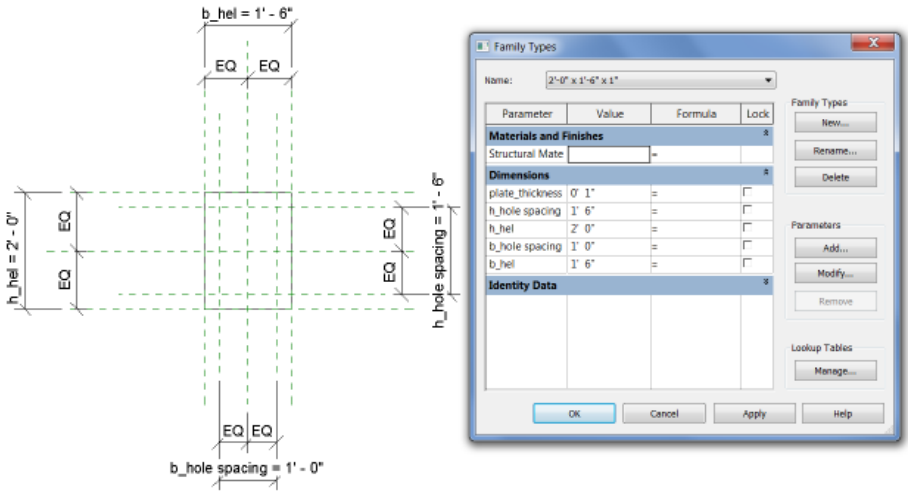
At this point you can continue to work with your Base Plate family or open the dataset family: SE3048-L BasePlate 2.rfa

1. ***From the Create Tab, choose Datum Panel, select Reference Plane***
   - ***Add four references planes that will serve as bolt hole origin points.***
   - ***Add the b_hole spacing and h_hole spacing shared parameters. As before, these will both be type parameters grouped under the Dimensions.***
   - ***Add two more aligned dimension strings with equality constraints to the hole spacing dimensions about the centerline of the plate.***

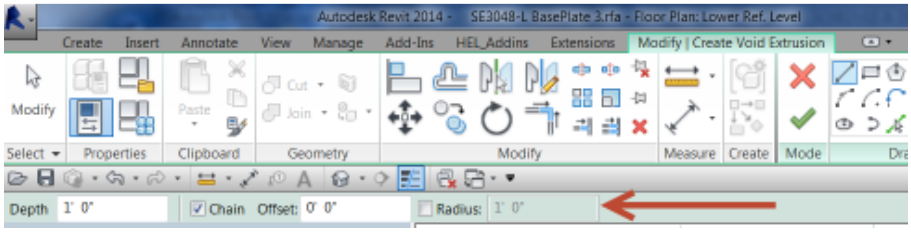


2. ***Flex the family.***

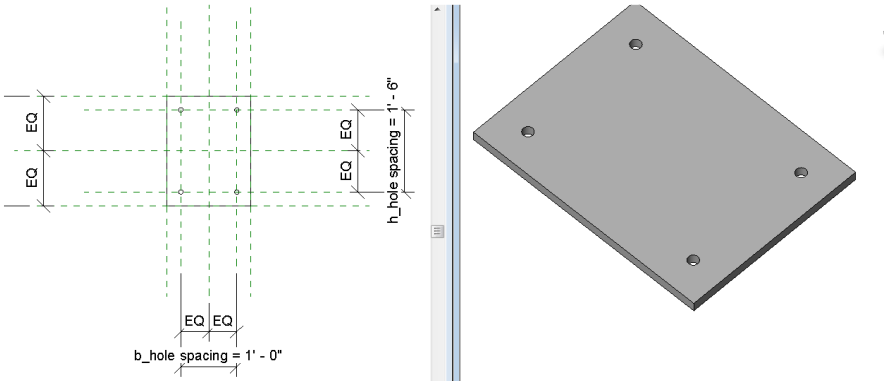
From the Properties Panel, choose Family Types. In the family types dialogue box change the h_hole spacing and b_hole spacing values and confirm that the reference plane moves accordingly.



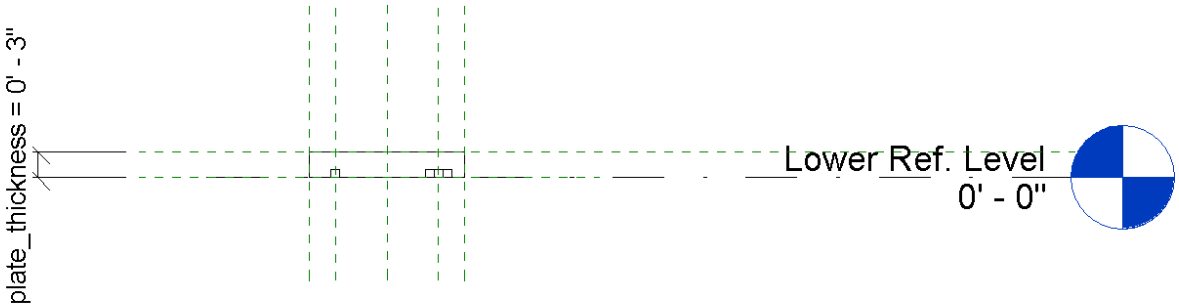
3. ***From the Create Tab, choose the Forms Panel, select Void Forms, then Void Extrusion***
    - ***Check the void extrusion setting on the option bar. In this case, change the depth to 1" to match our current plate thickness.***



- ***Add four 1" diameter circles at the intersection of the hole spacing reference planes.***
- ***Add a diameter dimension to each circle and constrain it with the hole_diameter shared parameter.***
- ***Finish Edit Mode.***



4. ***Open the Front Elevation.***
    - ***Change the plate_thickness value to 3" for easier visibility.***
    - ***Align and lock the void extrusion to the Top of Base Plate Reference Plane***
    - ***Change the plate_thickness back to 1" confirming the void extrusion is behaving properly.***



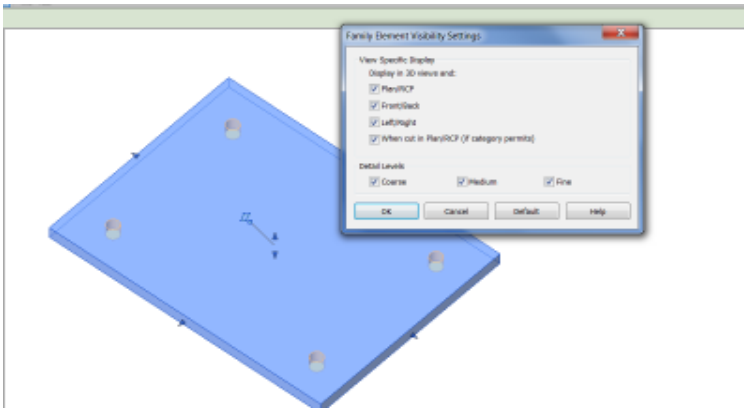
5. ***Flex the family.***

From the Properties Panel, choose Family Types. In the family types dialogue box change the h_hole spacing, b_hole spacing, and hole_diameter values and confirm that the void move and change size accordingly.

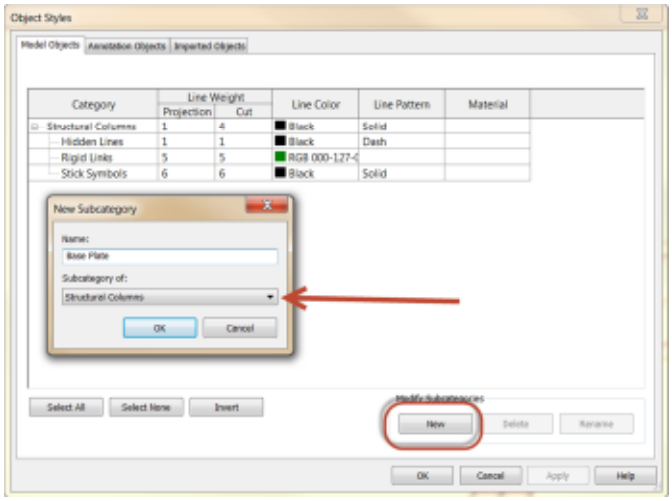
Finishing Touches – Visibility, Material and Shared Parameters

At this point you can continue to work with your Base Plate family or open the dataset family: SE3048-L BasePlate 3.rfa

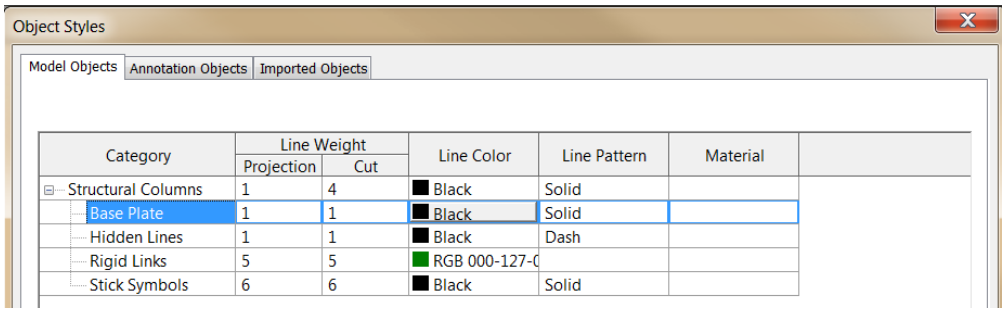
1. ***Visibility:***
   - ***Select the Base Plate Extrusion and choose Visibility Settings***
   - ***The Base Plate is currently set to be visible in all views at all detail levels. This is my preference. You can alter the visibility levels and add symbolic lines to suit your company standards.***



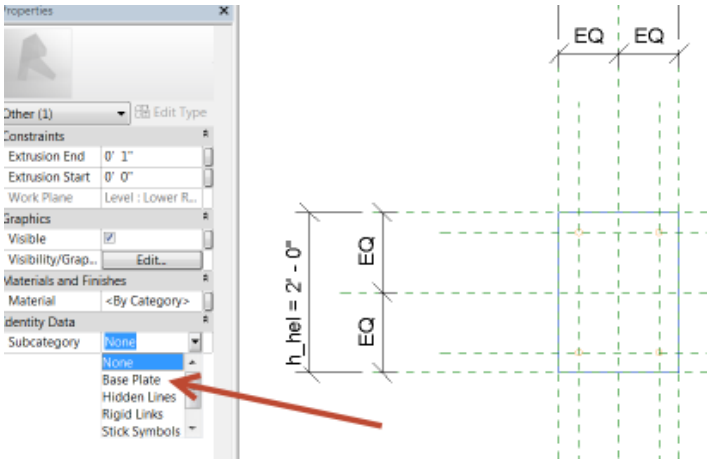
   - ***Select the Manage Tab and choose Object Styles and create a new Subcategory named Base Plate.***



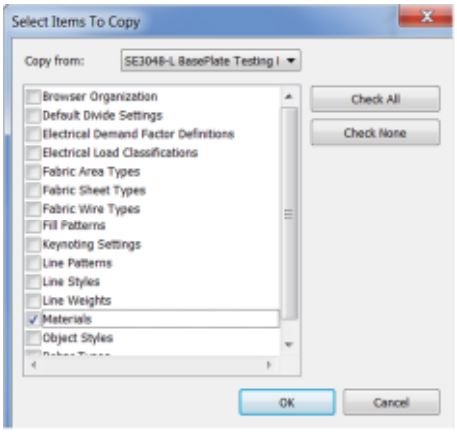
- ***Select the Manage Tab and choose Object Styles and create a new Subcategory named Base Plate. You can then set Object styles to control visibility of the base plate within the family and with your projects.***

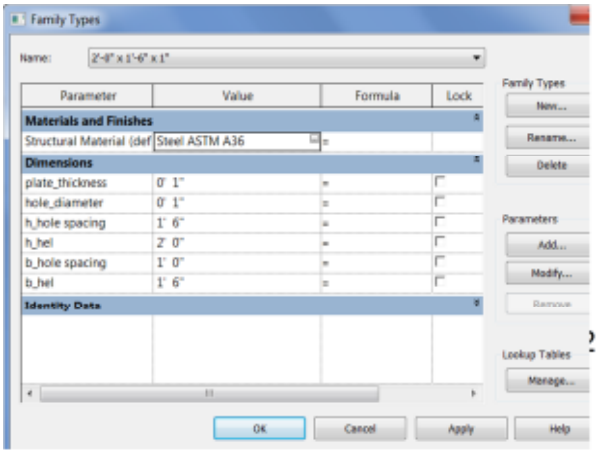


- ***Once the Subcategory is created it must be assigned to the base plate. Select the base plate and choose the Subcategory pull down. Set it to Base Plate.***

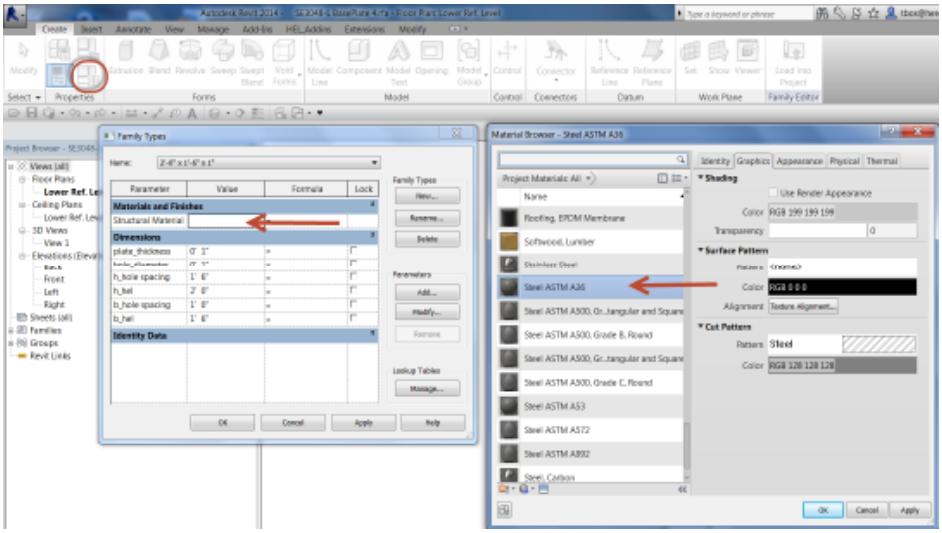


2. ***Material: There are a half dozen default materials in the structural column family template. Add a steel material to the Base Plate family.***
   - ***From the Manage Tab, select Transfer Project Standards***
   - ***Transfer Standards from the SE3048-L Family Testing Project***
   - ***Check none then Select only Materials to transfer into the Base Plate Family***





- ***Open the Family Types dialogue box***
- ***Select Material and choose Steel ASTM A36 from the list of materials now contained in the Material browser.***



NOTE: Ideally we would transfer project standards from the company template to maintain consistent standards. In lieu of transferring project standards for the material however, you can also create your own material by duplicating and editing one from the family template.

3. ***Shared Parameters: There are a few more shared utility type parameters to add to the family for the purposes of the schedule we will build in the next section.***

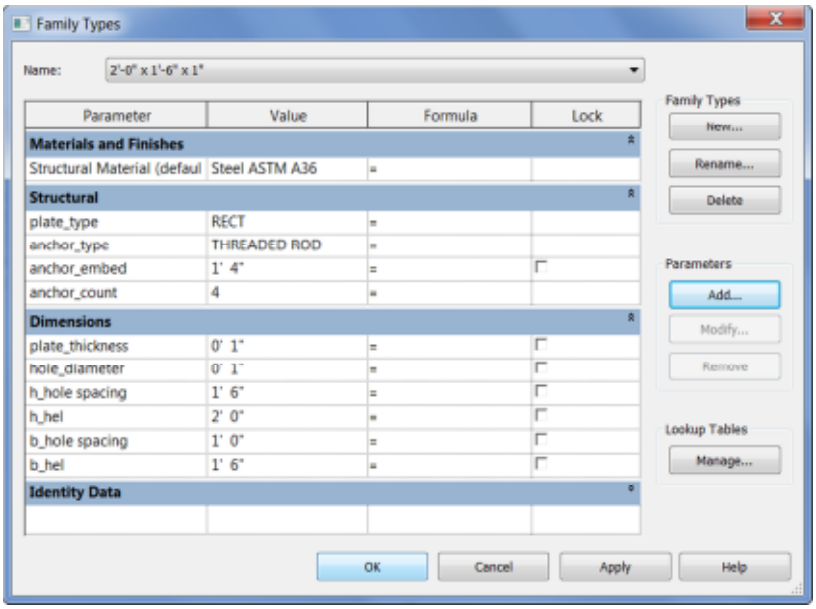
TIP: Adding non-geometrical shared parameters to a family means these parameters are specific to the base plate family. In this case, because we've used a structural column as the family template, adding the shared parameters to the schedule within our project would also assign them globally to all structural columns in a project.

4. ***Open the Family Types dialogue box and add the following shared parameters as Type parameters and Group under Structural.***

   anchor_embed
   anchor_count
   anchor_type
   plate_type

NOTE: In this case these shared parameters are not dimensions and should therefore be grouped in another category to suit your company standards. For consistency, I typically choose to group all company custom parameters under Structural for the ease of the users.

- ***Assign default text values to the newly added shared parameters. These values will then remain constant until changed for each new type of base plate created. If left blank, you would need to input these 3 values with each new type created, using this method you need only edit the anchor_embed parameter if necessary to change the default type.***



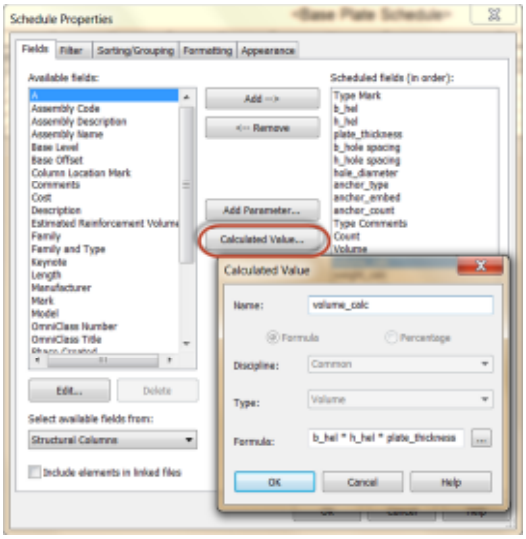
Section 3: Create a Steel Base Plate Schedule

1. ***Open the project SE3048-L Base Plate Schedule Project.***

2. ***From the View Tab, choose Schedules, and select Schedule/Quantities***
   - ***Select Structural Columns***
   - ***Name the schedule: Base Plate Schedule***

3. ***The Schedule Properties Dialogue box will open to the Fields tab, add the following parameters to the schedule:***
   - ***Type Mark***
   - ***b_hel***
   - ***h_hel***
   - ***plate_thickness***
   - ***b_hole spacing***
   - ***h-hole spacing***
   - ***hole diameter***
   - ***anchor_type***
   - ***anchor_embed***
   - ***anchor_count***
   - ***Type Comments***
   - ***Count***
   - ***Volume***

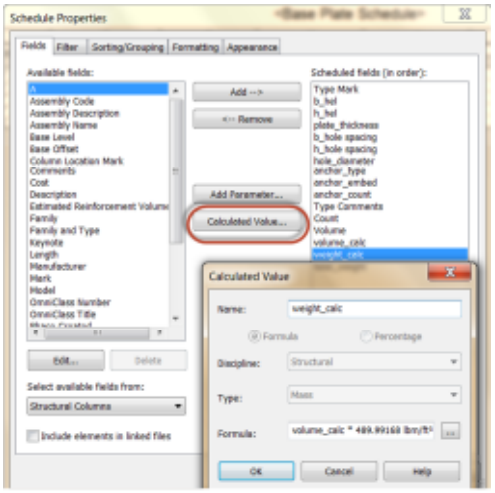
4. ***Add a Calculated Value named: volume_calc and add the following:***
   - ***Discipline: Common***
   - ***Type: Volume***
   - ***Formula: b_hel*h_hel*plate_thickness***



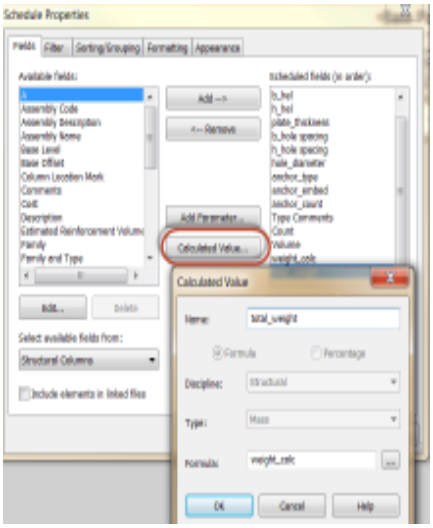
NOTE: The out of the box Volume parameter is a net volume value (revit will deduct the voids from the total plate volume). The volume_calc we have just added is a gross volume.

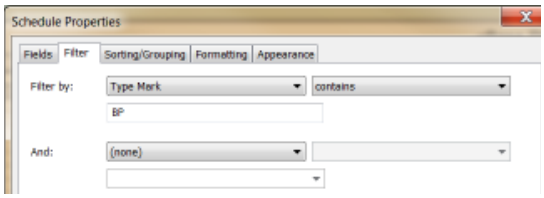
TIP: Select the … pickbox to add already scheduled parameters to the Formula instead of typing them in.

5. ***Add a Calculated Value named: weight_calc and add the following:***
   - ***Discipline: Structural***
   - ***Type: Mass***
   - ***Formula: volume_calc*489.99168lbm/ft³***



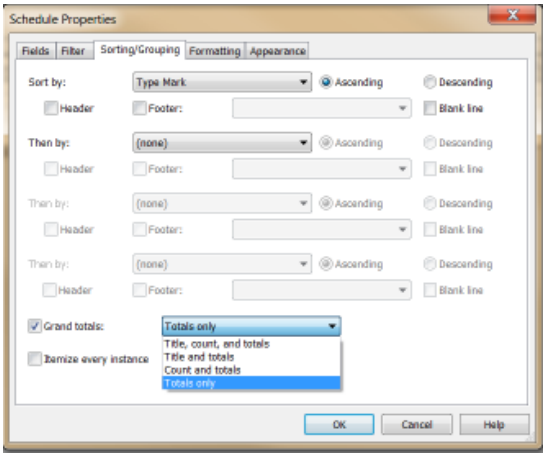
6. ***Add a Calculated Value named: total_weight_calc and add the following:***
   - ***Discipline: Structural***
   - ***Type: Mass***
   - ***Formula: weight_calc***





7. ***Select the Filter Tab and set the first filter to:***
   - ***Type Mark***
   - ***contains***
   - ***BP***

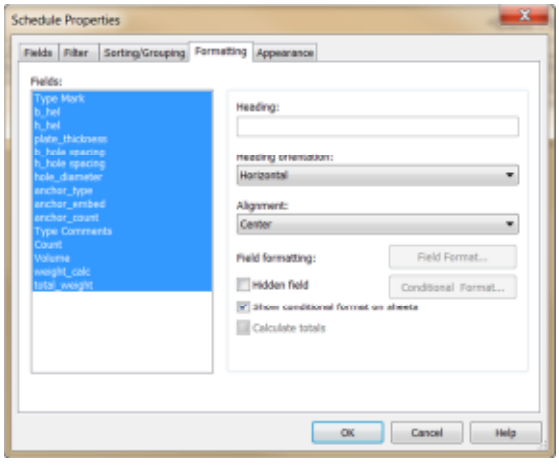
8. ***Select the Sorting/Grouping Tab and set the first sort filter to***
   - ***Type Mark***
   - ***Ascending***
   - ***Uncheck Itemize every Instance***
   - ***Check Grand totals and Select Totals only from the pull-down***

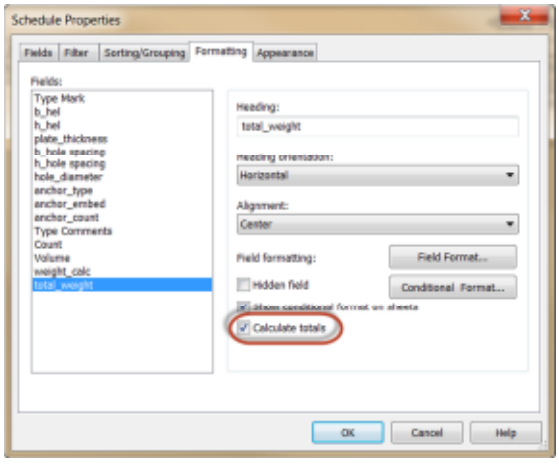


Note: You may wish to select "Count and totals" which will give you a total count of the base plates and their combined weights. However the count total aligns to the far left of the schedule far away from the count parameter and seemingly unrelated to the count parameter further along in the schedule.

BP3	0' - 10"	1' - 6"
BP4	0' - 10"	1' - 8"
BP5	0' - 10"	1' - 4"
26		

9. ***Select the Formatting Tab, Select all Fields and set the alignment to Center***





10. ***Select the weight_calc and check Calculate totals.***

Section 4: Create a Steel Base Plate Check Schedule

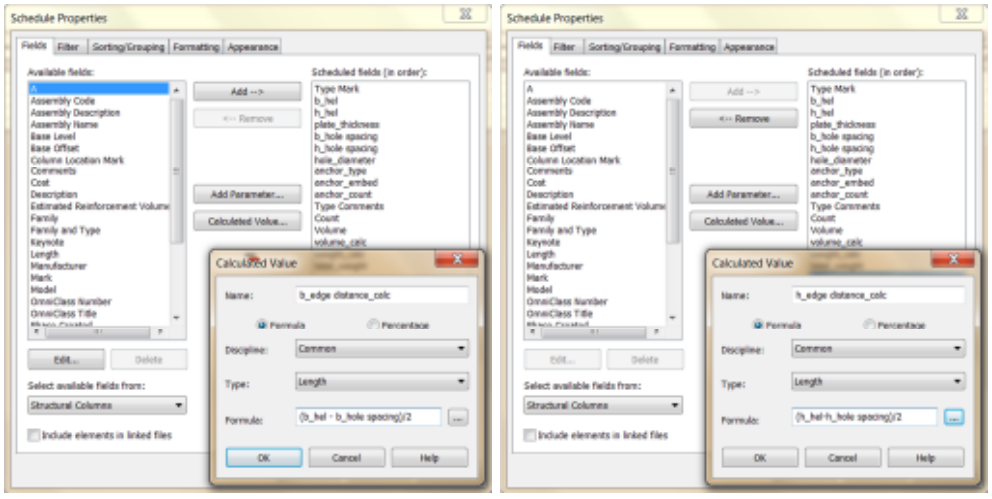
At this point you can continue to work in your Base Plate Schedule Project or open SE3048-L Base Plate Schedule Project 2 dataset.

1. ***Select the Base Plate Schedule from the project browser and duplicate the view.***

2. ***Rename the duplicated Base Plate Schedule: Base Plate Schedule – Check.***

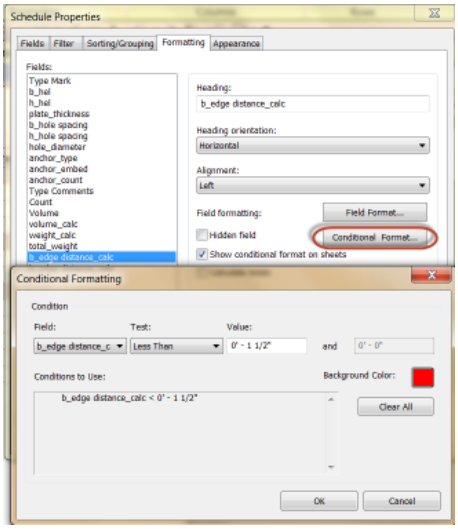
3. ***Open the Schedule Properties dialogue box to the Fields tab***

4. ***Add the Calculated Value: b_edge distance_calc***
   - ***Discipline: Common***
   - ***Type: Length***
   - ***Formula: (b_hel – b_hole spacing)/2***



5. ***Add the Calculated Value: h_edge distance_calc***
   - ***Discipline: Common***
   - ***Type: Length***
   - ***Formula: (h_hel – h_hole spacing)/2***

6. ***Navigate to the Formatting Tab***
   - ***Select the b_edge distance_calc***
   - ***Select Conditional Formatting***
   - ***Set Test: Less Than***
   - ***Value: 0'-1 ½"***
   - ***Background Color: Red***



7. ***Repeat the same steps for the h_edge distance_calc***

8. ***Note that the BP2 has flagged an error for the b_hole distance_calc.***

9. ***Return to the Base Plate Schedule and Cleanup / Format for Sheet Placement***
   - ***Schedule Properties box, Formatting, select the Volume and volume_calc fields and make them Hidden***
   - ***Revise all the Column Title names***
   - ***Apply your company template to the schedule***

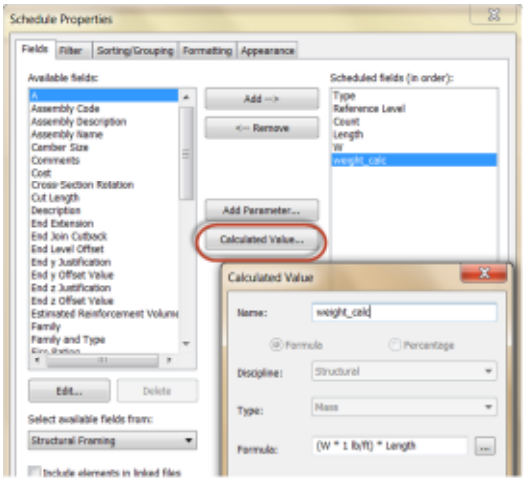
Section 5: Create a Steel Beam Schedule

At this point you can continue to work in your Base Plate Schedule Project or open SE3048-L Base Plate Schedule Project 3 dataset.

1. ***From the View Tab, choose Schedules, select Schedule/Quantities***

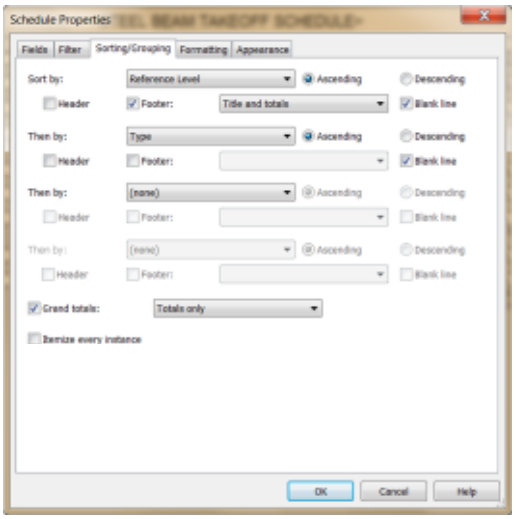
   - ***Select Structural Framing***
   - ***Name the schedule: STEEL BEAM TAKEOFF SCHEDULE***

2. ***The Schedule Properties Dialogue box will open to the Fields tab, add the following parameters to the schedule:***
   - ***Type***
   - ***Reference Level***
   - ***Count***
   - ***Length***
   - ***W***



3. ***Add a Calculated Value named: weight_calc and add the following:***
   - ***Discipline: Structural***
   - ***Type: Mass***
   - ***Formula: (W * 1 lb/ft) * Length***

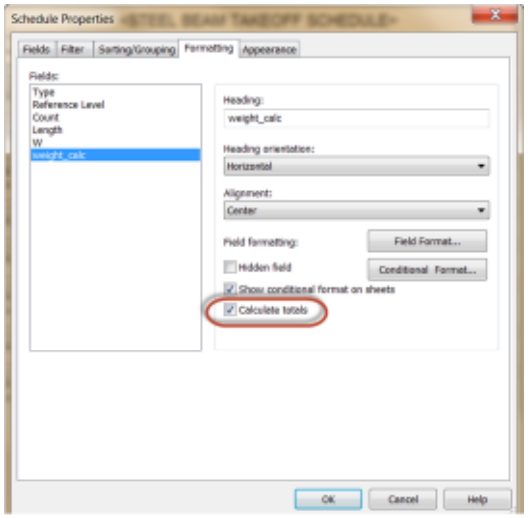
NOTE: The W parameter selected above has an "other" designation within the OOTB family. So we assign units by multiplying by 1 lb/ft.



4. *Select the Sorting/Grouping tab:*
    - *Sort by: Reference Level*
        - *Check the Footer Checkbox*
        - *Select: Title and totals*
        - *Check the Blank Line Checkbox*
    - *Then Sort by: Type*
        - *Check the Grand totals Checkbox,*
        - *Select: Totals only*
        - *Uncheck the Itemize every instance Checkbox*

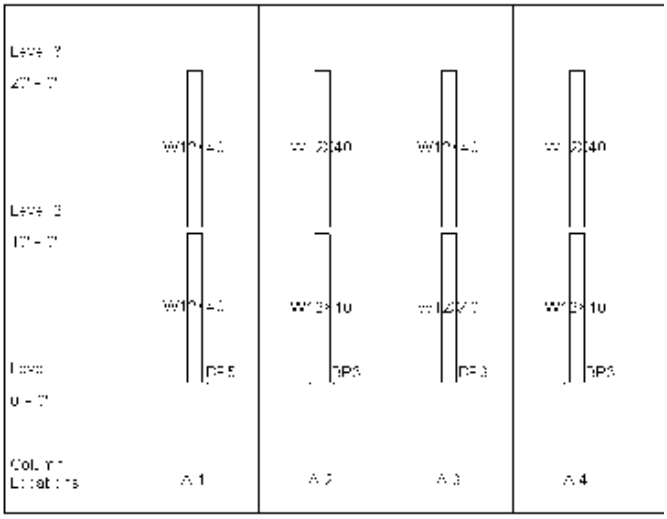
5. *Select the Formatting tab:*
    - *Select the field weight_calc and check Calculate totals checkbox*

6. *Cleanup the schedule for Sheet Placement*
    - *Revise all the Column Title names*
    - *Apply your company view template to the schedule*

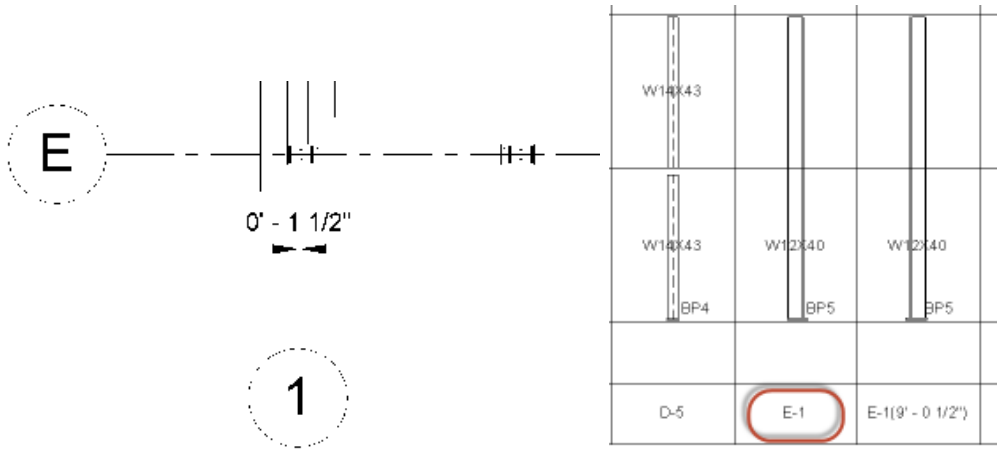


Section 6: Tips and Tricks for the Graphical Steel Column Schedule

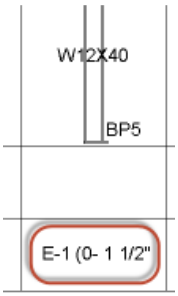
1. ***Tag Base Plates in the graphical column schedule.***
   Since the base plate family has been created using the column template family, base plates are visible and can be tagged along with the columns in the graphical column schedule.



2. ***Columns offset from gridlines.***
   The column location of columns that are offset yet still touching the gridline are actually indicated as centered on the gridline in the graphical column schedule.
   In the example below, the centerline of the column is actually 1 ½" away from grid 1, but the column location is noted as E-1.



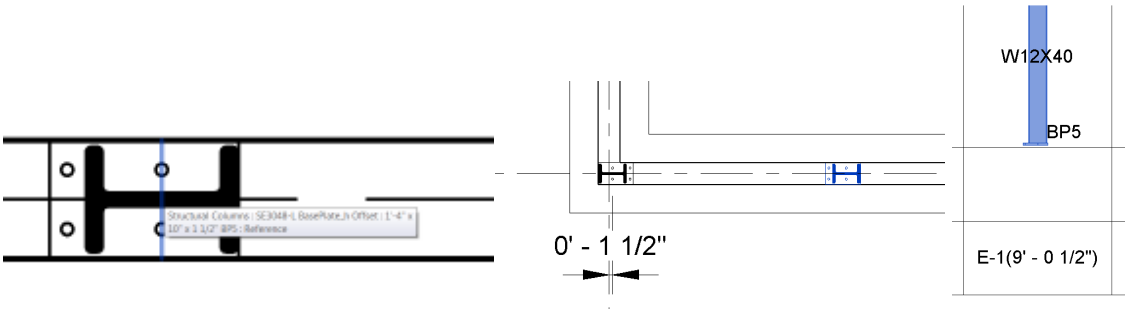
A little opaque text can remedy this issue, but remember to make a note of this important overridden value in the project team notes in your revit project.



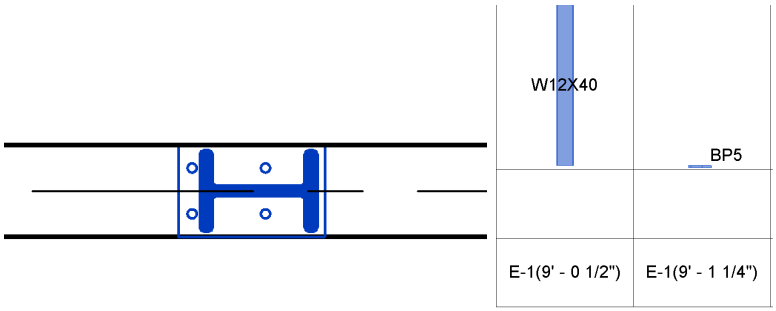
3. ***Base Plate Origins***

As mentioned earlier, all base plate families should be created in consideration with their origin being the centerline of column. This allows you to easily place and align base plates with the centerline of columns. If you are creating an offset non-symmetrical base plate identify the origins within the family and add parameters to flex and offset types accordingly.

In the SE3048-L Base Plate Schedule Project I have added an offset base plate family to highlight this point. In the clip below, the offset base plate origin has been assigned and is aligned with the centerline of column as is confirmed by the graphical column schedule.



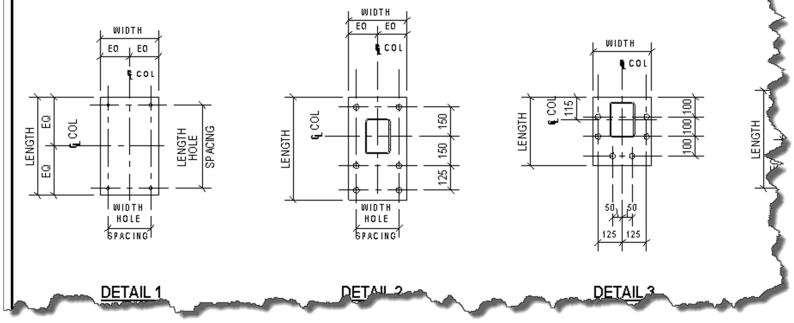
However, should we move that base plate even slightly from centerline of column, we can see that the graphical column schedule will now report the base plate and column as two separate columns.



4. ***Custom Base Plates and the Resultant Base Plate Schedule***
   Custom base plate orientations and bolting patterns will require additional parameters in the families and in the base plate schedule or perhaps just additional detailing. For our standards I have chosen to go with additional detailing and added a comment section to the schedule to reference the details. This is one method to achieve the same result without creating reams of additional base plate family types. See the clips below.

BASE PLATE

MARK	PLATE TYPE	WIDTH	HEIGHT	THICKNESS	WIDTH HOLE SPACING	HEIGHT HOLE SPACING	A. BOLT DIAMETE
BP1	RECT	280	280	22	180	180	20
BP2	RECT	300	300	32	200	200	20
BP3	RECT	350	350	38			32
BP4	RECT	125	250	13	50	175	13
BP5	L	125	190	13	50	175	13
BP6	RECT	230	500	38	100	125	32
BP7	RECT	230	400	38	130	300	32
BP8	RECT	230	280	22	130	200	20
BP9	L	155	225	22	75	175	13
BP10	RECT	230	500	20	100	125	20
BP11	RECT	230	650	38	100		32



BASE PLATE SCHEDULE

OLE G	A. BOLT DIAMETER	ANCHOR TYPE	ANCHOR COUNT	ANCHOR EMBED	COMMENTS	PLATE COUNT	WEIGHT PER PLATE (kg)	TOTAL WEIGHT (kg)
	20	STANDARD	4	400	SEE DETAIL 1	10	13.53968	135.3968
	20	STANDARD	4	400	SEE DETAIL 1	9	22.608	203.472
	32	DYWIDAG	6	900	SEE DETAIL 3	3	36.54175	109.62525
	13	KWIK BOLT	4	100	SEE DETAIL 1	5	3.189062	15.945312
	13	KWIK BOLT	4	100	SEE DETAIL 6	5	2.423687	12.118437
	32	DYWIDAG	6	900	SEE DETAIL 4	4	34.3045	137.218
	32	DYWIDAG	4	1200	SEE DETAIL 1	8	27.4436	219.5488
	20	STANDARD	4	400	SEE DETAIL 1	13	11.12188	144.58444
	13	STANDARD	4	400	SEE DETAIL 6	1	6.022913	6.022913
	20	STANDARD	6	400	SEE DETAIL 4	4	18.055	72.22
	32	DYWIDAG	8	1200	SEE DETAIL 5	2	44.59585	89.1917
								1145.343653