Modeling Reinforcement and Creating Shop Drawings in Autodesk Revit
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In this hands-on lab, you learn how to model reinforcement and create shop drawings from the model in Autodesk Revit Structure software. We use a typical parking garage as an example, and demonstrate techniques to use various tools within Revit, third-party add-ins, Revit® Extensions, and parts and assemblies to model rebar. We learn which modeling techniques are practical for different types of concrete elements, such as drilled piers, columns, beams, slabs, and walls. We then use the scheduling tools in Revit Structure, as well as add-ins that export and import our schedules to Microsoft® Excel®, to create and modify rebar bend schedules for the use in shop drawings and for export to fabrication. The new features in Revit Structure 2014, particularly the ability to apply overrides to the default host constraint behavior on a selected rebar element, are demonstrated. We also learn how to create custom tags and annotation elements that are useful in creating rebar shop drawings.

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

- Use the reinforcement modeling tools in Revit, as well as Revit Extensions and third-party add-ins.
- Describe the new reinforcement modeling tools in Revit 2014 and explain when to use them.
- Use schedule and links to Excel to create and modify rebar bend schedules and data for fabrication.
- Create custom annotation families, parameters, and tags to use in creating shop drawings from the Revit model.

About the Speaker
Dan received his bachelor's degree in Civil Engineering from the University of Illinois at Champaign-Urbana. After spending two years in Tampa designing bridges for URS Corporation, Dan attended Purdue University, where he focused his research on seismic design in steel-framed buildings, and received a Master’s Degree in Structural Engineering. Dan then moved to Denver, Colorado, where he worked as a Structural Design Engineer, and later, Structural Project Engineer for S. A. Miro, Inc.. During his five years with Miro, Dan became an in-house expert in Autodesk Revit Structure, and moved into the role of BIM Manager. In 2011, Dan co-founded MB BIM Solutions as a BIM-focused consultancy that provided construction-level modeling of structural systems and components for its clients. Dan is active in the Denver-area BIM community, with Rocky Mountain Building Information Society, as well as the BIM Users Group.

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Introduction

Why (and When) to Model Rebar:

There has been much debate on LinkedIn groups, and other internet forums, on why anyone in their right mind would model rebar to a fabrication level of detail. It is true that modeling rebar for an entire building is very time intensive and takes considerable effort. Modeling rebar for the sole purpose of meeting an arbitrary BIM LOD (level of detail) requirement is not recommended, unless that rebar model is going to be pushed downstream into fabrication/construction and used to save schedule or money.

Why/When to Model Rebar:
- Shop drawing production
  - Why = construction schedule and material tonnage ($$) savings
- Constructability, congestion, and coordination studies
  - Why = better constructability, reduced congestion issues, enhanced coordination

Why/When NOT to Model Rebar:
- Because you can
  - Why not = you'll blow your budget
- To draw details for construction documents
  - Why not = you'll end up chasing around bar in other unrelated views, modifications are more of a pain, and you can draw details faster using detail components

What Isn’t Covered in This Class:

For the sake of time, I won’t be demonstrating how to edit rebar shapes and hooks, welded-wire fabric, how to set up project and shared parameters, modeling rebar in curving concrete elements (use adaptive components – they are really cool!) and some of the nitty-gritty. My goal for this class is to get you into Revit and modeling bar. However, I’d be happy to help you out with this stuff, so feel free to drop me an email.

General Considerations for Starting the Model:

One of the first things to consider, in the case of a structural engineer acting as EOR for a project and simultaneously creating a rebar model and shop drawings, is whether to combine the rebar and design models, or create two separate models. We prefer to have two separate models, which are obviously then linked and copy/monitored. Here are the pros and cons of the separate model approach:

Pros:
- Design modeling vs. construction modeling – different needs and LOD
- File size – these models can get very big, and tougher to work with for the design team
- Possibility of design team inadvertently messing up rebar

Cons:
- Duplication of work, possibility of design model not matching rebar model
- Some data and details will need to be generated twice
It may make sense to combine the design and rebar model for some firms or for specific projects. In this case, using worksets is a good way to separate the rebar from the rest of the model.

Before starting on a rebar model, we recommend meeting with the fabricator, installer, and GC (or concrete sub) to kick off the project and determine pour breaks, bar lengths, installation preferences, BOM data preferences, etc..

A Good Rebar Template Goes a Long Way:

A good rebar template should have parameters set up specifically for modeling rebar and creating shops. These parameters are used primarily in conjunction with filters to help control visibilities of views, and to schedule data. They are also used to tag relevant data for the rebar shops. We use ‘pour’ for concrete elements, in order to filter views and schedules down to show specific pours. For rebar, we use the parameters shown below to manage view visibilities, Bill of Material (BOM) schedules, bar bend schedules, and also to tag relevant data on the rebar shops. We will get into the specifics of this later, but it is best to set up these parameters within your rebar template.

We also recommend setting up a logical view and sheet organization in your rebar template. This organization is specific to creating rebar shops, and may be a bit different than the organization you would use for construction documents. We organize views by elements types, which makes sense when navigating a rebar model. We keep this organization set up under a ‘template’ category, and then move views to the ‘project’ category as we develop the model and add views.
We also recommend keeping some typical 2D details (as drafting views) in your template, in order to copy and modify them quickly. As will be discussed, we prefer to use 2D details for some typical conditions, rather than live sections. Obviously, one big benefit to this system is that these are easily re-used from project to project:
Another item to include in your rebar template is view templates. For your first rebar job, there will probably be some set-up time to determine the look of different types of views that you desire. In most cases, a template will be applied to a view to initially set the view properties and visibility/graphics, but then modified to filter in/out certain pours that you may not want to see (i.e. a slab plan will have the rebar from an adjacent pour turned off). However, these view templates will help set up consistent views:
The next component to set up in your template is bend schedule and BOM’s. We prefer to leave in these schedules for all types of elements, and then delete the ones that are not relevant at the beginning of the project. Another way to handle this would be to set up one bend schedule and one BOM, and then duplicate it for each pour or element type (and just modify the filters to only include relevant rebar):

We also include rebar bend types in the form of a legend view (so that it can be placed on multiple sheets). We then copy and modify this view for each type of element, to pare it down to only include the bend shapes that are in these elements:
Another big piece of a template (not just for rebar), is some text that explains to new users how to navigate and work in the model. It is imperative that a relatively new user can jump into a model and understand the structure of how it works. We prefer to do this using a drafting view:

We also recommend setting your rebar cover settings to logical values in the template. This is done through Structure – Reinforcement (drop down) - Cover Settings. Though some different values may be used for different projects, it is worthwhile to set up some standard cover settings in your template. In this same drop-down, there is an option called ‘reinforcement settings’. We really like the ‘reinforcement rounding’ option that is new in Revit 2014, as this cleans up bar (and bar segment) lengths that Revit is rounding to very odd numbers. No more have bar lengths showing up in your schedules that are something like 4’ – 6 1/256’!!

Of course, it also makes sense to have tags, detail items, symbols, etc., that are typically used for rebar shops loaded into your template.

Let’s Start Modeling Rebar!!:

Well, Let’s Assign Pours First:

Assign pour numbers to all concrete elements to match the pour breaks and pour sequence determined by the GC or concrete sub. These will then be used to control visibility of elements on views.

Why not use phases for this? We have found that we have more control over visibility using a pour parameter than phases. Phases allow you to set all elements for certain phases to look a certain way, but not change this for different types of elements, and control transparencies.
Assign pour ‘DP1’ to eight piers in SW corner, and assign pour ‘DP2’ to the nine piers under the mat slab.

Then assign pour ‘GB1’ to the grade beam along grid A (between Grids 12 and 9), then the three sections of grade beam along grid 12 (between grids A and A.8). Assign pour ‘GB2’ to the grade beams to the plan north of here.

Then assign pour ‘GB1’ to pier caps in this same location as the grade beams in GB1.

NOTE: it is questionable on whether or not to include the pier caps with the same views/sheets at the grade beams, as these will be poured together. There are advantages and disadvantages to showing them on the same sheet. The advantage is that the rod busters want to look at one sheet when they are in the field. The disadvantage is that this may be too much information to clearly convey on one sheet.

Use this to convey pour information clearly. Create a 3D view, assign filters that isolate each pour, and then color-code this view.

We will also use this pour data to control the visibility of views (through filters), but more importantly, we will also assign this pour data to the rebar in these elements. More on this later.

Modeling Drilled Pier Rebar:

There is usually a big difference between piers in a design model vs. a construction model. For design documents, engineers have little motivation to correctly model the drilled pier length, and will often just
show a pier type (diameter and reinforcement layout), the top of pier elevation, and a bedrock embedment length.

However, when creating rebar fabrication drawings, piers of the same type will often have different reinforcing, due to the difference in embedment length and pier length (i.e. # of ties, length of verticals). Therefore, we like to use include the length as a TYPE parameter, and then have several different types for a single pier design (i.e. 36” K.1 has a different length and different rebar than a 36” K.2):
Let's assign correct pier types for the piers in pour DP1. Assumed bedrock elevation is 44'-0" below elevation 100'-0" (at elevation 56'-0"), so the 36" piers with T.O. pier at 96'-6" and embedment length of 8' will have a pier length of 48.5'. We will assign a pier type '36" Pier – Type K.1' for the three piers at A/12, A/11, and A/10. However, the pier at grid A/9.2 has the same design, but a length of 45.5', since the embedment length is only 5'. Let's assign a pier type '36" Pier – Type K.2' to this one, and then do the same exercise for the other piers in DP1.

Next we'll create a typical drilled pier rebar sheet. The philosophy on drilled pier rebar sheets is a bit different than other element types. Essentially we will just show the bend schedule, pier schedule with type data, plan showing pier marks, and some typical details. There is really no need to tag all of the rebar for these elements.
Create a drilled pier plan view, and then create dependent views for each pour. Change the VG of this view to halftone everything except drilled piers. For this view, we’ll turn off floors and halftone the other elements through the V/G model categories. We’ll also have to halftone the pier caps through a filter (since they are foundation elements), and change the linestyle of drilled piers with a filter so that the piers show up as a thicker black dashed line.
Tag pier top and bottom elevations using the spot elevation ‘MB BIM T.O. Pier Spot Elevation’. Select all instances of this in the view, change the ‘display elevations’ to show top and bottom, and add text to the suffix to show top and bottom of pier.

Now, let start actually modeling some rebar. We'll cut a section and model the rebar using two methods – Revit extensions, and manually entering bar.

Using the extension, select the pier and select extensions – reinforcements – piles. See the options below:
There are some limitations to the extensions, such as the shape it selects for the bars (some strange nomenclature instead of a T3 bar), and the bars not being set to ‘maximum number of spaces’ (to drag bar extents), and the inability to set a different ‘bottom cover’ for the longitudinal bars. However, the extensions are definitely the way to go for starting drilled pier bar, as we’ll see next.

Once the rebar is generated, let’s fix a few things by changing the stirrup shape to a T3, and changing the lap distance (G) to 1’-4”.

NOTE: In order to ‘finish’ the bar for this drilled pier, we would need to add the dowels that extend from the pier through the cap and into the column. It is much easier to add this bar once the column bar has been started, so we will add this bar when modeling column rebar, and then just assign it to the drilled pier within its data.

Now, just for comparison’s sake, let’s manually model this rebar. In an elevation of the next pier over, cut a section, and rotate it to look down. Select the pier, and click the ‘rebar’ button. In the shape browser, scroll down to shape T3. Mess with the ‘placement orientation’ to understand the effect of the cover settings, but then choose ‘parallel’ to workplane, and place the bar. Change the size to a #3, and adjust the lap (G) to 1’-4”. Then place a type 00 (straight) #9 bar perpendicular to the cover, and then use a radial array to place the other 10 of them.

Let’s go back to the elevation of the pier, and mess with the rebar constraints to demonstrate this tool that is NEW IN 2014. Take a straight bar, click ‘edit constraints’, and change the end of bar to the bottom of the pier cap instead of the top, with a 3” offset. Make sure you click ‘set as preferred’, or this won’t work.

Then, change the stirrup layout from ‘single’ to ‘maximum spacing’, set the max spacing at 12”, and then drag the extents of the group to the correct places. Then copy this up to the region with a 3” spacing.
Now that we’ve seen that the extensions are a way better way to go, let’s delete that bar we just created, and reinforce this pier by using the one we’ve already reinforced, and creating and copying an assembly.

Assemblies (first introduced in 2012), have gotten much better of the past two years, to the point where they have become quite useful, and replaced model groups within our workflows. There are still some disadvantages, such as the schedules and views, which limit their use to us for actually creating the shop drawings. However, most of the big problems in previous releases (inability to edit within assemblies, inability to change an instance of one assembly to a different assembly type, and the inability to combine assembly sheets/views with non-assembly sheets/views) have been eliminated.

To create an assembly for drilled pier bar, select all bar (at first, without the pier), and create an assembly and call it DP K.1 Rebar. Now copy it over to the adjacent K.1 pier. Let’s play with a few things to look at how assemblies work. Go to one of the assemblies we just created an edit it. Grab all of the straight bar and change it to type 00 instead of the type that the extension assigned. When finishing the assembly, Revit will inform us that we changed the assembly, so it created a new assembly. When this happens, we have to make sure to grab all instances of our previous assembly, and change the types to the new one that was just created. Also note that we can modify data within the rebar in an assembly (bar mark, pour), and it will NOT change that for the bar in another instance within the assembly. This is very nice.

Now copy this bar over the type K.2 pier (do this in plan). Revit warns us that a new assembly type is created, and this is because the host element for the rebar is fundamentally different from that in which the assembly was created (shorter pier length). This is good in this instance (since the pier is actually different), but can become annoying in other instances in which you want to copy a rebar assembly to a very similar element, but that isn’t exactly the same. Let’s modify the rebar in the K.2 pier using this
assembly as a starting point. Make the top longitudinal bars 3’ shorter, move the bottom longitudinal bars up 3’, and shrink the extents of the stirrups.

Now let’s assign relevant data to the rebar, which will then be used in the bend schedule, BOM, and filters. Assign 4T100 to the schedule mark for the stirrups, ‘DRILLED PIER’ to the Reinforced Element Type, and ‘DP1’ to the Pour parameter within the bar. We’ll use these in a little bit, but it is easier to assign them now before we copy them.

Next let’s create a bend schedule for drilled piers that will be placed on the drilled pier sheets. Click View – Schedules – Schedules/Quanties, and select ‘structural rebar’. Add the type, shape, reinforced element type, and schedule mark. Then sort by type and schedule mark, do NOT itemize every instance, and then filter out any straight bar and any bar from other pours. Finally, hide bar fields that do not apply.
Duplicate the bend schedule to create the Bill of Material (BOM) for drilled piers. This is the data that is submitted to the fabricator, and included the straight bar, all bar segment lengths, and bar quantities. It might be useful in the schedule to add (and hide) the reinforcement weight. This is a calculated parameter that is just Reinforcement Volume / 1 CF * 490 / 2000 (in tons).

Create a new sheet, and drop the DP Pour 1 plan view, the drilled pier nomenclature, and the bar bend schedule in this sheet. We would also drop typical details (which are done in legends to that they can be placed on multiple sheets) in this sheet. This is a case where it is clearly beneficial to just create a typical 2D detail that shows standard bar spacing, rather than live rebar.

**Modeling Pier Cap Rebar:**

Next, let’s model the bar in the pier cap at grid A/11 using the Revit Extensions for ‘pile caps’. Set the bar spacings to 6” in each direction, as well as the relevant bar types and sizes. It is clear that this extension won’t get us everything we need, but will get us close.
Since there is a lot going on here, let's create a 3D view to just look at this specific cap. Using ‘3D – DMM’ as a starting point, turn off everything but structural foundations and structural rebar in V/G, and make structural foundations partially transparent. Crop down the view to look at the cap that we just reinforced. A key step here that people often can’t find is that you now need to select the rebar, and go to ‘view visibility states’ within view properties, and make the rebar solid in your current view. I recommend doing this only as needed, as it slows down your model:

Now is a good time to mess with cover setting, and to demonstrate the different methods of setting covers. First is within the actual element properties, and the others are within structure – reinforcement – cover.
Again, we must set the bottom bars to be the correct S3 type. The top bars also came through the extension as the wrong bar type, so let’s change this to T9. You will notice that one of them has the wrong orientation. One way to fix this is by hitting the spacebar to rotate the bar. HOWEVER, be careful when rotating using the space bar, as this often messes up your leg dimensions (particularly for a type 17A L-shaped bar, where it is not obvious). Next, cut a section looking down so that we can get the top T9’s to match the bottom S3’s by changing the number and moving them over. We will also change the bars to ‘max spacing’, and drag the extents so that they are more like an actual installed condition.

We also have to check our bar segment lengths to make sure that they will fit inside one another. This can be seen in our plan view, as well as our section. We need to make sure that all of the vertical bars are correctly fitting within the ties (segment length = 3’-11”). Note that the ‘height’ of the vertical bars will actually need to be less than 2’-0” to fit within the cover requirement, in order to nest inside one another. Let’s set these bars to be 1’-11 ¼” tall. This is also a good time to take another look at the ‘edit constraints’ tool to see how we can manipulate how the bar is automatically snapping.

Now manually add T9’s to match the #4 ties, using the rebar tools and ‘parallel to workplane’ within the section view that is looking down.

Assign ‘PIER CAP’ to the Reinforced Element Type parameter, and ‘GB1’ to the Pour parameter. Set the bar mark for the #6 vertical S3’s to 6T200, their companion ties to 6T201, and the horizontal ties to 4T200 and 4T201. To check our data, we’ll now create a bend schedule for pier caps by duplicating the drilled pier bend schedule and switching the filter to show bar that is in caisson cap pours.
This is also a good time to create a 'working' schedule to help us start controlling the bar marks that we assign. Duplicate the caisson cap schedule, unhide the 'reinforced element type', only include bars that have a 'T' in their mark, and add the pour parameter. We will now use this schedule to QC that every bar we assign to the same mark has the same dimensions, and we will use this to choose the next bar mark to use.

Using what we learned about assemblies with drilled piers, create an assembly for the pier cap bar and copy it to the other pier caps. For the sake of time, we are going to skip creating a pier cap sheet and move on to modeling grade beam bar.

**Modeling Grade Beam Rebar:**

Look at details and model – this doesn’t work at the intersection of the GB, the pier cap, and the column at A/12. In reality, we would talk to the contractor and EOR here, and figure a solution to making this more 'buildable', using our model as a tool. Let’s assume they decide to drop the GB by 12", pour down the slab over the top of it, and have the bottom of GB match the bottom of pier cap. In the model, let’s drop the GB by 12", and change its depth to 30". Note that there is still a constructability issue at A/9.2 – we would also RFI this and work with the contractor for a solution (add a pier cap)?

Before modeling bar in the GB, assign the cover to be 3" on all faces except the top face, where we’ll set it to 1.5".

Select the GB, and open the reinforcement generator within the Revit extensions, and begin assigning the reinforcement criteria:
The ‘bar division’ tab is the most intricate, and we will not be able to get it to work exactly the way we want it to, so my advice is to not worry too much about this, as you will end up ‘touching’ most bar to modify it anyway.

Once the reinforcement is generated, you will see that we still have a lot of modification to do to the rebar in this GB (change the top cover to 1.5”, change the ‘type’ for all bars, get the longitudinal bars to be type 17A with a hook only on one end, add side bars, etc.).

Start modifying this bar to show the top bar spliced near the support at A/10, the bottom bar spliced near the midpoint between grids 10 and 11, and all of the main bar to have a hook at one end. This is best done by using a 3D views (with just the rebar on, and the rebar shown as solid), an elevation of this beam, and a section through it. Start by using bars that are relatively correct, changing their segment lengths and types, and moving them around and copying and editing.

Note that for the bottom bars, in this case, we would offset the splice slightly from the mid-span in order for the bars on both sides of the splice to have the same bar mark, and therefore make the installation a bit more clear.

Create the beam side bars by cutting a section, and then copying down a top bar twice, and changing the properties to be a #4 straight bar.
At this point, you probably notice a couple of things about how congested this is at the pier caps. One thing that you probably noticed is that we did NOT offset the bar to accurately show the offsets at the splices. We do NOT suggest doing this for most cases (it will take FOREVER!), except when you want to create a view that specifically shows this. You also probably noticed that the GB top and bottom bar conflicts with the pier cap bar, due to them sharing the same cover settings. This actually IS a problem, and it a few minutes, we’ll create a view that shows this that we can present to the client and EOR to get verification of cover modifications.

Let’s not forget to model the L-shaped bars that are cast into the GB and bend into the SOG – see the detail. This is a case in which we may model something different than what is shown on the CD’s, based on the contractor’s preferences. In many cases like this, they prefer to install these as straight bars and filed bend, so that they aren’t a trip hazard before the SOG is poured. Let’s do this by manually modeling the bar, and then changing the spacing rules.

Before we move on, let’s assign correct bar types, schedule marks, and pour and reinforcement element type data to all of this bar, just like we previously did for pier caps. Again, let’s create a bend schedule, and take a look at our working schedule to make sure that things are still looking good.

**Modeling Column Rebar:**

Before modeling any bar, I want to point out the tool that is NEW IN 2014, which is that we can change the join order for the column and SOG to make it correctly show the SOG cutting around the column, rather than the SOG cutting out a piece of the column.
Now let’s model the bar in the column at grid A/11, using the Revit Extensions first. The options here are now pretty robust, and can get us most of the way to where we need to be. Note that within ‘dowels’, we can define dog-leg bars as shown in the detail. We’ll have to make some assumptions here, and just set L1 to 2”, L2 to 12”, and L3 to 1.5”.

Now is a good time to start making better use of our ‘reinforced element type’ parameter settings within our view filters. In the 3D view that we have set up, let’s go to V/G – Filters – Add. Choose ‘drilled pier
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rebar’, ‘grade beam rebar’, and ‘pier cap rebar’. Click ‘edit’ and see that these are based on the ‘reinforced element type’ parameter within the bar. Uncheck the visibility box, and you will now see that we have turned off the rebar that we don’t want to see.

Notice that the ties didn’t do exactly what we wanted them to do, and neither did the dog-leg type 31 vertical bars. Let’s modify this manually by changing the layout for the ties. Then, notice that the type 31’s have grips that we can grab to tweak the geometry of the bends. This is a new(ish) feature, and very useful! However, to get all of these 10 bars to be the same, it is more useful just to edit this within the bar properties. Then, select the other vertical bars and assign this to all of them. This takes some messing with to get them all to be exactly identical (and correct), but once we do, we should assign a bar mark to them.

Note that in Revit, we don’t have the ability to match instance parameters from element-to-element, we can only do this to match types. However, I believe there is an add-on out there that will do this for us, and might be useful for instances like this.

Also to note is that some fabricators prefer to add a ‘stability tie’ at the very top here to keep the cage stable during erection. Remember that this tie’s will have dimensions smaller than the typical tie, since it will be used where the bars have already been bent inwards. Also note that it isn’t a bad ideal to add an inch or two to the splice length here (or anywhere), just to be safe and not have problems with the inspector.

Let’s also assign bar marks, pour data, reinforced element type data to this bar.
Now is a good time to use the column vertical bar that we just created to copy it into the pier, for use as dowels. Let’s extend this bar 71” into the pier and 3’-5” into the column, which means that when we add in the pier cap depth, we have a 142” long straight bar. Make sure to assign the bar to ‘drilled pier’ and pour DP1 (since this bar is actually cast within the pier, and will need to be place in the pier pour. Create an assembly for this column bar (and pier dowels), and copy it over to the adjacent C1 columns.

Note – it should be noted that we just potentially added a bunch of different pier types, since a K.1 could have several different column dowel layouts (and we would now have K.1A, K.1B, etc.).

**Put this All Together in a Sequenced 3D View:**

If it isn’t obvious yet, when we look at a 3D view and turn all the bar back on, we will see that there is a LOT of rebar in this small congested area. This would be a good area to get in front of the client to make sure the rod busters in the field understand, get the EOR to sign off on potentially different covers, and to make sure that the constructability is understood.

Make a copy of the 3D view, crop it down to show the bottom of the column, the top of the pier, and a bit of the grade beam on either side.

In V/G, expand ‘structural rebar’ to show that we can assign different colors to different bar SIZES within this. However, we don’t have the option to change the surface pattern per the bar size, so this won’t be great for this exercise. However, we do find this useful to set up a QC view that has different colors assigned to the different bar sizes so that we can quickly identify errors. 
One view that may be useful is a view that shows the bars color-coded by element type. The filters that we set up are perfect for this. In V/G, let’s add ‘column rebar’ to the filters that we have already set up, and then color-code the bar by changing the surface pattern for each element type.

Another view that could be useful is one that color-codes the bar by bar size. Though we just saw that we can’t do this within the model categories in V/G, there are two ways to do this. One is by (again!) setting
up a filter that groups bar by size, and then changing the surface pattern for each bar size. OR, we could quickly do this for a specific view by grabbing each bar size, selecting all instances in the view, and then overriding the graphics in the view. We can then lock this 3D view and annotate this showing the sequence of bar installation, or point out questions or concerns.

There are two major issues that are visible here (in addition to them having to thread all of the GB bar through the cap!!) that we should point out. Let’s create some annotation in red that points out that the column dowels fall outside of the pier cage, and that the GB bottom bar has to have a much increased cover (at least 4.5") in order to pass through the pier cap.

We can then export this view to a 3D PDF (using your favorite plug-in, we use Bluebeam), or also send this specific view to Navisworks for anyone to view using Navisworks Freedom. A picture (that you can spin around) is worth a thousand words (or a very unclear RFI)!!

**Modeling Slab and Wall Rebar:**

Up to this point, we have used the Revit Extensions and the manual modeling tools to model bar. Now would be a good time to note that there are a couple of other add-ins out there that can help with rebar generation. The most notable one (in my opinion) is from IDAT. This one is made for the precast concrete industry, but can be used to generate rebar for CIP elements. Another noteworthy plug-in is that from SOFISTIK. Their 'reinforcement detailing' plug in (which is FREE) is quite good, and rather comprehensive. This is used not to model bar, but to annotate it and create shops. We have started looking into it, but have not yet made the transition to incorporate this into our system. They are teaching a class at AU this year about this plug-in, and I’m looking forward to attending!
The main modeling tool that we have not yet talked about is the area and path reinforcement tools, which are primarily used for walls and slabs. These tools have gotten better the last couple or releases of Revit, to the point where they are now extremely useful. Previously, they had some major drawbacks (initially, it was more of an annotation tool and didn’t model rebar model elements, and then there were some scheduling issues).

For the sake of time, we will just quickly mess with modeling slab and wall bar, as these are typically the easier elements to model bar for. Let’s move up to Level 8. Change the view template to ‘none’, the detail level to fine, and the view to wireframe. Before we model anything, go to ‘structure – reinforcement – reinforcement settings’, and take a look at the options for Area Reinforcement and Path Reinforcement. These are helpful if you plan on using Revit’s area and path reinforcement tags, as you can change the nomenclature for tagging.

The main drawback to the area reinforcement tool is that you cannot define a max bar length, or any splice information. Let’s mess with the slab at Level 8 and see what options are available. We will assume we have a top and bottom mat of bar in both directions, with #4’s @ 18” in the left-right direction, and #4’s at 12” in the up-down direction. Before we define the boundary for the area reinforcement, choose the slab, edit the boundary, and then select it all and copy to clipboard. Exit out of the slab editor. Then click on the slab, and select ‘area’ under ‘reinforcement’. Pause here to look at the options available to use, and set the bar to our correct spacings. Note that we have the option to choose any (or all) of the four mats, can change cover settings, assign a max spacing or fixed number (good for column top bar), and assign hooks.
Paste aligned to current view to get quickly start the sketch. As you can imagine, with all of the jogs for balconies and such, this is going to be a mess to reinforce and install in a logical manner. A BIG part of reinforcing a slab like this is trying to lay the bar out in a logical manner that the crew in the field can easily install of the shop drawings.

Once the rebar is generated, note that we can grab the area reinforcement system and use the grips to adjust it. Also note that while the system is still in place (it acts much like a beam system), we are unable to modify properties of specific bar, but are able to assign data to our parameters for this bar. Let’s cut a section looking all of the way through the slab, and assign ‘BOTTOM’ to our bottom bar, and ‘TOP’ to our top bar.

Now let’s go back to our plan view, duplicate it, and call it out as a top bar plan view. Then set up a filter that turns off all ‘BOTTOM’ bar.
Notice that the area reinforcement tool did a very good job in getting us a preliminary rebar layout, correctly adjust lengths for edges, and more importantly, cutting the rebar for openings in the slabs. At this point, we cannot move or adjust any bar. Note what happens when we copy over a shaft opening – the bar automatically updates for this opening. Essentially, while we have the area reinforcement system in place, our rebar will update to adjust for slab changes.

When we do remove the system, our slab rebar has lost the ‘smart’ link to the slab, but can now be adjusted. We can now change bar lengths, and move around bar.

Though a one-time generation of the slab bar as one area reinforcement system is fast, a better way to do this is to define numerous area reinforcement systems within the slab to take splice locations and pour breaks into account. I like to plan out the most logical bar placement schemes, and then draw 40’ x 40’ (max) ‘grids’, than I then use to lay out rebar for chunks of the slab. This assumes that the max bar length per the fabricator’s specifications was 40’, and then I overlap them for splice lengths.

It should also be noted that when area reinforcement is copied from level to level, it loses its relationship to the host slab. However, I don’t see this as a big deal.
Let's now take a look at path reinforcement. This tool allows us to sketch a path along which rebar will be populated, and applies for a single layer and single direction of bar. This is useful for slab edge conditions and hairpin bars at PT tendons. Select the slab, and then 'path' under the 'reinforcement' tab. Pick along the slab edge, and then use the 'flip' toggle to get it facing the correct direction. I typically use this tool to initially lay out some bar, and then remove the path and edit the bar (typically the shape) to the correct type (U-shaped).

Modeling walls rebar is essentially the same as modeling slab rebar – the area and path reinforcement tools are key. All of the concepts that we learned modeling this slab bar should also be applied to walls.
Create Annotation for Rebar Shops

All-Encompassing Rebar Tag:

Before creating a grade beam rebar sheet, let’s take a look at the all-encompassing rebar tag that we have come up with. As I mentioned, SOFiSTiK has developed a pretty good (free) plug-in that is definitely worth taking for a spin, but we came up with an internal system for this that we have used (and tweaked) for the past couple of years that suits our purposes.

Let’s again grab a piece of bar, and notice that we have set up some extra parameters (in addition to the standard instance parameters) that we have not used, such as comments, hide in plan view, user bar quantity, user bar spacing, and accessory. Note that ‘hide in plan view’ is just a way for us to easily turn on and off certain bars in a specific view, and has nothing to do with tagging.

The reason that we have ‘user bar spacing’ and ‘user bar quantity’ is that sometimes we want a tag to show the number of bars or the bar spacing, but the bars layout in Revit is set to ‘single’. Examples of this are column vertical bars and beam longitudinal bars. Conversely, many bars are laid out using ‘maximum spacing’ or ‘fixed number’ or ‘number with spacing’ (such as ties or stirrups). In those cases, we want to tag the ‘quantity’ and ‘spacing’ that are instance parameters built into Revit for those bars.

In the project browser, go to TEMPLATE – HOW-TO – HOW TO USE REBAR TAGS. Here we have created a flow chart that shows our team how to use the rebar tag. Though it looks complex, there are
really only a few choices, and it becomes very easy to remember once you have used it a few times. The choices are:

- Straight bar vs. bent bar (bent bar tags the bar mark, and straight bar tags the length)
- Revit spacing vs. manual spacing (as described above)
- Arrow vs. no arrow
- Then, the type just determines where the lines of text are broken within the tag

There are also types for column vertical which put open or close dots in the tag to represent vertical bars already poured vs. those that are new for the pour being detailed.

Let’s open up one of these tags to see how it works. In the project browser, right-click on ‘MB BIM Rebar Tag _ Bent _ User SP _ Arrow’. Notice that the tag is just composed of multiple labels sitting on top of each other. Click on one of the labels and edit it. You can see the six parameters that are being referenced with the tag, and how the different types simply define where the tag has line breaks. Then, type parameters (and corresponding types) were set up as simple ‘yes/no’ type parameters that simply turn on the correct label for the tag type.

While the spacing, quantity, mark, and T/B parameters are obvious, it might be unclear what the ‘Accessory’ and ‘Comments’ parameter would be used for. Essentially, they just give us the ability to add some text or data after the bar mark, and at the end of the tag. An example of this would be grade beam dowels that are bent bars (bent into the SOG). Here, the tag would call out the bar as ‘12 – 3T201 SOG DOWELS @ 12” O.C. PROJECT 8”’. ‘SOG DOWELS’ would be the data entered into the ‘Accessory’,
and ‘PROJECT 8’ would be entered into the comments. We have found that with these two parameters, we very rarely need text, and can have tags take care of it all.

Rebar Tag Span Symbol with Moveable Dot:

I’m sure most of you know this, but line-based detail components are very useful. I want to quickly point out a line-based detail component that we use rather extensively in our rebar shops. We created a very simple rebar tag span symbol that has a drag-able dot (which is just another line-based detail component loaded into the main span symbol family. This is very useful for instance where we want to show the extents of an array of bars, but other tools (such as dimensions and tags) don’t suit our purposes.
Creating a Shop Drawing for the Grade Beam Previously Detailed:

To wrap up, let’s come full-circle back to the grade beam that we previously detailed, and create a shop drawing for it. First, duplicate the ‘DRILLED PIER OVERALL PLAN’ that we previously created (without detailing), and name it ‘GRADE BEAM OVERALL PLAN’. Create a duplicate as a dependent called ‘GRADE BEAM POUR GB1’. Go back to ‘DRILLED PIER POUR DP1’ and quickly draw a scope box that traces the crop region of the view. Go back to the ‘GRADE BEAM POUR GB1’ and apply this scope box.

Go to V/G and halftone everything except structural framing. In the filters tab, get clear the override on the drilled pier linetype. ‘Tag all Not Tagged’ using the structural framing tag ‘Structural Framing Tag-w-Studs-Camber Standard’. Note that this doesn’t really matter here where the GB’s are all the same size, but is useful for instances where the grade beam size changes. Cut a section looking at the grade beam that we reinforced, and adjust the section depth as needed. Name the view ‘GB 1-1 ELEVATION’, assign view group 2 to ‘PROJECT’, and view group 1 to ‘FOUNDATION’.

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Normally, we would just apply a view template to this, and we would get a great start to the view. Just for comparison’s sake, let’s go into view templates, and assign the ‘Detailing – Beam Elevation’ template to this. You can see that this is somewhat relevant to this view, but not completely (it is set up more for an elevated beam). UNDO this, and let’s set this up from scratch.

Make the following changes to the view properties:

- View Scale = ¼” = 1'-0”
- Detail Level = Fine
- Visual Style = Realistic
- In V/G:
  - In Model Categories:
    - Turn off structural columns and floors (as these will not yet have been poured)
    - Override the fill pattern for structural rebar to be grey and solid fill
In Filters:

- Add the column rebar, drilled pier rebar, and pier cap rebar filters
- Turn off column rebar
- Make the drilled pier rebar and pier cap rebar half-tone and transparent (60%)?

NOTE: This is all up to your preferences. In this case, it is arguable to have the pier cap rebar completely turned off, as it might make the grade beam bar show up a bit more cleanly.
Now let's start tagging the bar. Grab all bottom and top bars, and assign '3' to 'user bar quantity' (keeping an eye on your selection filter to make sure you have the right bars selected. Grab the top bars and assign 'TOP' to the top/bottom parameter, and vice versa for the bottom bars. Grab all 8 side bars (4 each side of the splice), and assign '4' to the user bar quantity, and type (1/2 E.F.) within the 'comments' parameter.

Now go to annotation – tag by category and select the tags button, and scroll to ‘MB BIM Rebar Tag _ Bent _ User SP _ Arrow : No Break’. I know this seems like a LOT to scroll through, but isn't used very often – you typically just right click on an existing one and ‘create similar’. Start tagging the bottom, top, and side bars. Note that for the side bars, since this is straight bar, the tag will be changed to be just like the top and bottom bars, but with 'Straight' instead of 'Bent'.

Now dimension the laps. As previously noted, we like to add an extra inch or two to laps, so we usually override the dimension to replace the text with something like ‘5'- 4" MIN. LAP’, and then below we call out the bar that is being dimensioned, such as ‘#8 BOTTOM BAR’. Do the same thing for the side and top bars.

Now lay out a dimension string for the stirrups, dimensioning from grids and edge of pier caps. Add a suffix 'CLR.' behind the 3" dimension to the pier caps, and text saying ‘6 SPACES’ below the dimension for the stirrup array. Tag these stirrups with a bent bar tag with an arrow, but that uses ‘Revit Spacing’. There is something important to note here – toggle the stirrup spacing type from 'number with spacing' to 'maximum spacing', and see the different in the tag. This is up to you on how you want this to look, but if you want to change it to max spacing, I would make sure to use the 'comments' parameter to add a 'max'.

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For the sake of time, let's leave the rest of this GB along and drop it onto a sheet. Create a new sheet, using the MB BIM 24x36 titleblock. On this sheet, drop the plan 'GRADE BEAM POUR GB1', the section 'GB 1-1 ELEVATION', and the schedule 'Rebar Schedule – Grade Beams'. In the project browser, right click on the 'BEND DIAGRAM LEGEND – ALL', duplicate it with detail, and rename it 'BEND DIAGRAM – GRADE BEAMS'. Delete out all bars except T2 and 17A, and then drop this onto the grade beam sheet.

This may also be a good place to drop the 3D view '3D – Pier Cap Congestion'. Drop this onto the sheet, and note that we will need to change the view scale down to 3/8" = 1'-0", and we'll need to turn off the scope box.

We also need a section cut through the grade beam to show up on this sheet. Let's activate the plan view, cut a section through the grade beam, and quickly turn off slabs and change the scale and detail level to make this look a bit cleaner. Dimension the covers, the bar projection, and drop this onto the sheet. Typically, we would use this section as a tracing pad to mimic this detail with 2D annotation components, and then drop this onto a legend. This way, we can use it over and over for all grade beam sheets. We would leave the information shown generic enough to be a 'typical' grade beam detail.

See below for the sheet that we quickly just created, and below that for a grade beam sheet from another project. You'll notice that the typical details are a bit more developed than what we just quickly created.
Modifying Data in Rebar Models

Excel Links:

We typically use the Excel Link found in Cad Technology Center’s (CTC) BIM Project Suite Premium. These excel links have gotten very good, and make it fast and easy to modify data, and push it through to the model. Because CTC’s excel link is a 3rd party add-on, Autodesk was not able to get it installed on the participant’s computers for this lab. Therefore, I will only quickly demonstrate this at the end of the class if time permits. However, I would strongly recommend getting into using excel links with Revit, and not just for rebar, as this has become a very efficient way to super-charge your data within your Revit model.

I hope you enjoyed this lab, and were able to learn some valuable information to take back to your office. Please don’t hesitate to contact me with any questions!

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