Rebar Detailing and Autodesk® Revit® Structure

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SE4281

This class covers the use of Autodesk Revit Structure software as a reinforcement detailing platform. We will examine the various reinforcement tools available in Revit, including rebar extensions, area reinforcement, path reinforcement, 3D rebar, and assemblies. We will also touch on some best practices, workarounds, shortcuts, limitations, and advantages. We will show you several examples of actual projects where Revit reinforcement has been used. We will share the models themselves, methods employed for presenting quantities, and placement drawings.

Learning Objectives

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

- List best practices for getting started with rebar detailing with Revit
- Recognize various limitations and advantages to Revit reinforcement tools
- Use the base Revit reinforcement tools
- Prepare shortcuts and workarounds working with the Revit reinforcement tools

About the Speaker

**Grant Doherty – Martin/Martin**
Everyone has their area that they excel in and thoroughly enjoy. For Grant this area is Building Information Modeling. I have been using BIM products for approximately ten years all the way since Revit 5. Since then I have expanded my BIM knowledge to more than just Revit including all three versions of Revit, NavisWorks, Autodesk Quantity Take-off, Robot Millennium, E-tabs, and others. I have also had the opportunity to see how BIM can affect more than just industry with how it can impact education, as my master's thesis illustrates.

I currently work at Martin/Martin in their construction services team helping produce shop and fabrication drawings and also assist in the development of project standards for the firm.

**Dezi Mackey – Martin/Martin**
Desirée (Dezi) received her bachelor's degree from University of California, Davis and her master's degree from Massachusetts Institute of Technology and now is a practicing structural engineer at Martin/Martin in Denver, Colorado. In the past several years she has been a regular Autodesk University speaker and has spoken at Revit Technology Conference USA. In addition she is the Chair of the Structural Engineers Association of Colorado's BIM committee, and she is currently serving as an AUGI board member as well as Treasurer. Finally, she also acts as a partner in her husband's BIM consulting company, BD Mackey Consulting.
Rebar General Notes

Rebar can be fickle with covers and snapping. You can often find rebar that has snapped oddly to other rebar or to covers which will then give a undesirable bend length such as one with a 256" rounding. For CD's this may be acceptable, but for shop drawing and fabrication lists this can cause issues.

Cover Settings:

For most rebar detailing setting your cover requirements should be one of the very first steps. There are three primary ways to adjust cover for an element.

-First is by adjusting the cover in an elements properties

![Element Properties](image)

This is typically the quickest way to modify cover setting of an element, but does not give much freedom as most (if not all) elements only give 3 faces to specify. Such as Inside Face, Exterior Face, and Other Face for a wall. This allows you to define the two primary faces, but then forces the remaining faces to be defined the same (top, bottom, left side, right side).

If cover has been defined differently for one "other" face than the rest, the properties will show this as "None". This also happens when an element has merged with another element such as a column merging with a wall or a beam merging with a slab.
-Second is by specifying the cover of an element in the "Edit Rebar Cover" tool.

This option really only works well with elements that have a consistent cover on all sides, such as a column or elevated slab.

-The third primary way of specifying the cover is by picking faces in the "Edit Rebar Cover" tool.

This gives great flexibility to specify the cover of each face. This then allows you to have a different cover for all 6 main faces of an element. To use this or the element cover tool, first select the element/face you would like to manipulate then use the Cover Settings drop down to change its cover.
To personalize your cover settings you can either access it through the ellipsis on the "Edit Rebar Cover" options bar or use the Rebar Cover Settings under the Reinforcement drop down.

A few last things to note, with Rebar cover is that you will be unable to host rebar in an element such as a wall that is 6" thick that has a 3" cover set to each face. To Revit, this leaves no space for Rebar. This is one of the reasons that cover should be one of the first things you look at when modeling rebar in an element. A lot about how rebar acts and reacts to model changes is based primarily on how the bars interact with the cover.

Introduced recently in Revit (either 2012 or 2013) is the ability for tie reinforcement to be pushed outside of cover. This does seem to comply with ACI in that typically smaller bars have a smaller cover requirement than larger bars. This seems to be atypical in practice for detailing, so will not be explored further here.
Rebar Family Editing:

Rebar family editing is pretty different from normal family editing. When editing a rebar family be sure to watch the shape status as it will tell you issues with the bar such as an undimensioned leg or a dimension being driven by a formula. Neither of which are allowed when loading a bend into a project.

The following images show the warning under the shape status that is given when there is not a dimension for each leg

The next images demonstrate the warning given when a dimension used to define a leg of Rebar is being controlled by a formula. (Note that the E leg is set equal to the C leg)
New in 2013 is the ability to drive a leg by an angle rather than by three legs of a triangle, typically "H" and "K". This method has to be in place of the triangle method not in addition to.

**Other General Rebar Notes:**

Grouping bars can cause the rebar to react differently than when not in a group. When changing some leg lengths of a group piece of rebar, the change will keep the end of the leg and push the rebar rather than keeping the rebar and just extending the leg. See below:

Also, keep track of the primary leg in Rebar families. This is the leg that stays consistent when switching from one bar to another, even if the leg dimension is different.
Rebar Extensions

IDAT

The first Rebar extension we are looking at is from IDAT. The primary thing to note about IDAT's add-on is that it is primarily for precast elements rather than cast in place. When using IDAT on CIP elements, it will just prompt that at least one element material type is not set to precast concrete. However, this is just a warning and IDAT will still reinforce the element.

There are two primary draw backs when it comes to using the extensions for Rebar. First, is the developer of the program will not be able to come up with every single way that an element may be reinforced. As seen below for a column reinforcement, IDAT only includes 3 different layout options, and these may not be the layouts you are looking for when detailing a column.

This issue is true for many of the element types in IDAT. IDAT is a quick tool to generate generic bar configurations, but is not really customizable to a firms typical detail reinforcement configuration.

The second issue is how it generates the bars. When modeling it is typically best to stick to ASA and CRSI shapes so when it comes time for fabrication things are frailly standard and typical. However, with IDAT, many of the bars will be generated as shapes such as "Rebar Shape 1" rather than correctly calling out a CRSI shape.
Autodesk Revit Extensions.

The second extension is the standard Autodesk Revit Extensions. The ARE reinforcement tools are much more robust than that of IDAT’s and allows for much further customization of bar configurations. In a column, IDAT prompts for standard tie configurations, you are given 3 choices to chose from and that is all (this does make sense for a precast tool). ARE however brings up a dialogue and allows the user to specify vertical reinforcement, stirrups/ties, dowels, bar distribution, and more.

This ability seems to be much more useful for CIP reinforcement, and does give a little more flexibility. However the two primary issues that arise with IDAT also come up with ARE. For a column, ARE only gives 4 reinforcement options, and these four seem even more atypical than those from IDAT. The fourth configuration consists of two U bars lapped together, personally I am not sure if this configuration even meets code requirements for column reinforcement.
Also, as with the IDAT extension ARE does not seem to be able to pull a CRSI bar shape for many of the different bar configuration and instead labels the majority of the bar shapes as "aci" bar shapes. This makes this difficult to schedule the reinforcement accurately for fabrication.

It really is hit or miss with both of these extensions, one of the nice features from IDAT is that it does create the bars in an assembly which can then be used to create the shop drawings from this. Overall with either of these extensions they just do not seem to provide enough flexibility to conform to company standards and bar configurations and do not really stick with the CRSI shapes. They both generate reinforcement extremely quickly, but if the user is going to have to go through and touch every bar to fix them for scheduling or to create correct configurations, it does not seem as worthwhile.
Path/Area Reinforcement

In the past (prior to Revit 2013), path and area reinforcement was really only useful for CDs for documentation, but for Shop and Fabrication it was not very useful at all since it was not able to be scheduled. Though in 2013 we are still not able to schedule area and path reinforcement, Autodesk has taken it beyond that, but allowing these tools to host 3D Rebar. The first thing that needs to be know about this ability is that in this ability is an option in the Reinforcement Setting. However this option is selected when the first time area/path reinforcement is used is then stuck that way until all the area and path reinforcement are removed from the project.

The Area and Path Reinforcement settings in this dialogue allow you to change naming conventions for tags. IE , the ability to tag a bottom bar as BOT, Bottom, B, etc.
Creating area and path reinforcement is fairly straightforward. Especially since 2013 with the ability for path and area reinforcement to host 3D reinforcement (which makes it schedulable) area and path reinforcement is now an extremely quick and effective way to model mass rebar in elements such as wall and slabs. To start, select the type you would like to utilize. (Either area or path).

Next you will need to select a host element. Currently (Revit 2013), only slabs, walls, and slab foundations are able to host area and path reinforcement. Though this should be able to cover the majority of mat type reinforcement, the only two that it may be missed on is wall foundations and isolated foundations.
After selecting a host for the reinforcement, Revit will open a sketch editor and require you to sketch either a path or area for the reinforcement. When sketching for area there is no need to have an inner sketch to form openings as long as openings have been modeled, though it is allowed to have loops within other loops.

One glitch that has been reported to Autodesk is openings in walls that cut through reveals and/or sweeps are not always recognized by area reinforcements. So in some cases the reinforcement will ignore the openings and will run through. This issue is most common when dealing with precast panels that have reveal chamfers built into the wall type.

To modify the information about the area/path reinforcement, utilized the properties when having the area/path selected. Path allows only a single layer, single direction of bar. Area reinforcement allows a set of steel in each direction on each face of a selected element. Each of which can be controlled independently of each other. When sketching the area reinforcement it is important to not which direction is the major direction. Currently the two mats that form area reinforcement are required to have the same major direction.
This means it is not currently possible to have a set of East-West bars both run as top steel and North-South bars run as bottom steel in a slab by using Area Reinforcement. This may not be all that common, but does happen. (See image below)
For the most part area and path reinforcement are extremely quick to model mats of steel. One other drawback is the inability to give a maximum bar length and splice length requirements, making them a little more advantages for CDs where laps are typically covered by notes and not modeled accurately as they might be for shop drawings. However, area reinforcement's ability to adaptively change when openings are changed, moved, or deleted makes it much quicker than manually detailing bar around every opening.

One final note for area and path reinforcement is that copying area and path reinforcement can be difficult especially when copying to different hosts, as it not always able to recognize the new host. This is just something to be aware of when utilizing.
3D Rebar (referred to as just rebar in this section)

3D Rebar gives a lot of flexibility to modeling rebar in Revit. Though there are many other tools both added on to Revit and outside of Revit that allow for Rebar detailing and all have their places, the use of the 3D rebar tools gives a near unlimited ability to detail most elements and allows the users to self maintain the information about the reinforcement. (This can be both good and bad). In general, when utilizing Revit as a modeling tool rather than a drafting tool, it can help designers and detailers understand and see the designs more clearly and help aid in decision making especially when it comes to constructability. This is really no different with rebar in Revit. Having to dive into the bar manually and look at how bars are configured, look at pour breaks, and other construction means and methods can aid in understanding the process, more so than having an automated tool that will do all the thinking and just throw bar in.

Placing Rebar:

One of the first things to know about rebar in Revit is that it really needs to be placed in sections of an element. So for walls, beams, slabs, and other more horizontal elements, reinforcement should be initially placed in a section or detail cut through the element. Columns and drilled piers however are more easily detailed initially from plan. The image below shows trying to place reinforcement in a wall from elevation.
As stated earlier in this section, manually detailing rebar gives a lot of flexibility. In areas where it would easiest to extend lap lengths or filed trim bars, many tools may try to over customize. One such example would be at a curved slab edge. Many auto tools will customize a bar around the curve which will cause nearly every bar to be different than the next or previous bar. This may not be the most efficient way for those placing the bar or ordering the bar.

**View Visibility States:**

The next thing to know about rebar is it's "View Visibility States." In view visibility states there are two primary check items. The first is "View unobscured," this option allows the particular bar to be shown through other elements in hidden line. Since rebar is nearly always hidden by the face of a host element, this can be useful to show select bars without having to go to wireframe and show all bars and elements. The second is "View as solid". This only applies to 3D views, and is the only way to show a bar extruded rather than with a line. For this to work the bar property has to have the view as solid checked, and the view must be set to Fine Detail level.

By default the view a bar is created in is automatically checked as view unobscured. So, in a plan view you are copying around slab bars, all of the bars copied in that view will be shown through the slab. Also, the View Visibility States dialoged does not take to key strokes, so typing in "Level" to quickly get down to a view name beginning with Level does not work. When projects start to get many views this can be a nuisance. As for the other views that are automatically set to unobscured and those that default as view as solid, I have not seen an consistency as to why some would be defaulted to checked over others.
Exporting to Navisworks:

In Navisworks 2013 there are now 4 options to bring Revit models. The first three are all directly through navisworks. Navisworks view will import the first view in Revit that contains the word Navis. The First 3D View brings in the first 3D View from the Revit file, although it is unclear what it means by first since in Revit the browser can be set up to alter what 3D view shows first. The final way directly in Navis is Entire Project, I believe importing rebar using this method brings it in as only 2D lines, and not extruded Rebar.

So with this, the easiest way to be sure of what you will be getting in Navis when it comes to rebar is to just export the view(s) that you would like from Revit using the exporter (the 4th way). The reason for this is because for rebar to be exported well into Navisworks it should be set to "View As Solid" to be exported and the view must be set to Fine Detail, because of this there is much more control when going into a view and exporting. Part of this issue comes with that the view as solid parameter is a bar instance parameter rather than a view parameter, so all of the bars wanted for exporting need this selected, rather than just quickly setting the 3D view for all rebar. Since the user still has to go into a specific view and set these parameters it just seems easier to then just export the view as it has been done in the past. There are a few ways to export Rebar as line rather than extruded, though I am not too sure of much use for this.
Modeling Rebar:

As stated above, when starting to model rebar it is best to go into a view cutting the element being detailed. When just starting to place bar in an element there are many things to consider.

The first (other than cover) would most likely be the general rebar information such as rebar shape which can be selected from the options bar and rebar size (properties box). The ellipsis in the options bar next to the bar shape opens and closes the "Rebar Shape Browser" which shows images of loaded bar shapes.

Next, select the layout of the rebar. (The ability to pre-select a rebar layout prior to placement is new to Revit 2012). In previous versions, bars had to be placed and then manipulated. The options for this layout are Single, Fixed Number, Maximum Spacing, Number with Spacing, and Minimum Clear Spacing. Fixed number does not allow the user to input "1", however Number with Spacing does.

One last thing to consider before placing the bar is the placement orientation. For a column in plan, Parallel to Work Plane is what should be selected for ties.
The other two options, Parallel to Cover and Perpendicular to Cover change the direction bars are placed based on the cover of the element. For elements such as walls and slabs, Perpendicular to Cover is most likely to reinforce along the length/height of the element unless reinforcing the end of a wall or the side face of a slab. (Parallel on Left, Perpendicular on Right below)

Once all of these are set, just click once the preview shows what you are looking for. After rebar is placed all of these options are still available to change, so it is not necessary to set all of these during placement, it can just make it easier. Many times after the first few sets of rebar are placed I find it easier to copy around bars and manipulate these properties, this way any information I put in the bar parameters such as comments, pour information, etc can be copied around quickly rather than having to rekey all the same information.
Assemblies

Overview:

Assemblies were first introduced in Revit 2012, however it is not my recommendation to use them in Revit 2012, and instead hold of using them until Revit 2013, where Autodesk made many improvements to assemblies making them much more flexible and much more user friendly. In 2013 there were many significant improvements made to assemblies, here are a few:

- Unlike groups, modifying an assembly that has multiple assemblies already modeled will make a new assembly of the one changed and leave the duplicates unchanged in their prior form. In 2012 this meant that all older copies of an assembly needed to be deleted and recopied. In 2013, it is now possible to select an assembly and change its type.

- In 2012 assemblies views were restricted from typical sheets and non-assembly views were restricted from assembly sheets. This restriction has been lifted in 2013, allowing for the views to be intermingled.

- Similar to groups, assemblies in 2013 now allow elements to be modeled while in the Edit Assembly mode. In Revit 2012 the only functionality that really existed inside the edit assembly mode was to add and remove elements from the assembly, and all model tools were disabled.

Groups vs Assemblies:

Groups and assemblies have many similarities, but with rebar there are a few key differences. The first being that groups constrain rebar significantly, rebar in groups do not really interact with hosted elements the way free and do not have comply with set cover requirements the way assembled rebar do. If the model is changed, for the most part the bars in a group will stay put and not change with any model changes. In assemblies, if a the host element changes for bars in an assembly, the bars in the assembly will follow just as they do outside of the assembly. (This functionality depends greatly on correct use of covers). The bars are also required to adhere to set rebar settings of host elements. Each has their place with rebar detailing.
Assembly Views:

There are two primary assembly view types, the detail views (plan, sections, etc) and schedules. The views in the assemblies work just like those outside assemblies when you consider that they are primarily detail views including the plan cut, so when adjusting a plan the typical play information Top, Cut Depth, View Depth, and Bottom are not available. The other noteworthy nuance with assembly views is that they will only show elements in the assembly, which means a host element needs to be included in the assembly to show more than just bars floating in space. This creates difficulties when working in the CD's model when doing shop drawings. Also, annotation elements such as grids and levels are not included in assembly views and are not allowed in assemblies. (Below shows an example of an assembly view where the host element is included in the assembly, and one where it is not)

Assembly Schedules:

Currently with Revit 2013 the stance I have towards assembly schedules is not to use them. The primary advantage to an assembly schedule is that it is pre-filtered based on the assembly so that only elements inside the assembly are included. However, to rectify this in a normal schedule all one has to do is filter based on Assembly Type and then they have full schedule functionality.

There are two primary issues with assembly schedules currently, the first is that they are set to some default on what is populated when a schedule is made. Each time an assembly schedule is made it defaults to a few particular values. In a project that may have 100s of assemblies this means all of the fields needed for rebar assemblies has to be manually changed for all 100
assemblies. Since assembly views can be placed on typical sheets and typical schedules can be placed on assembly sheets, having to manually manipulate each schedule when one can use the assembly type to filter normal schedules and then can duplicate to quickly create the 100 types.

The second issue with the assembly schedule is more for rebar than other elements. The assembly schedule is really a multi-category schedule and because of this there are a few fields that are not available in them. For rebar two of these are Shape (the parameter that says what CRSI shape it is) and quantity (the parameter that says how many bars are in a set of rebar). For rebar these two parameters are essential, so this alone really makes assembly schedules not viable for Rebar even in someone was willing to manually make all 100 schedules.
Best Practices

Using Spacebar:

The use of spacebar to rotate rebar around a host is not typically the best practice. There have been instances in which using the spacebar to rotate the bars around will swap leg dimensions. This becomes an issue when giving marks to bars. Two bars may be exactly the same in their form, but vary only on the leg dimensions. For example, the blow properties show a bars that are L shaped bars and are essentially the same bar other than the legs are swapped. This would typically result in two different bar marks for bars that are the same in reality.

CRSI and ASA Shapes:

Revit does allow users to sketch out odd shapes for rebar such as that seen below, but is it really practical? Just because we can sketch it in Revit, does not mean it can be easily fabricated.
Since the typical goal for doing 3D rebar in Revit is fabrication and layout drawings, why draw something that is difficult to fabricate when the standard CRSI and ASA bar shapes work 99% of the time.
Note that in the 2011 edition of ACI 318 the typical circular tie requirements have changed for column reinforcement. CRSI has yet to fully address this change since this is in a sense creating a new bar shape. In a typical T3 tie G is given for the lap length, but on ties with hooks A and G are used for the start and end hook lengths.

ACI 318-11 – 7.10.5.4

Where longitudinal bars are located around the perimeter of a circle, a complete circular tie shall be permitted. The ends of the circular tie shall overlap by not less than 6” and terminate with standard hooks that engage a longitudinal column bar. Overlaps at ends of adjacent circular ties shall be staggered around the perimeter enclosing the longitudinal bars.
Workarounds and Shortcuts

Here are a few other tips and tricks that I have found along the way or that others are doing that help them when using rebar in Revit. First, Rebar adds a large amount of information to a model, when modeling in the same file as the CD's it is typically best to put the reinforcement on its own workset purely to allow those working on only CDs and not shops to turn off the rebar workset and improve their model performance.

As stated before, worksets are really required for models that hold both the CDs and the shop drawings, however many firms are breaking out the rebar into a separate file and keeping two models. This can help the file performance for both parties significantly. Some oddities with grouping rebar is that the error "Last member of group instance was excluded" is given regularly even though the error is not correct.

Though groups constrain bars completely, this can be necessary to keep bars from snapping to odd covers and other bars which can give irregular bend lengths. This does then keep the rebar from being adaptive to the host element and then allows the bars to ignore cover. Grouping the bars can be both a hindrance and aid.

Lastly, use schedules to your advantage. Schedules are one of the most under used tools inside Revit, and users seem to forget that schedules can be used to push information to the model and not just read information. Be wary if using groups and schedules, because if a group is used more than once, the schedule cannot then be used to push information through. It can be extremely useful to set up starting schedules for typical schedules as well as having schedules pre-setup for other rebar management type tools such as bar marks, keeping track of epoxy coated bars, and keeping track of A706 rebar.
Limitations and Advantages

Limitations:

- It can be extremely slow and tedious to detail all the rebar manually when compared to the extensions and other tools such as Tekla. However, the flexibility to model odd geometries is beneficial. When it comes to Rebar shops there are three primary processes, the first is the review of the CDs to make sure all the bars are known. The second is the rebar modeling. Lastly is the detailing of the modeled rebar. For the most part Revit has little disadvantage over any other methods when it comes to the first and last portions. So really it is on the modeling side where the difference is, although there are areas to the detailing of rebar that could use improvement to help efficiency.

- The next limitation really goes without saying. If every element is detailed fully with the correct reinforcement and it has been thoroughly detailed the files can become slow and difficult to maintain. Currently any project that has rebar being detailed in it, requires at least 12gb RAM at least get through the model reasonably.

- Lastly, and probably the biggest drawback that I see is that rebar is not able to be nested into families. Without really getting into detailing a lot, it may not seem as though this is that critical, but having the ability to nest Rebar into beams, columns, drilled piers, caps, and spread footings would really change the game when it comes to rebar in Revit.

Advantages:

- Modeling rebar in Revit gives a great sense of how things can be put together. As said earlier, modeling rebar in Revit really requires a lot of thought regarding construction and process. When a program just throws rebar in for the detail the ability to see conflicts and other constructability issues can be easily missed.

- 3D rebar also allows coordination with lift models and other models for coordination. Coordinating lift drawings and embed plate drawings can become a much smoother process with rebar is modeled using a tool such as Revit.

- When the process is detailing rebar is coordinated correctly, construction schedules can be greatly reduced.