Producing Shop Drawings Out of 3D Reinforcement Models in Revit Structure

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SE5174

An important part of the Building Information Modelling (BIM) process for concrete structures is the derivation of 2D shop drawings from the 3D reinforcement model. This model is more or less the same worldwide; shop drawings, however, may be presented in many different formats. This class will show you how to use Revit Structure software together with SOFiSTiK Reinforcement Detailing to easily produce shop drawings and schedules out of Revit software models that contain rebar. Learn how to use individual content to meet requirements of different markets and company standards. A second part of the course will cover the creation and modification of the required families.

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

- use Revit Structure software for reinforcement design
- derive shop drawings and schedules from a 3D rebar model
- create local content to fulfil local requirements for deliverables
- understand the philosophy behind SOFiSTiK Reinforcement Detailing

About the Speakers
After receiving his diploma in structural engineering at Technical University in Munich, Thomas has worked in structural engineering and software development for over 30 years. He is the co-founder and CEO of SOFiSTiK AG, a leading German supplier of software for analysis, design, and detailing of structures. He was on the board of the German section of buildingSMART® for more than 10 years, and chaired the working group “Innovations” of the Bavarian chamber of building engineers. Whenever time allows, he loves to fly balloons and to sail.

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Armin studied structural engineering at Technical University in Graz, Austria. During this time and the first 3 years after receiving his diploma, he worked for several structural engineering offices. Afterwards he started a career as trainer and consultant for Autodesk® Software. Today he is known as one of the top experts for Autodesk® Revit® Structure in Europe. Since 2010, he works exclusively for SOFiSTiK successfully promoting BIM using Autodesk® Revit® Structure technologies.

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Introduction
Autodesk® Revit® Structure projects may be populated with reinforcement elements in several ways: It is possible to use native Autodesk® Revit® commands, tools like Revit Extensions or tools which use design results to automatically insert reinforcement cages like SOFiSTiK Reinforcement Generation. Producing 2-D drawing sheets out of the model is a special case, as reinforcement sheets generally display a symbolic presentation of rebars and fabric sheets instead of a physical view or section. Another problem is that the rebar is symbolically presented differently in the various countries around the world and sometimes it is even presented differently within a particular country.

In this lecture, a simple slab with supporting beams will be used to demonstrate the steps in the process.

Creation of Rebar

Creation with Revit
Rebars can be created within Revit with several commands which complement each other and may be used together:

- Single rebars and rebar sets can be created by selecting a host element and a layout rule (Single, Fixed Number, Maximum Spacing, Number with Spacing or Minimum Clear Spacing). The bar shape can be chosen from a list of shapes loaded in the project or it can be sketched individually. This works for linear members like beams or columns as well as for planar members like walls and slabs.
- Path reinforcement works with planar elements only. The user has to sketch a path which is the evolution line of rebars. This command is useful for edge reinforcement of slabs and walls, however only straight bars are possible at present.
- Area reinforcement is useful to easily distribute 4 layers of reinforcement in irregular shaped slabs and walls. Functionality is limited, as there can only be one diameter and one spacing per layer. The area system may be removed which results in several rebar sets. These sets may be edited as necessary.
- Finally there is the possibility to use Fabric Sheets. These are factory welded sheets with rebars in two directions. Fabric Sheets are commonly used in several parts of Europe.

Creation with Revit Reinforcement Extensions
Autodesk offers several tools for standard tasks like reinforcing slab corners, slab holes, spread footings, pile caps and piles as well as for walls, beams and columns. Required reinforcement has to be defined in dialogs by the user. These extensions can be downloaded from Revit Subscription Center.
SOFISTiK Reinforcement Generation
This tool uses analysis and design results, either from Revit Results Packages or from the SOFISTiK database and creates all reinforcement required from design for beams, columns, walls and slabs. Users may decide on the base reinforcement quantity and additional reinforcement is added according to certain rules reflecting requirements from standards or local practices. For details see Lecture SE1669 from AU 2013.

Creation of Shop drawings
It is very difficult if not impossible to produce proper shop drawings with pure Revit Structure. SOFISTiK Reinforcement Detailing is a software developed to accelerate and simplify this process. It can be downloaded from Autodesk Exchange Apps.

Bar marks
In most countries bar marks are numbered per drawing sheet, e.g. bar mark #1 on sheet 1 is generally different to bar mark #1 on any other sheet. Consequently rebar schedules are produced for each single sheet separately. To achieve this behavior, each rebar has to be assigned to a sheet. In Revit a sheet is composed out of several views, which can only be on
one single sheet. Therefore all visible rebars on a certain sheet can be assigned to this sheet with one simple command. In case there are rebars visible which are already assigned to another sheet, a warning will be given and the user has the choice to disregard this rebar for the current assignment.

After assigning rebars to a sheet, bar marks can be created with a simple command.

**Running Length**

In many cases it is desired to cut rebars on site according to the formwork. These rebars can be marked as “Running Length”. Regardless of their length in the model, there will be one rebar in the schedule per diameter only. The length is the added length of all rebars marked as running length with a certain diameter.

**Filters to display top and bottom layer separately**

In many cases it is desired to display top and bottom reinforcement of slabs in two different views. To achieve this, a parameter has been introduced which indicates the layer of each reinforcement element. This parameter can be set by the user or automatically within the software. SOFiSTiK Reinforcement Generation fills this parameter automatically, whereas in Reinforcement Detailing we have a tool, which determines the layer and writes this information into the parameter.

With Revit Filters this parameter can be used to control the visibility of each rebar according to the content of the parameter.
Adjust, Stretch, Split and Browse
SOFiSTiK Reinforcement Detailing includes a set of tools which enhance productivity and complement the functionality of Revit Structure.

A rebar set can be exploded, the resulting rebars may be stretched to the cover of a suitable face of the rebar host.
In some cases rebars should not be perpendicular to the driving line of the set. For this there is an easy way to rotate a set of single bars around the definition line of the set.

Revit can create straight rebars of any length. In most cases this length is limited on site. There is a command which splits rebar sets using different rules. A staggered split pattern provides laps in rebars in different positions.

Visibility of rebars (view unobscured or view solid) can be defined in Revit for each view. To switch this for all rebars in a view can be very time consuming. To assist with this there is a small tool helping users to set this behavior for all rebars in active or all views in one step.
A useful tool for checking bar marks and assignment of rebars to schedules is the command Browse. All instances of a selected bar mark or of all bar marks assigned to a certain sheet are displayed in red. In addition all rebars not assigned to a sheet can be marked with this tool.
Annotation of Rebars

Around the world, the annotation of rebars are treated differently. Annotation of rebars in sections are normally placed outside the section whilst annotations of slab and wall reinforcement can be inside. SOFiSTiK Reinforcement Detailing attempts to automate this process in a way that all annotations are clearly readable.
**Rebar Tags**

Rebar sets with a single rebar are annotated with an annotation object with a leader line. For sets with more rebars a combination of a dimension element and an annotation object are used. To achieve proper placement of annotations, SOFiSTiK Reinforcement Detailing uses the offset of the bounding box of all selected members.

**Hide and Tag**

For clarity, not all rebars of a rebar set are normally visible on a shop drawing. For this, 3 different commands are available:

- First is “Hide” which makes the original rebar set invisible on the sheet and inserts a detail element displaying the rebars which shall be visible. This functionality has been introduced by Revit 2015.
- Second is “Hide and Tag”, which hides all rebars but one and annotates this rebar with a distribution line.
- Third is “Hide and Detail” which additionally displays the bar shape turned into the drawing plane.

In all three cases the detail elements are automatically updated in case the rebar set has been changed.

**Customization**

**General Remarks**

SOFiSTiK Reinforcement Detailing was designed as flexible as possible regarding the customization of representation. Only the bar mark recognition had to be hardcoded. All other content are native Autodesk® Revit® families, which can be modified by users without programming skills.

**Customize rebar shapes**

Say we would like to create a rebar shape with a parameterized angle instead of the length [B].
We will use a standard rebar shape from the UK Template (*Structural Analysis-DefaultGBRENU.rte*). The shape we use is the Shape Code 15, which we will find it in the Project Browser under: *Families -> Rebar Bar -> Rebar Shape -> 15.*

When we edit that family we get into the family editor where we can see that even a Parameter [D] is defined which normally should produce a warning due to over constrain. However, this does not happen.

When we add a new angular dimension and apply a label to that, we can easily parameterize the angle of the leg [A].

Nevertheless, the behavior by changing some values of the parameters is not what we expect. When we modify the value of parameter [A] we would suppose that the parameter [Angle] remains unchanged. However, this is not the case, because the variation is dependent on the creation order of those parameters.

Therefore, best is to delete all dimensions, which are not necessary …
... and define corresponding formulas for additional parameters.

Customize rebar annotations
As mentioned before, we have full flexibility to change the look and feel of the annotation elements within Autodesk® Revit®. This gives users the possibility to use the tools for projects in any country they like. If required, the shape code information can be easily shown in the annotation by simply modifying the annotation family in the project.

All the annotations in the project are changed. If this is not desired, the family can be modified in a more sophisticated way. We simply create an additional label in the family, assign a visibility parameter, and duplicate the family type and specify different visibility states for each label object.
We can add as many labels as we like and assign them to different family types. An additional example could be a family type showing only the bar mark within a rectangle, which is, especially in UK, often used to tag rebars in cross section views.

**Customize the Hide&Tag element**

With the SOFiSTiK Reinforcement Detailing we use detail families to do a symbolic representation of rebar layouts in views. By default the representation looks like the following picture.

Using specified parameters users can control, for example, the number of rebars at the start and the end of the layout. Also the location of the dimension line is controlled by parameters.
Nevertheless, if we want to change the appearance of the "Hide&Tag" element, we need to edit the detail family. It is possible to change some parameters like the angle of the arrows direct in the family or to add for example a solid fill pattern inside the triangle of the arrow.

To modify the circle tick mark we must modify a nested family inside the "Hide&Tag" family. For example we can easily change the circle into a square.

If it is required that the tick marks are displayed where no rebar is displayed, we simple place an additional tick mark and create an array along the dimension line. For the array we need an additional parameter to define the number of tick marks.
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We can calculate the number with a simple formula in the family …

… and after loading the family back into the project, we get the following figure as result.

With an additional visibility parameter we can even control the visibility of those tick marks directly in the project for each instance of the detail families.

Customize the shape rebar detail
In Germany, for each rebar shape in the drawing, a so-called rebar shape detail is drawn on the sheet. In other countries this is required only for non-standard shapes, which are referred to as 99-shapes. For standard shapes the user can provide his one detail family (taking into account certain rules), but for 99-shapes the software will generate the family automatically in real-time. Nevertheless, we have possibilities to modify the representation of that object.
A reddish line represents the shape of the rebar and the lengths are described with text on the individual legs of the rebar.

We can simply modify the object style of that element to use a different color and/or line.

Of course we can also add additional dimensions like angular dimensions to that element.

**Bar schedule with customized Excel Template**

Although Revit Reinforcement schedules can be customized easily and can display almost any information available in a model, printing these schedules on A4 or letter sheets is not easily achieved. This is why the next version of SOFiSTiK Reinforcement Detailing will introduce a
new possibility to produce rebar schedules as Excel sheets. These sheets can be customized by users and can even contain dimensioned sketches of all of selected bar shapes.

**Conclusion**

Using Autodesk® Revit® Structure complemented with SOFiSTiK Reinforcement Detailing allows users to distribute reinforcement elements in BIM models and to produce shop drawings out of these models. Shop drawings can be adapted to local customs and needs. Although most of the features needed have been implemented with version 2015, further development of both products is necessary to close still existing gaps and to make users even more productive. Autodesk® and SOFiSTiK are collaborating closely to achieve this common goal.