The best rebar detailing tools for Revit

Alan Johnson
GRAITEC UK Limited

Joseph Pais
GRAITEC INNOVATION

Learning Objectives

- Generate parametric 3D rebar cages in few clicks
- Stop wasting time generating rebar schedules, do it in few seconds
- Get quantity takeoff for the entire rebar project
- Automate more, generate design driven rebar cages

Description

In this class, you will discover a set high-end effective tools to power-up your Revit for rebar projects management. You will see firsthand how to generate parametric 3D rebar cage within few clicks, save rebar cages templates and apply them on any new projects. We will see also how we can speed-up your daily job to create bending details on drawing views, to generate automatic Revit rebar schedules including bending schemas, to create reinforcement drawings based on user’s template, renumber all your rebar model and manage the rebar data to extract the status of the element or the quantity takeoff of the entire rebar project. We will apply all those productive tools on beams, columns, footings, shear walls, slabs managing complex geometries such as openings, depressions, continuous beams...

We will end the class also showing you the last level of rebar automation embedding the reinforced concrete design of the members within Revit automating the creation of designed 3D reinforcement cages in Revit, whilst using standard Revit families to configure automated drawings, views, bar schedules and comprehensive design reports
Speaker(s)

Alan Johnson- BIM Consultant at Graitec UK, as a BIM Consultant with over 20 years’ experience in the construction industry covering; Architecture, Structural Engineering, Civil Engineering and Demolition. Alan started out as a draughtsman using a drawing board and progressed to 2D CAD and then on to 3D CAD. Alan worked for several Architectural and Structural practices as a draughtsman / technician and spent many years working in Demolition as a structural technician. Alan now works for Graitec as a Consultant mainly providing training / consultancy and has over 6 years’ experience in software training, including Revit, Navisworks, (and Tekla). Alan is currently an Autodesk Certified Instructor and obtained a BTEC HNC in Building in 2003.
alan.johnson@graitec.com

Joseph Pais - Product Director at GRAITEC INNOVATION in charge of all internal products and also provides dynamic analysis and reinforced concrete consultancy to highly skilled GRAITEC customers. A structural engineer with 20 years’ experience in the AEC industry. Joseph started his career working for the French SNCF Company on the “Concorde Lafayette” train substation. Then, in 1997, he moved to GRAITEC France as a structural engineer doing demos-training-projects on the internal calculation software’s. Joseph has also taught dynamic analysis and reinforced concrete design for more than 10 years at the French university, Conservatoire National des Arts et Métiers (CNAM).
joseph.pais@graitec.com
# TABLE OF CONTENT

**THE BEST REBAR DETAILING TOOLS FOR REVIT** ................................................................................................................. 1

LEARNING OBJECTIVES ........................................................................................................................................................................ 1
DESCRIPTION ....................................................................................................................................................................................... 1
SPEAKER(s) .......................................................................................................................................................................................... 2
INTRODUCTION .................................................................................................................................................................................... 5
REVIT NATIVE REINFORCEMENT TOOLS .............................................................................................................................. 8
GRAITEC BIM DESIGNERS ................................................................................................................................................................. 11
  General concept ................................................................................................................................................................................ 11
  What are the benefits of applying a BIM Designers module within Revit®? .................................................................................. 12

BIM DESIGNERS DETAILING TOOLS ........................................................................................................................................... 15
  Revit Geometry management .......................................................................................................................................................... 15
  3D parametric rebar cages ............................................................................................................................................................. 19
  Copy rebar cage/Delete rebar cage ................................................................................................................................................. 22
  Transversal distribution ................................................................................................................................................................. 23
  Bending detail .................................................................................................................................................................................. 23
  Schedule Schemas ......................................................................................................................................................................... 24
  Set Rebar Number/Renumber Reinforcement ........................................................................................................................ 26
  Browse Reinforcement ................................................................................................................................................................. 27
  Rebar Visibility ............................................................................................................................................................................... 27
  Intelligent edit tools for reinforcement ...................................................................................................................................... 28
  Symbols and Dimensions .............................................................................................................................................................. 29
  Reinforcement drawings creation ................................................................................................................................................ 30

HOW TO AUTOMATE THE 3D REBAR GENERATION IN REVIT®? ............................................................................................. 33
  Transfer FEM results in Revit®? ................................................................................................................................................... 34
    Connect Advance Design® from GRAITEC with Autodesk Revit® .................................................................................................. 34
    Autodesk Revit® and the analytical model .................................................................................................................................. 36
  FEM results calculation – Link with Advance Design® ........................................................................................................... 40
    Export from Revit® to Advance Design® ................................................................................................................................... 40
    Saving back those results in Revit® ............................................................................................................................................ 46

AUTOMATICALLY PRODUCE THE DESIGN-DRIVEN 3D REBAR CAGES .................................................................................... 50
  Geometry definition ....................................................................................................................................................................... 53
  Loads and combinations ................................................................................................................................................................. 55
  Design and Reinforcement assumptions ....................................................................................................................................... 60
  Design-driven 3D rebar cages ....................................................................................................................................................... 64
  Generate automatically the reinforcement drawings ..................................................................................................................... 70
  Optimize the project with Design groups .................................................................................................................................. 71
  Manage the continuous Beams ..................................................................................................................................................... 73
  Manage the maximum bar length .................................................................................................................................................. 76

PREVIEW OF SHEAR WALLS DESIGN .......................................................................................................................................... 78

EXTRACT THE 3D REBAR DATA ....................................................................................................................................................... 82
  Rebar Data Extraction using Link to Excel .................................................................................................................................. 82
  Rebar data in PowerBI .................................................................................................................................................................... 86

FEW WORDS ABOUT THE GRAITEC POWERPACK FOR REVIT® ............................................................................................ 90
  Numbering tool ............................................................................................................................................................................. 91
  Element Lookup ............................................................................................................................................................................ 92
  Tools for quick dimensioning ...................................................................................................................................................... 94
  Categories Visibility ....................................................................................................................................................................... 95
Introduction

We all agree that BIM is fast becoming the industry de facto, with different progress status depending on the countries. Independently from the time it will take, all industries are converging to the same point: applying an industrial connected BIM workflow to an entire project, bridging the gap between all the stakeholders of that project. The objective is clearly to build Better, More with Less, as explained by Andrew Anagnost – Autodesk CEO: build better to reach people expectations, build more and more to fit the demand, with less wastes!

So, on every type of project, the adoption of a transparent and easy-to-apply BIM workflow is the key to success for all companies who wish to be effective and reduce risk of errors on huge projects. No doubt, we are all convinced about that, but the reality is slightly different: the workflow between structural engineers and designers is mostly stop-start, with little or no connected design workflow. At best, it seems there is an initial transfer of model geometry, and in some cases material property data, from one party (or product) to another. Which appears to be used to get the project started and, more often than not, a one-off one-way process, ill repeated thereafter. It seems there is still a tendency to favor the communication of design changes and the sharing project materials using digital 2D or printed documentation – arguably preferred to avert liability or avoid jeopardizing the integrity of the digital model.

Now, if we speak about the rebar detailing industry, it’s even worse and we have to admit that the switch from 2D to 3D is generally speaking not yet done. Currently, design and reinforcement drawings are shared between engineers and draftsman and go through several iterations. The space in-between is not well defined and can move depending on the companies involved, the project and the country. In the RC field, the creation of these drawings is incredibly time consuming, even using existing tools which are most of the time 2D tools

Classical workflows still applied is most of the rebar projects:

- The engineer runs a global analysis and designs each element, producing a design intent drawing or sometimes a more detailed one.
- The draftsman takes over the information and produces the reinforcement drawings including all annotations. In some cases, the draftsman can define all the constructive bars which are also dependent on country codes (Eurocodes, ACI codes, CSA codes, etc.). There may be several iterations between them to manage the full engineering cycle of a real project.
At this point, we all agree that most part of the bars are produced and placed considering design requirements, meaning that the main way to automate the generation of a 3D rebar cage is to embed the design codes within the reinforcement production application.

In order to improve in a significant way, the production of the 3D rebar cages on a building, we should be able to apply the following pitch: the “80%-20%” rule.

What does mean the “80%-20%” rule!

Let’s try to see how much different ways we can identify to produce 3D rebar cages on a building:

![Figure 1: 3D Rebar Production](image)

1. We can, or let’s say we should, automate the design and rebar on standard elements without investing time too much on this part of the engineering job: This can be done using the native Revit® tools + the GRAITEC BIM Designers tools.

2. We can continue also to annotate the elements, place dimensions, create the drawing using also the out of box Revit® functionalities completed by add-ons as the PowerPack for Revit® from GRAITEC (http://www.graitec.com/en/powerpack-for-revit).

3. The user can also apply advanced technologies provided by Autodesk®, such as Dynamo, to reinforce complex 3D geometries.

In this class handout, we will detail the two first points.

Now, if we come back to the definition of the “80%-20%” rule, the production of the 3D rebar cages and the associated documentation can be automated on 80% of the structural elements allowing the engineering team to concentrate on the 20% remaining part:
Another complexity is the conception of such a technology in a time full of uncertainties. Who is able to say how the industry will adopt BIM? How long it will take?

That is why we think it is important to analyze how an adaptive technology can help users switch to a full BIM workflow. There is no doubt that today most engineers and draftsmen still use AutoCAD, eventually enriched with an add-on module, to directly produce 2D reinforcement drawings without handling a 3D rebar model. Bearing this in mind, it is clear that Revit® comes with inventive (sometime disruptive) technology which is changing this way of working. Having a 3D reinforcement model introduce new innovative opportunities to automate the reinforcement drawings starting with this 3D reinforcement model created and handled in Revit Structure®.

In this class, we will see how to switch from a 2D workflow to an effective BIM workflow based on a 3D rebar model created in Revit®. We will start with some easy to use detailing tools to power up your Revit for rebar and we will then see how to automate more the process by generating design-driven reinforcement cages. We will see how we can embed in Revit all the needed information and discover that we can, using the BIM Designers modules from GRAITEC, run the RC design within Revit and automate the 3D reinforcement cages based on the “design and loads” information now held in the Revit® software analytical model. To reach this objective, we will see that we can apply various connected BIM workflows with the same objective at the end: consolidate all this engineering data within Revit® and benefit from the all Autodesk® ecosystem to share and visualize your all project and documentation in the cloud, within the BIM360 platform!
Revit Native Reinforcement tools

Let’s first have a quick view on the Revit native tools to place rebar on elements. The objective here is not to list them in detail but just to have an overview. We can use the standard reinforcement tools in Revit to place single and groups of rebar by space or number along with area reinforcement, path reinforcement and fabric sheets:

By selecting an element, we are given the rebar tool on the ribbon and we have a Rebar Shape browser or dropdown to pick the correct rebar shape, then using placement plane and placement orientation to position the rebar accordingly. This method of reinforcement is relatively easy but can be time consuming because we will possibly be jumping between multiple views to get the correct placement.
Let’s remind ourselves of the ‘standard’ workflow to create 3D rebar cages and reinforcement drawings using the existing tools in Revit Structure®:

We have to create first the rebar objects in 2D views before being able to see them on 3D views!

**Figure 3: Manual Rebar Workflow in Revit**
1. Let’s take the example of an isolated footing from a 3D model in Revit®. The objective is to create the 3D rebar cage and the corresponding drawing inside this structural element.

2. First, we have to create several 2D views (sections, elevations, callouts, etc.) around the element.

3. Then working on those different 2D views, we can start to place reinforcement bars using the Rebar Shape Browser in Revit®. Of course, as you know, to create all the bars, we need to switch several times between the different 2D generated views.

4. We also have to place in the different 2D views, all the tags, annotations, dimension lines, etc.

5. At the end of this process, we have the final 3D rebar cage completed for the corresponding structural element.

6. The final step is to create a drawing sheet, include in it the different 2D views, defining the right position and the right scale and define manually the rebar schedule if needed.

The complete process can take quite a few minutes depending on the complexity of the elements to be reinforced. Of course, we have to repeat this work for every element to be reinforced. This is incredibly time consuming and not the most interesting part of the job for a draftsman!

So, we see that Revit® is definitively the right BIM platform to handle 3D rebar models but we see also that there is room for specific tools to powerup Revit® for rebar placement and management.

Here is GRAITEC objective with the BIM Designers!
GRAITEC BIM Designers

General concept
GRAITEC BIM Designers are the next-generation software for automation, optimization and interoperability. Combining analysis, intuitive modelling, automatic drawing and report creation, GRAITEC BIM Designers are crafted to deliver exceptional performance and design accuracy across multiple BIM and analytical software applications.

www.graitec.com/advance-bim-designers

Working across multiple software platforms, including GRAITEC Advance Design, Autodesk® Advance Steel and Autodesk® Revit®, GRAITEC BIM Designers enable users to utilize the same model and analytical data simultaneously across all supported applications.

We will see that this multiplatform approach opens broad possibilities for multiple BIM workflows, especially if we include multi-users projects.
For the moment, let’s come back on the BIM Designers concept. With easy-to-use intuitive modelling tools, comprehensive built-in analytical assumptions covering a wide spectrum of uses and customizable outputs, GRAITEC BIM Designers not only add analytical capabilities to Revit® but also automate the creation and design of the 3D rebar models, producing fully detailed documents and simplifying and supporting a complex multi-discipline model-sharing BIM exchange workflow. We will detail later in this handout the design capabilities of the GRAITEC BIM Designers in Revit.

If you remember well the beginning of this class handout, we said that on a standard building, we can automate the production of 3D rebar cages on 80% of the building:

That’s the purpose of the BIM Designers!

What are the benefits of applying a BIM Designers module within Revit®?

Using the BIM Designers in Revit® does not change or make your workflow in Revit® more complex. On the contrary, they provide the Revit® user with increased productivity for 3D rebar cage creation and 3D reinforcement drawings:

- The BIM Designers provide a set of detailing tools to PowerUp your Revit® for Rebar projects.
- BIM Designers handle within Revit® the design of the elements and the automatic generation of the corresponding 3D rebar cage. The tools generate native Revit objects!
- Automatic creation of technical documentation: design reports, details Revit® views, drawing sheets, annotations and bar tags…
- Enrichment of the BIM model in Revit Structure® with the consolidation of the entire engineering data.
These modules are integrated in Revit Structure® and all the corresponding functions are available from a specific ribbon called “GRAITEC Concrete design”

- Here is the all ribbon including the design and detailing tools, depending on the technical profile of the Revit® user:

- The 1st part of the ribbon includes the design tools dedicated to design and rebar the reinforced concrete structural members:

- The 2nd part of the ribbon includes the detailing tools dedicated to the rebar detailers using Revit®:

So, as you can see, the BIM Designers is a wide range set of tools for all kind of users, from the draftsman to the structural engineer, providing dedicated tools for each step of the project.

Nothing is magic and coming from the hat! To automate the production of the 3D rebar cages in Revit®, the BIM Designers are embedding the reinforced concrete design within Revit®. Going through the BIM Designers ribbon, you will be able to:

- Define the concrete design assumptions (code dependent) within Revit®!
- Define the reinforcement assumptions, which are also partially design code dependent.
- Run the calculation of the concrete members and access to the design results: detailed reports, diagrams, working ratios, warning and error messages…
- Produce the Revit® detail views and drawing sheets applying your Revit® drawing templates.

I am sure that you start to see the productivity increase you can get using the BIM Designers within Revit®!
Our proposal with BIM Designers is not to change this workflow with a 'standard' Revit® workflow, but to automate it:

1. We can take the same example as before - we want to create the 3D rebar cage on an isolated footing and produce the reinforcement drawings.
2. To do this, we just need to access the specific 'BIM Designers' ribbon and run the calculation of the element.
3. Then you automatically get the design-driven 3D rebar cage, the corresponding detailed calculation report, the automatic creation of the requested 2D views, the bar schedule and the final drawing sheet of the element.

With BIM Designers, you can do this with just one click - and a job that takes several minutes to do with standard Revit Structure® tools will take just a few seconds! Just imagine the huge increase in productivity you will get. That's what we call; 'innovative technologies for the service of users!'

We will deep dive in those design capabilities later in this document. Let's now focus on the detailing capabilities on the BIM Designers!
BIM Designers Detailing tools

As mentioned before, when installing the BIM Designers on top of Revit, you get a suite of dedicated tools for rebar detailing in Revit:

- Easily manage the Revit objects geometry
- Produce parametric rebar cages.
- Copy 3D rebar cages from an element to other ones.
- Create annotations
- Modify existing rebar objects
- ...

All those commands are grouped in the 2nd part of the specific GRAITEC ribbon:

Let’s now have a deep dive on those tools and see how they can boost your daily job in Revit®.

Revit Geometry management

When running inside Revit®, the BIM Designers are reading the geometry and giving the offering the possibility to change it. Looking at Geometry, we can generate new sizes for each of the following elements – footings, columns and beams. When we generate a new element size it creates it as a new type to the original element and adds it to the type selector dropdown. You can apply this functionality also on a multiple selection of objects. So, as you can see, it’s a way to change the dimensions of a column, a footing or a beam much faster than using the Revit® native commands
The same behavior can apply to columns and beams!

Of course, any property change applied in the BIM Designers dialog is populated into the Revit® native properties. All of them are synchronized Realtime!
Through the BIM Designers dialogs, you can for example easily create an opening or a depression on a Beam:

- Just select the Revit® object and click on [Geometry]:
• You get a dialog with several tabs, where you can check the geometry of the Revit® element and adjust it. Some of those parameters are “read only” because managed by Revit!

• In the [Openings] tab, you can define an opening on the beam in a few seconds:
• You can do the same to create a depression on a Beam:

I let you estimate how long it takes to apply such features on a beam using the native Revit® functionalities!

3D parametric rebar cages

You can use the BIM Designers to generate a 3D rebar cage without designing the elements. This possibility can be interesting depending on the profile of the user applying the BIM Designers in Revit®:

• If the BIM Designers are used by a technician, he will expect to generate a 3D rebar cage based of few geometric parameters without any design step.
• If the BIM Designers are used by an engineer, he will expect to fully automate the generation of the code-check driven 3D rebar cages. We flow in the next chapters.

If you want to generate a 3D rebar cage just by defining few parameters through a reinforcement wizard, it’s quite easy:

• Just select an element and activate the icon “Reinforcement” from the Results panel. The dialog displayed depends on the selection and will be different if you select a beam, a column or a footing.
For any footing, column and beam reinforcement generated we can save out and re use them by simply loading them in, you can save out as many footing, column and beam types as you need.

Select the element, go to the reinforcement cage dropdown and load, select the previously saved cage and hit open, this will then generate the reinforcement cage for that element.
This possibility for you to save and load predefined parametric 3D rebar cages is a huge safe of time for your rebar projects:

- Thanks to those reinforcement templates, you can homogenize the rebar cages for similar elements.
- You can save rebar cages templates in a model and apply them on another model, means the work done for a project can be reused on other ones!
Copy rebar cage/Delete rebar cage

These two options were added in order to increase productivity whilst working with identical host elements that need to be reinforced and that already have reinforcement assigned to them.

The 'Copy Rebar' tool allows you to copy the entire reinforcement of an element to an identical or similar element that has no reinforcement assigned to it. The entire reinforcement cage can now be copied to one or more elements at a time. The reverse of the command is the 'Delete Reinforcement' tool, which offers the ability to delete the entire reinforcement of the selected host element, or certain parts of it.

You can duplicate 3D rebar cages on a multiple selection of identical elements within seconds...
Transversal distribution
This new feature increases productivity whilst working in Revit®, due to the automatic generation of transversal rebar sets with multiple spacing for linear elements. Users have the option to quickly create the different configurations of the transversal reinforcement in a cage with only one command.

Bending detail
A very useful tool that allows users to automatically generate all bending details for rebars at once the details are created as groups with specific line types and annotations which can be easily modified to obtain the desired display of the reinforcement detail.

Each rebar included in the selection has a corresponding rebar shape and all groups are arranged by default in the proximity of the source reinforcement.
Schedule Schemas
Activate the function “Schedule Schema” from the BIM Designers ribbon:

Please note that the bending details can be generated only on 2D views in Revit®
A process runs (it can take some time depending on the selection) and you will get a confirmation about the schemas creation. You can see those schemas in the Revit schedule, inside the “Image” column:

Each schema is created with a unique ID and assign to the corresponding element.
Set Rebar Number/Renumber Reinforcement

The GRAITEC BIM Designers modules propose different tools to manage the rebar numbering:

- Set Rebar Number
- Renumber Rebar
- Select by Rebar Number

With the “Set Rebar Number”, users can manually change the rebar number of a bar. If the chosen number is already assigned to a rebar, a warning message is displayed to inform the user of this situation and the corresponding rebar will receive a different number.

The “Renumber Rebar” tool automatically changes the numbers for all reinforcement, in order to eliminate the gaps that may appear in numbering or to create uniform counting starting from a specific number.

The numbers assigned to the rebars may also be used to filter rebars using this criterion with the tool “Select by Rebar Number”.

Those tools are easy to use and really increase your efficiency when managing rebar models in Revit®!
Browse Reinforcement

This command allows users to browse and select reinforcement, based on multiple criteria; reinforcement type, rebar number and shape, diameter, host type, level and material. Any combination of the above filters is allowed and the corresponding rebars are highlighted in the drawing. This method can be applied in two ways; as a single dialog or included in the selection options from other commands.

Rebar Visibility

The 'Rebar Visibility' tool allows users to change the view visibility states to show rebars unobscured and/or as solid in 3D views, or to hide certain bars. These settings are applicable for the fine level of detail and can be used in a very practical way for the active view or for the whole project. Once the visibility state is defined, users can change the status at any time to whichever combination suits best.
Intelligent edit tools for reinforcement

The BIM Designers offers several tools to adjust reinforcement to the desired parameters. A rebar set can be exploded to independent bars, which can be individually edited further. An alternative is to divide the set into two identical sets and modify them separately (the set in the above image was split into two parts to adjust them to the shape of the formwork). The case of this situation is to isolate a bar between two sets.

Users can also link two or more sets to create a single set, which can then be more easily manipulated.

Another editing tool such as ‘Rebar to Face’ refers to the option to stretch/trim the reinforcement sets to a chosen edge of the concrete element. The closest part of the rebar shape to this face becomes stretched or trimmed. The face to which the rebars are stretched/trim can belong to the same concrete element or to a different one (users can stretch the bars from a column to the exterior face of a beam supported by the column). The stretch tool can also be applied if the face of the host element is slanted.
The ‘Area to Element’ tool allows users to stretch already created area reinforcement to the dimensions of the host concrete element.

The cut reinforcement tools offer the option of adjusting the reinforcement cage as in the following situation; the cage is already modelled, and the user needs to create openings in the concrete element without deleting reinforcement. The rebar set can now be modified to cut the actual reinforcement to the edges of the openings, keeping the concrete cover.

Symbols and Dimensions
This set of tools offers representation styles for rebar sets in addition to the ones that are native to Revit®.
Users can choose to display only the dimension line, include an annotation or add a bending detail to each one of the above representation styles.

Reinforcement drawings creation

The reinforcement drawings creation is also automated with the BIM Designers. Starting from the 3D reinforcement rebar, the application can create the section views required, place annotations and dimensions, produce rebar schedules, bill of quantities and consolidate all those views in a drawing sheet. Those functions are also available from the “GRAITEC Concrete Design” ribbon:
FIGURE 2: AUTOMATIC DRAWING GENERATED WITH BIM DESIGNERS

This process relies on the Revit® templates like the ones used in Revit® to manually produce section views. Calling the function “Customize Drawings”, you get a dialog where you can define the drawing options:
• The user can apply a drawing template per member and per type.
• The user can also select a title block template.
• The user can decide to generate a rebar schedule from BIM Designers modules or just create a Revit® native one after.
• In addition to the views creation, it is also possible to generate the drawing sheets, either one per element, either one with several selected elements.

Just select the templates to apply, hit the “Generate drawings” icon and get the views and drawing sheets automatically.

You can decide to create the drawing sheets and “just” use the BIM Designers modules to generate all the section, details views per element (as we can see here above).
With the BIM Designers, you really can Power Up Revit® for your detailing projects.
How to automate the 3D rebar generation in Revit®?

In the 1st part of this handout, we have seen rebar detailing tools to power-up your Revit for rebar modelling and detailing. Those tools allow you to speed-up the manual creation of rebar in Revit, even applying the 3D parametric cages.

There is an additional way to fully automate the 3D rebar cage generation in Revit: embedding the Reinforced Concrete design part directly in Revit, using the BIM Designer technology from GRAITEC.

To apply such a workflow within Revit, we have to go through major important steps:
- The geometry of the concrete members to be designed is defined in the Revit model.
- With the BIM Designers, you can define the design and reinforcement assumptions directly in Revit.
- To design a RC member, you need to know and apply the loads manually or start the design from Results packages stored in Revit.
- Then, you can automate the 3D design driven rebar cages creation and the reinforcement drawings generation.

In the next pages, we will describe in detail such a BIM Structural workflow.

Let's come back few minutes on the BIM workflow we want to apply, we can summarize it with the following schema:
We start in Revit with the descriptive and analytical model.
We export this model to Advance Design which is the FEM software provided by Graitec.
You run the FEM calculation in Advance Design and you save back the results in Revit.
You can define this results package as an input for the BIM Designers modules to design the RC members directly in Revit and get automatically the 3D rebar cages and the corresponding drawings.

⚠️ Tip: This workflow can be applied linking Revit without any FEM system able to store results packages in Revit!

Transfer FEM results in Revit®?
   Connect Advance Design® from GRAITEC with Autodesk Revit®

Having some set of FEM results saved in Revit® is the starting point of the connected BIM workflow to automate the 3D design driven rebar cages. Having this in mind, I will explain you here how you can easily complete your Revit® model with different sets of FEM results saved directly in Revit®.

Today it is extremely unlikely that anyone is transferring results to Revit Structure® in a real workflow. I will try to explain why you would and what interest there is of having FEM results in the Revit® model. Right now, for users transferring this data to Revit®, it is a dead end with nowhere else to go and nothing else to do with the data. Now, imagine a process that allows you to get a 3D rebar cage in a minute, within Revit Structure® relying of the FEM results database! It really starts to make sense. That’s what we propose with our BIM Designers tools.

In this document, I will detail the workflow using Advance Design®, the FEM software from GRAITEC (www.graitec.com/advance-design):
Depending on your current FEM system, as we said before, you can apply the same workflow with any software able to store set of results in Revit® (like Autodesk Robot Structural Analysis® for example).

To get the FEM results in Revit, you need to follow those steps:
1. Build up a Revit model including the analytical model management.
2. Export the analytical model to Advance Design® to run the structural analysis for all the loads cases and combinations (created in Revit® or added in the FEM system).
3. After the FEM calculation, export back the set of results in a file.
4. Synchronize those results in Revit® and post process them using the “Structural analysis toolkit” for Revit!

As soon as you have the FEM results stored in your Revit® model, you will be able to apply an entire connected workflow to produce the rebar data (3D rebar cages, quantities, drawings) within your BIM model. In previous pages, we illustrated this workflow as following:

![Figure 4: Connected BIM Workflow](https://apps.autodesk.com/RVT/en/Detail/Index?id=4901636995211349921&appLang=en&os=Win64)

As I previously mentioned, to be able to apply this workflow, you have to download and install the “Autodesk Structural Analysis Toolkit” which is available from the Autodesk App Store (https://apps.autodesk.com/RVT/en/Detail/Index?id=4901636995211349921&appLang=en&os=Win64):
Autodesk Revit® and the analytical model

My objective, in the class handout, is not to teach you how to handle the analytical model in Revit® - just type few key words on a web browser and you will find plenty of information about how to deal with the analytical model in Revit®, that's the strength of the Autodesk users community!
But, on the other hand, being able to manage the analytical model is the unfordable starting point to apply a connected BIM model so allow me to give you here few advices. Some people still consider that Revit is not a tool for the engineer: this is fundamentally wrong!

The analytical model is handled in real time in Revit® in parallel with the descriptive model. What I am calling the descriptive model, is the usual 3D BIM model in Revit®. This can be a hugely time-saving for the engineer, but it does not mean that this proposed analytical model is perfect. Of course, the engineer must do his job and take the right decisions to adjust this model. You must be convinced that Revit® is a tool also for the engineer, not only for the technician.

So, in this class handout, we will consider as a starting point that the Revit analytical model has been fine-tuned by the engineer:

- Defining the right analytical properties on structural members:

- Checking the materials properties
• Defining the load cases and applying the loads:

• Making the right adjustments on the analytical model, aligning the analytical axes or creating some analytical connections:
• And manually adjusting the analytical geometry, depending on engineering choices: By default, we see that the analytical geometry corresponds exactly to the physical model! For the FEM calculation, the engineer may want to simplify this analytical representation.
FEM results calculation – Link with Advance Design®

Export from Revit® to Advance Design®

Having managed the analytical model in Revit®, we can now make the export from Autodesk Revit® to Advance Design®, the FEM software from GRAITEC. To be able to use the link between those two programs, you must install the GRAITEC BIM Connect Revit® plug-in, which is available free of charge from the GRAITEC website:


You can also get it from Autodesk Exchange App Store (https://apps.autodesk.com) using your Autodesk Account:

Tip: Please note also that the BIM Connect module is part of the GRAITEC PowerPack for Revit® add-on (www.graitec.com/powerpack-for-revit) among more than 100 features to power up your Revit!
After the installation, a specific ribbon “GRAITEC PowerPack” appears in the Revit® interface, with options to share the 3D model (Geometry, loads and loads cases, analytical properties), including an icon with a direct link to Advance Design®:

Let’s illustrate the link on the following example

- As we saw before, we start with a Revit Structure® model which also embeds the analytical model:
  - Export the geometrical and the analytical model from Revit®
  - Import a 3D model in Revit®
  - Synchronize changes between models.
  - Define the export/import settings
Using the GRAITEC BIM Connect module, we export the model from Revit Structure®:

- You can also export the Revit® model directly to Advance Design clicking on the corresponding icon. In this case, you will arrive directly in Advance Design®
- You can activate the automatic self-weight when exporting to Advance Design
- You can also activate the automatic launch of Advance Design®

You can edit a report (Log file) which is very important in a BIM workflow => this is a way to track the data exchanges along the production cycle of a project:
You then get the 3D analytical model in Advance Design, including the geometry and all the analytical properties; loads, materials, mechanical properties, analytical supports and boundary conditions on the elements. The model is ready to be calculated.

You can easily manage the 3D model in Advance Design® because the project browser three is the same than in Revit®:
At this stage of the workflow, you have a 3D model in Advance Design® corresponding to the analytical model sent from Revit® and you can benefit from an entire structural analysis software environment with all the functionalities required to fine-tune the FEM model:

- You can access all the properties of each member, either to check what was defined in the Revit® analytical model, or to stipulate your own assumptions. This is an important step for you as an engineer who must be able to trust the FEM model.
- You can define what kind of finite element you would like to apply, e.g.; a beam with 6 degrees of freedom, a truss with only 3 degrees of freedom working in tension or compression, a tie, a cable, etc.
- You can check and change the boundary conditions on the elements; rigid or semi-rigid links, elastic supports, articulations between slabs and walls, etc.
- Set the meshing parameters.
- Define the loads, either manually or using the automatic generator for climatic and seismic loads (for example according IBC2012):
With Advance Design®, you can run a FEM analysis and get all the requested results (including internal forces on all elements for all the load cases) that you can post process graphically or with tables in reports:

**Figure 7: FEA Results in Advance Design®**
Saving back those results in Revit®

After the calculation, advance Design gives you the possibility to send back the calculated model to Revit Structure® to synchronize the FEM results in Revit® and automatically fill the results database (what we call “results package” in Revit®). This process is done following several steps:

- Activate the results export in Advance Design, from the [Manage] ribbon:

![Advance Design results export settings](image)

This action will create a GTCx file on disk which describe the entire geometry of the 3D Advance Design model, but which also include the FEM results.
• Before importing this file in Revit®, you must check that the option [Import FEM results] is checked in the settings of the BIM Connect (from the GRAITEC Powerpack for Revit®):

• Then, you have to call the synchronization dialog from the PowerPack:
[1]: you click on “Load” to load the GTCx file created by AD.

[2]: then, you can click on apply to apply the content of the GTCx files (the FEM results) to the Revit® model. This process will take between few seconds to several minutes depending on the size of the project. You can close the dialog at the end of this step.

[3] and [4], with the “Filter” and “Attributes” buttons, you can filter which elements you want to see in the synchronization dialog and which parameters you want to synchronize.

### Tip:

1. **the set of results does not appear in this synchronization dialog, you just see the name of the GTCx synchronized file.**

2. **you must keep in mind that you can click on “apply” even if you have not validated the changes appearing in the synchronization dialog.**

3. **Obviously, you can in the same step, validate some changes in the descriptive model and import the FEM results.**

At this stage, the FEM results coming from Advance Design® are saved in Revit® and you can post process them directly in Revit®:

- **At the end of the [Analyze] ribbon of Revit®, you have two functions called [Results Manager] and [Results Explorer]:**
• With the ‘Results Manager’, you will be able to see all the results package available in the current Revit® model (with its corresponding status) and select the one you want to access:

• Then with the ‘Results Explorer’, you can view the main results on the members and supports, selecting the load case or the combination you wish to see:
Automatically produce the design-driven 3D rebar cages

At this stage of the workflow, you have enriched your Revit® model with engineering data saved in the results packages available using the Autodesk Structural Analysis toolkit. Those results will be the input for our BIM Designers tools who will allow you to handle the reinforced concrete design within Revit®.

The benefit of this multiplatform adaptive technology is that you can use those detailed design tools directly in your Revit® environment to generate the rebar objects automatically and enrich the BIM model with reinforcement data.

The automation of the BIM workflow with the BIM Designers can be summarized as following:

**Figure 8: BIM Designers in Revit®**

We have seen that on the GUI point of view, all the corresponding additional functions provided by BIM Designers in Revit® are placed in a specific ribbon called “GRAITEC Concrete design”
We will now focus on the design capabilities on the BIM Designers, which correspond to the 1st part of the “GRAITEC Concrete Design” ribbon:

To automate the production of the 3D rebar cages in Revit®, the BIM Designers are embedding the reinforced concrete design within Revit®. Going through the BIM Designers ribbon, you will be able to:

- Define the concrete design assumptions (code dependent) within Revit®!
- Define the reinforcement assumptions, which are also partially design code dependent.
- Run the calculation of the concrete members and access to the design results: detailed reports, diagrams, working ratios, warning and error messages…
- Produce the Revit® detail views and drawing sheets applying your Revit® drawing templates.

Let’s remind ourselves of the 'standard' workflow to create 3D rebar cages and reinforcement drawings using the existing tools in Revit Structure®:

1. Let’s take the example of an isolated footing from a 3D model in Revit®. The objective is to create the 3D rebar cage and the corresponding drawing inside this structural element.
2. First, we must create several 2D views (sections, elevations, callouts, etc.) around the element.
3. Then working on those different 2D views, we can start to place reinforcement bars using the Rebar Shape Browser in Revit®. Of course, as you know, to create all the bars, we need to switch several times between the different 2D generated views.
4. We also must place in the different 2D views, all the tags, annotations, dimension lines, etc.
5. At the end of this process, we have the final 3D rebar cage completed for the corresponding structural element.
6. The final step is to create a drawing sheet, include in it the different 2D views, defining the right position and the right scale.

The complete process can take quite a few minutes depending on the complexity of the elements to be reinforced. Of course, we must repeat this work for every element to be reinforced. This is incredibly time consuming and not the most interesting part of the job for a draftsman!

Our proposal with BIM Designers is not to change this workflow with a 'standard' Revit® workflow, but to automate it:

1. We can take the same example as before - we want to create the 3D rebar cage on an isolated footing and produce the reinforcement drawings.
2. To do this, we just need to access the specific ‘BIM Designers’ ribbon and run the calculation of the element.
3. Then you automatically get the design-driven 3D rebar cage, the corresponding detailed calculation report, the automatic creation of the requested 2D views, the bar schedule and the final drawing sheet of the element.
With BIM Designers, you can do this with just one click - and a job that takes several minutes to do with standard Revit Structure® tools will take just a few seconds! Just imagine the huge increase in productivity you will get. That’s what we call; ‘innovative technologies for the service of users!’

In the following pages, we will see in detail how we can apply the BIM Designers in Revit® and create a streamline workflow for rebar creation and management:

- How to define the geometry for the calculation
- How to manage the loads and combinations.
- How to design a single element or a group of elements
- How to handle the design code checking.

All those steps done within the Revit® model!

**Geometry definition**

Obviously, when running on top of Revit®, the BIM Designers modules automatically detect the geometry of the elements defined in the family types of Revit®. We have previously seen that using the BIM Designers dialogs, the user can also quickly manage the geometry.

To explain you the way it works, let’s take the example of a RC Beam on which we want to review the geometrical assumptions before designing the element:

1. Just select the Revit® object and click on [Geometry]:

![Image of Revit® software interface with BIM Designers module open on a RC Beam project]

*Autodesk® Revit® 2020 - First For Results Version - Concrete Building Design (Revit Structural) - RC Beam Level 2*

*Modify / Structural Frames*

*Modify / Structural Frames*

*Detail the geometry of the selected RC member*

*Press F1 for more help*
2. You get a dialog with several tabs, where you can check the geometry of the Revit® element and adjust it. Some of those parameters are “read only” because managed by Revit!

3. In the [Section] tab, you can define/adjust more parameters about the section, important for the design such as the compression flanges on each side of the section:
Loads and combinations
To be able to design an element, you must define the loads, the loads cases and the combinations depending on the design code applied. As we previously saw in the standalone behavior of the BIM Designers, we can apply manually any kind of loads on an element.

For that, just select the element in Revit® (an RC beam for example) and click on the icon “Loads and combinations”:

You will be able to quickly define distributed loads, punctual loads, variable loads... All those loads are saved within the Revit® model. Even if it’s easy to manage, this is not the most effective way to manage the loads on members.

In the previous chapter of this document, we saw that it is possible to save in Revit® different set of FEM results in “Revit results packages”. But, we did not answer the question why for? why should I do this? What is the benefit of storing the FEM results in the Revit® model? For what use?

Now if we put BIM Designers in the picture, we suddenly realize that it really makes sense and brings to life an effective and easy-to-apply workflow for my reinforcement generation in Revit®. We can illustrate this workflow with the following schema, that we already introduced you at the beginning of this handout:
• We start the workflow in Revit Structure® where we can manage define the analytical model in real time according to the descriptive model (see previous chapters).
• We export the Revit® model to Advance Design® or to any other FEM system compliant with the results packages in Revit: in this FEM system, we can run the calculation, post process the FEM results, generate reports and send the FEM results back to Revit Structure®.
• From the FEM results stored within Revit®, we can start to design the structural elements with the BIM Designers modules and automatically get the 3D rebar cage, the design reports, the 2D views with tags-annotation-dimensions and the final drawing sheet.

At this step of the workflow, you must define which set of results packages you want to consider for the code design check with BIM Designers. In the [GRAITEC Concrete Design] ribbon, you must click on “Import Analysis Results” and select which set of results you want to apply:
• If you select “Do not import”, it means that you will have to enter manually all the loads on each member.
• If you select “Import FEM results from Revit”, the BIM Designers modules will automatically load the internal forces from the Revit results package, the one selected in this dialog.

💡 Tip: You will get a message asking for a confirmation to apply this new set of results: if you do so, it will overwrite all the manual loads you may have defined before using the BIM Designers dialogs!
To review, change or define the loads on each member to be designed, you must click on the [Loads & Combinations] icon:

1. Select first the element on which you want to apply/change the loads.
2. Click on the icon [Loads & Combinations]

You can notice that the content of the dialog is contextual to the selection and will be different if you have selected a beam, a column or a footing.
4. In the tab [Load case definition], you can see the existing load cases (from the Revit® results package), create new load cases, change the factoring coefficients, manage the self-weight…

5. In the [Combinations] tab, you can generate automatically and change the combinations:

---

**Tip:** You can run the calculation of an element without generating the combinations. In this case, the BIM Designer module will generate them automatically!
6. In the [Loads definition] tab, you can see the loads and change them, define the position of the loads and impose different loads at the bottom and the top part of the column:

Design and Reinforcement assumptions

The initial Revit® model does not, however, include any structural design assumptions. This is what is introduced with the BIM Designers. When you select an appropriate element in the Revit® 3D model, you can access the corresponding icon on the GRAITEC ribbon from where you can manage all the Design and Reinforcement assumptions for the selected object:
7. Clicking on “Design Assumptions”, you will access the design assumptions corresponding to the selected elements and depending on the design codes set in the localization settings. The system is intuitive to use: depending on the selected elements, the BIM Designers will display the corresponding design assumptions.
   a. If you select one or several footings, you will get the corresponding design assumptions dialog just clicking on the corresponding icon from the “GRAITEC Concrete Design” ribbon:
   
   ![Design Assumptions dialog for footings]

   b. If you select one or several columns, you will get another dedicated dialog, using the same icon.
   
   ![Design Assumptions dialog for columns]
c. The same if you select a reinforced concrete beam:

Tip: it is important to notice that the content of those design assumptions dialogs is initialized with the design templates you have selected clicking on this icon.

The creation of templates cannot be done within Revit® but must be done using the standalone version of the BIM Designers modules.
Clicking on “Reinforcement assumptions”, you will be able to define all the preferences you want to apply for the automatic placement of bars inside the concrete.

Here are some of the reinforcement assumptions for a column - longitudinal and transversal bars, stirrup shapes, starting bars, number of bars and maximal diameters depending on the column size, etc.

The content of the dialogs will be different if you select a beam or a footing.
Of course, both assumptions families are country code dependent (Eurocodes with different national appendixes, US codes and Canadian codes) and the user can set the design codes through the “Localization” dialog:

**Design-driven 3D rebar cages**

Once you have defined all those assumptions (geometry, design and reinforcement assumptions, bar stocks...), you can run the calculation of the reinforced concrete members (beams, columns and footings) and get the 3D rebar cage. Just press the [Calculate] icon and get the 3D rebar cage on the corresponding elements:
The created bars are native Revit® objects which can be changed through the default Revit® properties and functionalities:

With the BIM Designers, you can either design and instantly get the 3D rebar cage with single or limited elements or design the full model and get the complete 3D rebar cages within a few minutes, instead of hours - if working with standard Revit® tools!

Also, an important point is the fact that the BIM Designers are dedicated to 3D rebar production. All the produced 3D rebar cages are parametric. At any time, you can select a footing, a column, a beam - just click on the icon ‘Reinforcement’ and change the 3D rebar cage in the parametric reinforcement dialog:
Thanks to GRAITEC BIM Designers, you can create a detailed design report directly in Revit®. You will get all the design detail in a technical document, including all the formulas and corresponding articles from the standard, the numerical applications and the corresponding graphics. To generate this report, just click on the icon ‘Generate Report’, select a report template, define the level of details and run the generation. You will complete the report in seconds!

When you make a change in this dialog, the design is updated in real-time and you can see immediately if the real reinforcement defined fits with the design requirements. If not, you will get an error message.
### 3. Global assumptions

Concrete design code:
- ACI318 - 14
- IBC 2012

### 3.1 Materials

- Concrete quality: ACI318 - 14, Chapter 19
- Steel quality: ACI318 - 14, Chapter 18

#### 3.1.1 Concrete

- Strength:
  - Characteristic strength: $f_{ck} = 3000$ psi
  - Modulus of elasticity: $E = 5000000$ psi
  - Concrete ultimate strain: $\epsilon_u = 0.003$
- Density: $\rho = 150$ lb/ft$^3$

#### 3.1.2 Steel

- Ultimate strain: $\epsilon_u = 0.002$
- Modulus of elasticity: $E = 29000000$ psi
- Yield strength: $f_y = 60$ ksi
- Ultimate strength: $f_u = 80$ ksi
- Characteristic stress: $f_{ck} = 30$ ksi
- Plastic strain: $\epsilon_p = 0.003$
- Torsion:
  - Modulus of rigidity: $G = 20000000$ psi
- Tensile strain: $\epsilon_t = 0.002$

### Combination of Loads and Combinations

<table>
<thead>
<tr>
<th>ID</th>
<th>Combination</th>
<th>Code</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>1.20k(1)+1.00k(2)</td>
<td>ACI318</td>
<td>ULS</td>
</tr>
<tr>
<td>100</td>
<td>1.20k(1)+1.00k(3)</td>
<td>ACI318</td>
<td>ULS</td>
</tr>
<tr>
<td>100</td>
<td>1.20k(1)+1.00k(4)</td>
<td>ACI318</td>
<td>ULS</td>
</tr>
<tr>
<td>100</td>
<td>1.20k(1)+1.00k(5)</td>
<td>ACI318</td>
<td>ULS</td>
</tr>
<tr>
<td>110</td>
<td>1.20(1)+1.00k(2)+1.00k(3)</td>
<td>ACI318</td>
<td>ULS</td>
</tr>
<tr>
<td>110</td>
<td>1.20(1)+1.00k(2)+1.00k(4)</td>
<td>ACI318</td>
<td>ULS</td>
</tr>
<tr>
<td>110</td>
<td>1.20(1)+1.00k(2)+1.00k(5)</td>
<td>ACI318</td>
<td>ULS</td>
</tr>
</tbody>
</table>
In addition to the detailed design reports, you can also access the integrated graphical post-processing engine to visualize in Revit® the design results as interaction curves on columns, stability verification on footing, crack width check and stress diagrams on beams. For this, just select an element and activate the function ‘Diagrams’.
Nothing is magic and this all requires preparation. The 3D reinforcement rebar is not produced out of thin air! Every bar, every result can be justified. Of course, you will not check all the calculated elements one by one, that would waste too much time. At any moment, you can call up the 'Project Status' dialog and see directly which element is calculated, which have errors or warnings and which ones remain to still be designed. That is the main board of your RC project:
Generate automatically the reinforcement drawings

In the 1st part of this handout, we have seen the possibility, using the GRAITEC BIM Designers detailing tools, to generate drawing views, tags and annotations, rebar schedules, drawings sheets per element or for a multiple selection of elements...

As soon as you have design some members, checked the design results, you can fully automate the entire reinforcement drawings creation process!

As seen before in this handout, just select the templates to apply, hit the “Generate drawings” icon and get the views and drawing sheets automatically:

This kind of section view is produced automatically by the BIM Designer module. The bar tags, the annotations are used from the Revit® template (RVT file) you have defined in the drawing settings.
Optimize the project with Design groups
We just saw that using the BIM Designers in Revit® will allow you to generate design-driven 3D rebar cages in tens of elements within few seconds. But, to be honest, it makes not really sense to generate the 3D rebar cages in the elements one by one: that’s not the way an experienced engineer will optimize his project to reduce the costs.

With the BIM Designers, you can group identical elements even if they do not have the same loads applied. When running the design, the BIM designers will calculate the theoretical reinforcement values for all elements of the group and generate the real 3D rebar cage based on the envelop of the theoretical values: that’s the only way to be sure that we do not miss the worst case.

To create design groups, it’s quite easy:
- Select the elements you want to group and click on the icon “Create design group” => the BIM Designers will check the compliancy of the selected elements: same section, same dimensions, same materials. If the system found an inconsistency, you will get an error message with all the details:

For example, if you select columns with different sections and try to group them, you will get this error message.
If you select elements which can be grouped, you will be prompted to define a group name and a design template:

And you will be able to manage the grouped elements from the “Design status” dialog:

You can explode the group, add an element to the group or exclude an element from the group!
As soon as you select a single element from a group and calculate it, all the elements from that group will have the same 3D rebar cage, based on the same design assumptions. That’s a very important functionality which will allow you to generate the reinforcement for the entire building in a very effective and productive way.

Manage the continuous Beams
Most of the time, in case of continuous beams, the Revit® user is modeling those continuous beams per span, for example to be able to generate annotations and tags per span. On the other side, the engineer would like to consider a continuous element for the design even if modeled as single spans by the draftsman. This often ends to a wrong model either on the draftsman or the engineer side.

Here is an example of a continuous beam modeled as two single spans in Revit®:

![Continuous Beam Model](image)

We have implemented in BIM Designers an effective tool which allow the engineer to define afterwards a continuous beam without imposing to the draftsman to model it such a way.
The tool is very easy to use:

1. Just select the two spans you want to group:

![Select spans](image1.png)

2. In the “GRAITEC Concrete” ribbon, activate the function “Create Multispan Beam”:

![Activate function](image2.png)

You will have to define the name of the continuous beam.

![Define name](image3.png)
Then, you can reinforce the entire continuous beam in few seconds running the calculation with the BIM Designer “Calculation” icon:

And get the “Design Status” dialog where you can see the continuous beams

We just saw that using the BIM Designers in Revit® will allow you to generate design-driven 3D rebar cages in tens of elements within few seconds. But, to be honest, it makes not really sense to generate the 3D rebar cages in the elements one by one: that’s not the way an experienced engineer will optimize his project to reduce the costs.
Manage the maximum bar length

When you design a Beam in Revit with the BIM Designers, you can use an option to define and check the maximum longitudinal bar lengths and automatically split the bars.

You have to select a beam in the Revit model and go the reinforcement assumptions from the GRAITEC Concrete ribbon:

You can activate the check and decide to automatically split the bars exceeding the predefined length. After, you have to choose the joining method => if you choose “Bars lapping”, you can choose an automatic overlapping length or an imposed one...
If you choose “Mechanical couplers”, you just have to define the distance between the extremities of the two bars and select a coupler Revit family.

If you do not define a Revit family, BIM Designers will apply the default system one.

You get a 3D rebar cages with the bars automatically split at the right place according to the predefined length:
Preview of Shear walls Design

In April 2019 (release 2020), GRAITEC will release two new BIM Designers reinforcement modules in Revit® for shear walls and RC slabs reinforcement.

Even if those two new modules will be available in few months, we will give you here an overview of their coming capabilities.

The release 2020 of the BIM Designers will enhance the design and the detailing of gravity walls and shear walls, including groups of shear walls. The way of working will be the same one that what we have defined for beams, columns and footings previously in this document.

You have to create a Revit® model including some structural concrete walls:

And you can then design and detail automatically a single shear wall or a group of shear wall within few clicks!
• Select 3 shear walls and group them into a design shear wall group:

• You can access and change the Revit® geometry through the BIM Designer dialog, for example to create an opening on the wall:
• Define the design and the reinforcement assumptions:

• Define the loads: vertical gravity loads, horizontal loads, seismic resultants:
- Run the calculation and get the 3D rebar cages automatically, including reinforcements around opening and vertical stiffeners in case of a group of shearwalls:

And... generate the drawings with all the detailing tools already described in this handout!
Extract the 3D Rebar data

Rebar Data Extraction using Link to Excel

GRAITEC has developed a tool which allows you to extract any data from Revit® to Excel. This powerful tool, available in the GRAITEC Powerpack for Revit®, gives you the possibility to synchronize data using a bi-directional link between Autodesk Revit® and Microsoft Excel:

Users can export any Revit® schedules or compose a list of parameters to be treated as a table, to manage them in Excel. Once modified, the tool can import the data back into Revit and the schedules or parameter values will be updated according to the changes.

Tip: If the schedule in Revit is customized in matters of appearance and merging, then the resulted Excel table will preserve the desired format from Revit.

The most impressive aspect of this new tool is that it offers a powerful and strong link between the Revit project and the managing of data in Microsoft Excel. Also, the time consumed to handle modifications and updates in either of the two platforms is reduced to minimum, since the process of project organizing and documenting in Revit is accurately performed.
There are several methods through which users can create such a link between a Revit project and an Excel spreadsheet:

- **Empty**: A new link can be created from scratch, meaning that the user will select one or more categories, pick from the available parameters, and generate an Excel file with several spreadsheets, one for each selected category.
- **From existing link**: A new link can be obtained starting from an already existing one, by creating a duplicate which can be edited. The advantage is that there is no need to start the whole process for two similar links all the way from the beginning.
- **From current schedule**: If the command is applied in an active schedule, then the resulted Excel table will contain the rows and columns as they were created in the Revit Schedule. Modifying the data in the Excel file and importing it back into Revit will affect both the information in the schedule and the elements from the model.
- **From multiple schedules**: The tool can be used to create an Excel file with multiple sheets, containing the information from several schedules included in the current project.
- **From current selection in Revit**: The category/categories for which Excel tables will be created may be limited to result from a selection of elements in Revit.
- **From entire project**: For each category loaded in the project, a spreadsheet will be created in Excel, with the possibility to exclude some categories or to customize the list of loaded parameters.
After the structure of the link is decided, the “Export” operation generates the Excel file, which can be opened directly from the “Synchronization” dialog:

Users also have the possibility to save links as templates to be further used in other projects. The template is saved as an *.xls file containing the fields that form the header of the table, and it can be used to create a new link out of it.

💡 **Tip:** If the source schedule from Revit has one of the following applied: filters, sorting, grouping, the resulted appearance will be preserved

Obviously, this tool can be used to export rebar data from Revit® to Excel using the native Revit® rebar schedules as an input.

From example, here below, we have a Revit® model on which we have created a detailed rebar schedule:
If you want to postprocess this rebar data in Excel, simply call the “Link to Excel” command from the Powerpack ribbon, click on “Add new link” and choose to start from an existing schedule:

If you call the “Link to Excel” function from the selected schedule in the Revit Browser, this schedule will be selected by default as an input for the Excel export!

And automatically get the corresponding table in Excel from where you can create any dynamic tables and charts you need:
Rebar data in PowerBI

Another way to extract and postprocess the rebar data is to link to PowerBI. Power BI is an analytics solution that lets you visualize your data and share insights across your organization or embed them in your app or website. It Connect to multiple of data sources and provide you features and a dedicated user interface to make live dashboards and reports.

There are no build in features, or apps that we know to connect directly Revit to Power BI. For that reason, they are mainly two majors workflows available:

- A first simple one based on exporting some files and manage them.
- A second one a little bit more complex, using settings with database.

Export files Method:

- Export Revit data from a schedule, using a file format where the data are at separate into tabs
- Import data in to Power BI
- Create a data model or simply just begin visualizing the data automatically.
Database Method:
- Set a database to store the data coming from the Revit model (SQL Server express, SQL server, MS SQL …)
- Export the database with a dedicated tool (such as Revit DB link …)
- Create some connection string between your Revit model and the target database
- In Power BI, create a connection to your database using protocols
- Select the data tables and define the relationships to visualize your data
- Assemble your dashboards

With Power BI it’s possible to manage the refresh your dashboard, and all of your data will be up to date.

Obviously, the first method is the readiest solution for most of Revit users, without a minimal knowledge on database file format management and settings needed.

If we have a deep look on this first method, one of the most important thing is to start is a full model which contain the right attributes needed for data visualization. For that, because Revit properties can miss some key parameter expected for the project management, Revit users should sometimes add attribute, and manually or automatically fill them. Thus, the data management process will make possible the creation of the right dashboard.

Revit reinforcement properties propose all geometric attributes but it’s not possible for example to directly know on which level the rebar belong too. For that specific case, we can think about creating a shared parameter and manually fill it.
Some others practical cases can pose some problems in the data extraction for example how handle the case where the same single bar cross two altimetric levels? to which level should we assign this rebar? There are many examples than impose in the global process to custom the data, so that at the very end, we will have the right understanding of the dashboard result.

To send data from Revit schedule to Power BI, we can use the *.csv file. Multiplies export will generate separate *.csv files that we can merge in Power BI.

Global workflow:
To create the dashboard, the process is very close to Excel smart chart then. You can choose the graphical format, select filter and custom the display by inserting images (logo or other image files format.).

This kind of analytical are really valuable for Project managers who want to monitor their rebar projects实时!
Few words about the GRAITEC PowerPack for Revit®

Revit® is an extremely versatile BIM platform able to produce impressive multi-discipline project models but as every experienced user will tell you, tools which speed up processes or make it easier to achieve certain tasks, are always welcome. Autodesk is committed to providing a robust BIM platform in Revit®, and whilst they focus on workflows and performance, Autodesk look to their experienced partners, like GRAITEC, to provide essential localized tools dedicated to improving their users’ everyday experience.

GRAITEC PowerPack for Autodesk Revit® is packed with tools for Architects, Engineers, M&E Consultants and specialist detailers providing a wealth productivity tools across all disciplines. GRAITEC PowerPack for Autodesk Revit® comes in multiple languages and delivers a wide range of purpose-built tools and utilities which have been expertly localized to help Revit® users across the globe deliver their projects more efficiently. GRAITEC PowerPack for Autodesk Revit® is readily available from the Autodesk Exchange App Store or directly from GRAITEC. GRAITEC Revit® subscription customers can access the PowerPack as a loyalty benefit at no extra cost.

When installed, you can access to the PowerPack for Revit® functionalities through a dedicated ribbon:

In this document, I just give you a quick overview. Do not hesitate to connect to our web site to have more information and get a trial license (http://www.graitec.com/en/pp_revit.asp).
Numbering tool
One of the most requested and expected functionalities is the generic “Numbering” command. Its major advantage is that with only one tool users can apply, re-organize or remove a numbering sequence for ANY loaded category from the project. The complexity of the command resulting from its vast applicability area is balanced by the intuitive and user-friendly way it was designed.
Element Lookup
Starting with the new 2018 R2 version of GRAITEC PowerPack for Revit®, a new tool is available under Identity category, it lets you search through the project database using a set of multiple customized queries from the available list of parameters.

<table>
<thead>
<tr>
<th>Unnote</th>
<th>Analyze</th>
<th>Massing &amp; Site</th>
<th>Collaborate</th>
<th>View</th>
<th>Manage</th>
<th>Add-Ins</th>
<th>Site Designer</th>
<th>GRAITEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>family manager</td>
<td>watermark manager</td>
<td>element lookup</td>
<td>add parameters</td>
<td>cad to rfa converter</td>
<td>3d view</td>
<td>openings</td>
<td>join&amp;unjoin geometry</td>
<td></td>
</tr>
</tbody>
</table>

Files | Identity | Modeling |

Set up a list of multiple queries and search elements by filtering the parameters. By default all type of parameters are available in the list, but you can stringe them by unchecking one of the categories.

After pressing Search, all the elements that fit your query criteria will be listed. you can choose if the elements should be searched in the entire Project, Current view or through a previously made Selection.

By clicking on an element in the list you can choose to Select | Show | Isolate it in the project.

You can choose the Current configuration, which can be set to [default] or you can choose from a list of previously saved configurations. You can add a new configuration by pressing the Configuration manager button, a dialog box opens, press Add new and enter the configuration name. After that select the configuration from the current configuration list and set up the list of desired queries.
Tip: The Element lookup tool can also be used to find objects in a model thanks to the IdGtcParameter or the mark number

Multiple queries can be made and combine into clauses with logical operators, so that advanced research queries can be made on a 3D model.
Tools for quick dimensioning

The user can now save time in detailing the project using these annotation tools. This way, dimensions can be easily added to the drawings. Instead of manually selecting each element, users can now automatically create a chain of dimensions along a direction or based on a line that intersects model elements. Individual dimensions can also be joined to create a single chain which can be moved or copied in an easier way.
Categories Visibility
This tool offers the user the possibility to quickly switch the visibility of selected categories of objects (floors, walls, windows, etc.) in the current view. It behaves as an interactive switching of elements’ visibility and can be applied separately for each view. Its major advantage is that it is easy-to-use, with results that can be seen in real-time.

Join & Unjoin Geometry
Join & Unjoin Geometry is a feature, designed to improve the laborious workflow of Revit when it comes to joining geometry and switching the join order of elements.

This is an automated function with which the user can choose what type of element to join to another, and easily switch the order of the join condition. The associated dialog features many options that the user can choose from to obtain the desired result:
The settings button accesses the Configurations manager dialog, where the user can add presets based on the rules that are currently used. Implicitly, the dialog only shows a "default" configuration. The user can create new configurations by clicking the Add new button, which opens a new dialog used for entering a configuration name. Configurations can be exported and saved, for future use in other projects. Presets can also be imported using the Import from file button.

After the user finishes creating/importing/exporting the configuration presets, they will be listed in the current configuration drop-down menu, where they can be easily accessed and used. The major advantage of the tool is that all three disciplines in Revit can have separate presets.
The Range section of the dialog relates to the range in which the tool can operate and the elements to include/exclude from the process.

- Range of operations: select from the available options: Project (affects all visible elements in the entire project), Active view (affects the elements from the view that the user is in) and Selection (allows the user to join a selection of elements).
- Exclude: select from the available options: Temporarily hidden elements (exclude/include the hidden elements in the joining process) and All structural elements (exclude all the elements that are structural).

The Rules section includes three major categories, each with a drop-down menu with several options:

- Operation refers to the type of functionality that the user wants to perform.
- First category and Second category list all the elements that Revit can join or unjoin.

<table>
<thead>
<tr>
<th>Operation</th>
<th>First category</th>
<th>Second category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Join</td>
<td>Floors</td>
<td>Walls</td>
</tr>
<tr>
<td>Join</td>
<td>Ceilings</td>
<td>Ceilings</td>
</tr>
<tr>
<td>Join</td>
<td>Columns</td>
<td>Columns</td>
</tr>
<tr>
<td>Join</td>
<td>Roofs</td>
<td>Roofs</td>
</tr>
<tr>
<td>Join</td>
<td>Mass</td>
<td>Mass</td>
</tr>
<tr>
<td>Join</td>
<td>Structural Columns</td>
<td>Structural Columns</td>
</tr>
<tr>
<td>Join</td>
<td>Structural Foundations</td>
<td>Structural Foundations</td>
</tr>
<tr>
<td>Join</td>
<td>Structural Framing</td>
<td>Structural Framing</td>
</tr>
<tr>
<td>Join</td>
<td>Walls</td>
<td>Walls</td>
</tr>
</tbody>
</table>

- To enable or disable a certain rule, select or deselect the corresponding check box under Is enabled.
- To swap the first category with the second category, click the button from the with column.

The last 4 columns in the Rules section display statistic information: Number of intersections, Number of not joined, Number of joined and Number of joined inversely.

**Tip:** By default, this statistic information is automatically calculated after every modification of the information in the user interface. The function can be turned off by deselecting Automatically calculate statistics after every change in UI. If this functionality is disabled, the user will be able to run the command whenever it's necessary, by clicking the Recalculate statistics button.
Conclusion

We hope that by reading this document, you learned how to powerup your Revit® for rebar projects using our new technology (BIM Designers and PowerPack) to produce and detail 3D rebar cages within Revit®.

With BIM Designers technology, our objective is to help Revit rebar users to switch from their old tools to a new and innovative solution using Autodesk and GRAITEC tools together, eing able to apply and get the benefits of a connected BIM workflow:

- PowerUp Revit with some effective detailing tools dedicated to Rebar drafters.
- Understand that analysis results are part of the BIM model, relying on a real 3D BIM application which is Revit®.
- Draftsmen’s can generate 3D Generic 3D rebar cages based on geometrical parameters and saving a lot of time on their daily job.
- Engineers can take design driven decisions in the Revit® using BIM Designers tools. Thanks to this, Revit® is now able to understand and post process the engineering data.
- Engineers and detailers communicate via a 3D model (using the BIM Designers 3D rebar) and not only via drawings. Even more, they can share the job inside the same application, Revit®!
- All the information can be easily shared using the Autodesk BIM360® capabilities.
With the power to automate and control complex manual processes, as well as bridge the ‘analytical and detailed model data-sharing’ gap between engineers and draftsman, GRAITEC BIM Designers help you take advantage of BIM for reinforced concrete structures. Then, it’s up to you to decide how you want to apply this technology! It’s your decision how to use the analytical model to transform it as a benefit and not a waste of time!

The workflow being proposed in this class handout may look disruptive at first but it is not. It goes far beyond the current argument of ‘having all the data in a single model’ but represents a new intelligent workflow with real benefits offered by the rebar BIM Designers for automating downstream processes and bridging a ‘defined’ stop/start gap between engineers and detailers.

We are convinced that the entire rebar industry is moving into this direction and it’s our job to work to providing you with effective tools to accompany you in this transition! It’s time to take advantage of industry-driven-intelligent-automation and connect your structural BIM workflows. It’s time to change the game.

For further information, please contact:

Alan Johnson  
GRAITEC UK Limited  
Phone: +33 (1) 69 85 56 22  
E-mail: alan.johnson@graitec.com  
Skype: live:alan.johnson_36

Joseph PAIS – Graitec Product Director  
GRAITEC INNOVATION SAS  
Phone: +33 (1) 69 85 56 22  
E-mail: joseph.pais@graitec.com  
Skype: joseph.pais