AUTODESK UNIVERSITY 2014

Structural Analysis Workflows with Plant Design Suite Ultimate

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SE5099 - In this class you will learn best practices for collaboration of 3D models from AutoCAD Plant 3D, Revit, Advance Steel and Robot Structural Analysis.

Learning Objectives

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

- Get an overview of Advance Steel and Robot Structural Analysis
- Learn best practices for model interoperability with Autodesk Advance Steel, Revit, and Plant 3D
- Learn how to perform structural analysis of steel with Robot Structural Analysis
- Learn how to collaborate between engineering disciplines with Navisworks

About the Speaker

Jason Drew is a Premium Support Specialist in the Enterprise Priority Support program with Autodesk where he provides support for AutoCAD Plant Design Suite products. He joined Autodesk with Customer Service & Support in October 2011. Previous to working at Autodesk he has three years' experience as an Intergraph SmartPlant P&ID administrator/designer. His original background is information technology where he worked for six years providing computer support for an engineering company in Tulsa, Oklahoma. Jason has also worked with an Autodesk Partner, D3 Technologies, providing training and support with AutoCAD Plant 3D and AutoCAD P&ID.

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About the Co–Speaker

Jad Dellel wore multiple hats between Structural engineer, Product Support, Training, Consulting, Sales, Team Management, and Project Management. He Joined the Autodesk Switzerland office in 2010 and moved to Autodesk Canada (Montreal.) In 2012 he joined the Premium Support Team.

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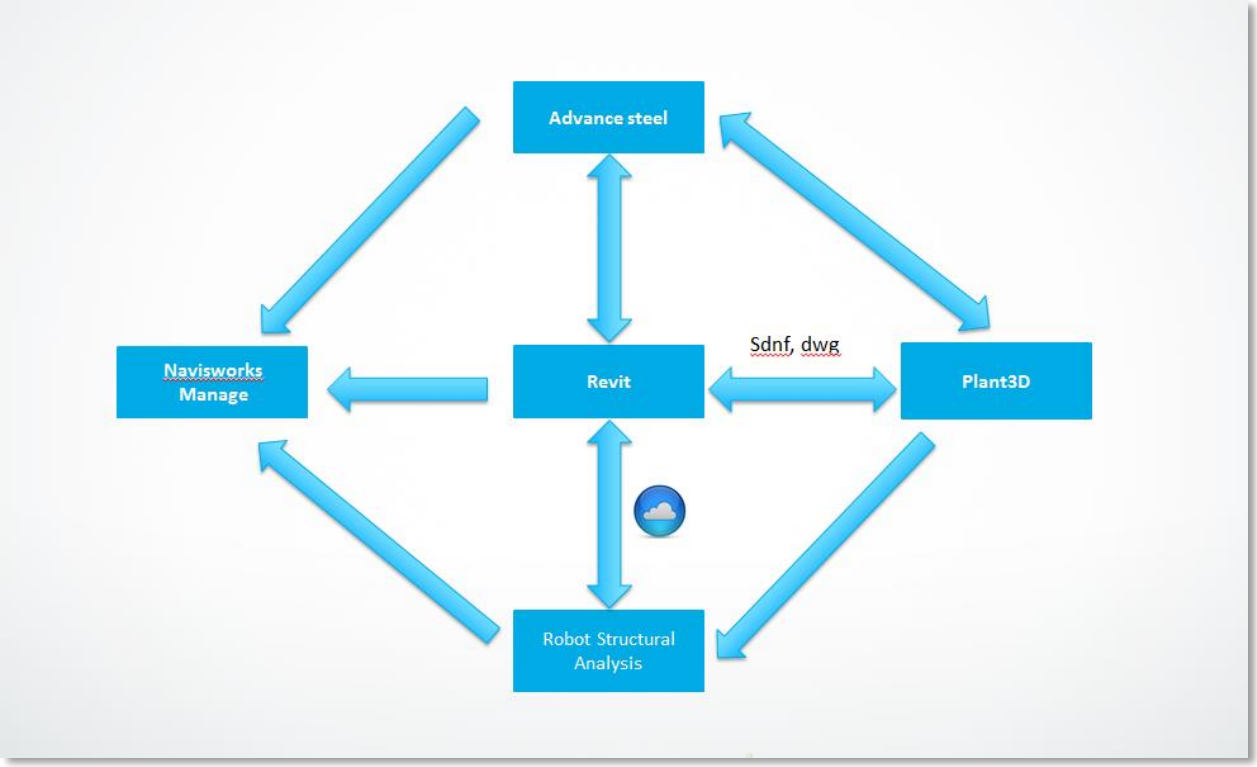
Introduction

In this class we will discuss workflows for structural steel analysis. The applications we will be working with are:

- Autodesk AutoCAD Plant 3D
- Revit Structure
- Robot Structural Analysis Professional
- Advance Steel
- Navisworks Manage

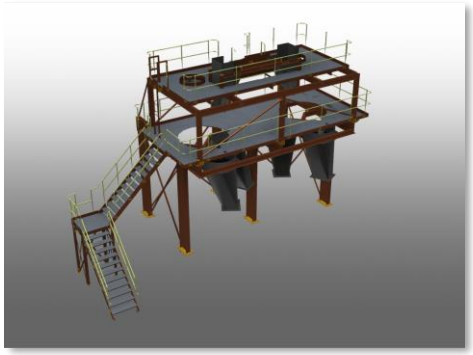
We'll start off with an overview of these applications then move into interoperability of steel models between them. Next we'll go into Robot Structural Analysis and learn about running analysis on the steel design. For example, self-load, usage loads, and climatic loads. Finally we'll show how Navisworks Manage can be used to bring the models together from separate disciplines and how to perform clash detection.

Everything is about workflows; initially the concept for this class started as an internal project to understand all the possible workflows available for a Plant Designer using Plant 3D and collaborating with a structural Designer / Engineer who is familiar with Autodesk Products.



Overview of Structural Applications

Advance Steel



Advance Steel is a CAD software application for 3D modeling and detailing of steel structures and automatic creation of fabrication drawings, bill of materials and NC files. With the Advance Steel Plug-in, Revit users can quickly connect their models to Advance Steel using the export, import, and synchronize features to transfer the model BIM data.

For more details about Advance Steel, please visit:

http://www.autodesk.com/advancesteel

Autodesk Advance Steel in 3 Minutes

Robot Structural Analysis (RSA)

RSA is structural analysis software based on the Finite Elements Method (FEM), providing a country-specific analysis and a wide collection of design codes for structural engineers. Many types of structures could be analyzed by RSA: buildings, bridges, tanks, silos, etc.

For more details, please visit: www.autodesk.com/robot

Revit®

The Revit platform for building information modeling (BIM) is a design and documentation system that supports the design, drawings, and schedules required for a building project.

In the Revit model, every drawing sheet, 2D and 3D view, and schedule is a presentation of information from the same underlying building model database.

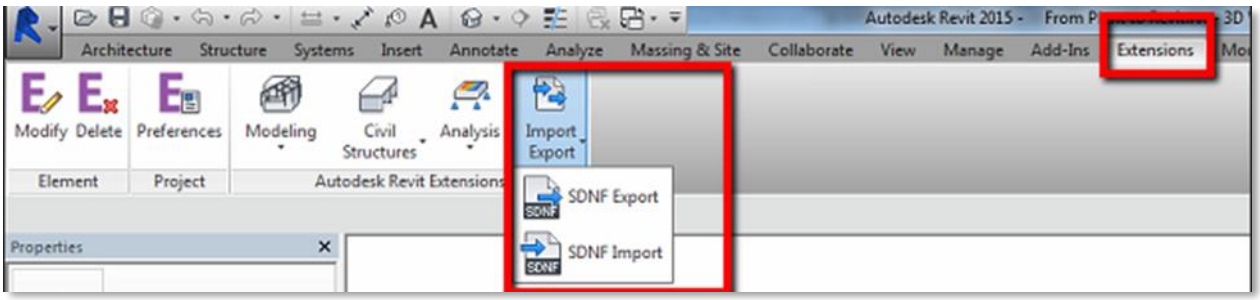
For more details, please visit: http://www.autodesk.com/revit

To get started with Revit: http://knowledge.autodesk.com/support/revit-products/getting-started

Revit Extensions

Revit Extensions (REX) are the must have tools for Revit Productivity, It provides more capabilities to your Revit software, the most useful extensions are:

- Timber Framing Extension
- Compare Models
- Grids Generator
- Civil Structures
- CIS/2 Import/Export
- Excel based model generation
- Frame Generator
- Composite Design
- **SDNF Import/Export** (this extension is required for this class)



The following article will help you to find and download the REX:

http://knowledge.autodesk.com/search-result/caas/sfdcarticles/sfdcarticles/How-to-find-and-download-Autodesk-Revit-Extensions.html

AutoCAD Plant 3D

Autodesk® Plant Design Suite 2015 provides comprehensive plant design, modeling, and review software. AutoCAD Plant 3D allows users to easily design pipe, equipment, and steel models and generate isometric and orthographic deliverables. AutoCAD Plant 3D also includes AutoCAD P&ID which is a design package for process and instrumentation diagrams.

Since Plant 3D is built on top of AutoCAD you can use the same commands you are familiar with in addition to commands that are designed to operate on Plant 3D objects. AutoCAD Plant 3D comes with AutoCAD P&ID functionality built-in. You can create and edit P&ID drawings within the P&ID workspaces in Plant 3D.

Plant 3D allows you to:

- Create and modify spec sheets and catalogs
- Create and edit P&ID drawings
- Perform pipe routing
- Design and place equipment
- Model preliminary structural steel
- Generate isometric drawings with automatic annotations
- Generate 2D orthographic drawings with annotations and customized bill of material
- Generate customized project reports
- Export and import data to Microsoft Excel spreadsheets

For more details about AutoCAD Plant 3D, please visit:

http://www.autodesk.com/products/autocad-plant-3d/overview

Best practices for model interoperability with Autodesk Advance Steel, Revit, and Plant 3D

In this section we will discuss the best practices for using 3D models between Advance Steel and Revit with Plant 3D.

Exporting steel from Plant 3D to Revit or Advance Steel

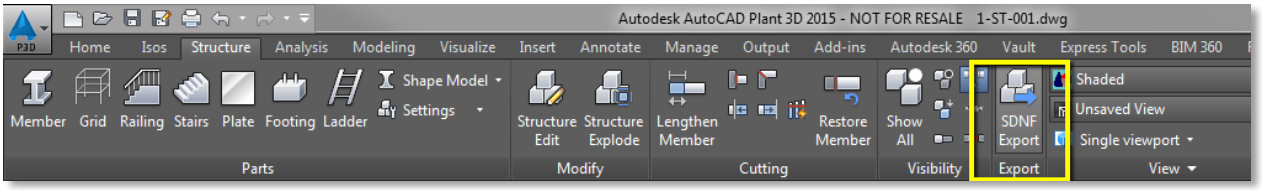
You can select structural objects in a Plant 3D drawing and export them to a Steel Detailing Neutral Format (SDNF) file. Structural objects you can export to this format are:

- Structural members
- Railings
- Ladders
- Stairs
- Plates

When you export railings, ladders, and stairs to SDNF they are exploded into individual members. Please note: ladder cages are not included in an export.

Before attempting an export of steel from Plant we recommend consolidating the separate structural steel objects into layers. For example, make sure steel members, stairs, ladders, grating, etc. are on their own layer. This will help simplify the export as typically only steel members will need to be exported from Plant 3D to SDNF.

1. Click on the *Structure* tab on the Ribbon Bar
2. Click SDNF Export button



3. Choose a location for the output file and fill in the information in the SDNF Export window
4. Click the *Select Objects* button
5. Use a window to select the objects to be exported (non-structure objects will be filtered out) or type in ALL on the command line if you want to export all steel in the drawing

6. Click the Export button

Please refer to Autodesk Screencast video for an example of this workflow:

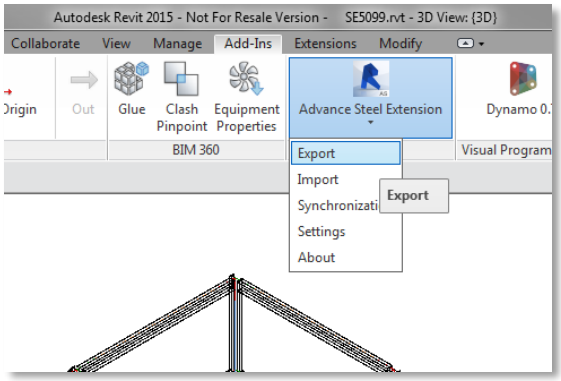
AU2014: SE5099: Exporting Structural Steel from Plant 3D

Export / Import for Revit and Advance Steel with Extension (.GTCX)

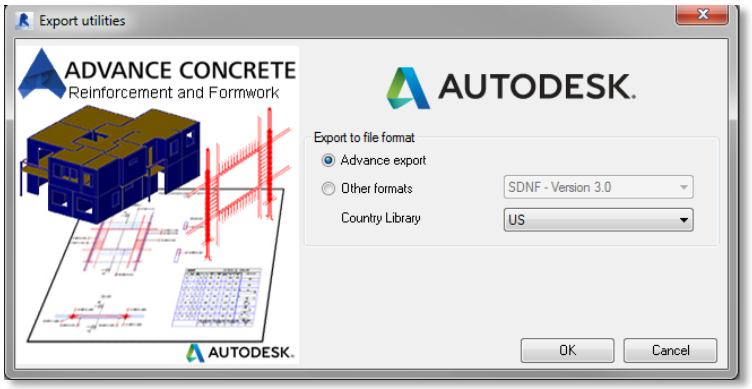
Steel models that have been imported into Revit through SDNF or created from within Revit can be exported to a .GTCX file and then imported into Advance Steel. This special file is used to transfer data between the two applications. This feature requires the use of Advance Steel 2015.1 Extension available from the Autodesk Exchange Apps Store.

Export to a .GTCX file from Revit

1. From the Add-Ins tab on the Ribbon Bar click the Advance Steel Extension button:

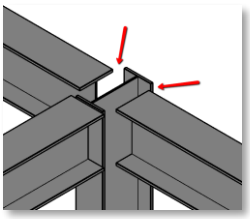


2. Select “Export” from the list
3. Make sure “Advance export” is selected:



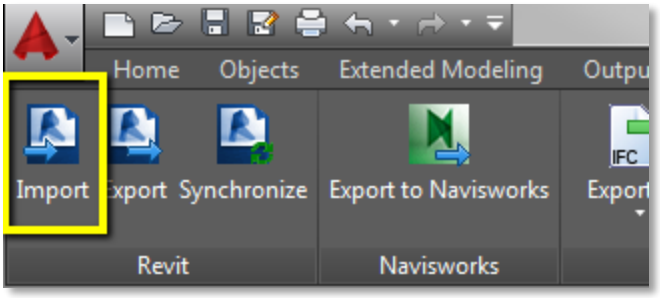
4. Click OK button
5. Specify a location for the exported file

If you do not want beam shortenings from Revit to be exported with the .GTCX file, un-check the “Export beam shortenings” checkbox from the Settings for the Advance Steel Extension. The settings are available from the drop-down list of the Advance Steel Extension on the Add-Ins tab in Revit.

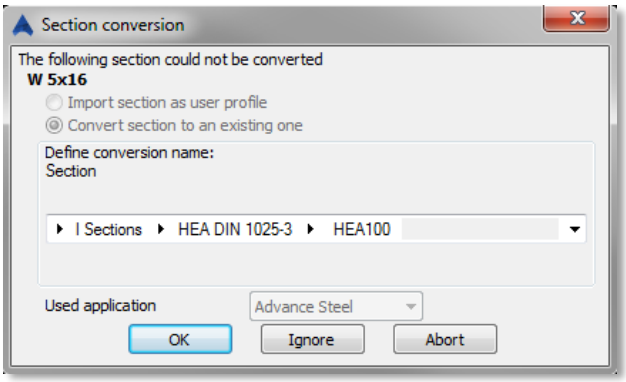


Importing a .GTCX file into Advance Steel

1. From the Export & Import tab on the Ribbon Bar, select Import on the Revit panel:



2. Browse to the location of the .GTCX file and click the Open button
3. Map sections as required:



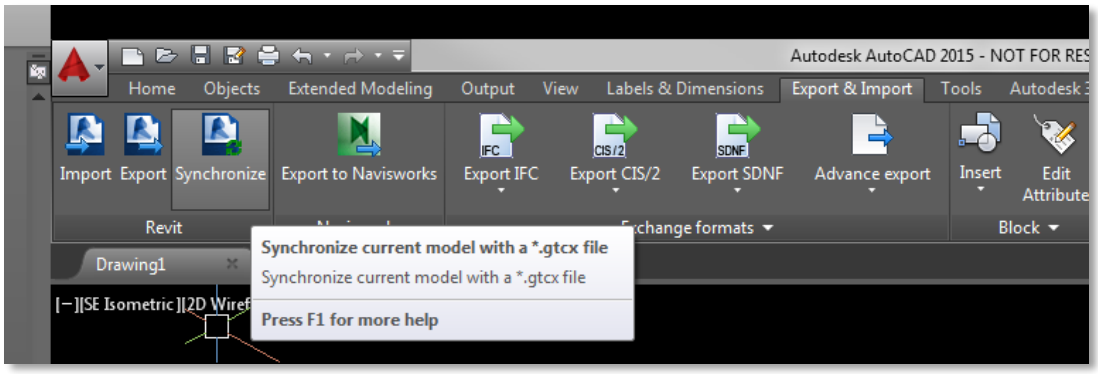
4. The steel members are now imported from Revit and ready to use.

Synchronizing .GTCX files between Revit and Advance Steel

Once a .GTCX file has been exported and imported into the corresponding application, synchronization can be used to keep the file up to date.

Advance Steel Synchronization

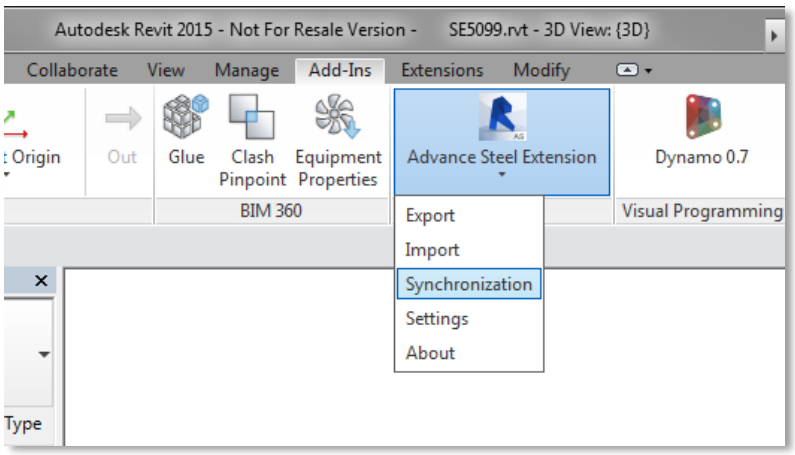
1. Select the Export & Import tab from the Ribbon Bar
2. Click the Synchronize button from the Revit panel:



3. Click the Load button and browse to the .GTCX file and open it

Revit Synchronization

1. Select the Add-Ins tab from the Ribbon Bar
2. Click the Advance Steel Extension drop-down button
3. Select Synchronization:



4. Click the Load button and browse to the .GTCX file and open it

Exporting from Revit Structure to Plant 3D

After modifications have been made to the model in Revit Structure you can export the Revit model to a .DWG file. This drawing can be imported into your Plant 3D project or attached as an XREF. This updated model will replace your preliminary steel model that was created inside of Plant 3D.

One recommendation is creating a new "host" or container drawing inside the Plant 3D project where the Revit .DWG will be inserted as an XREF.

This accomplishes three things:

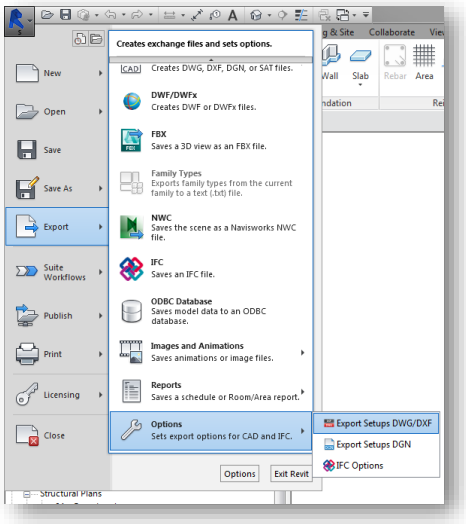
- *The Revit model can be re-exported (overwrite the .DWG file) at any time by the Revit designer*
- *Existing Orthographic views in the Plant project using this drawing can easily be updated*
- *No need to remove and add the drawing into the project again*

DWG Export Setting in Revit

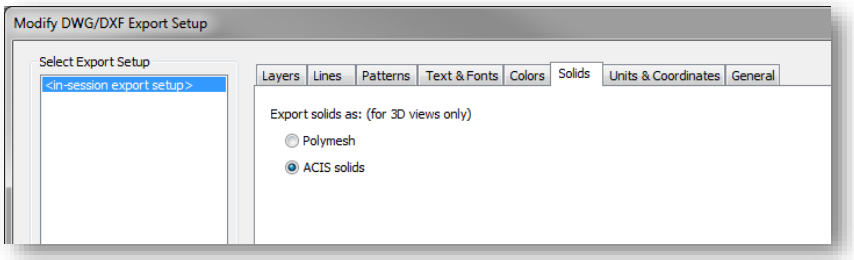
The default setting for DWG/DXF export in Revit is Polymesh export for solids. This needs to be changed to ACIS solids so the Orthographic views can be properly generated from the exported geometry within AutoCAD Plant 3D.

To change this option inside of Revit:

1. Click on the Application Button in the upper left-hand corner of the Revit application



2. Go to Export -> Options -> Export Setups DWG/DXF
3. Click on the Solids tab
4. Select "ACIS solids"
5. Click OK



Using Advance Steel models with Plant 3D

3D model drawings from Advance Steel can be used in your Plant 3D project. Just like .DWGs exported from Revit, you can either copy them into the project or use a host/container drawing to insert the Advance Steel drawing.

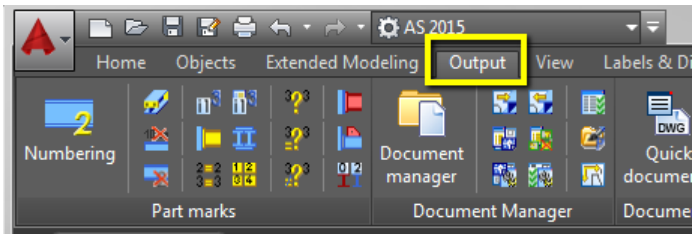
Advance Steel Output Settings

The default setting for Advance Steel is to save ***without*** proxy graphics. This means the DWG files will be saved with no proxy objects. This needs to be changed to *Save with area Proxy-Graphics* so the Orthographic views can be properly generated within AutoCAD Plant 3D. This setting is drawing specific and must be changed on each drawing that is exported.

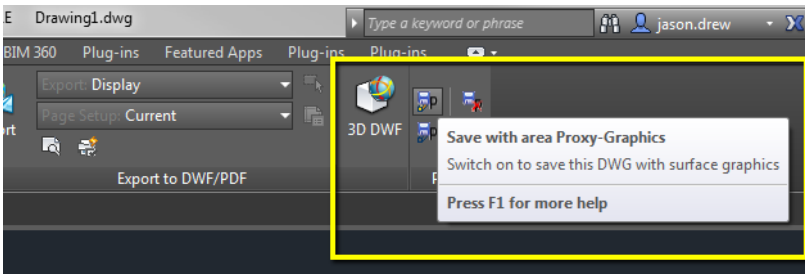
Note: If you are using the Advance Steel 2015.1 Object Enabler this setting can be left as default. Plant 3D will be able to process the Advance Steel objects for Orthographic view generation through the use of the Object Enabler.

To change this option inside of Advance Steel:

1. Click on the Output tab



2. Click the button for “Save with area Proxy-Graphics”



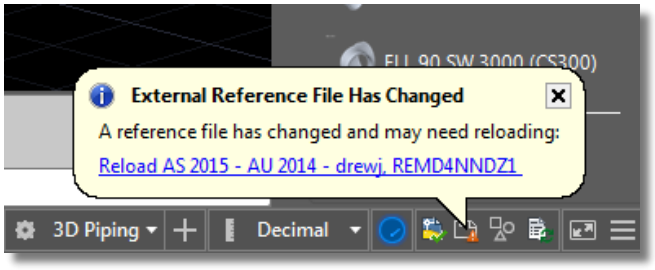
Attaching Advance Steel Drawings to Plant 3D models

Once you have detailed your steel model in Advance Steel it's time to bring the updated model into Plant 3D. In this example we will create a new drawing in Plant 3D to host the AS model and then attach it as an XREF into the Plant 3D pipe and equipment drawing.

1. Create a new Plant 3D drawing inside the project
2. Open this drawing and use the XREF command to attach the new AS model

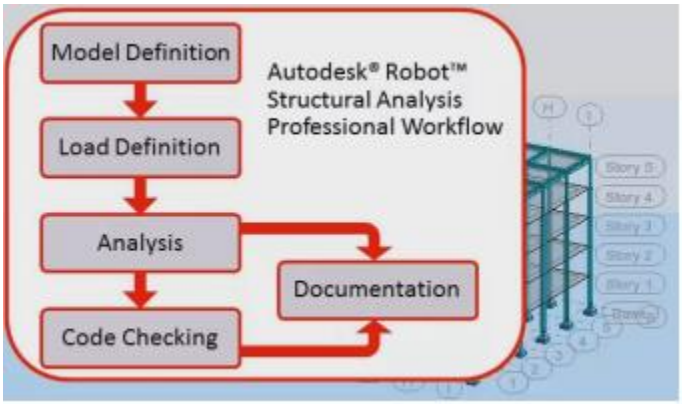
   Note: Make sure the attachment type is set to "Attachment" and not "Overlay
3. Open the pipe and equipment model where the preliminary steel model was attached
4. Unload the preliminary steel model XREF
5. Attach the new drawing with the Advance Steel model into the pipe and equipment drawing

Now with the Advance Steel model in your project any future modifications that are made in Advance Steel will carry over when the XREF is reloaded.



How to perform structural analysis of steel structures with Robot Structural Analysis

The following chart is illustrating the structural analysis process:



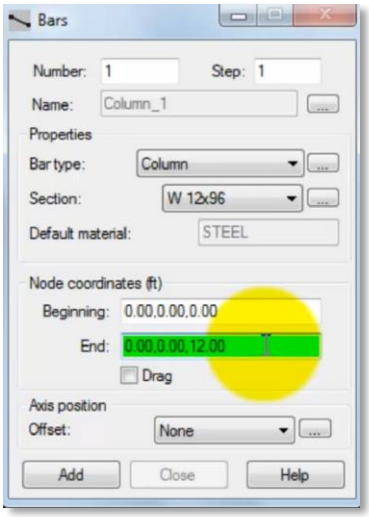
Model definition

The 3D model could be created from scratch (using Structural Axis import .DXF or .DWG background) or imported (from Revit ideally.)

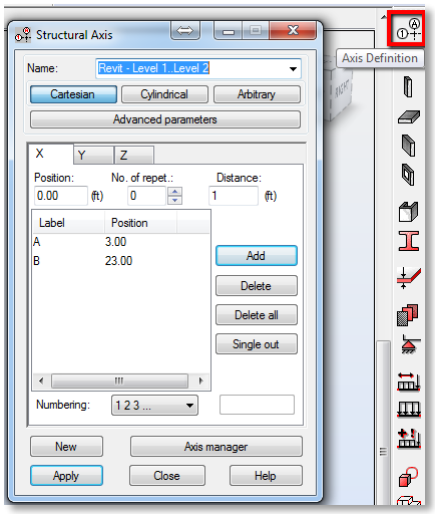
Creating a new model from scratch

There are different options to achieve that:

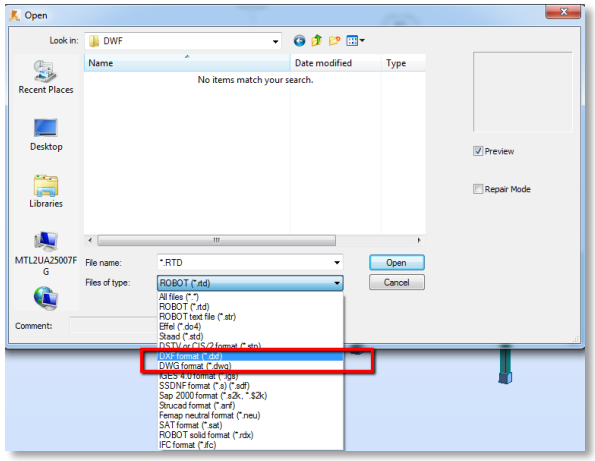
1. Use the coordinates:



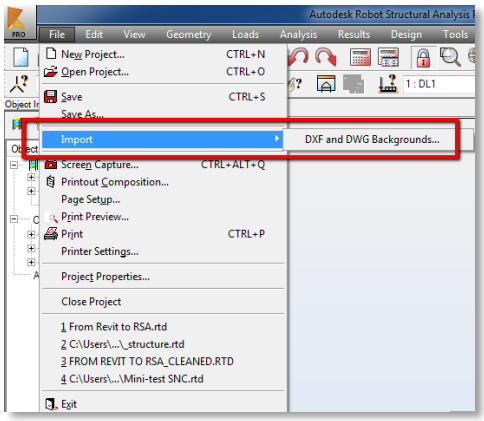
2. Use the Structural Axis



3. Import DWG/DXF (other formats are available) file and convert lines to bars:



4. Import DXF/DWG as backgrounds:



Import a Revit file

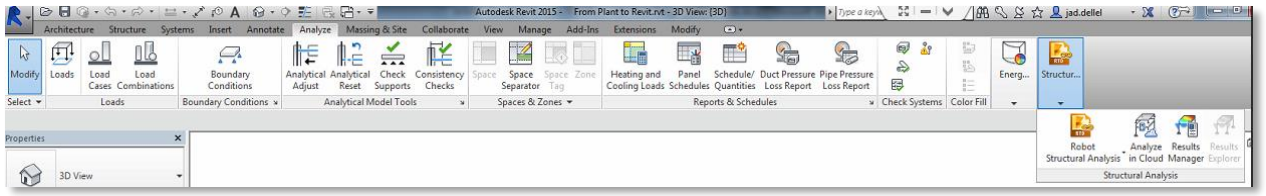
In Revit, the analytical model is a representation of the structure required for structural analysis and design.

In general, the user may need to prepare the Revit model for structural analysis, by doing the following:

- *To prepare analytical views use the analytical model settings tab to specify auto-detect and consistency check tolerances.*
- *Adjust manually the analytical model (click analytical adjust, select an analytical element to display its direct manipulation controls).*
- *Download and install the Structural Toolkit to enable the integration with RSA and RSA360: [AU2014:SE5099: Download Structural Toolkit from App exchange]*

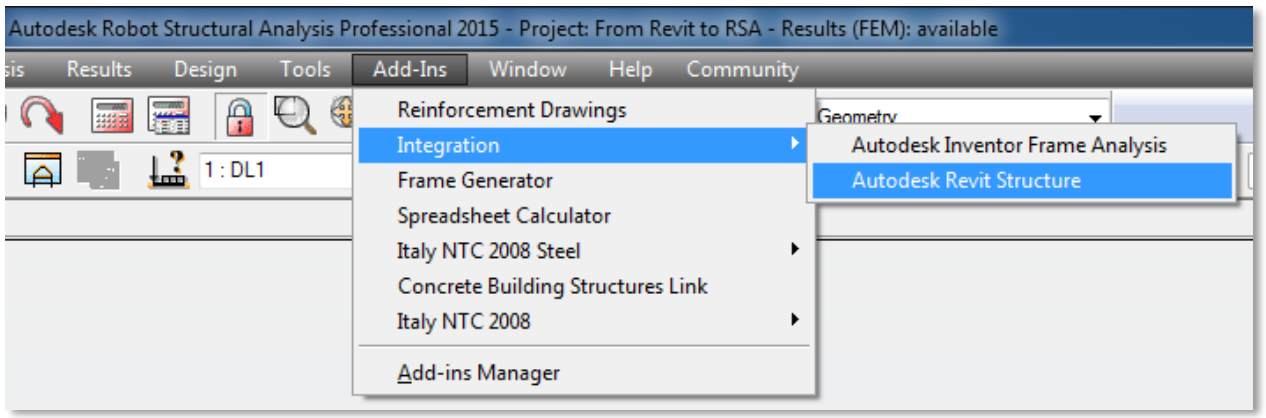
Send the Revit model to RSA

In Revit, click **Analyze** tab ➤ **Structural Analysis** panel ➤ **Robot Structural Analysis** ➤ **Robot Structural Analysis Link**

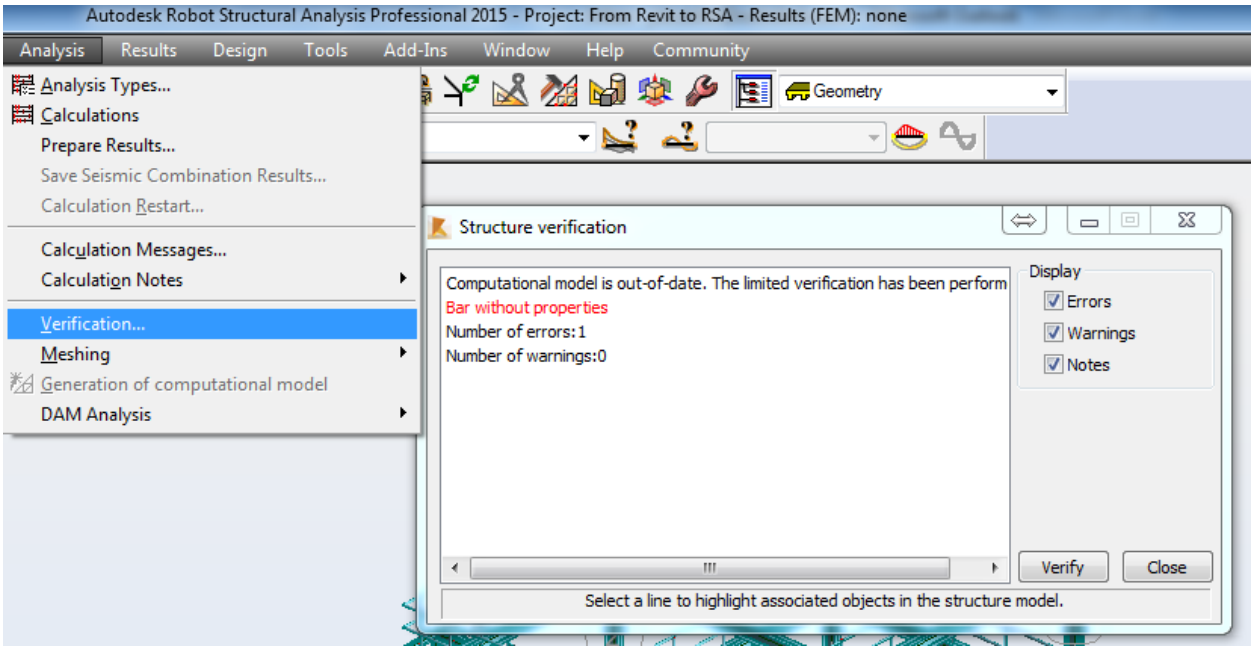


[AU2014:SE5099: Exporting a Revit Model to Robot Structural Analysis]

If you created your 3D model from a scratch in RSA you could use the Revit structure Add-in to export your RSA model directly to Revit.



The structural engineer may need to run verification and fix errors before proceeding, supports in some cases need to be rectified or added.



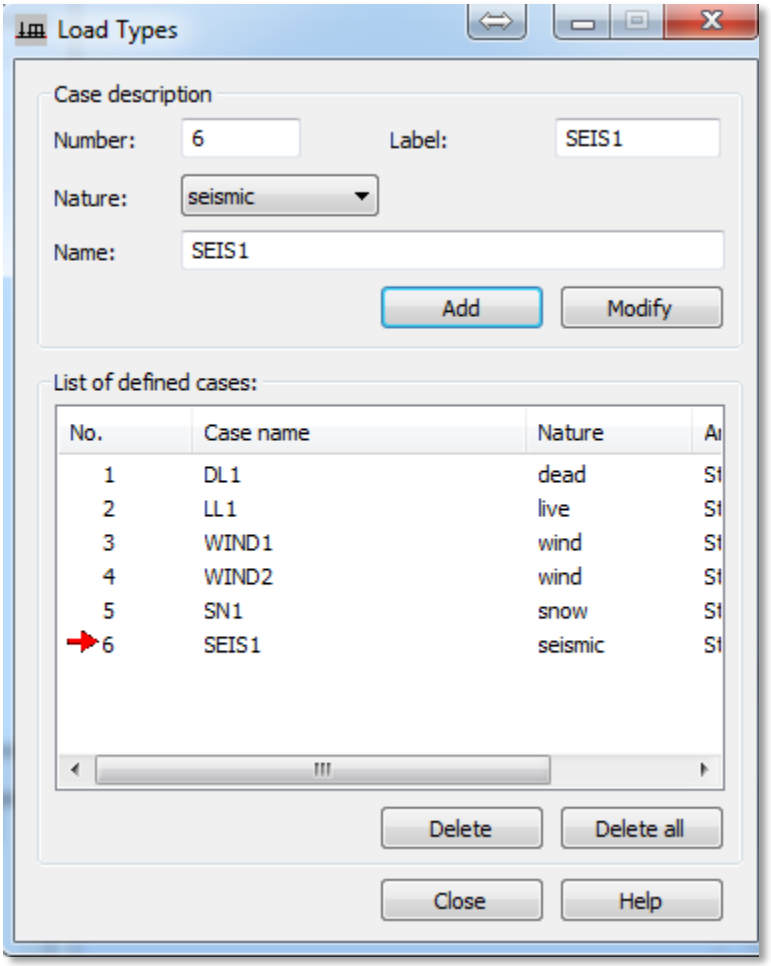
[AU2014:SE5099: Check and add supports to Structural Model in RSA?]

Load definition

Most basic type of loads could be applied within Revit, but RSA offers an extended choice of loads and some of them could be generated automatically like Wind, Snow, Seismic (available in some codes)

To apply a load in RSA, a load case needs to be set up first (Loads\ Load Types…) 

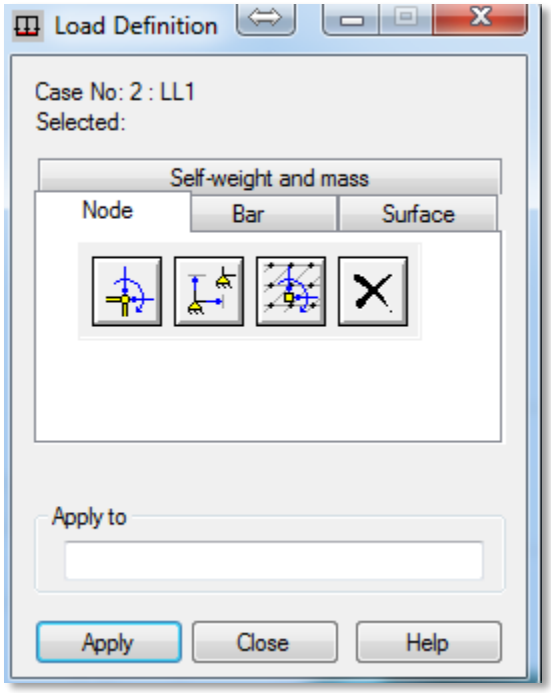
So, for instance, Dead, Live, Wind, Snow and Seismic loads were defined below:



Once a load case has been set up it can be applied to structure elements such as nodes, bars, or surfaces.

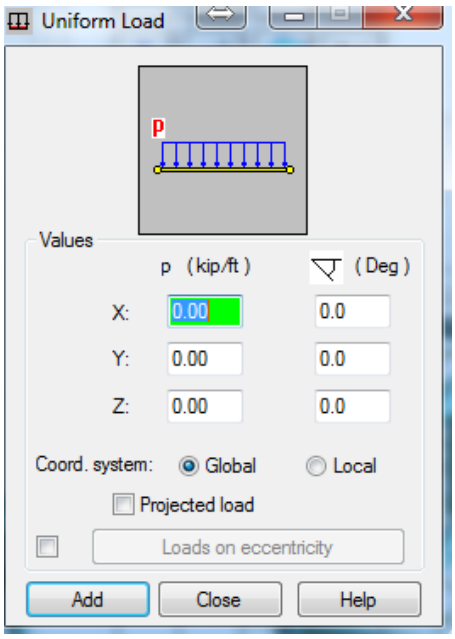
Load Definition Setup in RSA

1. Click Loads ➤  Load Definition. The Load Definition dialog opens.
2. Go to the tab corresponding to the type of structure element on which the load must be applied.



3. Click on the type of load that you want to define. A dialog corresponding to the type of load selected opens.

   Specify the necessary values for the load and then click Add. The type of load is now displayed under the load case name in the Load Definition dialog and the cursor changes to a load symbol.

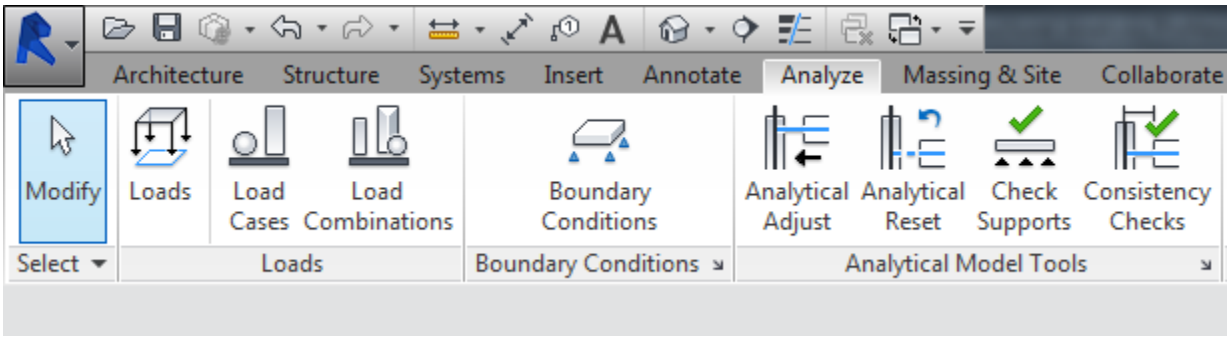


4. Apply the loads to the structure.

[AU2014:SE5099: apply a load in RSA]

In Revit within the Analyze tab, Load cases and Loads could be defined as well.

Load Definition Setup in Revit

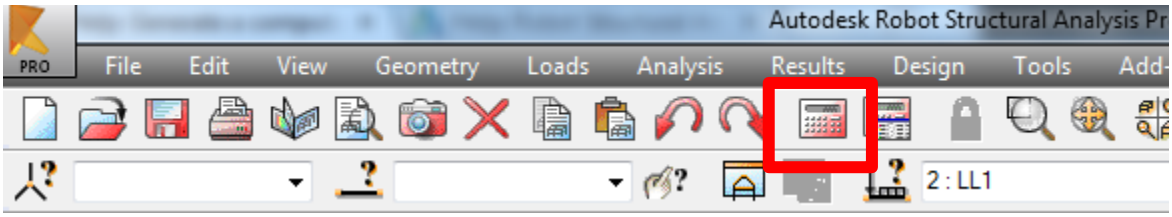


AU2014:SE5099: apply a load in Revit

Analysis

Many kinds of analysis could be performed such as static-linear, dynamic, non-linear, etc.

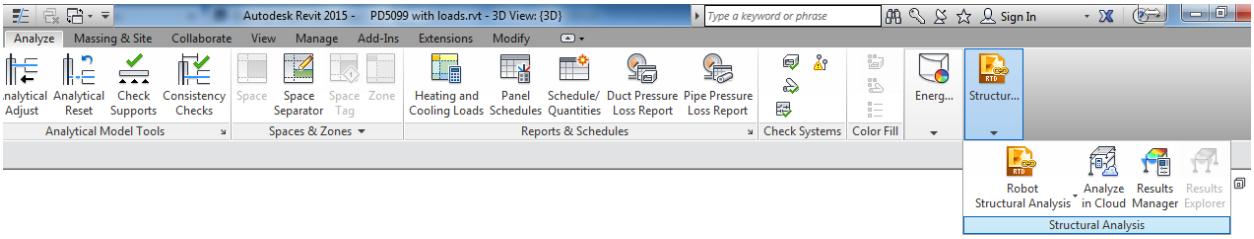
To run a static-linear analysis, just hit the calculations button:



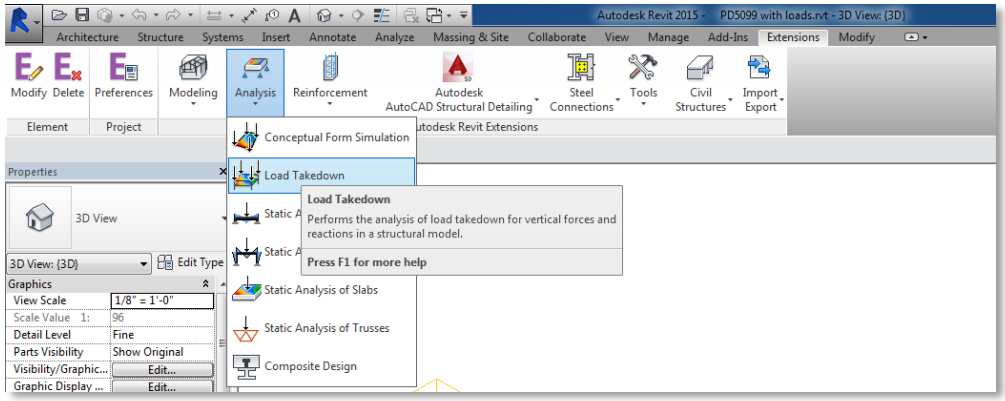
The results could be displayed on Diagrams, Maps and spreadsheets.

For more advanced analysis (dynamic, non-linear…) please refer to the RSA Help or check some advanced classes on the Autodesk University web site.

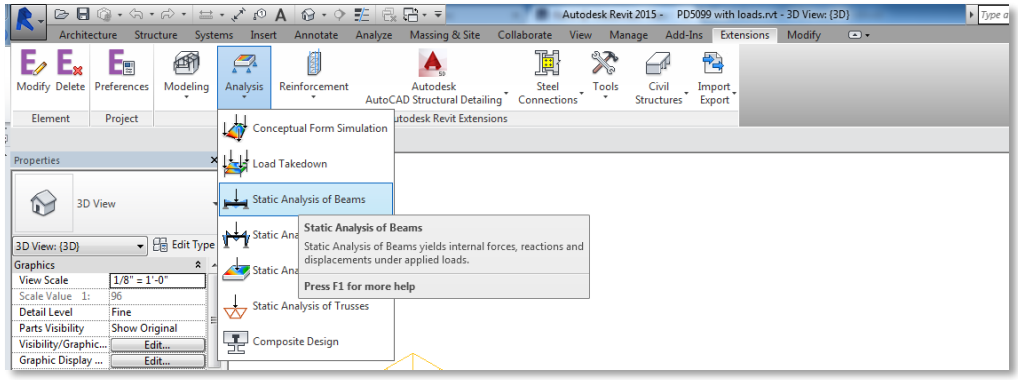
There is also another alternative (very interesting for large models) to run a static-linear analysis using RSA360 (Analyze in Cloud):



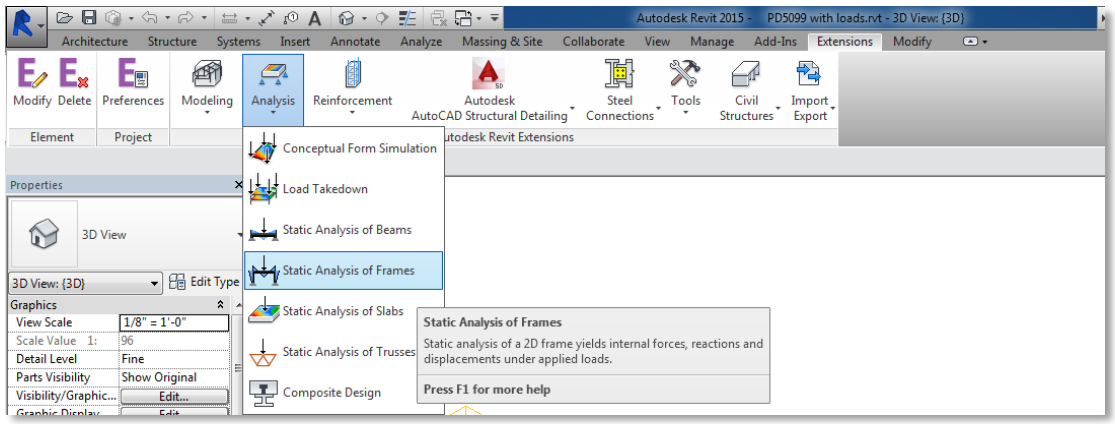
The Load Takedown Extension is also a good option to perform the analysis of load takedown for vertical forces and reactions (without using RSA or the cloud.)



*If you need to run analysis for a specific beam you could use the **Static Analysis of Beams** extension:*

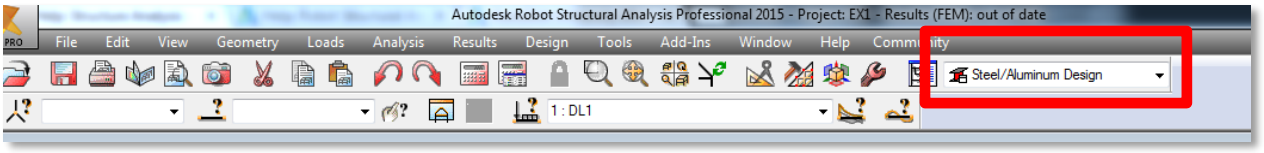


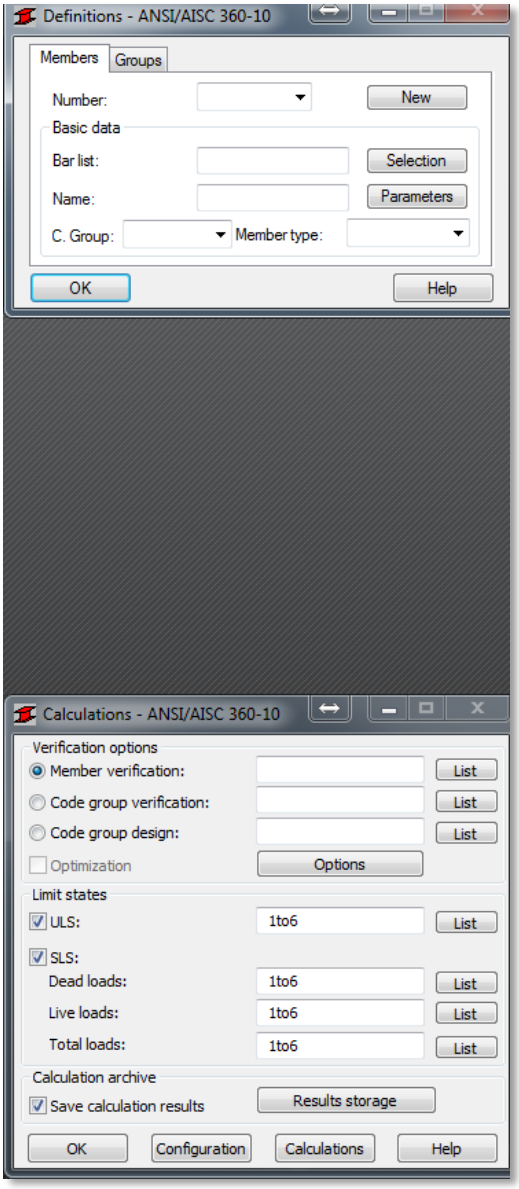
*Another interesting Revit Extension is the **Static Analysis of Frames** which could be used if you are interested to run a static analysis of a 2D frame without using RSA or RSA 360.*



Code checking (steel design)

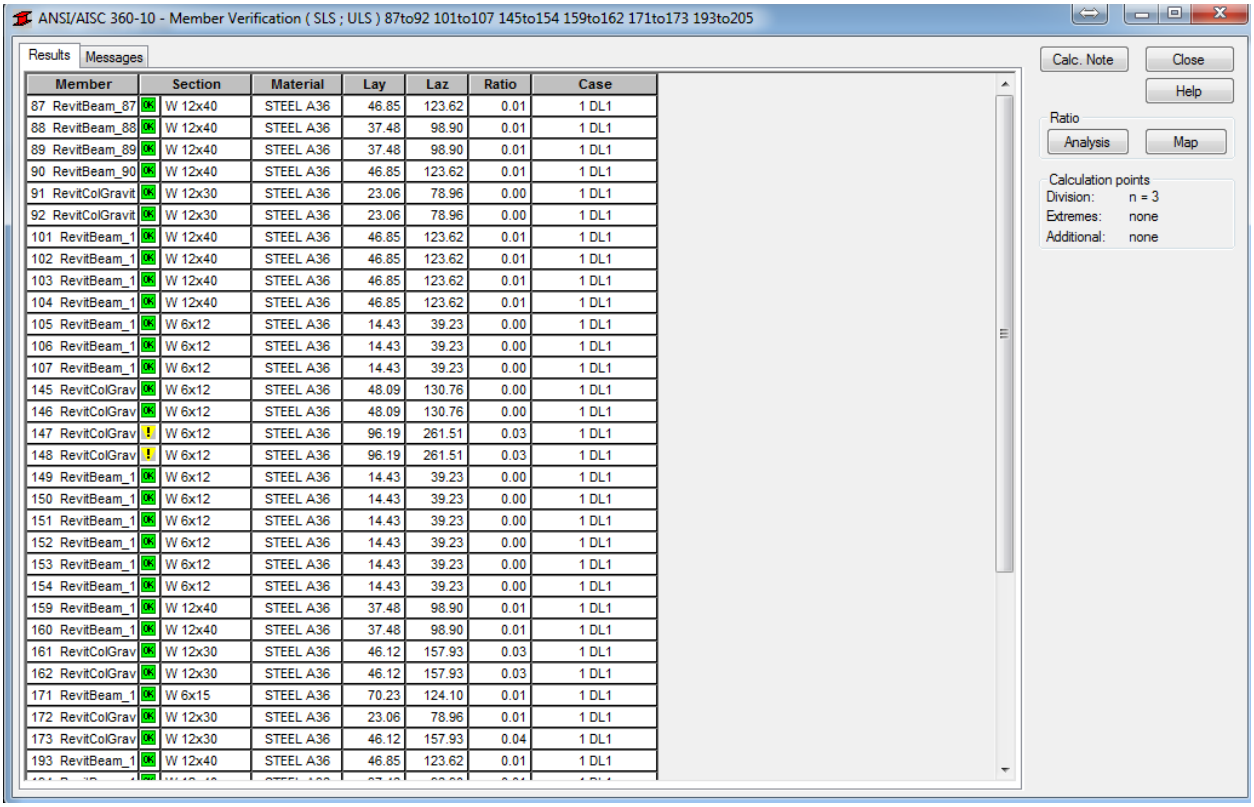
The steel design option offers the possibility of a quick and efficient verification of sections used in the structure. The user may apply a ready-to-use template containing a layout of dialog boxes necessary for design of steel elements.





Selection of the Steel Design template makes successive operations aimed at structure verification considerably easier:

- Selection of members to be verified
- Start of member verification
- The short results dialog box contains the most significant information about sections

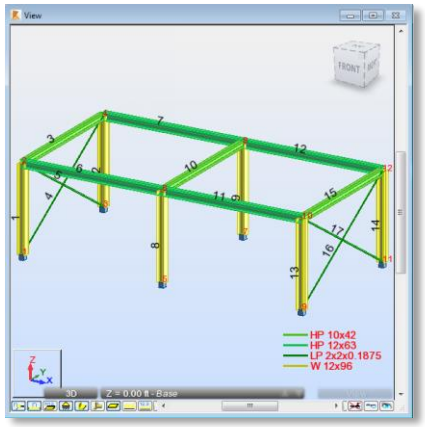


Member	Section	Material	Lay	Laz	Ratio	Case
87 RevitBeam_87	W 12x40	STEEL A36	46.85	123.62	0.01	1 DL1
88 RevitBeam_88	W 12x40	STEEL A36	37.48	98.90	0.01	1 DL1
89 RevitBeam_89	W 12x40	STEEL A36	37.48	98.90	0.01	1 DL1
90 RevitBeam_90	W 12x40	STEEL A36	46.85	123.62	0.01	1 DL1
91 RevitColGravit	W 12x30	STEEL A36	23.06	78.96	0.00	1 DL1
92 RevitColGravit	W 12x30	STEEL A36	23.06	78.96	0.00	1 DL1
101 RevitBeam_1	W 12x40	STEEL A36	46.85	123.62	0.01	1 DL1
102 RevitBeam_1	W 12x40	STEEL A36	46.85	123.62	0.01	1 DL1
103 RevitBeam_1	W 12x40	STEEL A36	46.85	123.62	0.01	1 DL1
104 RevitBeam_1	W 12x40	STEEL A36	46.85	123.62	0.01	1 DL1
105 RevitBeam_1	W 6x12	STEEL A36	14.43	39.23	0.00	1 DL1
106 RevitBeam_1	W 6x12	STEEL A36	14.43	39.23	0.00	1 DL1
107 RevitBeam_1	W 6x12	STEEL A36	14.43	39.23	0.00	1 DL1
145 RevitColGrav	W 6x12	STEEL A36	48.09	130.76	0.00	1 DL1
146 RevitColGrav	W 6x12	STEEL A36	48.09	130.76	0.00	1 DL1
147 RevitColGrav	W 6x12	STEEL A36	96.19	261.51	0.03	1 DL1
148 RevitColGrav	W 6x12	STEEL A36	96.19	261.51	0.03	1 DL1
149 RevitBeam_1	W 6x12	STEEL A36	14.43	39.23	0.00	1 DL1
150 RevitBeam_1	W 6x12	STEEL A36	14.43	39.23	0.00	1 DL1
151 RevitBeam_1	W 6x12	STEEL A36	14.43	39.23	0.00	1 DL1
152 RevitBeam_1	W 6x12	STEEL A36	14.43	39.23	0.00	1 DL1
153 RevitBeam_1	W 6x12	STEEL A36	14.43	39.23	0.00	1 DL1
154 RevitBeam_1	W 6x12	STEEL A36	14.43	39.23	0.00	1 DL1
159 RevitBeam_1	W 12x40	STEEL A36	37.48	98.90	0.01	1 DL1
160 RevitBeam_1	W 12x40	STEEL A36	37.48	98.90	0.01	1 DL1
161 RevitColGrav	W 12x30	STEEL A36	46.12	157.93	0.03	1 DL1
162 RevitColGrav	W 12x30	STEEL A36	46.12	157.93	0.03	1 DL1
171 RevitBeam_1	W 6x15	STEEL A36	70.23	124.10	0.01	1 DL1
172 RevitColGrav	W 12x30	STEEL A36	23.06	78.96	0.01	1 DL1
173 RevitColGrav	W 12x30	STEEL A36	46.12	157.93	0.04	1 DL1
193 RevitBeam_1	W 12x40	STEEL A36	46.85	123.62	0.01	1 DL1

The option of steel verification and design enables a quick and efficient ULS analysis of sections used in the structure.

Practice

In the following tutorial you will learn how to model a 3D frame



Step 1: Set preferences

Step 2: Add sections

Step 3: Define the structure

Step 4: Define supports

Step 5: Copy existing 2D frame

Step 6: Define load cases

Step 7: Apply load cases

Step 8: Generate a manual combination

Step 9: Run a calculation

Step 10: Display beam results graphically

Step 11: Display results on bars in tabular form

Step 12: Stress Analysis for structure

Step 13: Definition of code parameters

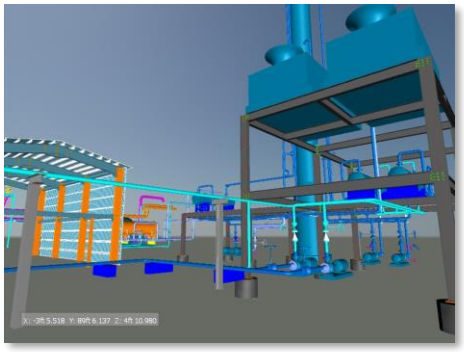
Step 14: Define groups of members

Step 15: Code group design

Step 16: Code group verification

Collaboration between engineering disciplines with Navisworks

In this section we discuss the use of *Navisworks Manage* to bring the models together with other disciplines. This includes appending the models and running clash detection against the steel structures. The samples models from the class will be used.



The first task is appending the models into Navisworks. You can import many different file formats directly into Navisworks. In this example we will be appending .DWG files from Plant 3D and Advance Steel.

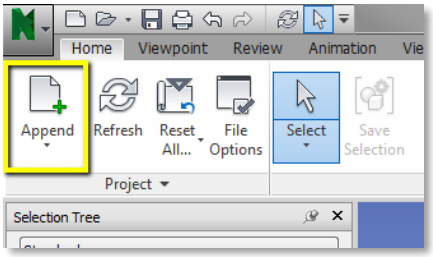
Make sure you have the proper Object Enabler installed for the application you appending from. For example, you would need to have the Plant 3D Object Enabler loaded onto Navisworks Manage in order to properly display the Plant specific objects.

Object Enablers for Autodesk applications can be found on this site:

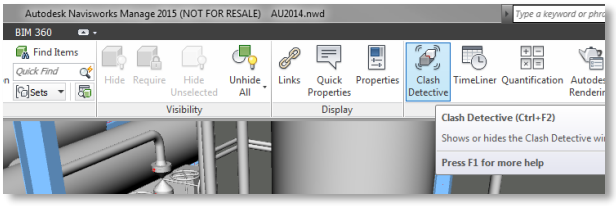
Autodesk Knowledge Network: Object Enablers

Appending models and running a clash detection in Navisworks

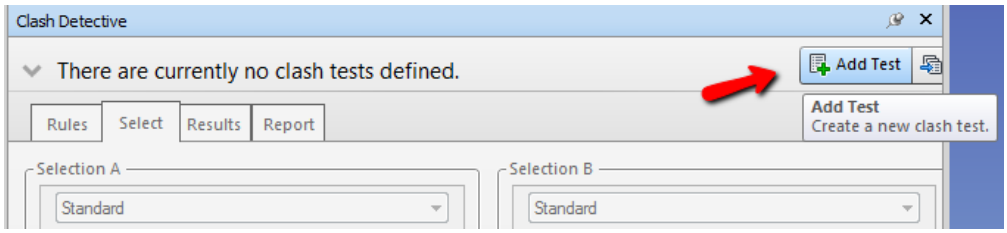
1. Click the Append button on the Home tab of the Ribbon Bar. Select the models you wish to include and click the Open button.



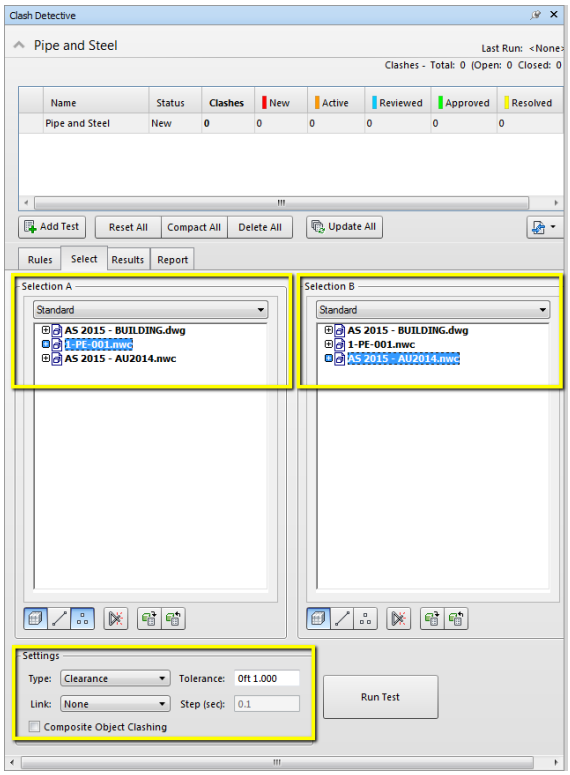
2. Click the Clash Detective button on the Home tab of the Ribbon Bar



3. Click the Add Test button from the Clash Detective palette



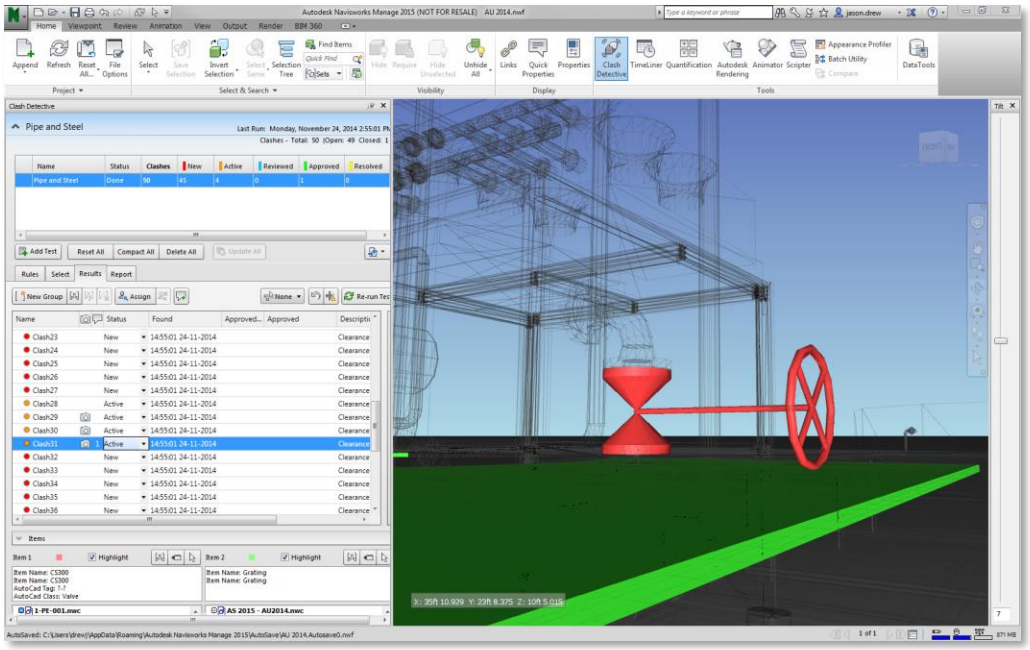
4. Give the test a name and make a selection for A & B
(Clashes will be tested between Selection A and Selection B)

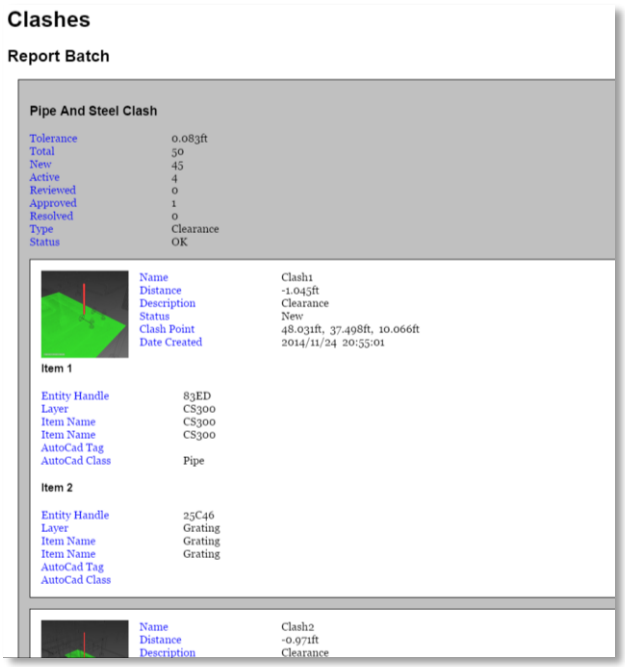


5. Adjust the settings in the lower section of the Clash Detective window to set the tolerance of what will be detected as a clash. For example, we want to check for any clearance issues and we want the tolerance to be 1”. Any clashes within the range will be reported.
6. Click the Run Test button
7. The Clashes will be displayed in the Results section

The test results, status of the clashes, and comments can be saved in the Navisworks .NWF file. When the drawings change and the .NWF is refreshed the clash test can be re-ran and the statues will be maintained for any existing clashes.

The results can also be exported to an XML file and imported back in at a later time. Also, a complete report can be written to XML or HTML format for delivery to a client of design team.





Clashes

Report Batch

Pipe And Steel Clash

Tolerance	0.083ft
Total	50
New	45
Active	4
Reviewed	0
Approved	1
Resolved	0
Type	Clearance
Status	OK

Name	Clash1
Distance	-1.045ft
Description	Clearance
Status	New
Clash Point	48.031ft, 37.498ft, 10.066ft
Date Created	2014/11/24 20:55:01

Item 1

Entity Handle	83ED
Layer	CS300
Item Name	CS300
Item Name	CS300
AutoCad Tag	
AutoCad Class	Pipe

Item 2

Entity Handle	25C46
Layer	Grating
Item Name	Grating
Item Name	Grating
AutoCad Tag	
AutoCad Class	

Name	Clash2
Distance	-0.971ft
Description	Clearance

Figure 1. Clash Report in HTML format