iTWO cost 7.0

DIGITAL DRAWING FILE OPTIMISATION

For Measurement & Estimating Purposes

Simple tips for a collaborative approach
to improved drawing file intelligence

RIB
running together

Acknowledgements

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1 Introduction

All construction projects will have a number of key objectives, and almost without exception these will include adherence to cost and budgetary constraints. Whilst there is nothing new in these requirements, the way and speed they can be achieved has improved significantly and continues to improve because of the use of iTWO costX®. iTWO costX® is an interoperable estimating software tool which supports the seamless transfer of digital design information between designers and non-CAD users for measurement and estimating purposes.

Amongst other powerful features, iTWO costX® allows its users to measure from a variety of drawing file formats without running CAD software, and without the ability to amend or alter the files. The measurements are then utilized in the preparation of working documents required for the various stages of a project, such as option or change appraisals, estimates, bills of quantities, material schedules, tenders, and the like.

Whilst iTWO costX® supports a wide variety of file formats, thus enabling its use on any project, file formats for design data vary and each inherently provides differing levels of data richness and functionality. iTWO costX® users can leverage better drawing file intelligence in a way that can dramatically improve productivity, and this means that the arrangement and configuration of data for each drawing file format can be optimized to improve communication and yield the greatest benefit to the team. This enables work that traditionally could have taken days to complete to be done in hours, leading to improved project delivery and resulting in benefits to the client and design team alike.

Notwithstanding these benefits, electronic drawing files are commonly issued in the lesser intelligent file formats, usually basic 2D raster or vector PDF files, sometimes 2D or 3D CAD formats and only occasionally 3D object-based BIM models. Furthermore, the file data is often not configured in a way to best suit the measurement process and quantity extraction. This represents a missed opportunity because regardless of the file format used, the configuration of data for each drawing file format can easily be optimized to improve communication and yield the greatest benefit to the team.

This document aims to provide general tips and guidance for the more common file formats on how drawing files may be arranged and optimized to improve team communication, and specifically to assist in the quantities measurement and estimating activities. It is not intended to be a mandatory requirement for each file format, but rather to reflect some of the more common optimizations which are of benefit.

Generally, the simple suggestions made in this document will be broadly applicable and could readily be incorporated into workflows for most projects. However, they are by no means exhaustive and it is up to project teams to establish their own information exchange protocols and collaborative workflow methodologies to suit project requirements and individual circumstances.

2 What to Provide - Overview

Drawing file formats which can be used for measurement and estimating purposes range from simple 2D raster formats, through 2D PDF or CAD files, to 3D object-based DWF™ , DWFx™ and IFC BIM models. Each of these formats progressively provides increasing levels of drawing file intelligence which can be leveraged by iTWO costX® users to dramatically improve measurement and estimating productivity.

Quantities are obtained either by on-screen measurement from 2D or 3D drawings, or by importing dimensional information directly from the BIM data model.

The details below reflect a general preference order based on the useable intelligence contained within various file formats, although iTWO costX® supports the use of all of them.

2.1 3D DWF™ and DWFx™ Files from Revit®

If Revit® is the software used to design the building, a multi-sheet DWF™ or DWFx™ export with a default 3D model view (or series of 3D views each showing different elements) and 2D sheets of all plans, elevations and sections will enable iTWO costX® users to utilize the database information to automatically generate quantities from the 3D views, and augment the database quantities with additional measurement from the 2D or 3D drawing views or sheets.

With Revit®, DWF™ and DWFx™ files are preferred to IFC files, but if an IFC is specifically required refer to IFC Files from Revit®.

There are several optimizations which can assist the team when producing 3D models and views in Revit®, these are described in 3D DWF™ and DWFx™ Files from Revit®.

As Revit® is also capable of exporting individual DWG™ files of the 2D views and sheets, these may also be requested where additional measurement functionality may be required. Please refer to 2D CAD files.

2.2 IFC Files

Provide an IFC 2X3 Extended Coordination View export with Base Quantities and with dimensional instance properties (quantities) mapped as a Property Set. Prior to export ensure that objects are mapped to their correct IFC categories, which may involve use of override settings and creation of additional IFC-specific parameters.

For more details refer to IFC Files and if ArchiCAD®has been used also refer to IFC files from ArchiCAD®.

In addition to the IFC, provide a full 2D set of plans, sections, elevations and details in 2D DWG™ format as described in 2D CAD files.

2.3 2D CAD Formats

For most other CAD packages, DWG™ files can be used as an interoperable format between design disciplines to aid coordination, not least because the logical use of layers and blocks within them allows the identification and isolation of the relevant details, and this assists with the speed of measurement. There are several beneficial optimizations when producing DWG™ files as described in 2D CAD files. Note that iTWO costX® cannot be used to alter or amend DWG™ or any other CAD files. 2D DGN™ files are also supported by iTWO costX®.

2.4 Vector-based PDFs

PDF files are a commonly issued output for design data, in part because this format is read-only and can be easily opened with a number or freely available and simple to use viewing packages. PDF files exported from a CAD package will usually contain vector coordinates however little else of the embedded intelligence of the CAD files from which they are generated.

Whilst vector PDF files can readily be used for measurement in iTWO costX®, advanced measurement tools such as blocks and polylines which rely on CAD intelligence are not available. However if there is no choice but to issue vector PDF files there are a few optimizations which can enhance the data and thereby usability of the file, such as including layers in the PDF file to allow isolation of the relevant details which is of assistance for both review purposes and when taking measurements from the drawing. Please refer to Vector based PDF Files and Their Limitations.

2.5 Raster Image Files (incl. Raster PDFs)

Raster image (JPEG, BMP, TIFF, etc) and raster PDF files provide the least data and do not contain any vector or other intelligence from the source CAD file. Sometimes, certain export settings in CAD programs will determine whether a PDF is produced as a vector or raster file, or a combination – it can be quite common for PDF files to contain both vector and raster components. Whilst raster or combined raster/vector files can readily be used for measurement in iTWO costX®, it is preferable to issue the DWG™ source files or all-vector PDFs as they have a far greater range of use. However if there is no alternative but to issue image raster files, the details in Raster Image Files (incl. Raster PDFs) and Their Limitations provide several optimization tips.

3 General Guidance (All 2D File Formats)

Irrespective of the file format provided, one of the key features of iTWO costX® is the ability to identify and track changes which occur on progressive drawing issues. Consequently there are a few general suggestions to consider when creating and issuing drawings for a project which include:

1. Try to use a consistent scale, orientation and position for progressive issues of each drawing.

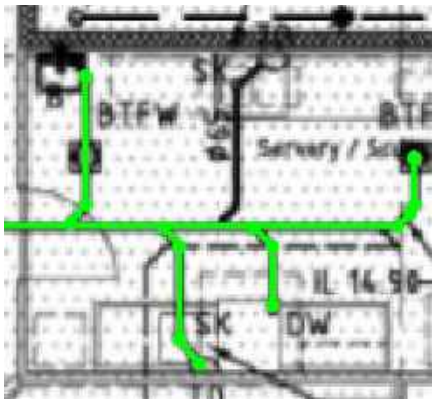
2. Try to be consistent with the drawn information included on each drawing for progressive issues.

3. Consider establishing a drawing numbering/referencing structure and use it consistently for progressive issues.

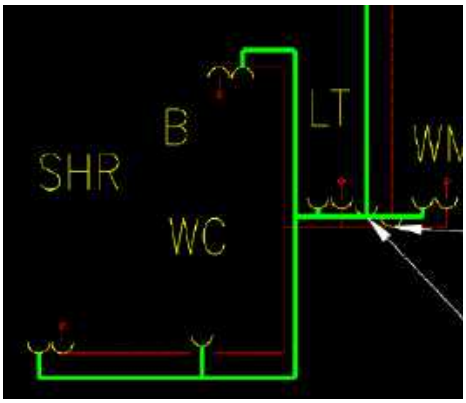
4 Raster Image Files (incl. Raster PDFs) and Their Limitations

CAD programs are based on vector graphics, however the drawings are often published and issued in one of the raster image formats which means that the inherent resolution and intelligence is lost. Often the drawings are difficult to read but cannot be enlarged without further loss of resolution, and the scale can sometimes be difficult to determine accurately.

iTWO costX® supports both raster and vector formats but uses different modes of measurement for each, reflecting the nature of the data available. Measurement of a raster image traces an overlay over the top of the drawing, whereas vector measurement attaches to the actual vector lines within the drawing. Hence vector measurement is faster and more accurate, and can identify changes in drawing revisions by detecting the amended vector co-ordinates of the measured lines.



Raster Mode measurement in iTWO costX®

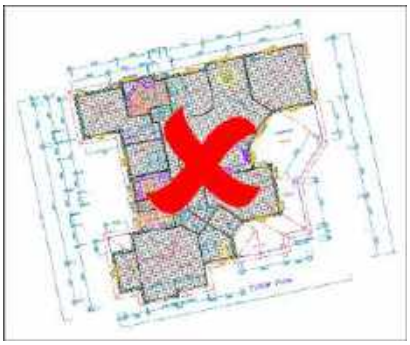


Vector Mode measurement in iTWO costX®

For these reasons, although AutoCAD® and similar CAD programs can export/plot raster image files, the preference is to receive DWG™ files or Vector based PDF files (refer to 2D CAD files and 3D Drawing Files and BIM Models). If you have no choice but to issue raster files instead of vector files it is critical to provide scale information, particularly as the image may get distorted during transmission. This seems basic but is neglected surprisingly often.

1. Provide X and Y scale bars and / or figured dimensions to allow the drawing scale to be calibrated more accurately.

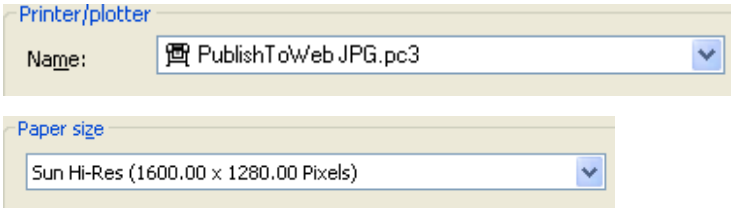
2. Orientate the drawing to be appropriately rotated (e.g. square to the boundary of the image file).



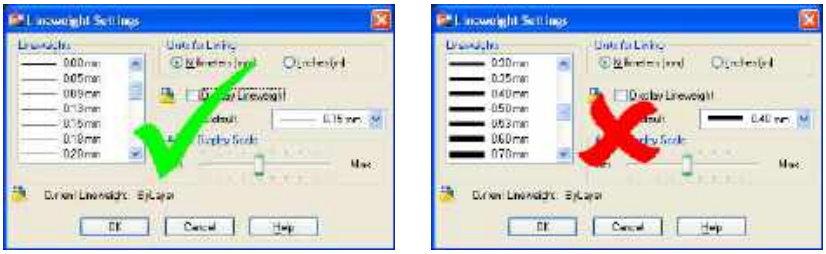
3. Use a consistent scale and orientation for progressive drawing issues.

4. A JPG or PNG file format would be preferred over BMP and TIFF due to file size and quality considerations.

5. If plotting from a CAD package directly, choose an appropriate paper size setting (e.g. 1600 x 1280 pixels, A3 etc. or larger for very large drawings) to enhance resolution.

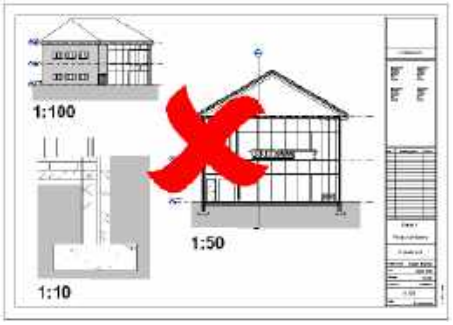


6. Try not to use heavy lineweights, as these may obscure other drawn details.



7. If scanning a drawing use a DPI setting of 100-150DPI generally, for drawings with very fine details use a DPI setting of 200-300DPI.

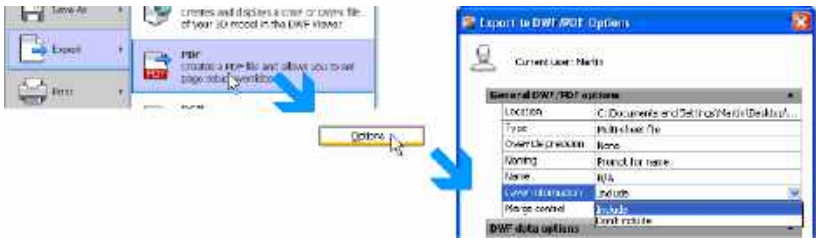
8. Try not to have views at different scales in the same image file. Where this is not possible try to arrange the views at one scale in one area of the sheet and views at a different scale in another area of the sheet rather than having details at different scales interspersed throughout the image.



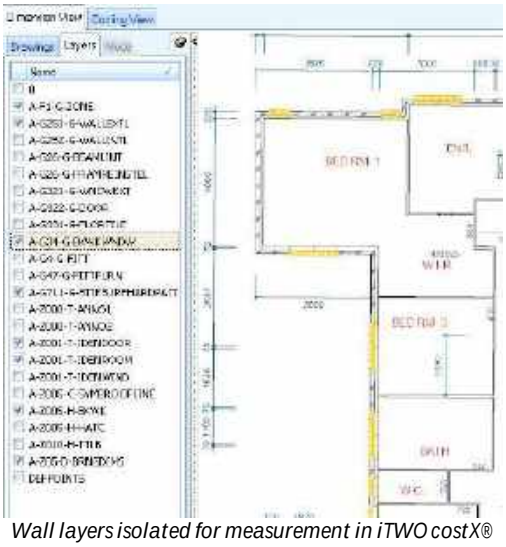
5 Vector-based PDF Files and Their Limitations

A commonly issued output from CAD programs is a PDF file which contains vector co-ordinates but little else of the embedded intelligence of the source CAD files. This means that measurement can be done in vector mode but advanced measurement tools which rely on CAD intelligence such as polylines and blocks are not available. Also, layer information is commonly excluded from PDF files, which means that the drawing view cannot be filtered to facilitate the measurement process.

Owing to its superior resolution and accuracy, a vector PDF is preferable to a raster image but the preference would be to receive DWG™ files (refer to 3D Drawing Files and BIM Models).If you have no choice but to issue vector PDF files instead of CAD files, export as a PDF (in preference to plotting to a PDF printer) and be sure to include layer information. Note – vector PDFs with layers included can also be exported from a DWG™ opened in AutoDesk® DWGTrueView™ .



If layers are enabled in PDF and CAD files, the estimating software can filter the display to make viewing and measurement much quicker and easier, by 1) eliminating unwanted data to reduce clutter and 2) isolating data for measurement.



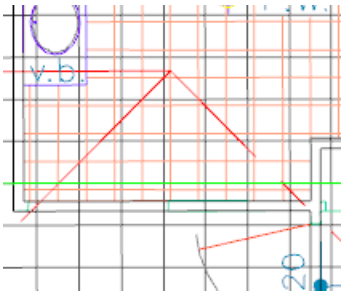
Wall layers isolated for measurement in iTWO costX®

Hence it is very helpful if layers are configured in a logical manner, for example:

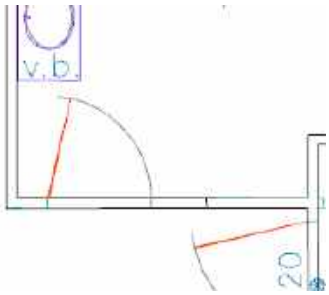
- Put different building elements onto different layers.
- Put like items within an element onto the same layer or distribute them logically onto a series of layers.

- Ensure the layer states are correct for all layers before saving the file. Layers which are not required should be frozen.

- Use the hatching tools to create hatching or include it on a separate layer.



Unfiltered Layers in iTWO costX®



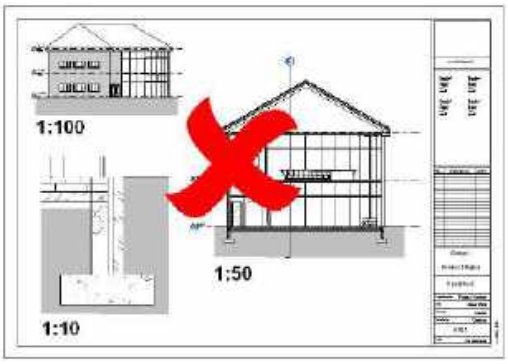
Filtered Layers in iTWO costX®

1. Provide scale annotation, scale bars and / or figured dimensions.

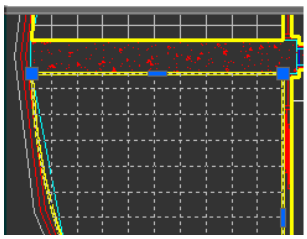
2. Orientate the drawing to be appropriately rotated (e.g. square to the boundary of the image file).

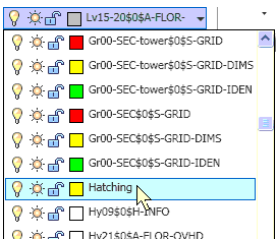
3. Use a consistent scale and orientation for progressive drawing issues.

4. Try not to have views at different scales in the same PDF file. Where this is not possible try to arrange the views at one scale in one area of the sheet and views at a different scale in another area of the sheet rather than having details at different scales interspersed throughout the image.



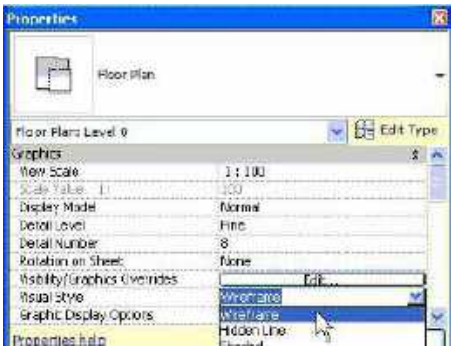
5. Try to include any hatching in the drawing on a different drawing layer(s) to other drawn details to enable it to be displayed or hidden as necessary.





6. If creating a PDF from AutoCAD® use the export to PDF option rather than printing to a PDF.

7. If creating a PDF from Revit®, select a hidden line or wireframe visual style so that the PDF will be in vector format. Styles such as shaded, colored, etc will result in raster or combined raster/vector content.



6 2D CAD Files

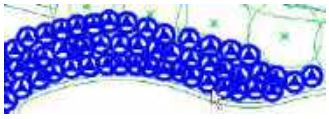
The 2D CAD formats such as DWG™ , DWF/DWFx™ and DGN™ are capable of being rich in content and iTWO costX® users (who cannot edit the drawing file as iTWO costX® is read-only) can exploit this intelligence with various advanced measurement tools.

6.1 Blocks

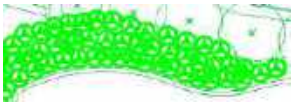
iTWO costX® can make use of blocks by counting all instances of a block in a single action, hence it is very helpful if blocks are included in drawing files and are configured in a logical manner.

1. A single block object being recognized in iTWO costX®.

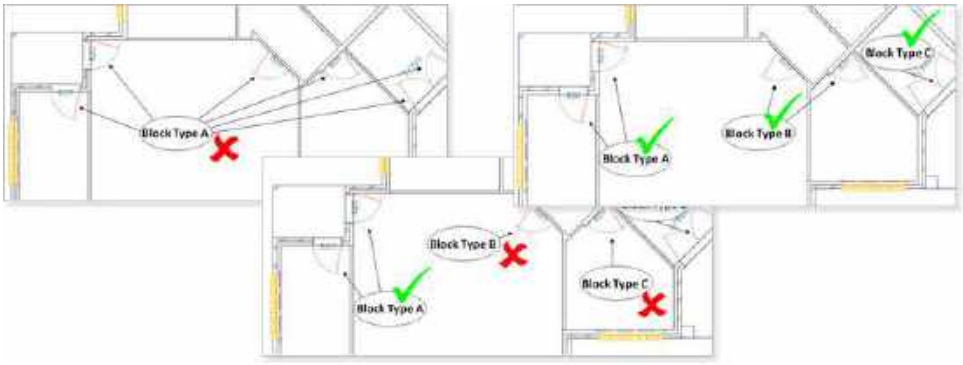
2. Multiple instances of the same block being recognized in iTWO costX®.



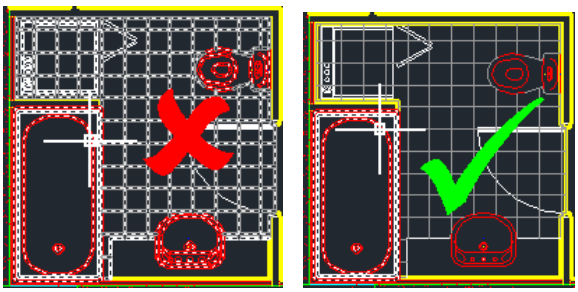
3. Clicking once with the mouse measures all such blocks on the drawing in a single action.



- Do not group multiple objects into a single block.
- Co-ordinate blocks with layers so that details can be isolated and then measured very quickly.
- Try not to use the same block for different (albeit visually similar) objects in a drawing, equally try not to use different blocks for the same object in a drawing.



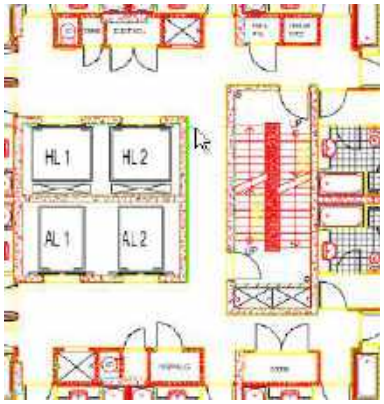
- It is better to define individual composite 'objects' as blocks and not to create blocks comprising multiple objects.



6.2 Polylines

Simply put, CAD drawings are made up of multiple lines and arcs. The polyline command allows a series of lines or arcs to be combined into a single continuous entity to create highly complex shapes.

iTWO costX® is able to recognize the geometry of polylines and automatically return the area and perimeter of the shape, no matter how complex, with a single action. Hence it is very helpful if floor plans, rooms, areas, etc. are defined by polylines in drawing files.



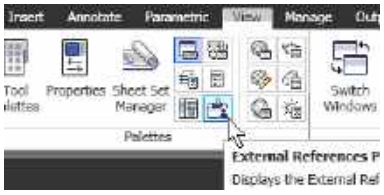
Cursor positioned over polyline in iTWO costX®

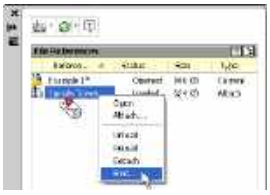
Polyline being recognized in iTWO costX®

A single mouse click captures area and perimeter

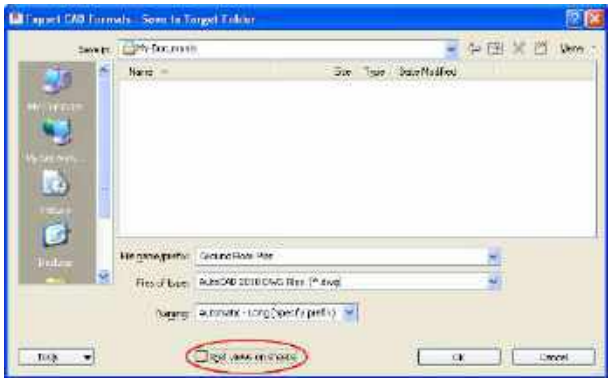
6.3 X-Refs

Dependent files e.g. Xref 's / non-standard fonts should be either bound in with the DWG™ file or provided as separate files using the correct relative directory structure.



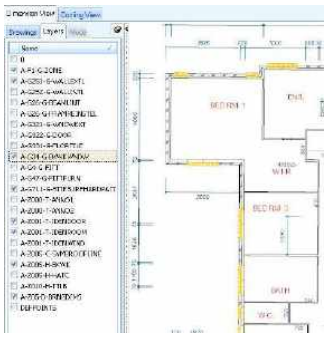


If exporting to DWG™ from Revit® the Xref views on sheets in the Save to Target Folder dialog option should not be ticked.



6.4 Layers

iTWO costX® is able to use layers where provided to filter the display to make viewing and measurement much quicker and easier, by 1) eliminating unwanted data to reduce clutter and 2) isolating data for measurement.



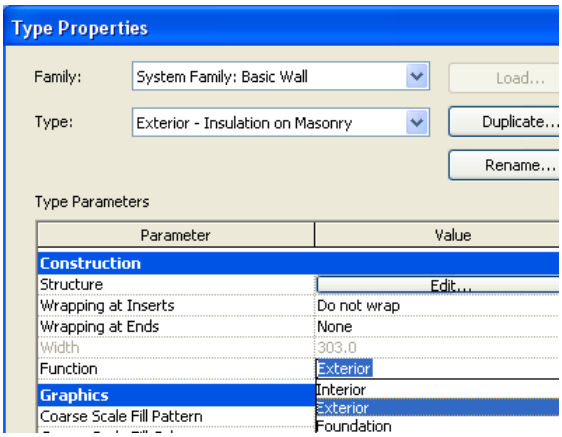
Hence it is very helpful if layers are provided and configured in a logical manner.

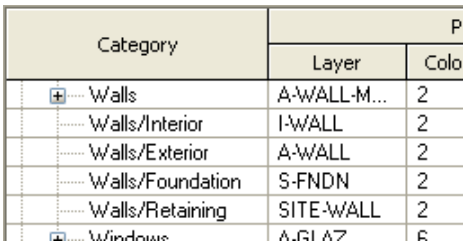
- Put different building elements onto different layers.
- Put like items within an element onto the same layer or distribute them logically onto a series of layers.
- Use the hatching tools to create hatching rather than using other tools to represent hatching. Try not to disassociate/explode hatching.

- Review the layer states for all layers before saving the DWG™ , layers which are not intended to be seen should be frozen.

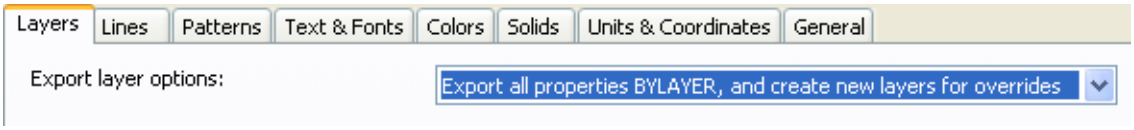
- If exporting a DWG™ file from Revit® arrange object categories into logical and appropriate layers, eg. separate the wall finishes from the structure.

- Specifying appropriate Type Properties and Layers where the layers can be specified in conjunction with the Type Properties (e.g. specifying an Interior or Exterior function for walls) can also be beneficial.





- Set the Export layer options to “new layers for overrides”.

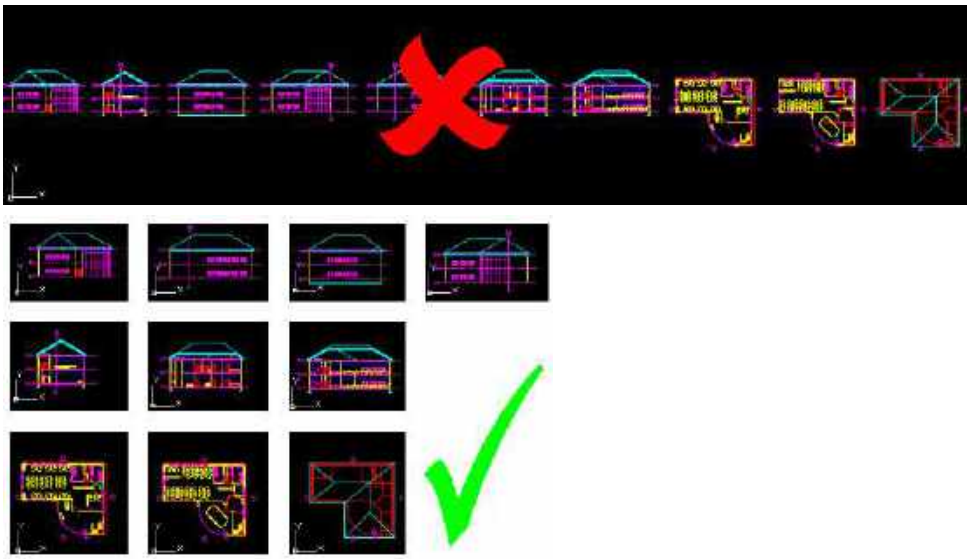


- Under the general tab, tick the check box to export rooms and areas as polylines.

6.5 Model Space and Paper Space

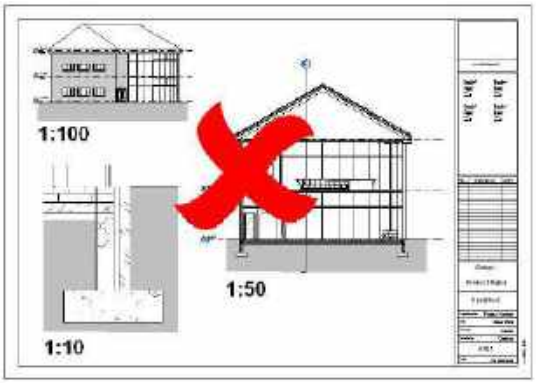
iTWO costX® will default to Model space views since these contain the active model and hence are the most accurate with no scaling required as they are generally at 1:1. If the file contains both Model Space and Paper Space, an option is provided to load either or both, but Model space is preferred.

- Rather than multiple Paper space sheets with viewports to a single Model space view, a separate Model space DWG™ file for each plan / elevation / section / etc. is preferred. On larger buildings, where plans etc. may normally be divided between several Paper space views (eg. to fit onto a series of A3 sheets), do not break the Model view up in the same way. It is preferred to measure on a single Model space view for an entire level/floor.



- Avoid using different unit scales in the same Model space, eg. if 1 unit represents 1mm avoid mixing this with another scale for 1 unit.

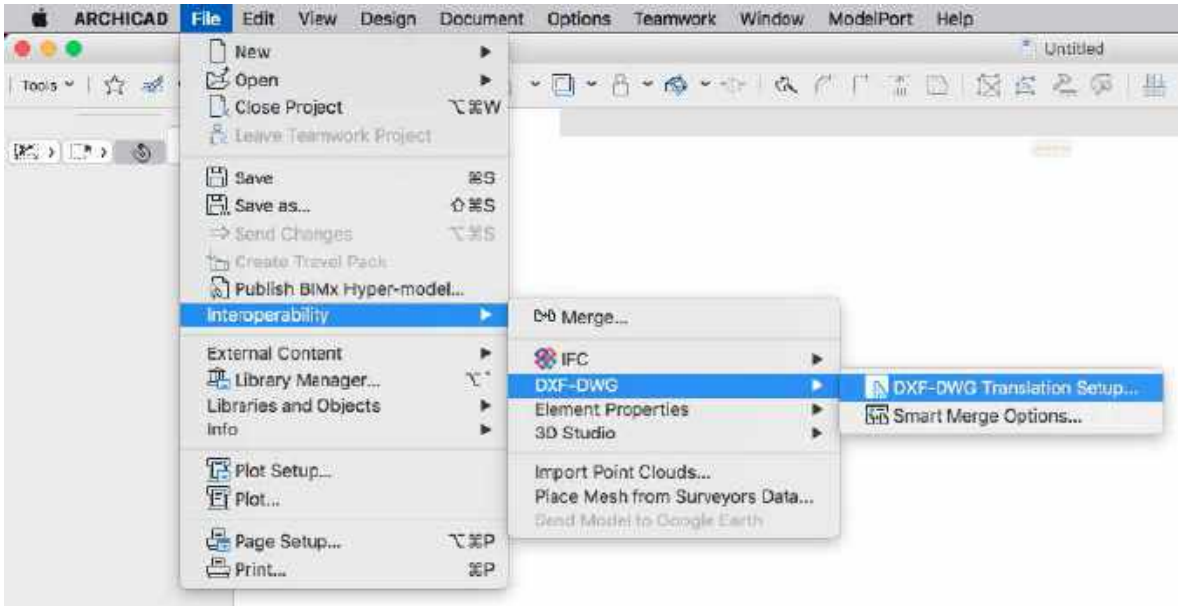
- Provide scale annotation, scale bars and / or figured dimensions on Paper space sheets.



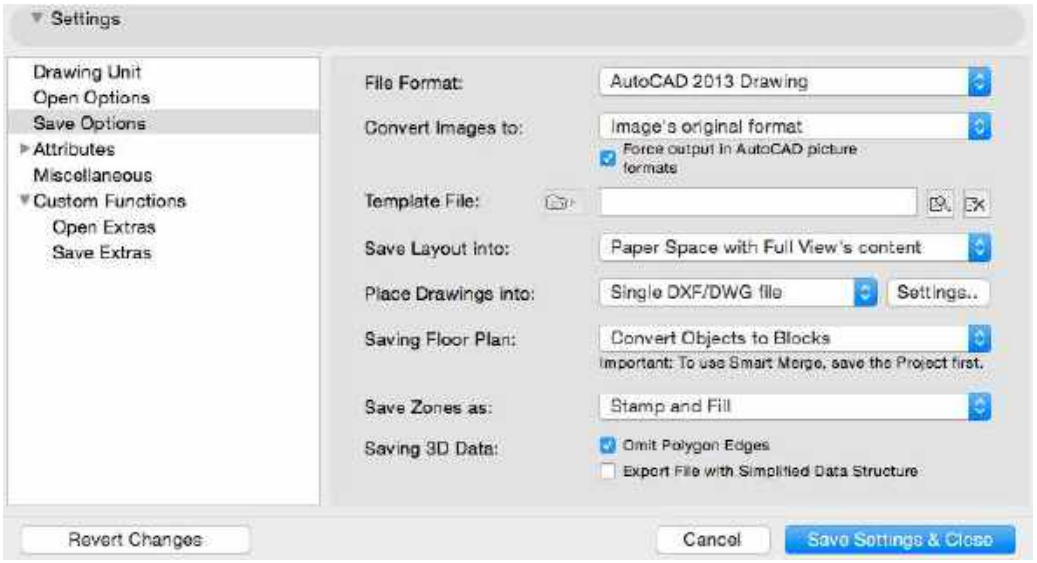
- Avoid where possible having views at different scales on the same Paper space sheet, where this is not possible try to arrange the views at one scale in one area of the sheet and views at a different scale in another area of the sheet rather than having details at different scales interspersed throughout the image.

6.6 DWG™ Files from ARCHICAD®

ARCHICAD® provides a variety of settings to improve the quality of exported DWG™ files. These settings can be set up in the DXF-DWG Translation Setup under the File/Interoperability/DXF-DWG menu.



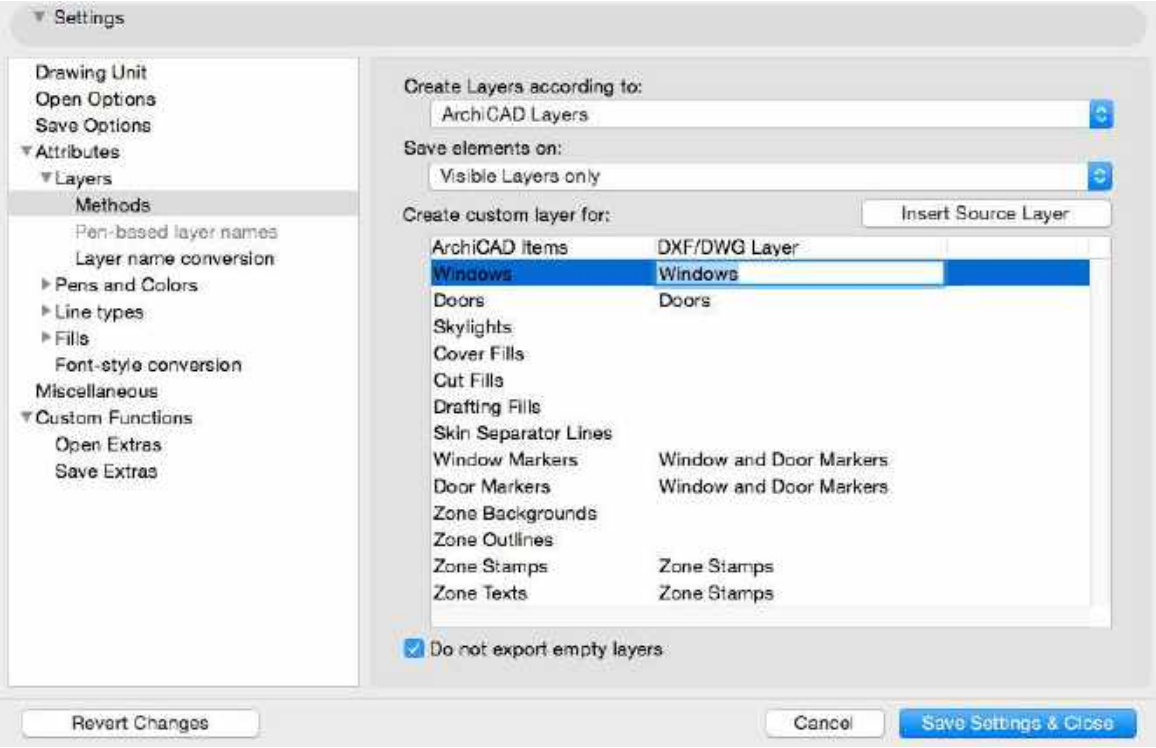
- Under Save Options in the DXF-DWG Translation Setup, change the File Format to the newest version of AutoCAD® available.
- Change the Save Layout into: Paper Space with Full View's content
- Change Place Drawings into: Single DXF/DWG file.
- Change Saving Floor Plan to: Convert Objects to Blocks.



- Under the Attributes/Layers/Methods in the DXF-DWG Translation Setup, choose Create Layers according to ARCHICAD Layers.

- Change Save elements on to: Visible Layers only.

- Create custom layers for Windows, Doors, Window and Door Markers, Zone Stamps and any other Layers you might want independent control over.



Polylines for individual spaces (rooms) and one for the entire net area of the building must be drawn prior to export. Note that these closed polylines cannot contain any curves; curved segments must be approximated by small line segments. Locate the polylines according to the required measurement standards (inside face, centerline, etc.).

While not required, when exporting data from ARCHICAD®, it is also useful to make sure the pen colors are legible on both a black and white background.

Objects with multiple instances such as typical doors or the like may be exported with each instance as a unique block. It may be necessary to edit the file in an AutoDesk® application so that all alike objects are the same block.

6.7 AEC Entities in AutoCAD® Architecture Libraries

Sometimes if a drawing contains certain AEC entities from the AutoCAD® Architecture libraries there can be problems with the display rendering the geometry correctly.

A solution is to save the DWG™ drawing with the AEC objects exploded which will enable the geometry to be displayed. The following are the steps to export the DWG™ with exploded AEC entities in TrueView™ .

- Open TrueView™ (drawing file does not need to be opened).
- From the main menu select DWG Convert.
- You will need a suitable conversion setup to convert the drawing. If you have not created one follow these steps:
- Click the Conversions Setups button.
- Click the New button.
- Enter the name of the new conversion setup (such as “Explode AEC Entities”).
- Make sure it is based on “Standard” and click Continue.
- Change Conversion package type to “Folder (set of files)”.
- Select file format “AutoCAD 2013 Drawing Format with Exploded AEC Objects”.
- Check the Conversion file folder and Path options to save the file in the desired location.
- Other options that may be useful are “Bind external references” and “Purge drawings”.
- Click OK, then Close.
- Select the conversion setup for exploding the AEC entities (“Explode AEC Entities”).
- Click the Add files button.
- Select the file(s) you want to convert and press OK.
- Click Convert.
- TrueView™ should notify you once the conversion is complete.
- You can now close TrueView™ .

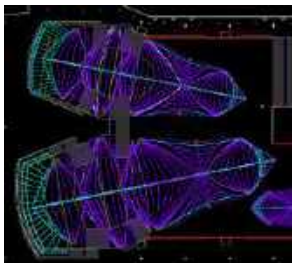
7 3D Drawing Files and BIM Models

7.1 Overview

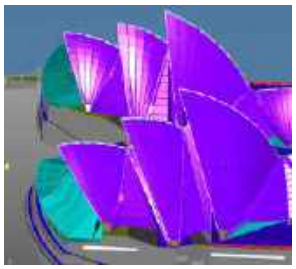
It is important to differentiate between BIM models and 3D Drawings.

Traditional 2D and 3D CAD programs use vector graphics to replicate the human process of drawing on paper. Vector graphics is the use of geometrical primitives such as points, lines, curves and shapes or polygons, which are all based on mathematical equations, to represent images.

Regardless of whether it is rendered in 2D or 3D, a vector based CAD drawing like the following example of an AutoCAD® DWG™ file is simply a collection of lines, arcs and text.



2D Plan View in iTWO costX®



3D View in iTWO costX®

Because they are based on geometric data, these graphical models cannot describe the physical attributes of the entities they represent, nor the relationship of the entities to each other. To overcome this limitation, design-related industries have developed object-based data model applications, specific to their operating environment, that can represent the physical and performance attributes of entities in addition to their graphical properties.

In the case of the AEC industry this translates to a data model built around building entities and their associated inter-relationships. The interface remains graphic, but geometry is only one of the properties of the entities, which will also contain physical and performance data such as spatial relationships, geographic information, quantities and properties of the building components.

The process of optimizing the design by interrogating and analyzing the data within the model is referred to as Building Information Modelling (BIM). Consequently, the data model for a building is referred to as a "BIM model".

iTWO costX® is able to view BIM models in DWF™, DWFx™ and IFC format and access the database to extract information, with several extraction methods available. The opportunity therefore exists to use this dimensional data for quantification purposes, instead of measuring the quantities. This greatly improves productivity, and consequently reduces response times.

Issue of data-rich BIM model files therefore enables the iTWO costX® user to collaborate in the design effort far more effectively, and designers can respond to this change by increasing the amount of object data held in the database. However, for estimating or scheduling purposes it will generally be necessary to augment the BIM data with additional measurement from 2D or 3D drawing views, particularly with early design intent models.

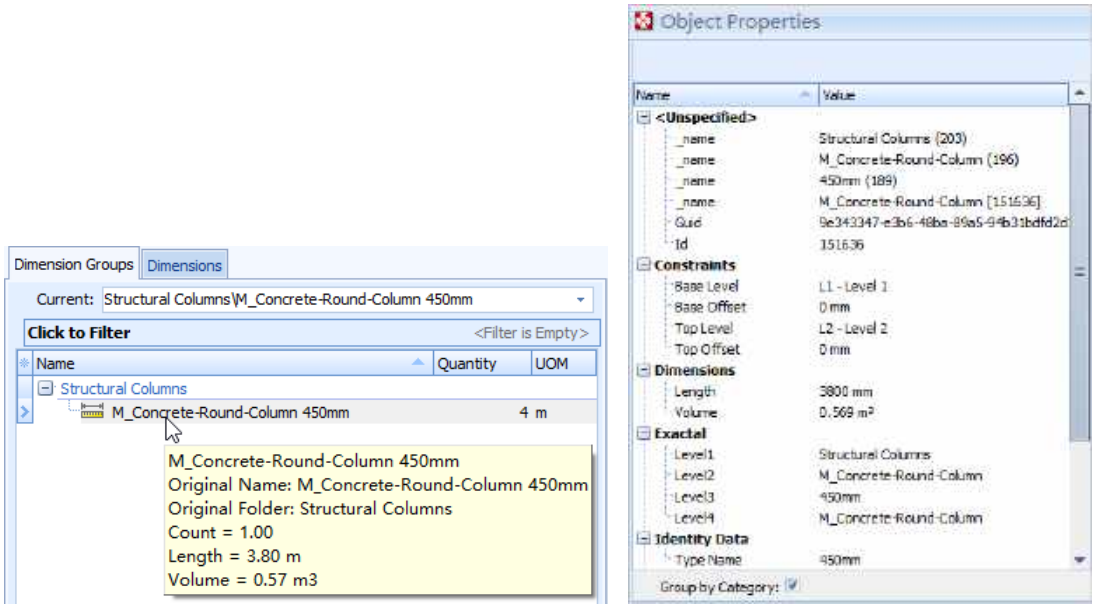
7.2 Methods of Data Extraction

There are three options available to iTWO costX® users for data extraction from BIM models:

- by use of iTWO costX® BIM Templates;
- by use of Model Maps;
- by creation of special object-based Dimension Groups.

7.3 BIM Templates

iTWO costX® ships with a selection of BIM Templates. These templates are XSLT files which have been written specifically to extract and sort data from 3D DWF™ and DWFx™ model files. The default template, called "Revit® General", categorizes the data in accordance with the Revit® object hierarchy of Element Category, Family name and Family type. By using the "Import Dimensions Using BIM Template" button and selecting the "Revit® General" template, iTWO costX® will create a list of dimension groups using the Revit® Category to name the Dimension Group folder, and the Revit® Family Name + Family Type to name the dimension group. The quantity will generally be drawn from the first dimension property. An example is shown below.



The import routine is automatic and works on whatever model objects are being viewed on the iTWO costX® screen at the time. This means that users can filter the view to limit the import to selected objects, or they can view the entire model in which case the import will provide them with a complete schedule of Dimension Groups listing the quantities of every object in the model, all at the single click of a button.

An optional alternate BIM Template called "by QSID or ELEMENT CODE" will search for a text parameter called QSID or ELEMENT CODE within the model and use this to group the Dimension Groups. These parameters need to be added into the model as Shared Parameters if this option is to be used.

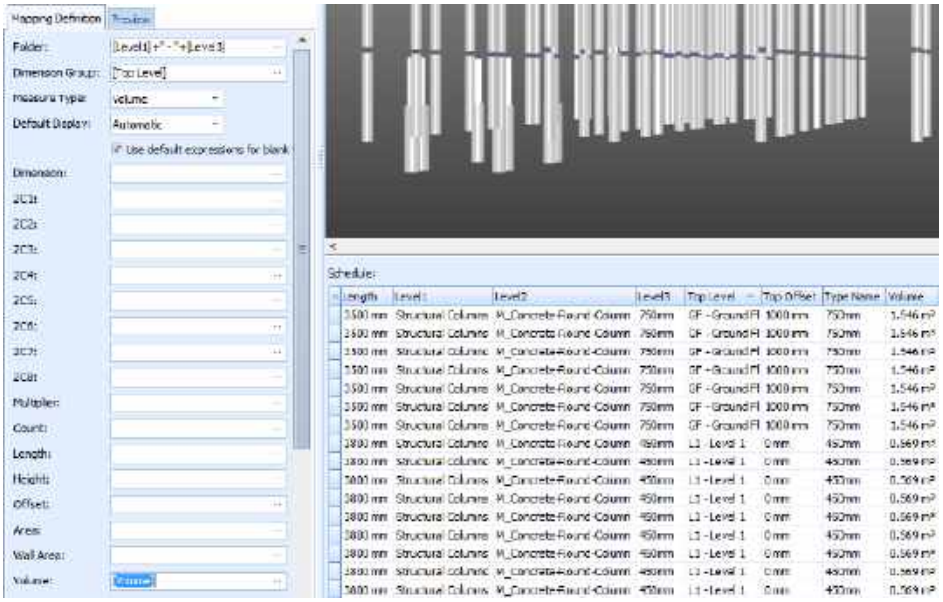
These templates are written around model data being presented in standard Revit® family categories and will generally only produce satisfactory results when used with DWF™ and DWFx™ files exported from Revit®. For IFC files, Model Maps or object-based Dimension groups will be used.

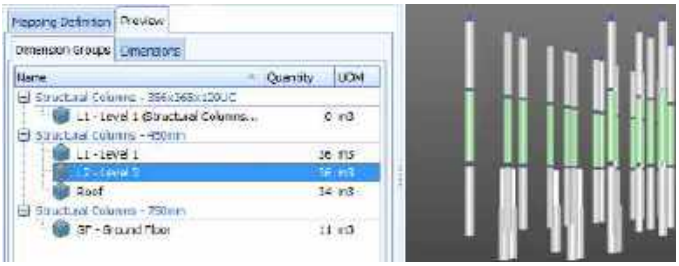
7.4 Model Maps

A Model Definition Tool allows iTWO costX® users to view the model data in a schedule format and configure a Model Map to extract data from the model using any combination of object properties. This means that instead of generating quantities using the standard iTWO costX® BIM templates, users have the option to define Model Maps to customize the quantities extraction. This provides an opportunity to provide additional data within the model to facilitate the model mapping process.

To assign the Model Definition, the iTWO costX® user filters the model view to the required branch of the model tree, and then drags and drops the required data from the Schedule into the corresponding field in the Mapping Definition tab. Free text in quotes may also be entered.

In the example below, the data from the columns in the Schedule headed Level 1 and level 3 will be combined to name the dimension group folder, the Top Level data will categorize the dimension group, and the Measurement Type will be volume, using the data from the Volume field in the Schedule.





Model Maps are highly effective for DWF™ , DWFx™ and IFC files. Similar to BIM Templates, they automate high-volume extraction of model data, but in a custom configuration.

7.5 Object-based Dimension Groups

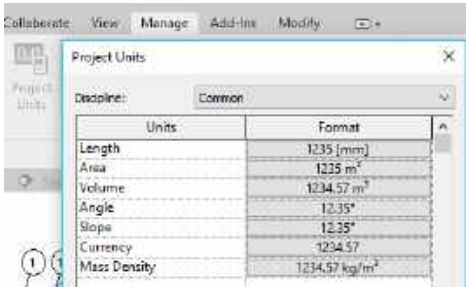
These work in a similar way to Model maps but are individually created for specific objects or groups of objects.

8 3D Drawing Files from Revit®

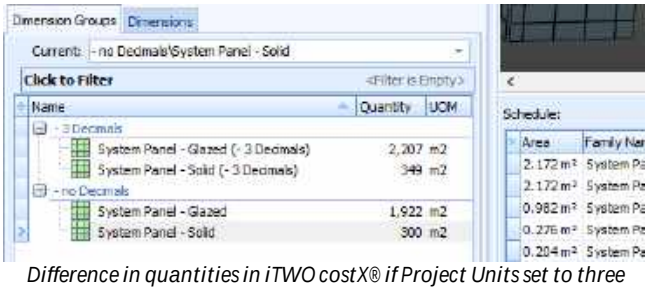
The following tips will help to facilitate data extraction from RVT™ , DWF™ and DWFx™ files.

8.1 Project Units

The total quantity of each object type is the cumulative value of the dimensions of each individual object. If the Project Units in Revit® are set to whole numbers (which is the default setting), each dimension will be rounded off which will affect the cumulative total. Therefore the Project Units need to be set to two or preferably three decimal places to provide an accurate cumulative total.



Set Project Units to three decimal places

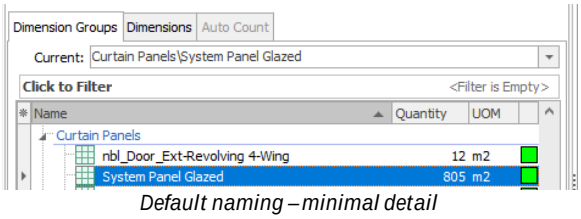


Difference in quantities in iTWO costX® if Project Units set to three decimals instead of no decimals in same model

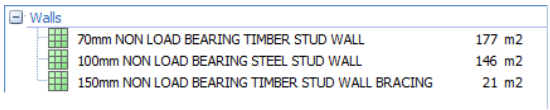
8.2 Family Naming Conventions

iTWO costX® extracts dimension data (quantities) from the Revit® object properties. The default iTWO costX® BIM Template (Revit® General) groups and sorts the quantities according to the family naming structure of the model.

Therefore, a more descriptive family naming convention can greatly improve communication.



Default naming – minimal detail



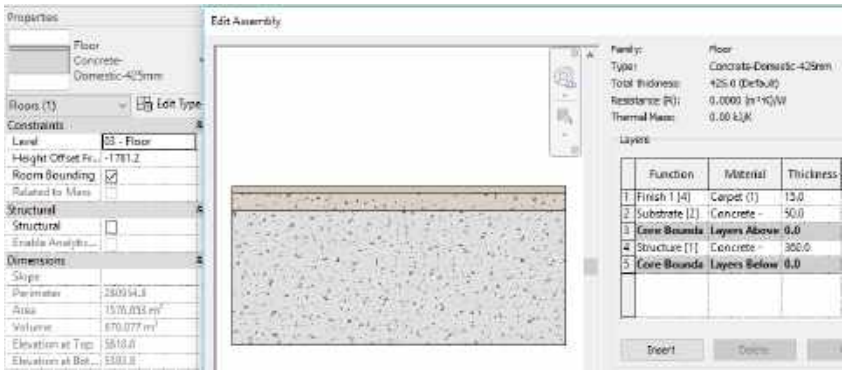
Descriptive naming

In view of the above, try not to use mass or generic model families for objects in detailed models, and do not group disparate objects into a single mass or generic family, as this severely compromises the usefulness of the output data. Select an appropriate element category for each individual object.

Mass naming

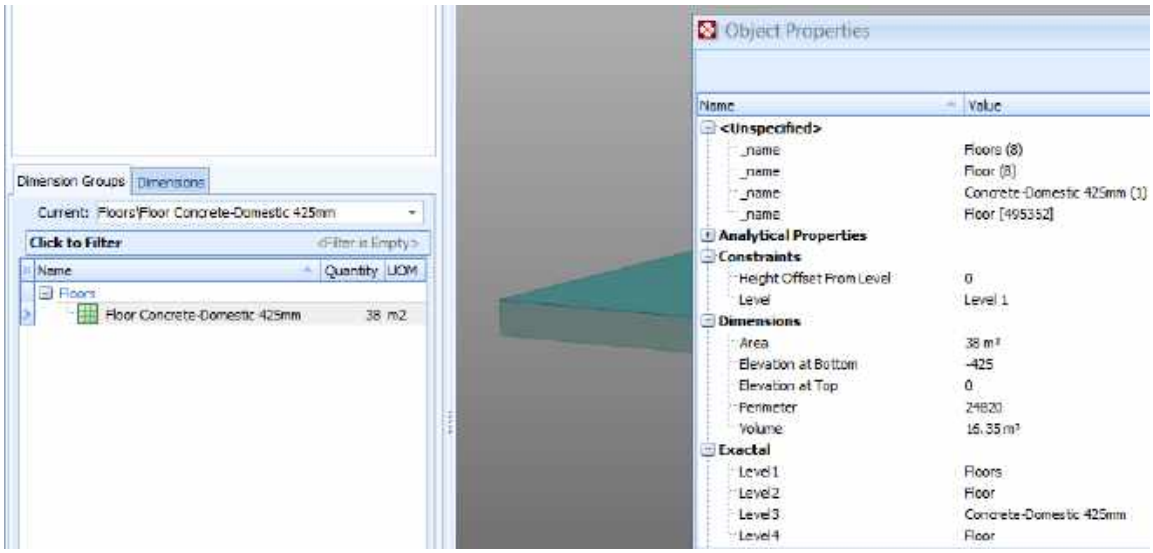
8.3 System Assemblies

In Revit® multiple elements can be combined into a single assembly that can be independently scheduled, tagged, and filtered. Most model elements can be included in assemblies and layered elements such as walls, floors, flat roofs, etc are invariably modeled as assemblies.



Floor Assembly in Revit 2019®

When exported to a DWFx™ an assembly such as the floor shown above appears as a composite whole and its component parts, or layers, are not separately identified within the 3D DWFx™ view and are not represented on 2D views and sheets.



iTWO costX® screen shot of composite slab assembly

It is very important that the component details are communicated in full, and to assist in this one or more of the following solutions could be considered:

- Providing assembly information as a text or “Description” parameter.
- Using more descriptive Family / Type naming conventions.
- Providing detail sections as 2D sheets.
- Providing schedules detailing system assemblies.

Another option is to use the Revit® “Parts” function which will break the layered assembly into its component layers.

8.4 Parts

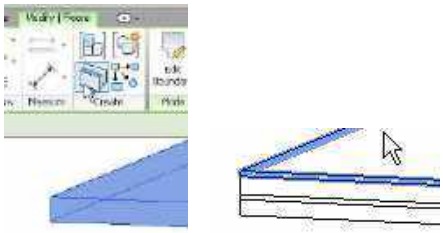
In Revit®, many elements can be divided into discrete parts that can be independently scheduled, tagged, filtered, and exported. The Part function is designed to support aspects of construction workflows, such as pour schedules for example, by enabling a slab to be separated into areas or zones based on the pour sequence. Parts can also be generated from elements with layered structures, not just to separate the layers but also to allow the layers to be individually manipulated or sub-divided. Parts are dependent to elements and are automatically updated and regenerated when the original element from which they are derived is modified. Each part can also be independently scheduled and the schedule will also update when parts are modified.

If a layered assembly is separated into its constituent layers, the layer data will be available in a DWF/DFWx™ export. Typically this might apply to elements such as:

- Walls (excluding stacked walls and curtain walls)
- Floors (excluding shape-edited floors)
- Roofs (excluding those with ridge lines)
- Ceilings
- Structural slab foundations

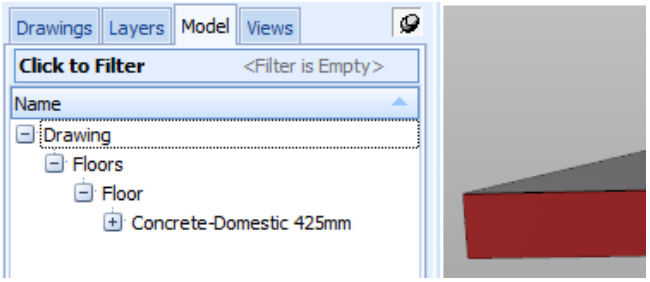
In the drawing area, select the elements from which you want to create parts, then in the Create tab of the Modify ribbon click on the Create Parts button to separate the layers. The DWF/DWFx™ can now be exported with each layer of the assembly as an individual Part with its own discrete Object Properties.

Alternatively, to avoid disassembling your working model view, create a new default 3D view, select all elements in the view and click on the Create Parts button. Export the DWF/DWFx™ file from this view.

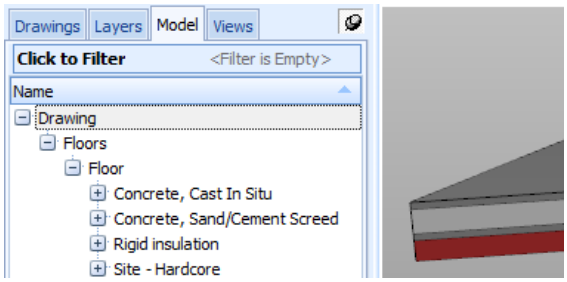


For each part, the Identity Data properties have been expanded to contain details of the individual layer and this data is available for iTWO costX® to create the separate Dimension Groups.

The Parts properties can also be viewed as branches of the Model Tree.

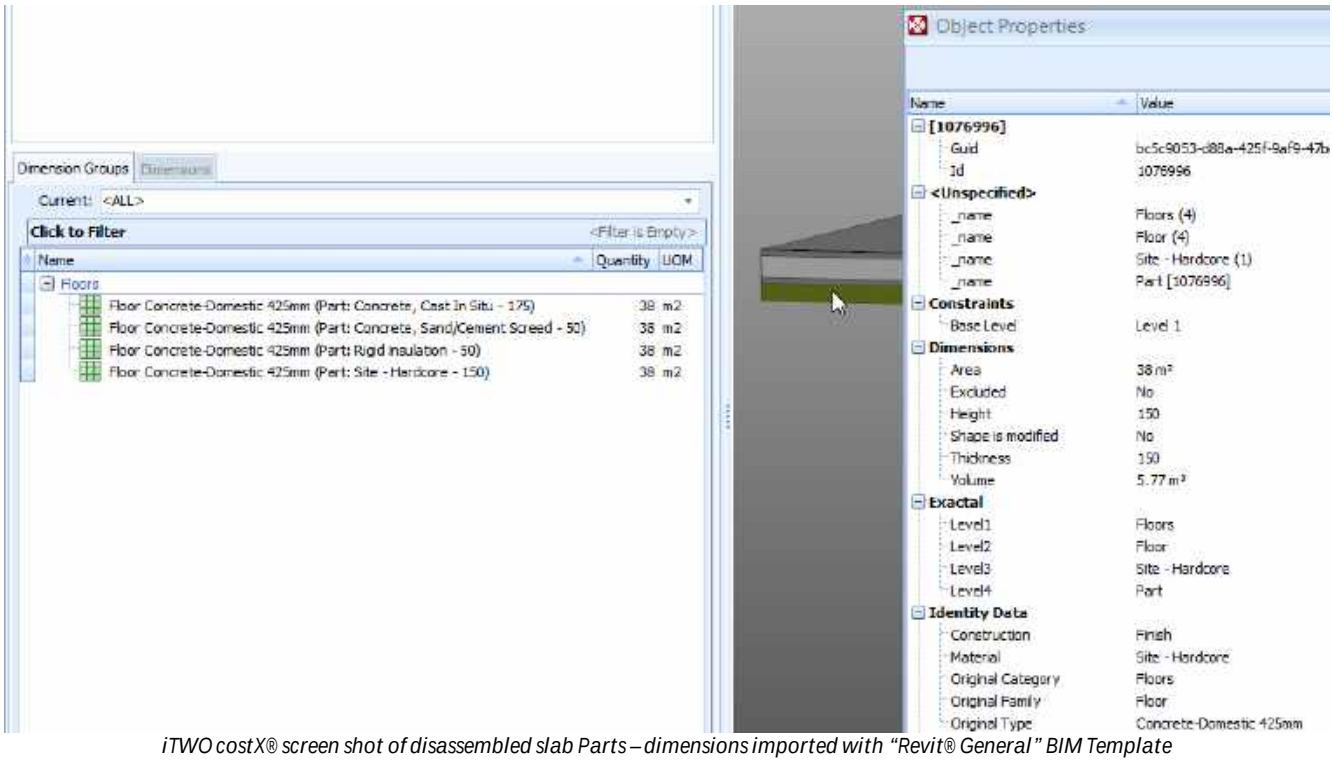


Model View in iTWO costX® – Assembly only



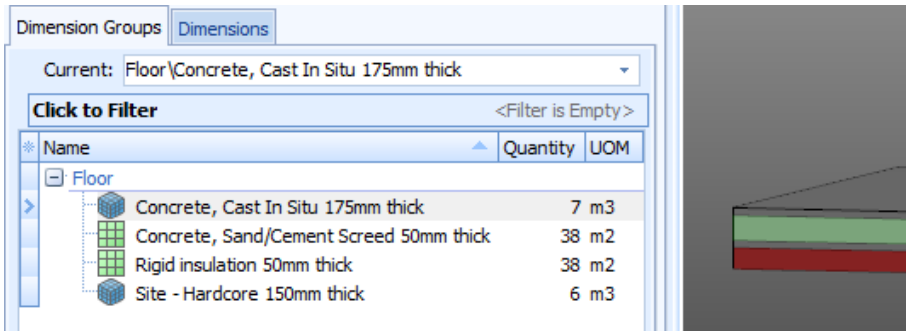
Model View in iTWO costX® – Parts

The disassembled slab will now import with the "Revit® General" BIM Template in separate constituent Parts.



iTWO costX® screen shot of disassembled slab Parts – dimensions imported with "Revit® General" BIM Template

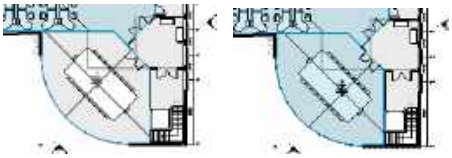
The Parts properties can readily be used to create mapping definitions for Model Maps.



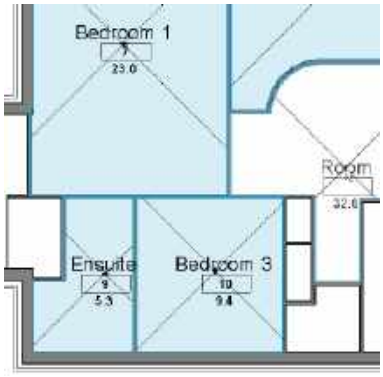
iTWO costX® screen shot of disassembled slab Parts – dimensions imported with Model Map

8.5 Areas/Rooms

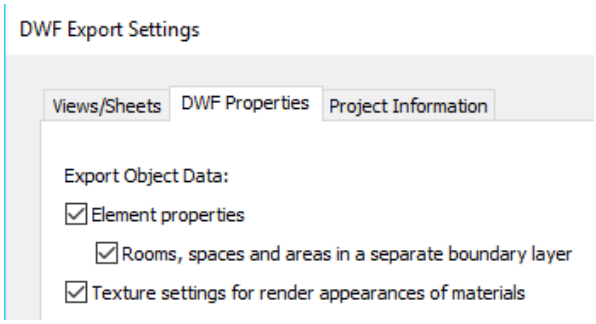
Room and area data is very useful for estimating purposes, particularly during the earlier design stages when composite rates/m2 or ft2 are used to develop budget estimates. Use the Room and Area tools to include this in models.



Edit the Area Type Properties to show area data.

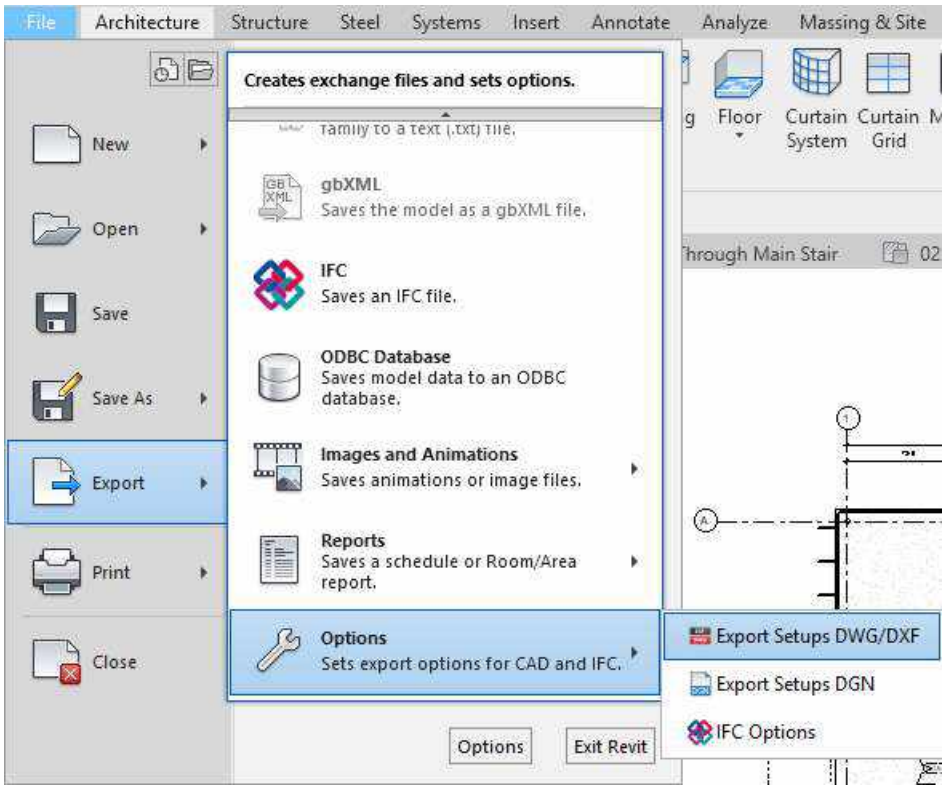


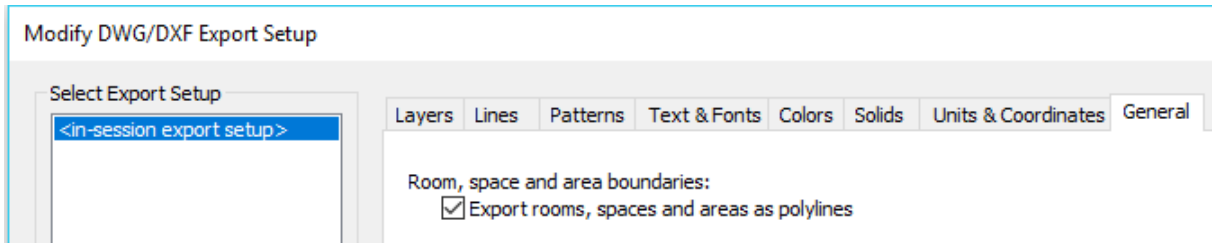
When exporting the file, open the DWF™ Properties tab in the export dialog window and tick the "Rooms and Areas in a separate boundary layer" checkbox (if exporting a 2D or 3D DWF™ view). The room data will now be exported with the file.



Room data in DWFx™ shown in iTWO costX®

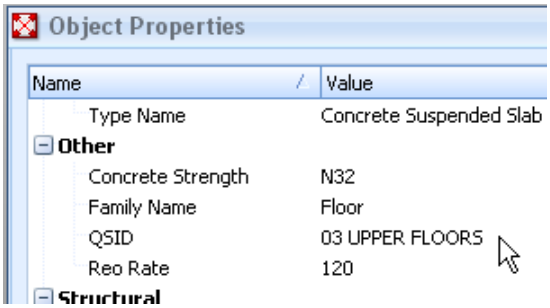
If the file is to be exported as a DWG™ then the export settings can be set to "Export rooms, spaces and areas as polylines".

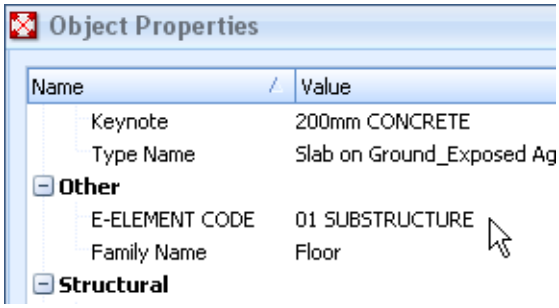




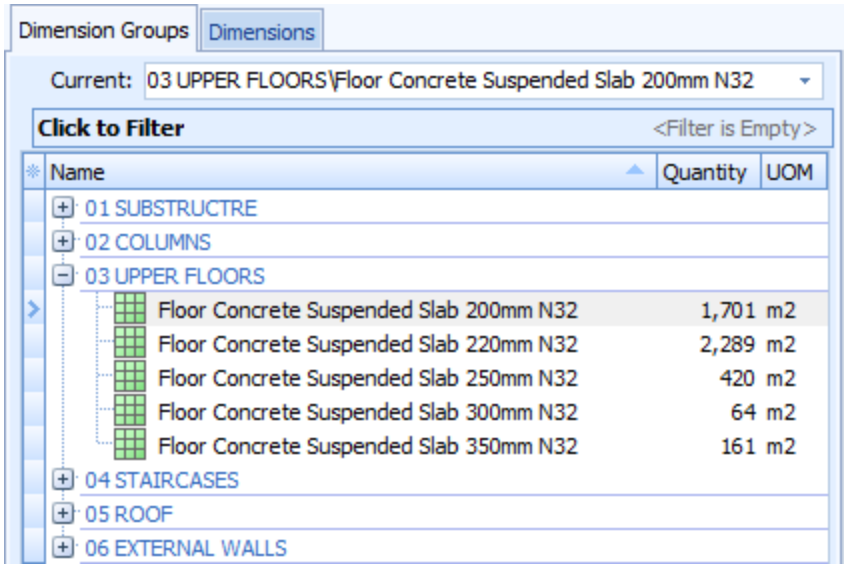
8.6 Shared Parameters

Additional Shared Parameters may be added within Revit® to enrich the data included in the DWF(x)™ file. This data can then be accessed via Model Maps. Additionally there is a BIM Template available for elemental coding called “by QSID or ELEMENT CODE”. This requires a text Shared Parameter to be created with the name QSID or ELEMENT CODE.

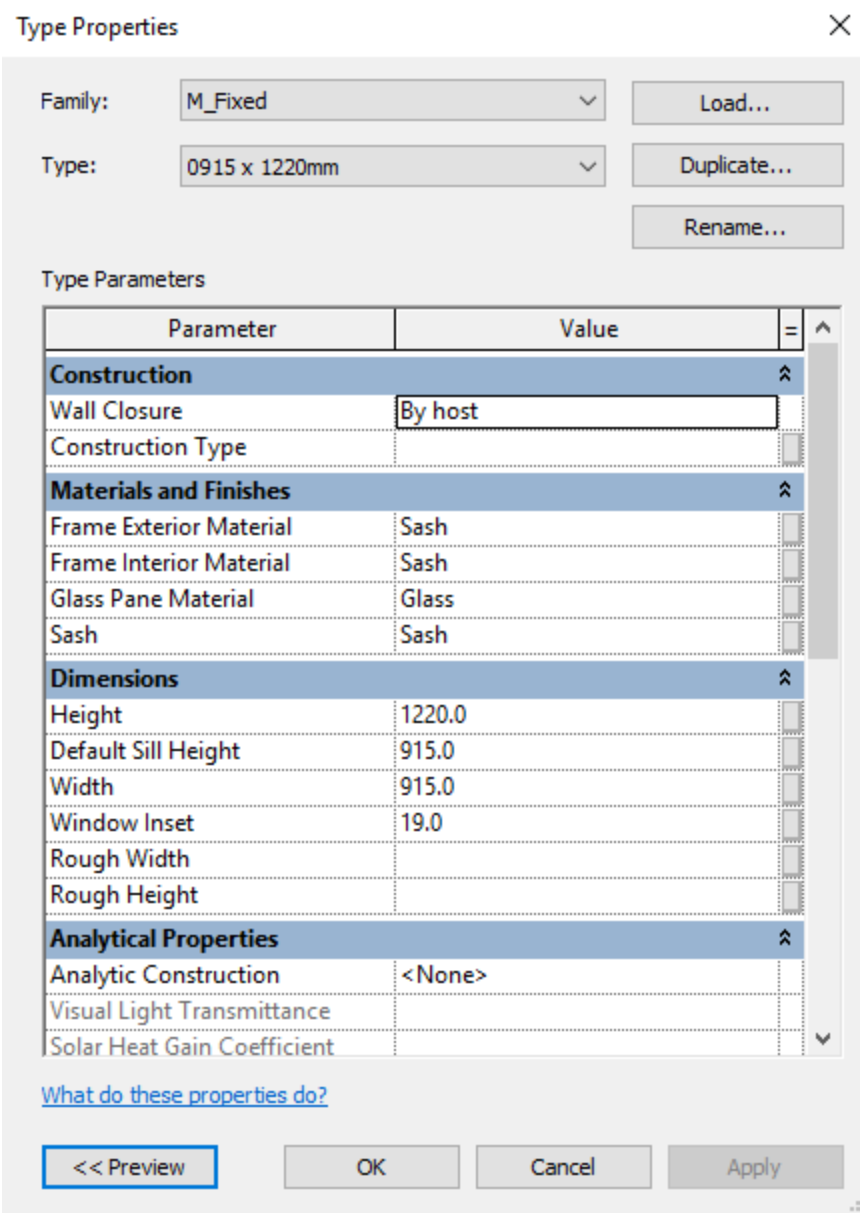




If this is included in the model, the BIM template “by QSID or ELEMENT CODE” will sort the dimensions into QSID or Element folders instead of by Category.



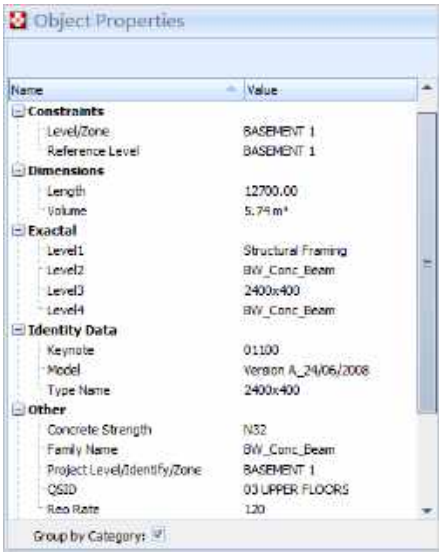
Formula-based parameters can also be added to provide additional measurement data such as window areas or downpipe lengths.



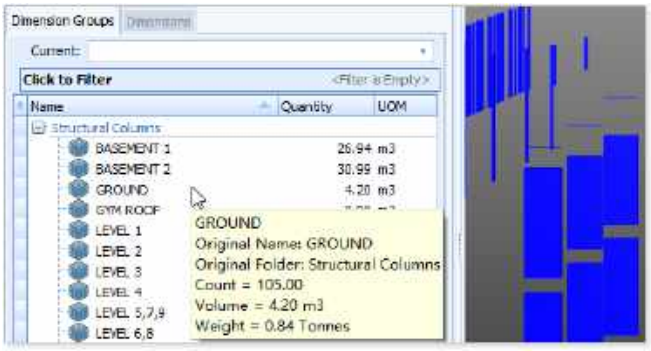
Parameters should generally be added as Instance Parameters because not all Type Parameters get written to the DWF(x)™ file. Refer to Appendix A for details on how to add Shared Parameters into Revit®. Use Autodesk® Design Review to review the content of DWF(x)™ files.

The following examples are all taken from a single model in which the designer had added the following Shared Parameters based on advice from his estimator:

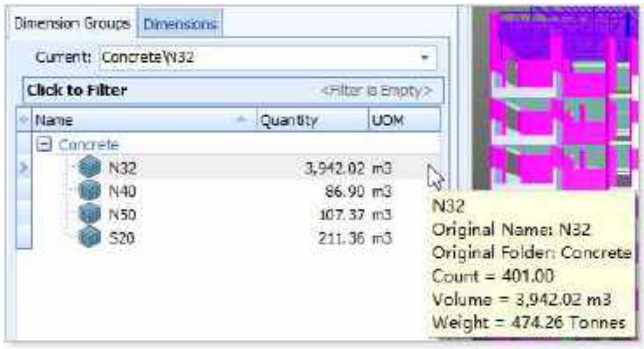
- A Building Level/Zone to allow the quantities to be grouped by location.
- A concrete mix strength to allow the quantities to be grouped by concrete strength.
- A reinforcement factor (Reo Rate) expressed in kg/m3 to allow an approximate reinforcement tonnage to be automatically generated.
- Also, ensure that concrete structural framing includes a length dimension in addition to volume to allow for calculation of additional estimate items such as formwork.



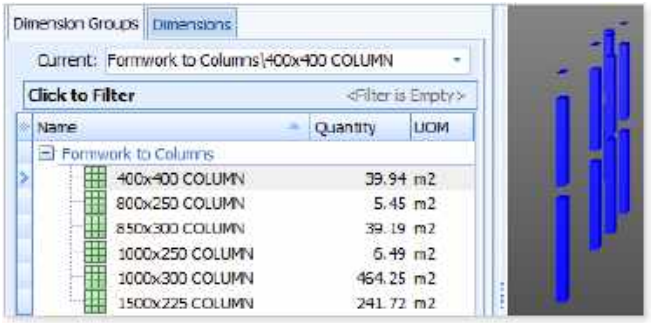
Object properties viewed in iTWO costX®



Volume of concrete and weight of steel grouped by iTWO costX® into Building Level



Volume of concrete and weight of steel grouped by iTWO costX® into Concrete Strength



Column formwork derived from length dimension in iTWO costX®

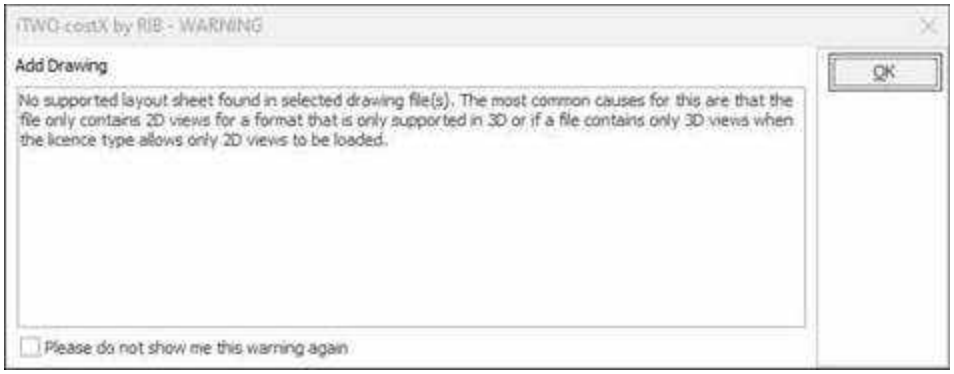
8.7 Using RVT™ Files

When using RVT™ files, they are upgraded in the background each time upon opening to Revit® 2022 format, hence files that are already in Revit® 2022 format will load far quicker than any previous formats.

RVT™ files from Revit® versions 2015 to 2022 are currently supported.

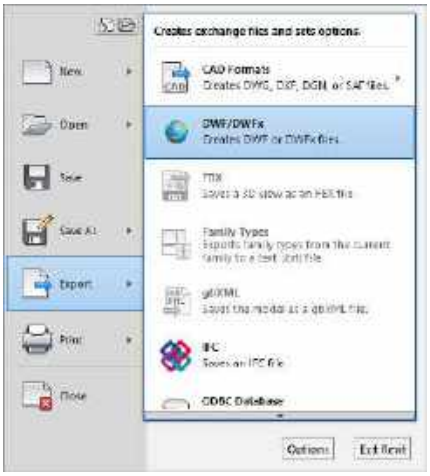
Opening RVT™ files is much more resource intensive than other 3D formats, so check the latest system requirements to ensure good user experience.

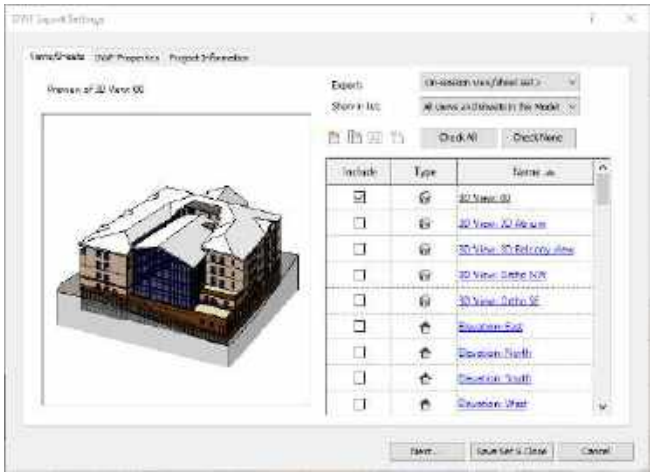
RVT™ files need to have 3D and/or 2D Views present in order to be opened, so if a message similar to the below is presented upon opening then the views will need to be re-created within Revit® by the file originator before the file can be opened:



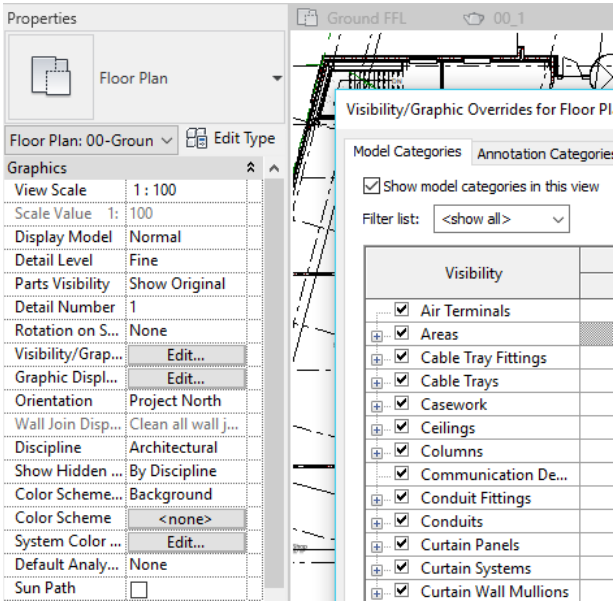
8.8 Exporting RVT™ Files to DWFx™

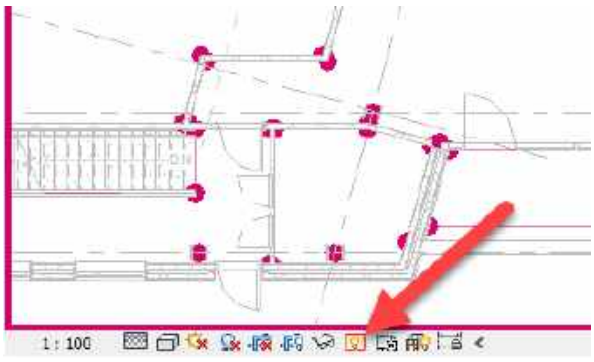
- Provide a multi-sheet DWFx™ export containing the 3D view (or views) and the 2D views and sheets of all plans, elevations and sections etc. The 3D views will be used to import BIM dimensions, and the 2D views and sheets will be used to check and augment the quantities. Some users may also request the 2D sheets and views separately as DWG™ files or the source Revit® RVT file.



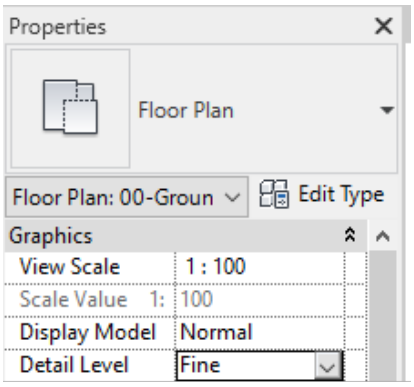


- Review the visibility settings and verify all intended / required objects are not hidden in view before exporting the file.

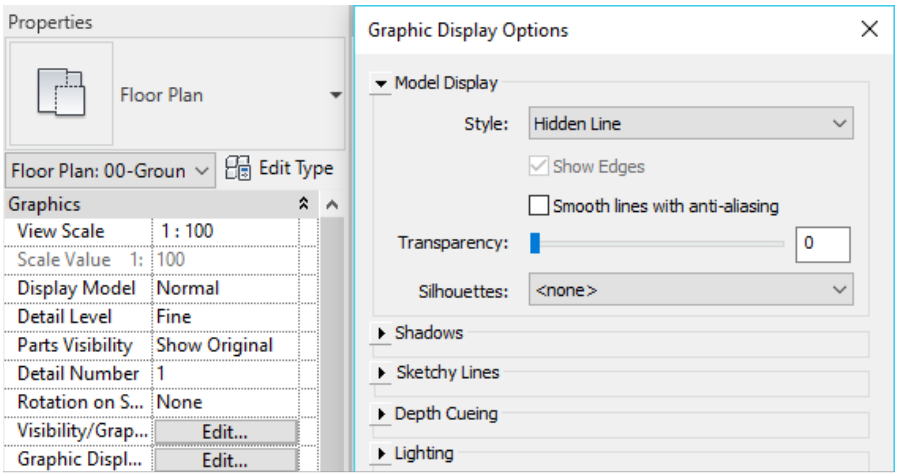




- Select a detail level on views / sheets etc. as fine to allow additional information to be available in the 2D DWF™ files.



- Select a hidden line or wireframe Graphic Display Option for views as appropriate for the content.



- Set the view range / clip settings appropriately on views / sheets.

- If the model contains linked CAD files with multiple instances of a typical object or group of objects, the multiple instances may all have the same object ID. With duplicate IDs, the quantities imported into iTWO costX® from the DWFx™ will derive from the source file, and not from the multiplicity of instances. For example, if a typical apartment is repeated twenty times in a model and the IDs are duplicated, the quantities will only relate to one apartment, not twenty. For this reason the Revit® project should be bound before exporting the DWFx™ to remove the duplicate IDs. If it is preferred not to bind the project, then copy the project, bind the copy, and export from the copy.

8.9 Exporting RVT™ Files to IFC

Refer to IFC Files from Revit® for more information.

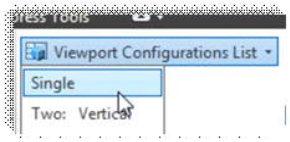
9 3D DWF™ and DWFx™ Files from AutoCAD® MEP

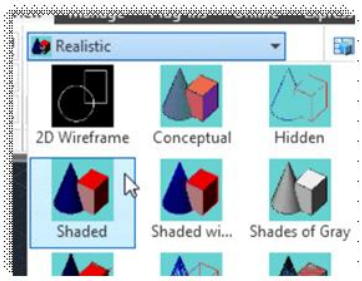
9.1 Publish Settings

Provide as a minimum a DWFx™ file containing the 3D Model view. The 2D views and sheets of plans, sections and details etc. can also be incorporated into a multi-sheet DWFx™ file. The 3D Model view will be used to import BIM dimensions, and the 2D views and sheets will be used to check and augment the quantities. Some users may also request the 3D Model view and 2D sheets and views as the source AutoCAD® MEP DWG™ file.

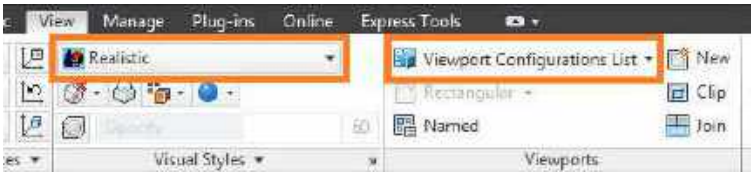
Publishing the 3D Model View Only to a DWFx™ File

- Prior to commencing, open the 3D Model view and change the Viewport Configurations setting to Single and the Visual Styles setting to Shaded.

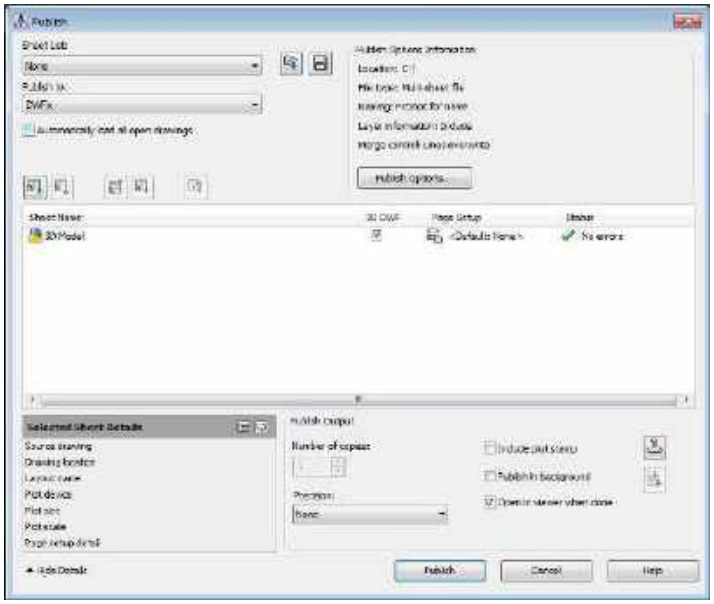




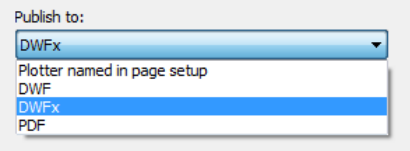
Both of these setting fields are located on the View Ribbon Toolbar.



- From the main menu double click on the Publish option, alternatively enter publish on the command line and press the Enter key. The Publish dialog is displayed.



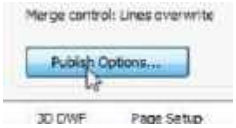
- In the Publish to: field on the Publish dialog select DWFx. iTWO costX® also supports the DWF™ file format.

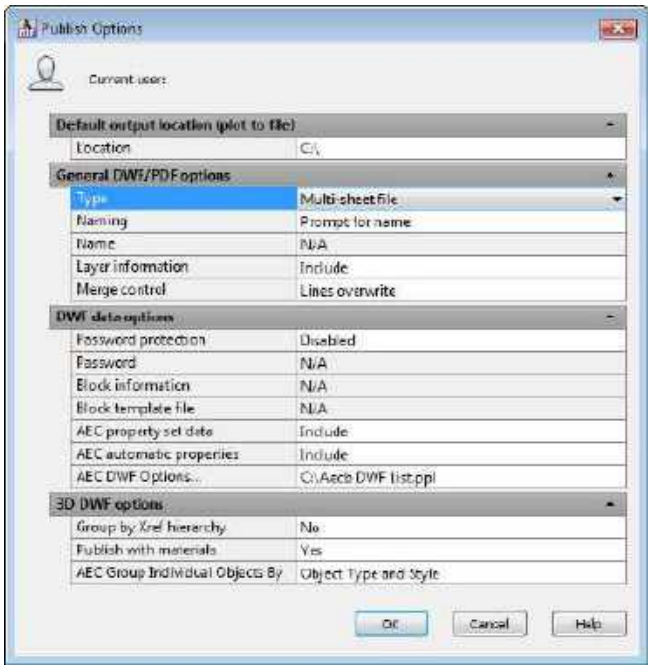


- Ensure the 3D Model view is included in the sheet list and remove any other sheets which are listed, leaving only the 3D Model view, sheets can be added or removed using the Add and Remove Sheets buttons located above the sheet name column.

- Place a tick in the 3D DWF checkbox to the right of the 3D Model view sheet name.

- Click on the Publish Options button. The Publish Options Dialog is displayed (shown below).



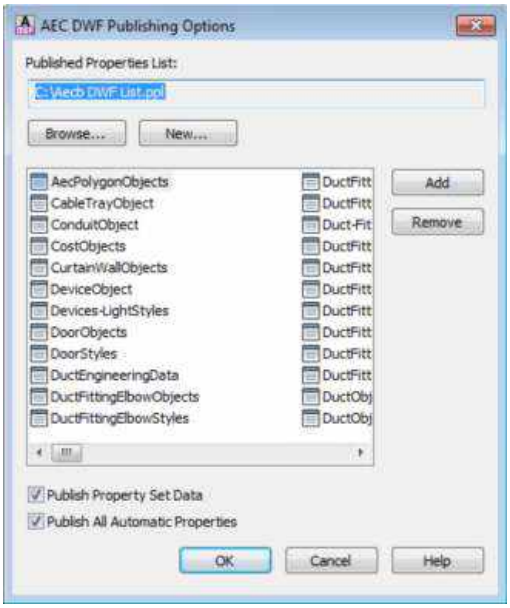


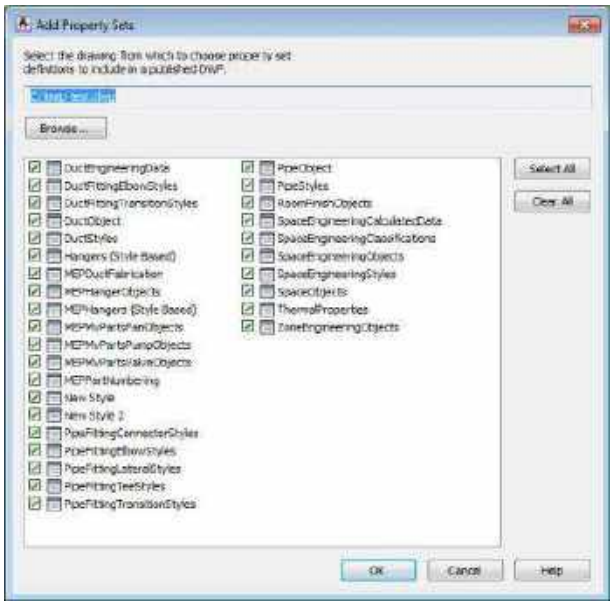
- Under the DWF data options section ensure the AEC property set data and the AEC automatic properties fields are selected as Include.

- Also verify that the Published Properties List (PPL) file identified in the AEC DWF options field is the correct file and also verify that all of the required Property Sets have been selected in this PPL file.

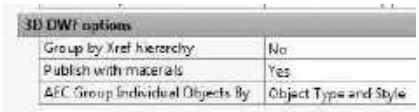
- To verify (or amend) the selected Property Sets for the current drawing click into the AEC DWF Options field and click on the (ellipsis) button displayed on the far right of the field.

- Select and open the PPL file, the AEC DWF Publishing Options dialog is displayed (shown left below). Click on the Add button, the Add Property Sets dialog is then displayed (shown right below), all property sets for the currently selected drawing will be displayed, ensure all of the required property sets are selected (checkboxes are ticked) then click the OK button to return to the AEC DWF Publishing Options dialog and click the OK button to close it and return to the Publish Options dialog.





- Back in the Publish Options dialog under the 3D DWF options section ensure the AEC Group Individual Objects By field is selected as Object Type and Style.



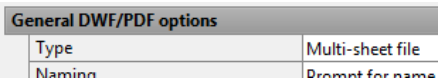
- Click OK to save the changes and close the Publish Options dialog and return to the Publish dialog.

- Back in the Publish dialog click on the Publish button, the Specify DWFx File file browser dialog will be displayed, navigate to the location in which to save the file and amend as desired the file name, when the required selections have been made click on the Select button to save the file to the selected location with the selected file name.

- A prompt may appear asking whether the current list of sheets should be saved, to save the current sheet list click Yes and choose a location and file name for the sheets list, otherwise click No to discard the sheets list.

Publishing the 3D Model View and 2D Sheets to a DWFx™ File

- The above noted process details how to create a DWFx™ file containing only the 3D Model view, if additional 2D sheets / views have been created in the AutoCAD® MEP DWG™ file they can also be included with the 3D Model view in the same multi-sheet DWFx™ file, the process is the same as noted above except that the required sheets should be added to the sheets list and sheets which are not required should be removed from the sheets list in the Publish dialog using the (Add or Remove Sheets) buttons. Additionally ensure the Type field under the General DWF/PDF options on the Publish Options dialog is selected as Multi-sheet file.



9.2 Layer Setting Visibility

Before exporting the DWFx™ file verify the layer settings are correct for the objects intended to be included in the published file.

- To display the layer settings click on the Layer Properties button located in the Layers section of the Home Ribbon Toolbar.

- For objects intended to be included in the published DWFx™ file ensure the layer they are included on is turned on (the symbol is displayed in the On column for the layer), the layer is scheduled to be included in the plot (the symbol is displayed in the Plot column for the layer) and the layer is not frozen (the symbol is displayed in the Freeze column for the layer).

- For objects intended to be excluded from the published DWFx™ file ensure the layer they are included on is turned off (the symbol is displayed in the On column for the layer), the layer is scheduled to be excluded from the plot (the symbol is displayed in the Plot column for the layer) and the layer is frozen (the symbol is displayed in the Freeze column for the layer).

9.3 Property Sets and Property Definitions in AutoCAD® MEP

Object property data can be enriched to include additional information for measurement and estimating purposes by the creation of new Property Definitions within Property Sets. In Design terms Property Sets and Property Definitions within AutoCAD® MEP are typically used to create text based data for use with scheduling and tagging functions in the software, however the data can also be included within a published DWFx™ file enriching the data for measurement and estimating purposes. Property Definition values can be manually specified i.e. a field in which a value can be entered/amended manually or be formula based i.e. a field in which a value is automatically calculated or text concatenated based on values derived from one or more other property values for each object. Property sets can be created, for subsequent addition to objects, at an Object level (to be added to an individually selected object or to several/many selected objects or all objects of the same type - if all drawing objects are selected) or at a Style level (to be added to an object belonging to a specific style name within the host style (e.g. a specific size of duct or pipe within the duct style or pipe style) which then adds the property set automatically to all other objects belonging to the same specific style name.

Adding Property Sets and Property Definitions is a broad and relatively complex topic and it is envisaged that this will be undertaken by an experienced AutoCAD® MEP operator who is knowledgeable on this topic, the following however outlines the basic methodology, some of the text / options within the dialog boxes may vary to those indicated below based on the style of the source template or drawing on which the current drawing was based on.

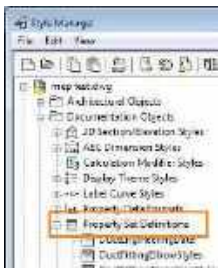
1: Naming Conventions for Additional Property Definitions

The requesting iTWO costX® user / organization and the AutoCAD® MEP operator / organization should agree the need for, and format of, any required prefix for the names of the added property definitions to denote them as additional property set/property definition values as opposed to the default properties. As a suggestion a prefix of PSMD (Property Set Manual Definition) could be used for added manual property definitions, and PSFD (Property Set Formula Definition) could be used for formula based added property definitions.

2: Creating a New Property Set

Click on the upper half of the Style Manager button located on the Manage Ribbon Toolbar (or select the Style Manager option if a sub-menu is displayed). The Style Manager dialog is displayed.

Property Sets are considered to be documentation objects. Therefore, expand the Documentation Objects folder listed beneath the required drawing name and select the Property Set Definitions folder.



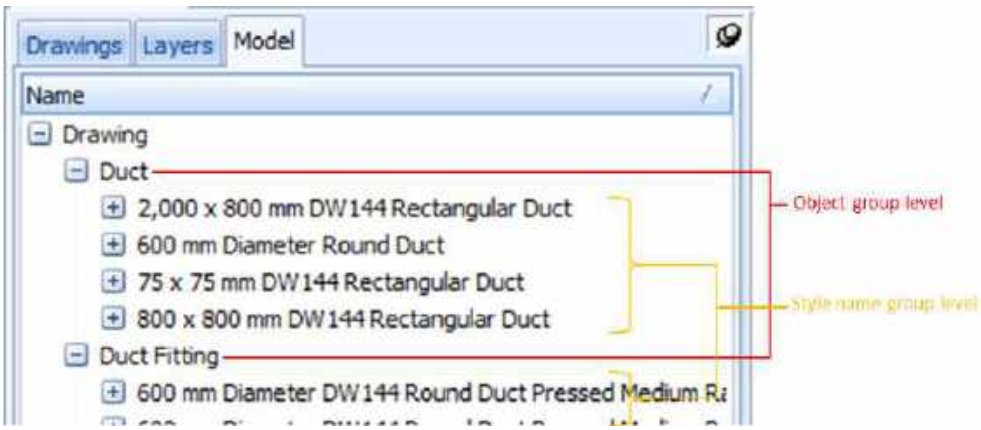
Click on the New Style button, in the right hand side of the Style Manager dialog under the General tab enter a Name for the new style and optionally a Description.

Click on the Applies To tab.

Property sets can be created, for subsequent addition to objects, at an Object level (to be added to an individually selected object or to several/many selected objects or all objects of the same type - if all drawing objects are selected) or at a Style level (to be added to an object belonging to a specific style name within the host style (e.g. a specific size of duct or pipe within the duct style or pipe style) which then adds the property set automatically to all other objects in the drawing belonging to the same specific style name.

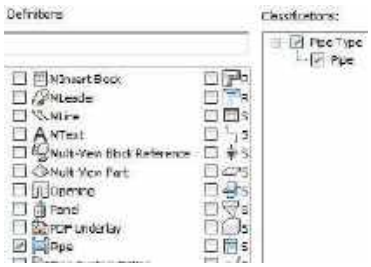
Generally iTWO costX® users would be importing dimensions at an object grouping level rather than at a Style name grouping level, and would normally anticipate any manual or formula based property definition values to be added to all objects of the same type (all objects in the same object group), consequently property sets (and hence the property definitions created within the property set) should normally be created at an Object level and be subsequently added to all objects of the same type (all objects in the same object group). If however the property definitions to be created in the property set only apply to one or more specific style names the Style and Definitions options could be selected instead.

The following example indicates the grouping levels of objects & style names within iTWO costX® for an example DWFx™ file exported from AutoCAD® MEP.



Select either the Objects or Styles and Definitions option as required (please refer to the paragraph above).

Place a tick in the checkbox to the left of the required Object or Style, if the Classification section of the dialog displays further checkboxes and classification descriptions these can be used to refine the objects or styles the property set will be available for addition to, place a tick in the checkbox to the left of the required classifications / sub-classifications (although as noted above generally the property set should be added to all objects of the same type, in which case all checkboxes should be selected (ticked).



To apply the property set to further Objects or Styles repeat this process for each additional object or style.

The Property Set has now been created and is ready to have Property Definitions defined within it.

3: Creating a New Property Definition within a Property Set

As the values created by the property definitions may be used by the recipient of the published version of the drawing to filter objects and or extract dimensions for similar drawing objects (i.e. objects having one or more common property or belonging within the same object group or style name) the property definitions should be applicable to (and be subsequently added to) all objects of the same object type or style name type, generally property definitions which intend to add a fixed value or description applicable to all objects of the same type or style name type should be added as Manual Property Definitions and property definitions which intend to add values or descriptions which will vary between objects of the same type or style name type (but are derived from common property sources) should be added as Formula Based Property Definitions.

If a new property set has just been created and is currently selected in the Style Manager dialog then click on the Definition tab. Otherwise open the Style Manager dialog, click on Manage Ribbon Tab and click on the upper half of the Style Manager button) and expand the Documentation Objects and Property Set Definitions folders listed under the required drawing and select the required property set definition object and then click on the Definition tab. Note: if a new property definition is being added to an existing property set it would be worthwhile reviewing the settings selected under the Applies To tab, if the new property definition which is to be created applies to a different selection of Objects or Styles it may be better to create a new property set and select the required properties or styles for the new property set rather than amending the existing one.

The new property definition can be either Manual or Formula Based (there are also further options, such as automatic, but the two mentioned previously are likely to be the most useful in respect to adding data for measurement purposes), click on the required Add … Property Definition button located at the right hand side of the dialog.

Add Manual Property Definition

If a Manual Property Definition was selected (e.g. to provide a fixed text description or value to be added to all or multiple objects, or a blank property field which can be added and completed on an object by object basis) the New Property dialog is displayed.

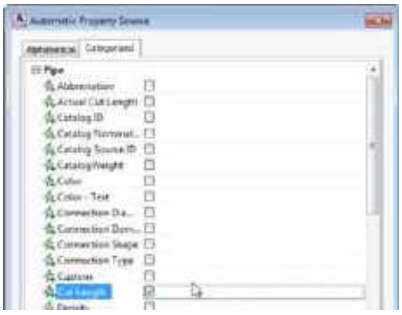
Enter the required name in the Name field and select the required Start With option (this can be either the text or value entered into the Default field (select the *DEFAULT* option or one of the values from the existing properties), then click the OK button.

In the Type field click on the drop down selection button and choose the required type setting for the new property definition.

In the Default field enter the default value for the new property definition. Optionally Units and Formatting may also be selected. Also ensure the Visible checkbox is ticked.

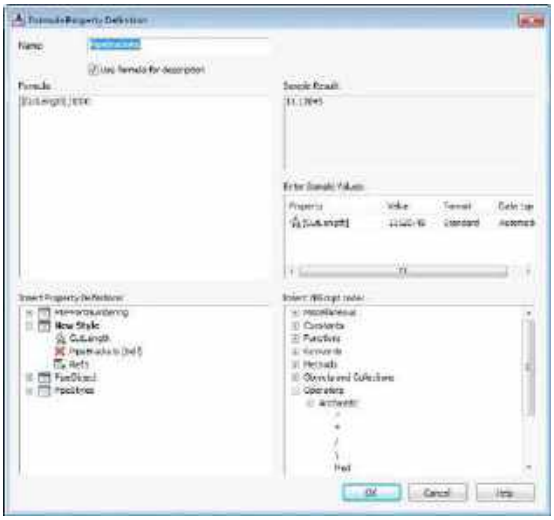
Add Automatic Property Definition

If a formula based property definition is to be used the properties which will be used in the formula will need to be added to the property set first as Automatic Property Definitions. Click on the Add Automatic Property definition button and select the required properties by placing a tick in the checkbox to the left of the required properties then click the OK button. Once added ensure the tick is removed from the Visible checkbox for each of the added automatic property definitions.



Add Formula Based Property Definition

If a Formula Based Property Definition was selected (e.g. to add values or descriptions which will vary between objects or style name types but which are derived from common property sources) the Formula Property Definition dialog is displayed. Enter the name for the property definition in the Name field and construct the required formula in the Formula field by double clicking (or right click and select Insert) on the required Property Definitions and VBScript codes augmented by directly entering any other requirements for the formula (e.g. quotation marks or other text or values).



Note: For property values of property definitions to be added into the formula correctly they need to be inserted from the Insert Property Definition list and be inserted from the same property set as the formula based property definition is being added to, if VBScript functions have been used in the formula the formula should start with RESULT =.

To review a Sample Result of the formula enter sample values as required against each of the properties listed in the Enter Sample Values: section of the dialog, the result of the formula based on the sample values will be displayed in the Sample Result: section of the dialog, if necessary amend the formula until the desired result is obtained.

Once the required formula has been constructed, click the OK button to add the property definition. In the property definitions list select as appropriate any required Units and Formatting and ensure the Visible checkbox is ticked for the property definition.

To add further property definitions repeat the above process as required. Once the required property definitions have been added, click the OK button to close the Style Manager dialog.

4: Adding an Object Based Property Set to an Object

As the property definitions may be used by the recipient of the published version of the drawing to filter similar drawing objects and or extract dimensions the property set should normally be added to all objects of the same type.

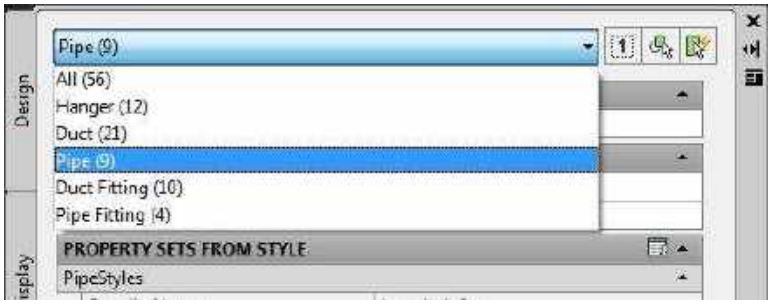
To ensure all of the required objects are displayed in the 3D Model view ensure all of the required layers are visible, not frozen and not locked.

If objects have been isolated end isolating the objects by clicking on the end isolate objects button on the information bar beneath the drawing window or use the end isolating objects option on the right click menu under the isolate objects option.

Either select the required object or objects or select the entire drawing (the object type to add the property set to can be filtered in subsequent steps) in the 3D Model view.

Display the Properties window (click on the Properties vertical tab usually docked on the left or right of the user interface, otherwise press Ctrl + 1 on the keyboard). Display the Extended Data section by clicking on the Extended Data vertical tab.

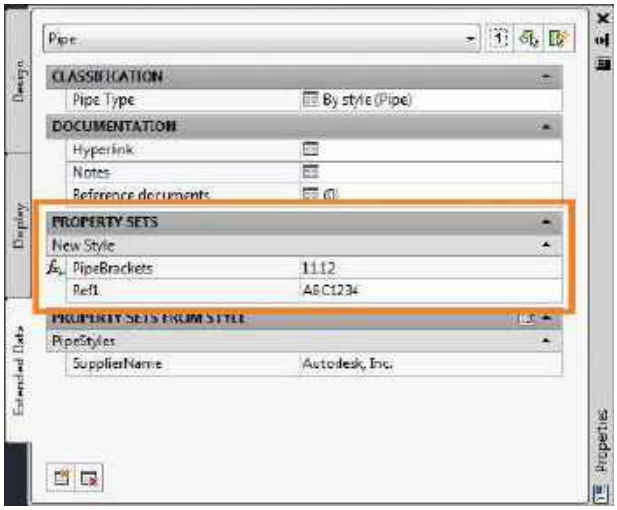
If multiple objects were selected use the drop down object type selection list to select the required object type.



At the bottom of the properties window click on the Add Property Sets button, add or remove the ticks from the checkboxes to the left of the property set names in the Add Property Sets dialog to select or de-select them and click on the OK button when the required selections have been made.

The property set(s) will then be displayed in the extended data section of the properties window. If multiple objects are currently selected the property fields may be unavailable for editing and may display *VARIES* rather than formula based data. If Manual Property Definitions were created in the property sets these will display the entered default value (assuming the Start With option was selected as Default when

the property definition was created). If it was intended that a manual property was added and its value completed / amended on an individual object by object basis or to otherwise review property definition values for specific objects ensure only the required object is selected in the 3D Model view.

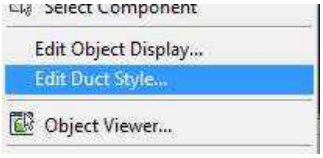


It is also recommended to verify formula based property definition values for a number of objects to ensure they are displaying the calculated value which would be anticipated for the selected object.

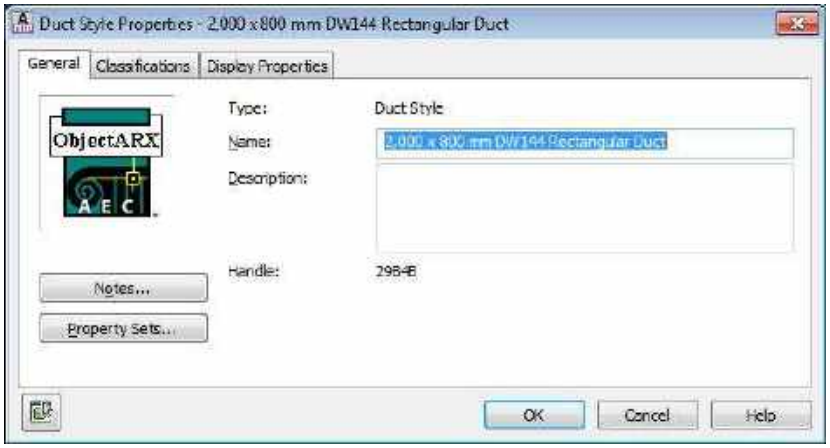
5: Adding a Style Based Property Set to an Object

As the property definitions may be used by the recipient of the published version of the drawing to filter similar drawing objects and or extract dimensions the property set should normally be added to all styles names within the style, this will need to be done for each style name in turn.

Select an object belonging to the required style name type in the 3D Model view and right click over it and select the Edit… . Style option.

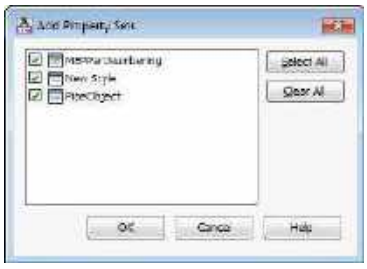


The … Style Properties – *style name* dialog is displayed.



In *style name properties* dialog under the general tab click the Property Sets button. The Edit Property Set Data dialog is displayed.

Click on the Add Property Sets button at the bottom of the Edit Property Set Data dialog, the Add Property Sets dialog is displayed, add or remove the ticks from the checkboxes to the left of the property set names in the Add Property Sets dialog to select or de-select them and click on the OK button when the required selections have been made.



The property set(s) will then be displayed in the Edit Property Set Data dialog, click on the OK button to close this dialog then click on the OK button on the *style name properties* dialog to close this dialog.

The property set(s) and property definitions within will then be added to the extended data section for the selected object and all objects belonging to the same style name type within the drawing.

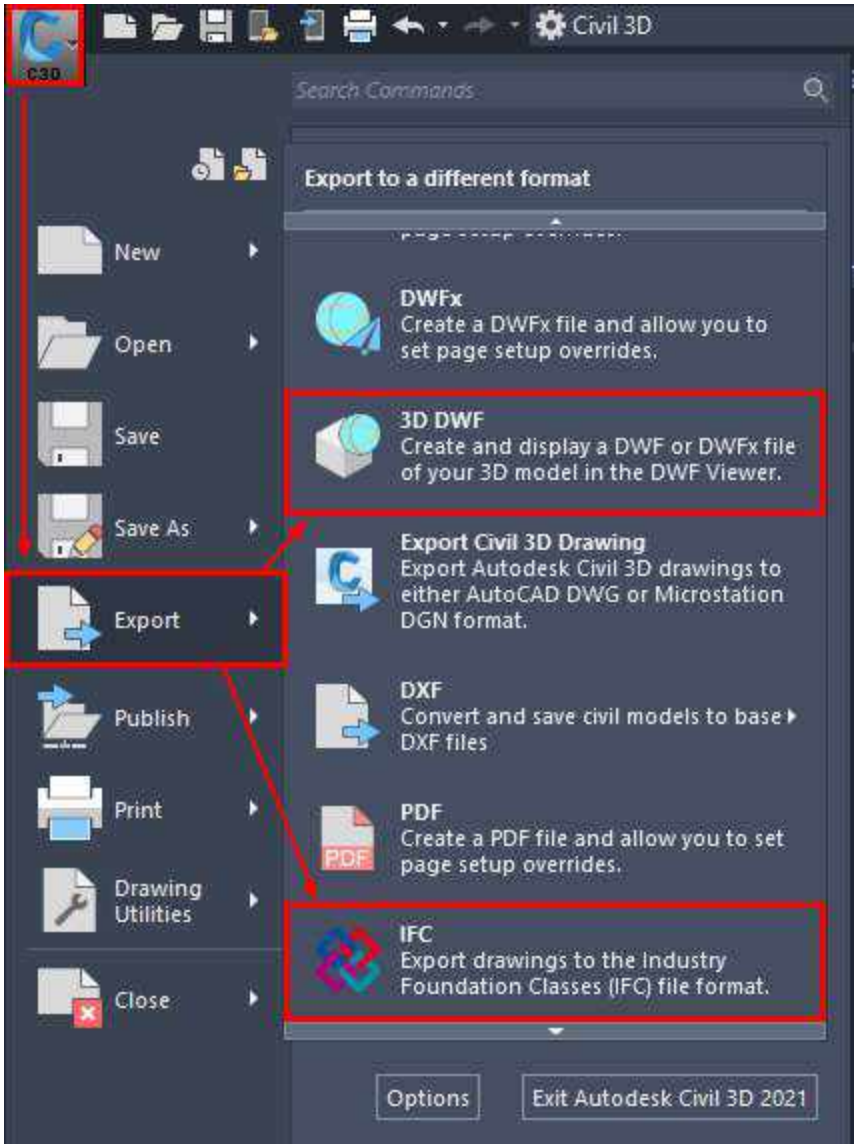
To review these properties for the selected object open the properties window (click on the Properties vertical tab usually docked on the left or right of the user interface, otherwise press Ctrl + 1 on the keyboard) then select the Extended Data vertical tab.

If Manual Property Definitions were created in the property set this will display the entered default value (assuming the Start With option was selected as Default when the property definition was created) if it was intended that a manual property was added and its value completed / amended on an individual object by object basis review and amend as necessary the default values (this will also need to be done for each object individually). It is also recommended to verify formula based property definition values for a number of objects to ensure they are displaying the calculated value which would be anticipated for the selected object.

10 Drawing Files from Civil 3D®

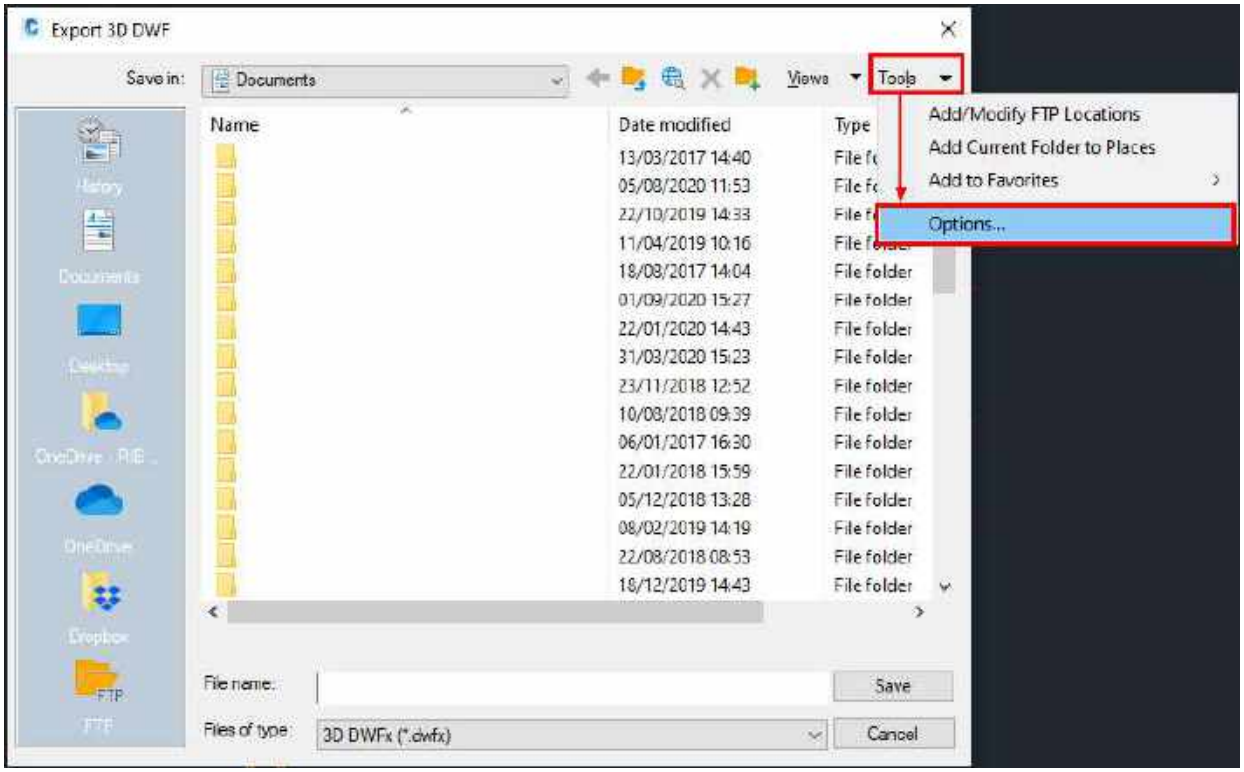
Civil 3D® includes various export options for different file formats, with varying degrees of graphical and geometrical fidelity and information preservation.

The two main options for export into iTWO costX® are DWF™ /DWFx™ and also IFC.

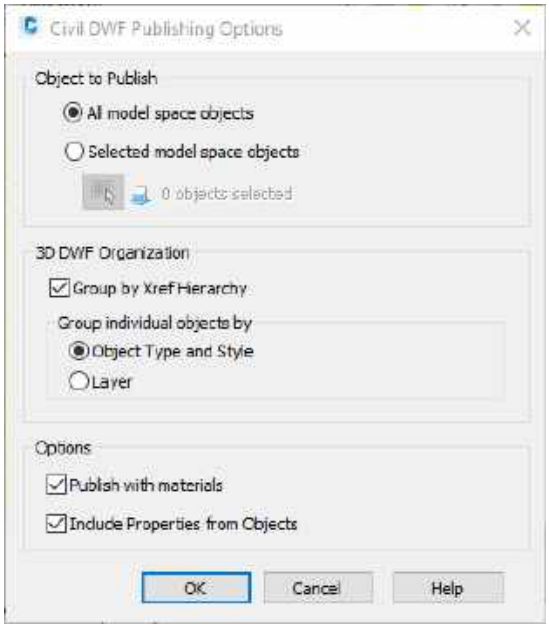


10.1 3D DWF™ and DWFx™

Once "3D DWF" has been selected, from the dialog box the export options can be adjusted as follows, and then the file saved to the chosen location:

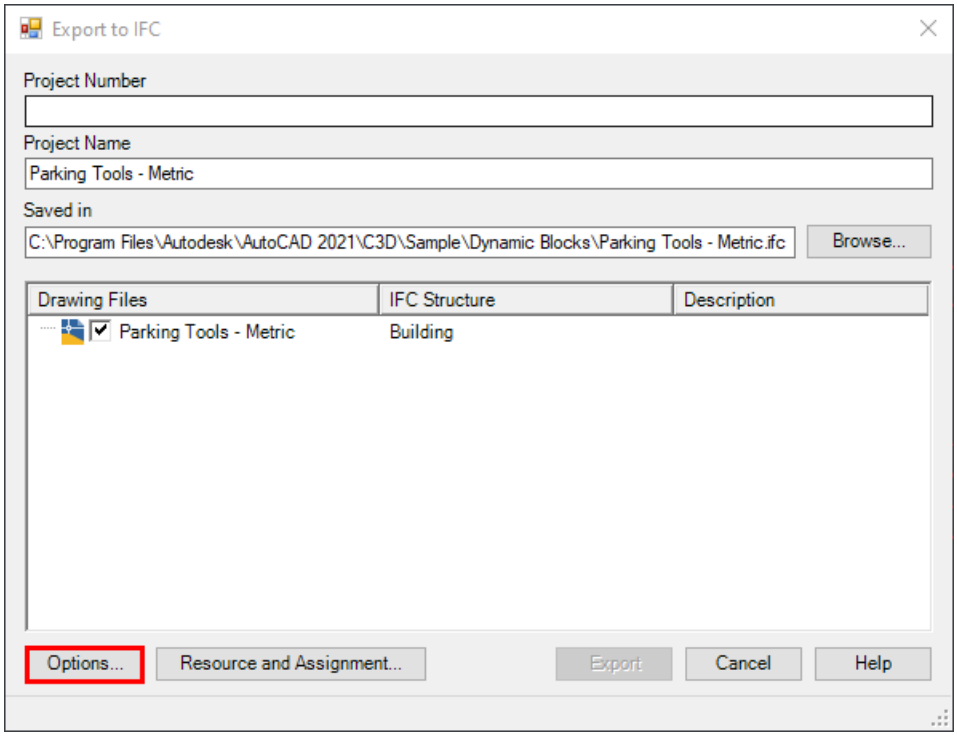


Within the "Civil DWF Publishing Options" the settings can be adjusted if required to suit the particular requirements of the project:

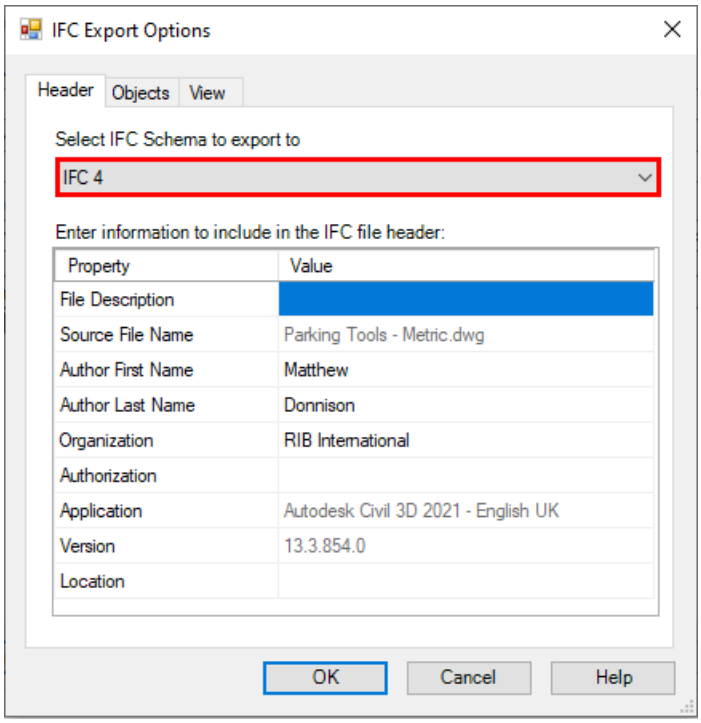


10.2 IFC

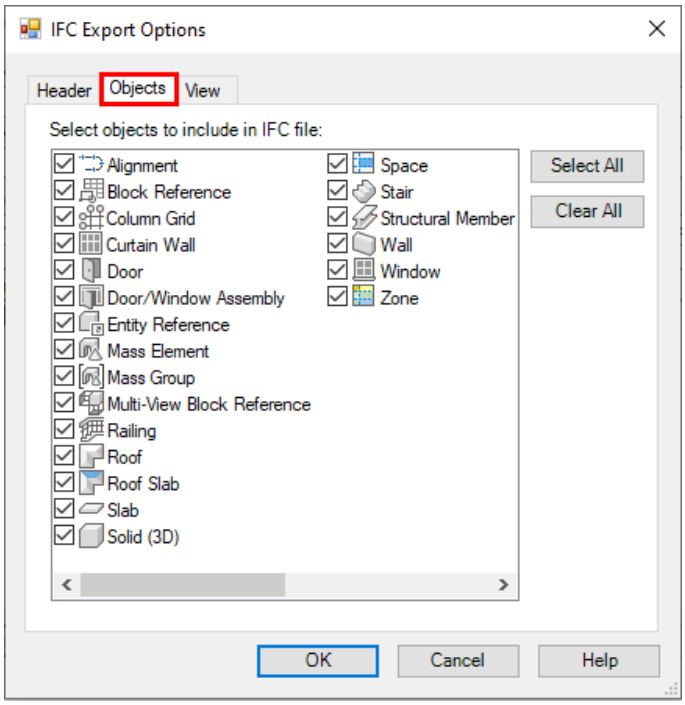
Once "IFC" has been selected, from the dialog box the export options can be adjusted as follows, and then the file saved to the chosen location:



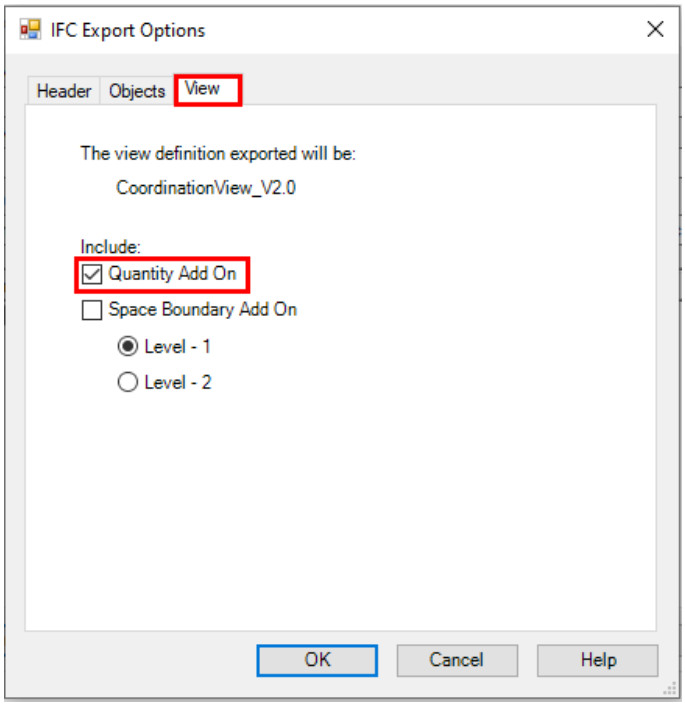
From the "IFC Export Options" the IFC Schema can be chosen (i.e. IFC 2x3 or IFC 4):



Under the 'Objects' tab the required objects can be selected:



Under the 'View' tab the 'Quantity Add On' checkbox can be selected to export quantity property sets as IfcQuantity:



Further information can be found on the Autodesk® website, and further general guidance on IFC can be found in the IFC Files section.

11 IFC Files

11.1 The IFC Standard

The current IFC release is IFC 2x3 Edition 3 (Feb. 2003) as amended by IFC 2x3 TC (Technical Corrigendum) 1 (July 2007). TC1 did not amend the IFC 2x3 exchange file and both versions can be used.

IFC4 (formerly called 2x4) was released on 12 March 2013, published as ISO Standard 16739. Implementations will start appearing in authoring applications from 2016 onwards.

IFC cannot replicate the authoring functions of the various proprietary BIM applications, nor is that its intention. It is a file format whose purpose is to facilitate cross-discipline data sharing and exchange by providing a broadly based, vendor-neutral repository for data relating to building objects.

The process of sharing data via the IFC format is termed an IFC Exchange. In practical terms, the need to convert the host data to IFC format and the fact that the IFC is structured to support a multiplicity of data types across a wide range of disciplines can lead to a high level of complexity in the IFC model. IFC exchanges therefore follow what is termed an "Exchange Requirement" which specifies the data that needs to be present in any given exchange and thereby limits the scope of the exchange to more manageable proportions.

The buildingSMART® Standard for Processes, formerly called the IDM (Information Delivery Manual), defines typical exchange requirements for a given discipline or scenario, so that different audiences can focus on the data relevant to them. An associated IFC View Definition, or MVD (Model View Definition) defines a subset of the IFC schema that will satisfy the specified exchange requirements. In other words, when you export an IFC governed by an MVD, you are only exporting selected parts of the information which goes to make up the entire data model.

The MVD provides implementation guidance for all IFC concepts (classes, attributes, relationships, property sets, quantity definitions, etc.) used within the subset. It thereby represents the specification for the IFC export by BIM applications, so that their exports satisfy the exchange requirements.

The official buildingSMART® MVD for the AEC industry is the IFC2x3 Coordination View Version 2.0. This can be extended with add-on model view definitions to support additional exchange requirements including:

- The Quantity Take-off add-on view which adds the ability to transmit Base Quantities for spatial, building, building service and structural elements.
- The Space boundary add-on view - it supports the use of BIM in thermal and energy analysis by adding building element to space relationships.
- The 2D Annotation add-on view - it supports the exchange of additional 2D element representations and annotations of building models
- The IFC2x3 Structural Analysis View
- The IFC2x3 Basic FM HandOver view

Work is currently underway in defining the first IFC4 based BIM work flow support definitions (MVD) based around a Reference View and Design Transfer View.

For further information refer to www.buildingsmart-tech.org.

11.2 Quantities in the IFC 2x3 Coordination View v2.0

When exporting an IFC file, IFC-compliant architectural BIM software maps the IFC export to the requirements of the IFC2x3 Coordination View v2.0 model definition. The main purpose of the Coordination View is to allow sharing of model data between the architectural, structural and MEP disciplines for coordination purposes. The standard does not specify requirements for export of dimensions (termed "out of view").

Quantity	Quantity	
IfcPhysicalComplexQuantity	Quantity	0
(ABS) IfcPhysicalQuantity	Quantity	n
(ABS) IfcPhysicalSimpleQuantity	Quantity	n
IfcQuantityArea	Quantity	0
IfcQuantityCount	Quantity	0
IfcQuantityLength	Quantity	0
IfcQuantityTime	Quantity	0
IfcQuantityVolume	Quantity	0
IfcQuantityWeight	Quantity	0

Quantity Properties Out of View (buildingSMART® IFC 2X3 Coordination View Definition v.2.0)

Generally, this will mean that a standard IFC exported from architectural BIM software will not include explicit quantity data, unless the Quantity Take-Off add-on view extension has been used to include Base Quantities in the export or the dimensional instance properties (ie. quantities) of the host model have been specifically included in the IFC export as a Property Set. Note that some IFC Viewer software such as Solibri® Model Viewer calculates quantities and displays them as entity properties. These quantities are not an attribute of the IFC file, and have been separately calculated by the Viewer program from the IFC geometry. Consequently, the same IFC opened in iTWO costX® (or other IFC Viewers such as Data Design System® DDS-CAD) will not have those quantities. Because the quantity values are not explicit model properties and are not based on the original model and intentions of the model author, their accuracy is dependent upon the calculations undertaken by the Viewer program and the data it uses as the basis of the calculations.

Property Sets

Some properties of an object are absolute. These fixed properties are termed Attributes. Other properties are more variable because they may be seen or interpreted differently by different parties, or may be contextual, or assigned to an object by a relationship. These types of properties can be grouped together as a "Property Set" and added to the object as additional parameters to suit particular situations. The properties within a set can be either standard (conforming to the rules of the IFC schema) in which case the set name will begin with the prefix "Pset_" or they can be custom, which means they are created by the exporting application and the names of these sets will normally include the name of the exporting application.

Proxies

When BIM applications export to IFC, the data has to be mapped from the host schema into the IFC schema. Many architectural object classifications have direct IFC counterparts and will be mapped accordingly, eg. an object having a Wall-subtype in ArchiCAD® will be classified as IfcWall. If an object has no corresponding IFC element type it will be exported as a Proxy. The default setting is to export the objects as a general solid object in a generic IfcBuildingElementProxy element. As a general solid object, it has geometry but no properties which is obviously undesirable and therefore to be avoided. It is possible to map objects to alternate IFC elements prior to export, to reduce the number of proxies, or proxies can be defined with geometry and property sets to behave like regular entities.

IFC Files and iTWO costX®

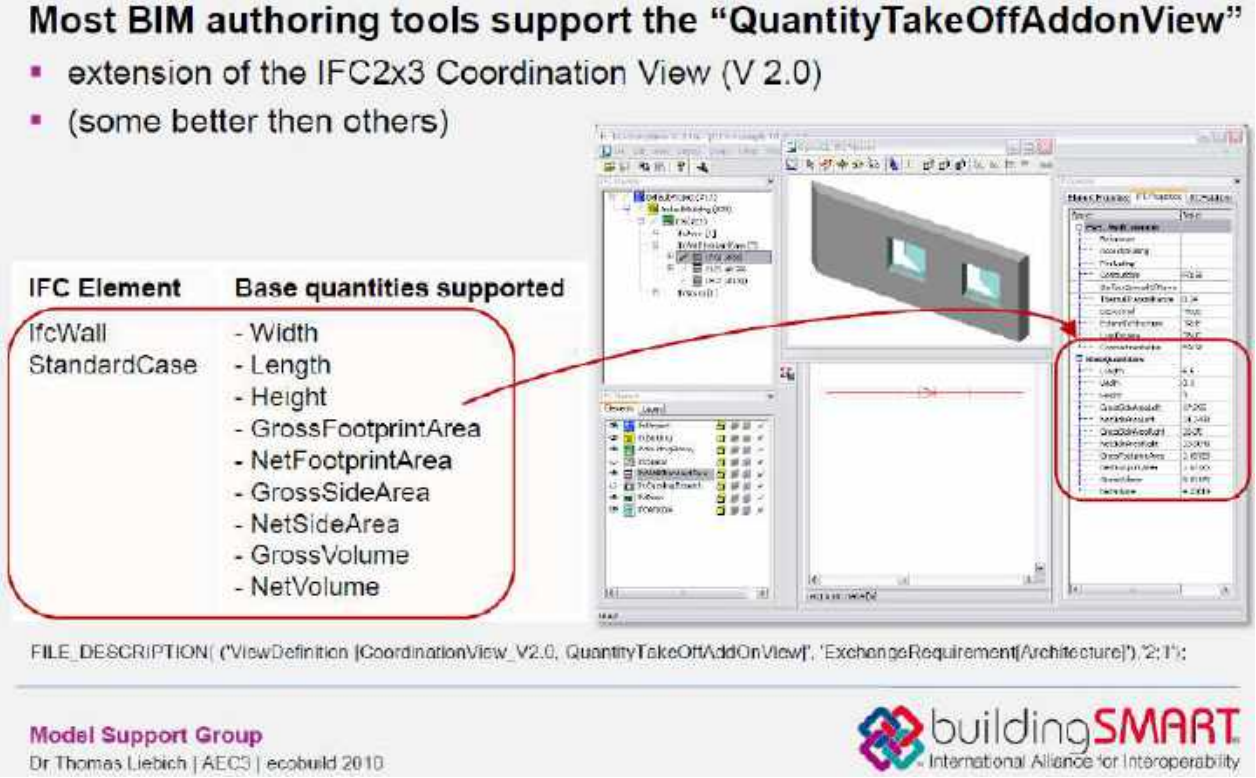
Owing to differences in IFC implementation by the various authoring applications and the multiplicity of supported data types, IFC file configuration and data content will differ between projects. Consequently it is difficult to define a standard for automatic quantities extraction via a iTWO costX® BIM Template. Data extraction from an IFC file is therefore supported with Model Maps and Object-based Dimension Groups (see 3D Drawing Files and BIM Models).

Whilst the IFC is structured to accommodate proprietary data models, the responsibility for creating them lies with the authoring application that exports the IFC. If the correct associations are not explicitly made in the source file, they cannot proceed in the IFC and hence may not appear in a downstream application. Thus, how a model file is prepared for export to IFC is extremely important and is a critical factor in the ultimate success of the IFC exchange process.

11.3 Base Quantities

In 2006 buildingSMART® commenced work on a definition of model-based quantities to create an open standard for quantification of building spaces and elements, termed “Base Quantities”. These are described in the document “Information Requirements for Model-based Quantities - Definition of Base Quantities” dated 2010-12-08.

To augment the IFC 2x3 Coordination View definition, the Quantity Take-off add-on view adds the ability to transmit Base Quantities for selected spatial, building, and structural elements. However, it is important to note that Base Quantities are not explicit dimensional properties of the model – they are separately calculated from the model geometry as part of the IFC export process.



Currently, Base Quantities can generally be included in an IFC export as a tick-box option. They will however be an integral part of the forthcoming IFC 2X4 release.

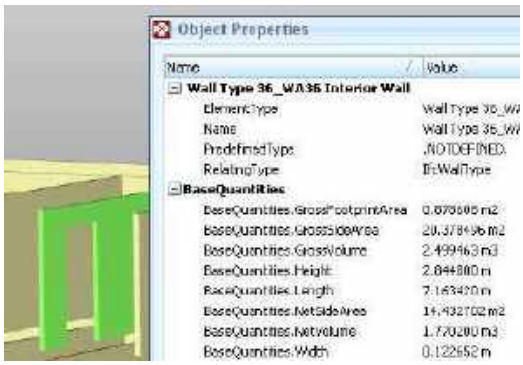
Graphisoft® ArchiCAD® 15

IFC Translators

- **Base quantities (length, area and volume)**
  Check this box to add Quantity Takeoff parameters to Wall, Column, Beam, Slab, Roof (slab) and Zone elements in the IFC file. This data is useful in the Interoperability with cost estimation applications.
  For example, the following quantities (IfcElementQuantity) can be exported together with a Wall.
  - Height,
  - Perimeter,
  - Gross volume,
  - Net volume (volume reduced e.g. by columns embedded into the wall),
  - Gross Floor Area (doors are not considered),
  - Net Floor Area (area reduced by door footings),
  - Gross Wall Area (openings are not considered),
  - Net Wall Area (area reduced by openings).

IFC 2X3 Reference Guide for ArchiCAD®15

Base Quantity definitions have only been written for selected elements, and Base Quantities are only included in the export for those elements.



No Base Quantities are provided in the IFC for excluded elements such as Casework and Plumbing.

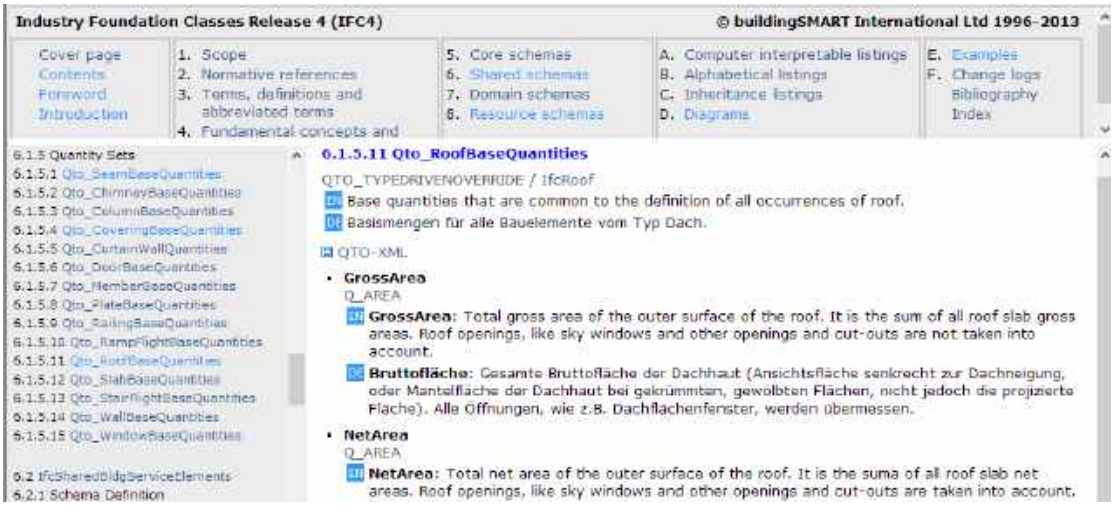
Footings and Roofs do not have Base Quantity definitions as these are "container" elements, meaning they are an aggregation of sub-components (slabs, beams, etc). The sub-components can contain their own quantity information but when aggregated into IfcRoof or IfcFooting the quantities are not identified. It is expected that these will be available in the IFC4 release.

It is also possible for Base Quantities to be manually entered by the user, overriding the automatic calculation during the export process. The Base Quantity specification only indicates the standardized means of measuring and recording the quantity data, to eliminate possible errors in receiving applications that may miscalculate any automatic derivation from the given geometry. Preferably, the dimensional instance properties of the model should be included in the IFC as a Property Set as these are explicit model properties unlike the Base Quantities which are separately calculated from the model geometry as part of the IFC export in accordance with a set of rules published by buildingSMART®.

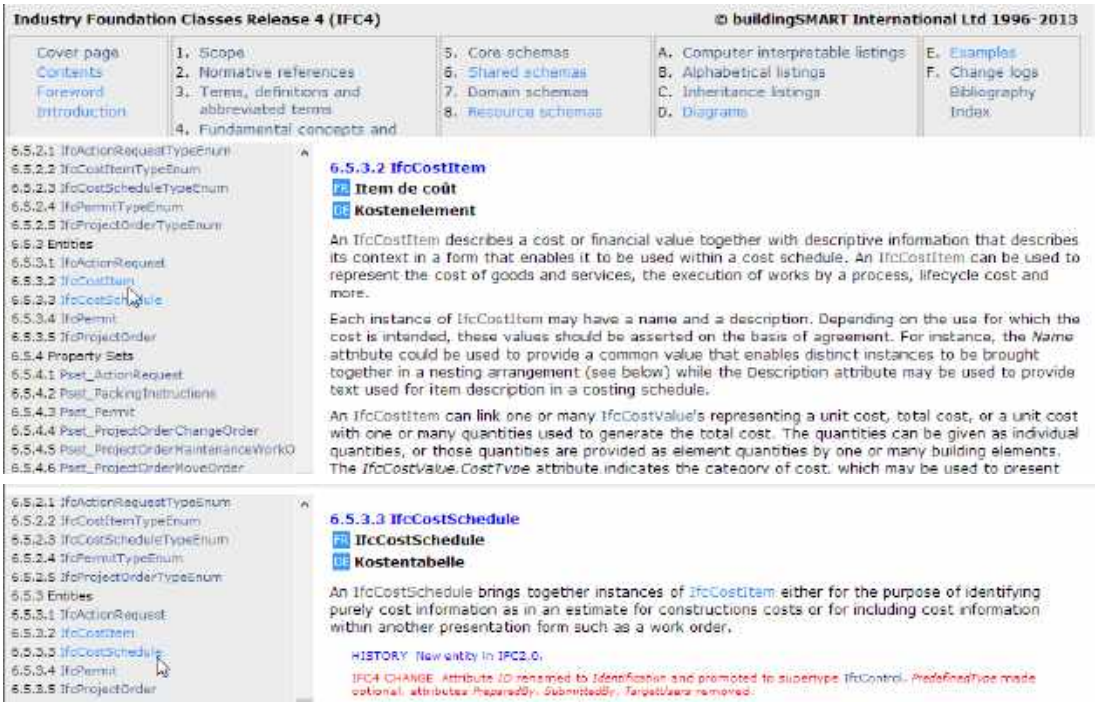
11.4 Quantities in IFC4

For details of the new IFC4 standard, refer to https://technical.buildingsmart.org/standards/ifc/ifc-schema-specifications/. Two changes relating to support for new BIM workflows and 5D model exchanges which should appear in IFC4 implementations are stated as:

- *Standardized quantities for QTO - Definition of international base quantities, defined as separate XML schema + configuration files linked to IFC spec. This includes the welcome addition of a BaseQuantities Definition for IfcRoof Element.*



- *Major efficiency improvement for 5D - Similar rework for cost items and construction resources, now linked to schedule and BIM. This relates to the definition of cost items within 4D schedules.*



11.5 IFC Files - Issues to Consider

- IFC is an open standard data specification. The responsibility for populating the data model with the appropriate parametric properties and relationships lies with the host authoring application.

- As an open standard, IFC by definition cannot exactly replicate a closed proprietary system. Hence an IFC is not an exact copy of a proprietary data model, but is an alternate representation based on its own open geometry standard (STEP). Different standards of IFC implementation by the various authoring applications can lead to data loss in the IFC exchange.

- Proprietary data models need to be mapped to their corresponding IFC categories which may involve translation routines, override settings, and creation of additional IFC-specific parameters.

- Objects that do not have corresponding place-holders in the IFC schema may need to be manually mapped to an alternate IFC element prior to export. If this is not done they will be exported as a general solid object Proxy (IfcBuildingElementProxy), which means that the geometry gets exported but not the properties.

- Export of quantities is not part of the IFC 2X3 Coordination View definition. Consequently, a standard IFC export from most IFC-compliant AEC applications will not include quantity data unless the model dimensional properties are specifically mapped to the IFC as a Property Set, or the Base Quantity add-on is used. A MVD for IFC4 based around a Reference View and Design Transfer View has not yet been widely implemented but is expected to include Base Quantities by default. For further information refer to https://technical.buildingsmart.org/standards/ifc/mvd/.

- Base Quantity values are calculated from the model geometry as part of the IFC export process and are not explicit properties of the host model. The model dimensional properties should be included in the IFC as a Property Set in preference or in addition to Base Quantities.

- Base Quantity definitions have currently only been written for selected building elements and spaces, and the quantities included in a Coordination View IFC with Quantity Take-Off add-on will be limited to those elements.

- IFC files can be zipped to reduce their size for transmission purposes. They can also be further compacted by use of a utility such as Solibri® IFC Optimizer, described as a lossless IFC optimizer that purges redundant data from the IFC. The concern with such a process is the potential effect on data integrity and whether required information is lost or reformatted so that it is not recognized or processed correctly by downstream applications.

11.6 IFC Files - What to Provide

If the design package is Revit®, DWF(x)™ files are preferred to IFC owing to their closer integration with the host application. Provide a multi-sheet DWFx™ export as described in 3D DWF™ and DWFx™ Files from Revit®.

For other BIM software, or if an IFC is specifically required from Revit®, provide an IFC 2X3 Extended Coordination View export with Base Quantities (or IFC4 when available). For Revit® this is described in IFC Files from Revit® and for ArchiCAD® in IFC files from ArchiCAD®. Prior to export ensure that objects are mapped to their correct IFC categories, which may involve override settings and creation of additional IFC-specific parameters. Include the host model dimensional instance properties (quantities) as a Property Set in the IFC.

Review the resultant IFC by use of an IFC Viewer such as DDS-CAD Viewer. Bear in mind that some IFC Viewer software such as Solibri® Model Viewer calculates quantities and displays them as entity properties. These quantities are not an attribute of the IFC, and have been separately calculated by the Viewer program from the IFC geometry. Consequently, the same IFC opened in iTWO costX® will not have those quantities.

Hence you may potentially see three alternate sets of quantities - the model dimensions, the IFC Base Quantities and the Solibri® Quantities.

Of these, the model dimensions are preferred because they are explicit properties of the model itself. Next are the Base Quantities which are calculated from the model geometry in accordance with a set of rules published by buildingSMART®. The Solibri Quantities are not part of the IFC and will not be available when the IFC is opened in iTWO costX®.

In addition to the IFC, provide a full 2D set of plans, sections, elevations and details in 2D DWG™ format as described in 2D CAD files. 2D DGN™ files are also supported by iTWO costX®. The IFC will be used to import BIM dimensions, and the 2D views and sheets will be used to check and augment the quantities.

12 IFC Files from Revit®

Refer to 3D Drawing Files from Revit® for Revit® optimizations prior to export.

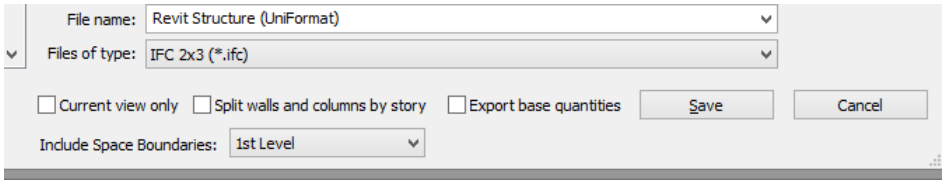
To export an IFC from Revit®, there are two alternate User Interface options. The standard interface which installs with older versions of Revit® has no configuration options available to the user, in this case the alternate User Interface can be downloaded for free from either SourceForge or the Autodesk Exchange Apps Store and with that, you can create user-defined Property Sets.

Newer versions of Revit® do not require this step.

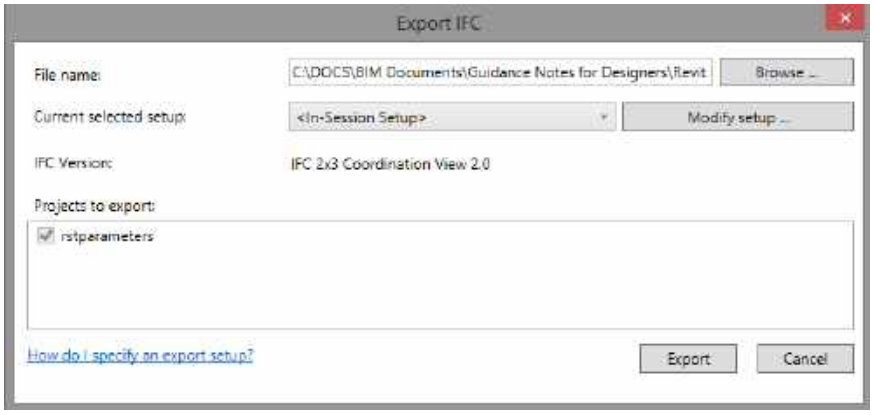
https://sourceforge.net/projects/ifcexporter/?source=directory

To export an IFC, select the Export button under the main menu.

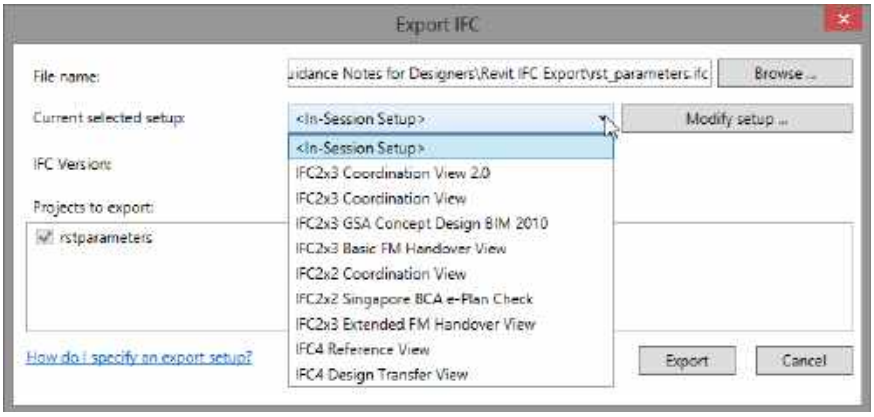
With the older standard interface, only tick box options are available as shown below. Be sure to tick the Export base quantities box. The Revit® dimensional properties will be included as a Property Set by default.



With the alternate interface (included with newer versions of Revit®), there are several configuration options available.

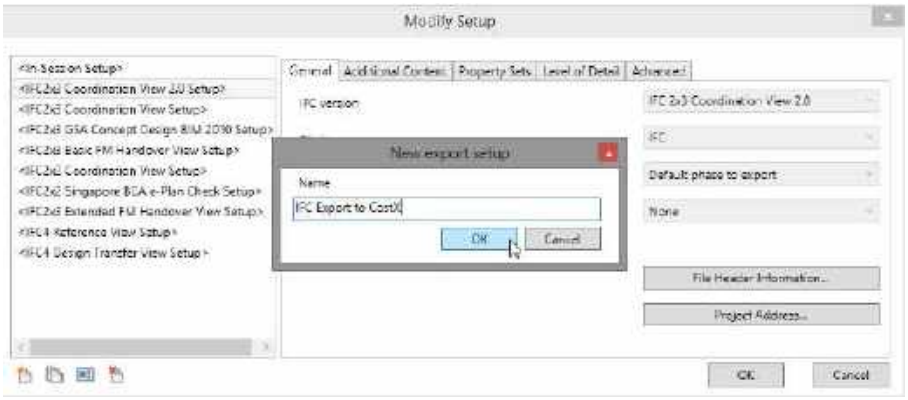


- In the Export IFC dialog, for File name, click Browse, and navigate to the target folder for the IFC file.
- Enter a name for the IFC file, and click Save.
- For Current selected setup, select the IFC setup to use to create the file.
- The <In-Session Setup> option is a modifiable setup which is not saved between sessions. You can configure the options as desired to export the project to IFC. There are 9 built-in setups. These setups correspond to the IFC version options. These setups cannot be modified or deleted, but they can be duplicated to create a customized version.

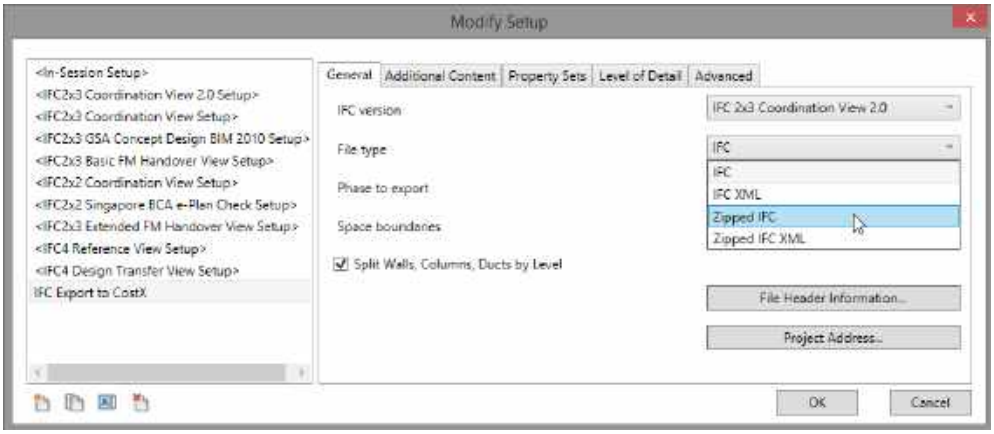


- Optional: Click Modify setup... to customize the IFC setup options.

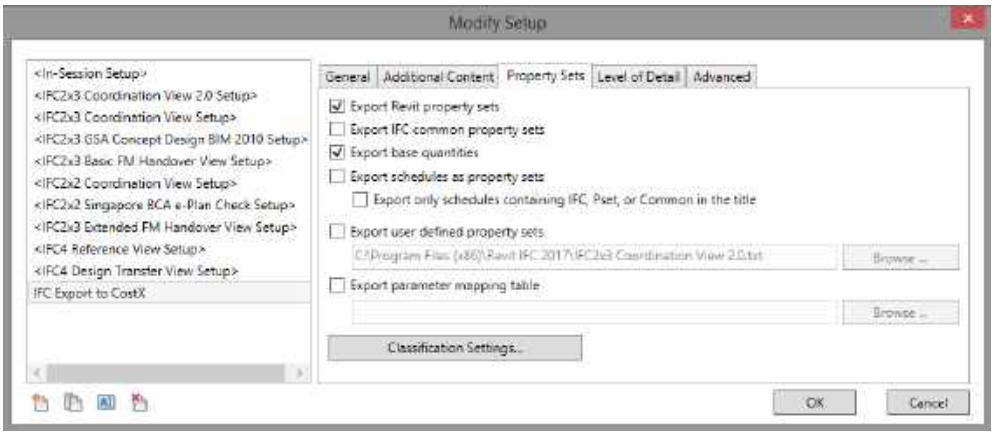
- The Modify Setup dialog displays. You can modify the In-Session Setup or add additional named setups using the Create or Duplicate options. The new setup configurations you create are saved with the project, and can be reused if the same model is exported.



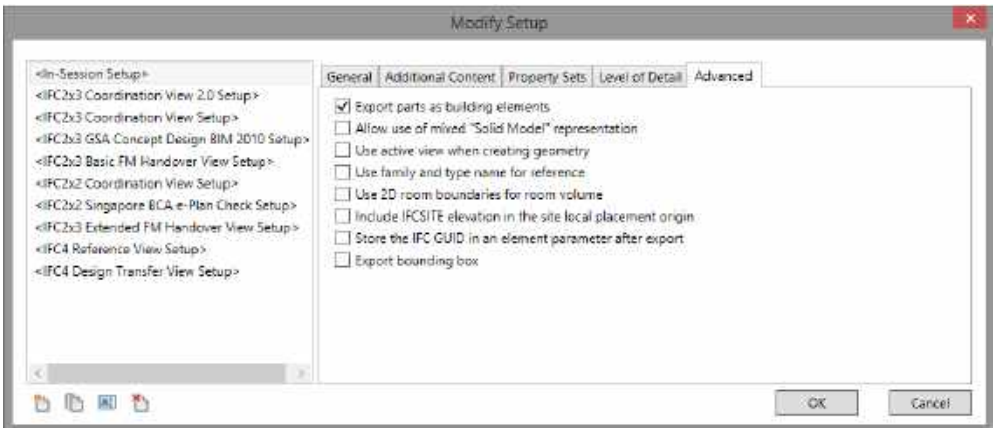
- Under each of the tabs there are various optional settings. Under General, a zipped IFC will be a smaller file size than an IFC. Tick the Split Walls.. check box if this is required by the recipient.



- The Additional Content tab is optional. Under the Property Sets tab, tick the two boxes as shown below. The Export schedules... and other options can be selected if relevant/required.



- Under the Advanced tab, tick the Export parts... option if the Parts tool has been used.

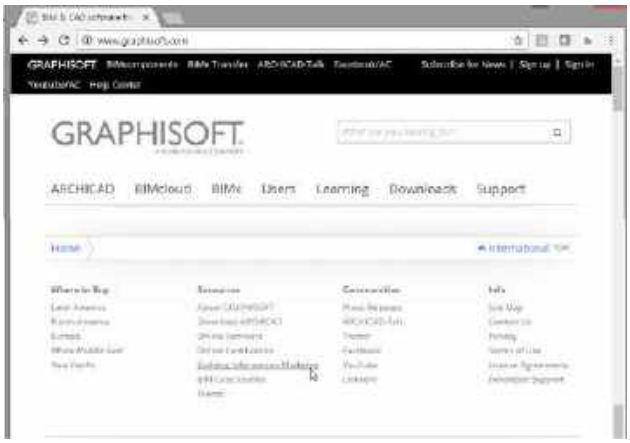


Refer to the Revit® help files for more details on IFC Export Setup Options.

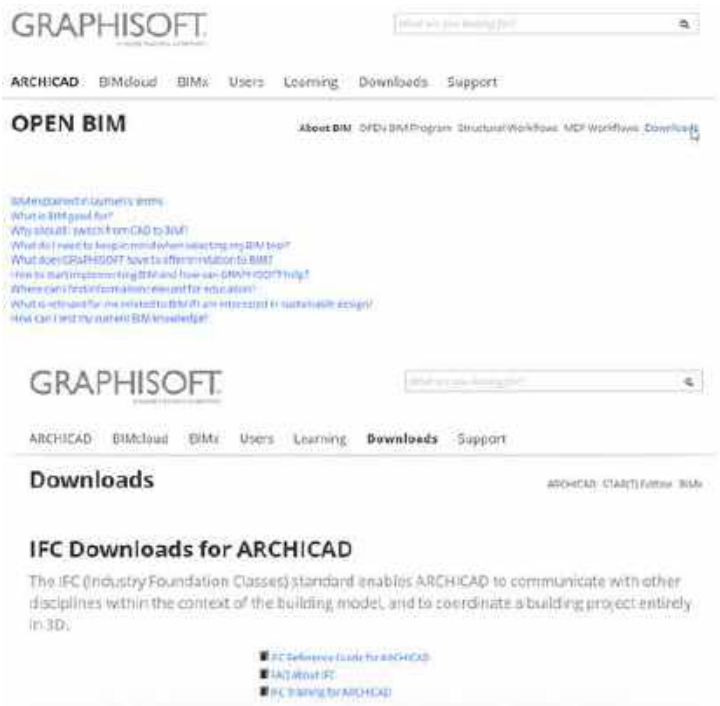
13 IFC files from ARCHICAD®

13.1 Sources of Information

The Graphisoft® website is a good source of IFC-related information. Scroll to the bottom of the Homepage and select the Building Information Modelling link.



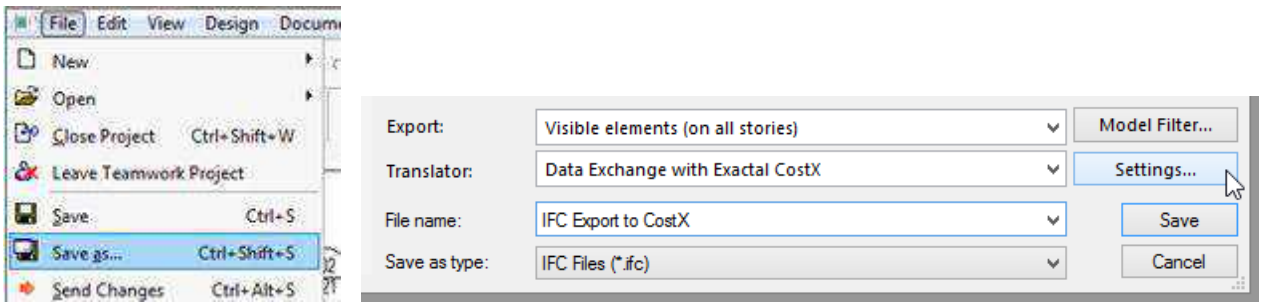
On the Open BIM page, click on the Downloads link. The IFC Reference Guide for ARCHICAD® (available for various versions 15 through 20) is an essential reference for information on IFC management when using ARCHICAD®.



The following pages contain some suggested settings to help optimize IFC files exported from ARCHICAD® 20 for use in iTWO costX®.

13.2 IFC Export Settings

From the main File menu select Save as… . In the menu dialog there are a number of selections to be made.

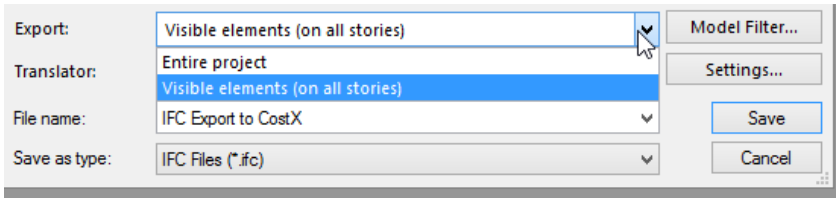


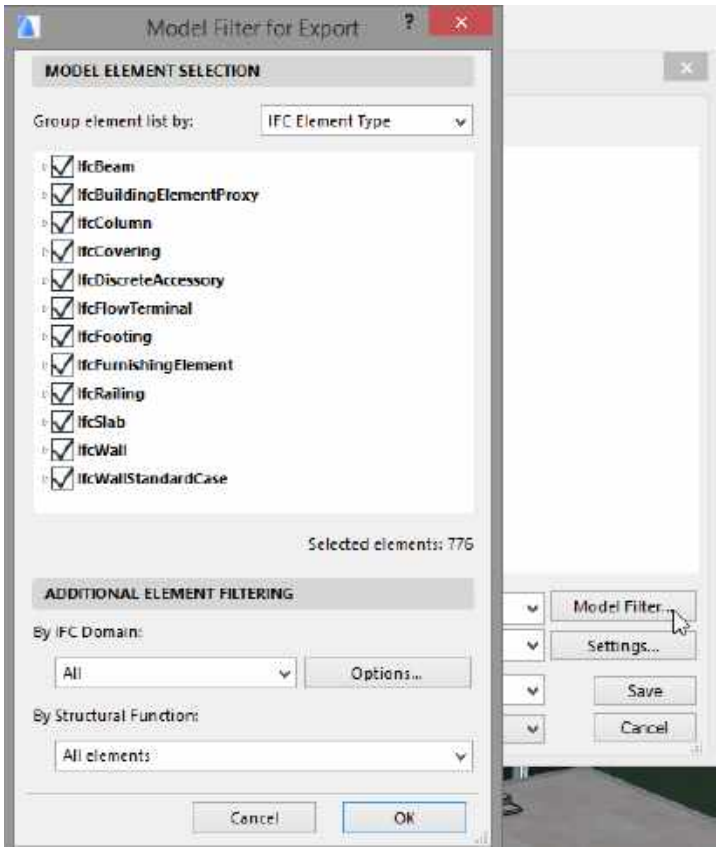
In the Save as type: field, select IFC 2x3 file (*ifc)

In the File name: field, enter a name for the IFC file

In the Translator: field, a list of existing translators is available from a drop-down list. The default General Translator does not export quantities so is not recommended. In some regions, the ARCHICAD® installer will include a iTWO costX® Translator but if not the Settings… button can be used to edit another translator or create a new Translator (see IFC Translators).

The Export: field can be used to filter the elements for the current export so that the content of the IFC can be limited to the specific requirements of the information exchange. The reason for filtering the elements rather than including all of them is to keep the IFC file size down and make model navigation easier for the recipient. These settings can be fine-tuned with the Model Filter... options.





Owing to their potential complexity, IFC files can reach very large file sizes leading to problems with file transmission and the hardware capabilities of the recipient.

Consequently, it may be necessary to create a set of IFC files with each one limited to particular elements or disciplines.

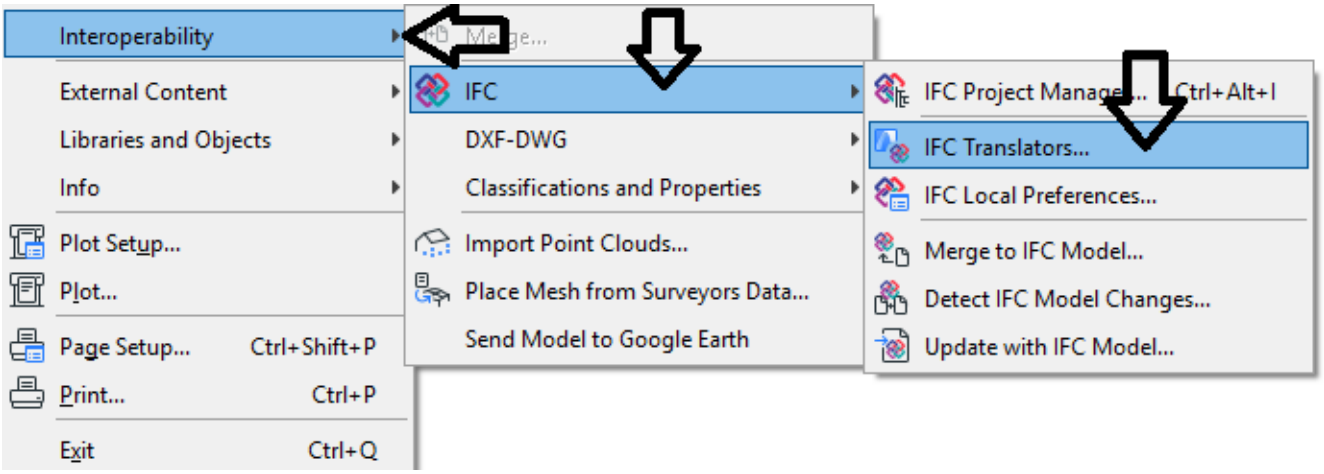
IFC files can be zipped to reduce their size for transmission purposes. They can also be further compacted by use of a utility such as Solibri® IFC Optimizer, described as a lossless IFC optimizer that purges redundant data from the IFC. The concern with such a process is the potential effect on data integrity and whether required information is lost or reformatted so that it is not recognized or processed correctly by downstream applications.

13.3 IFC Translators

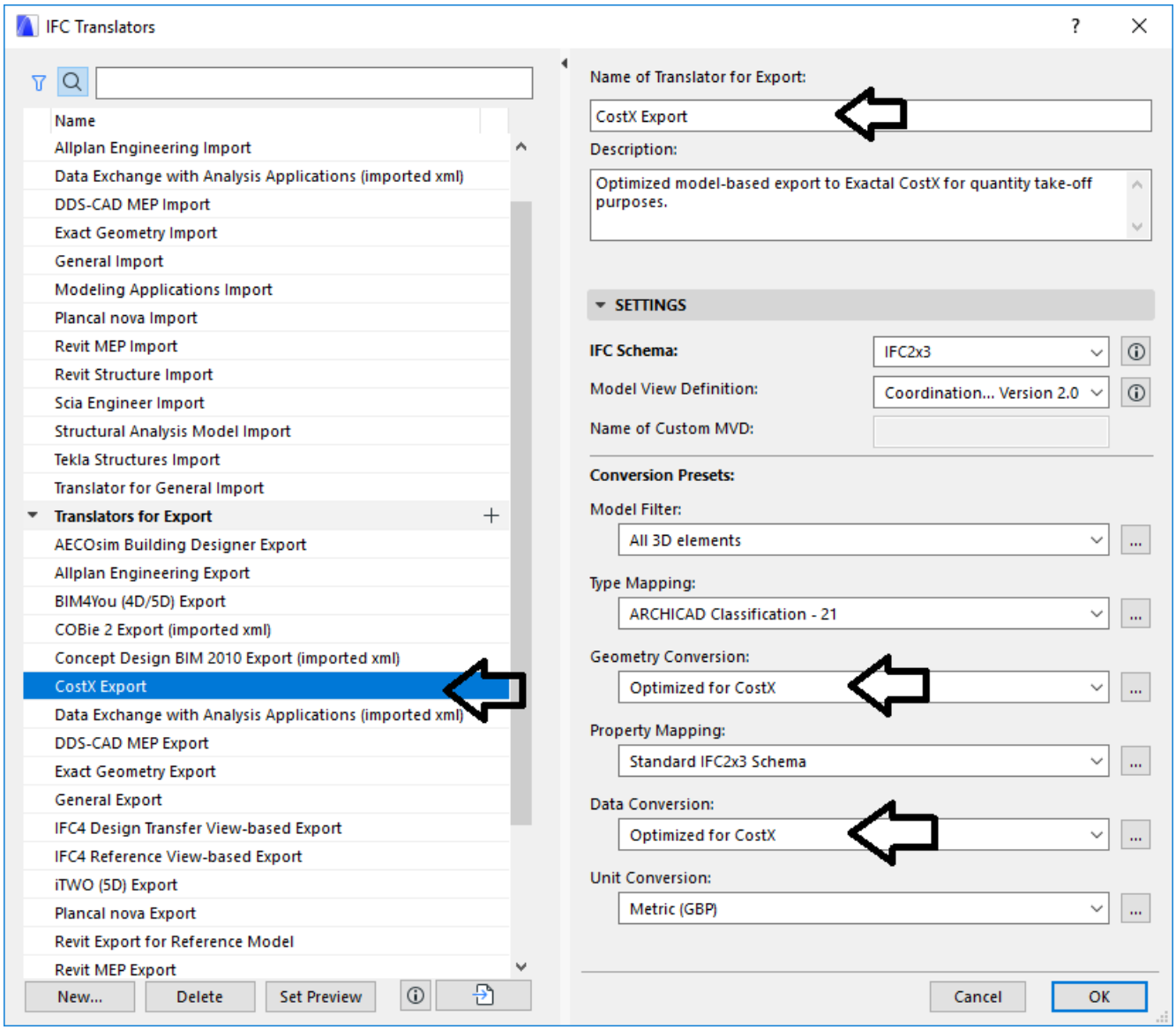
Although the Export settings can be used to modify the content of an IFC, exports generally will be governed by the settings of the selected Translator. These settings can be configured within the IFC Translation set-up to suit the requirements of the intended recipient and filter the IFC to limit its file size.

In some regions the ARCHICAD® installer will include a default iTWO costX® Translator. To view the translator properties, edit or create a iTWO costX® Translator, open IFC Translation Setup as follows:

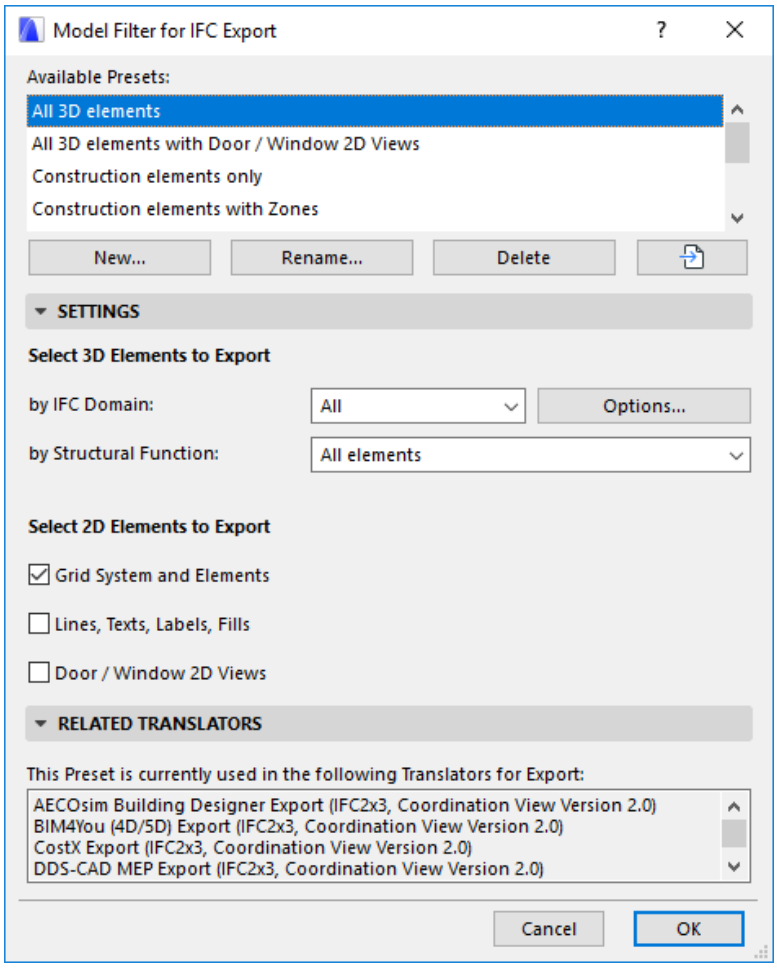
Select File/Interoperability/IFC/IFC Translation Setup...

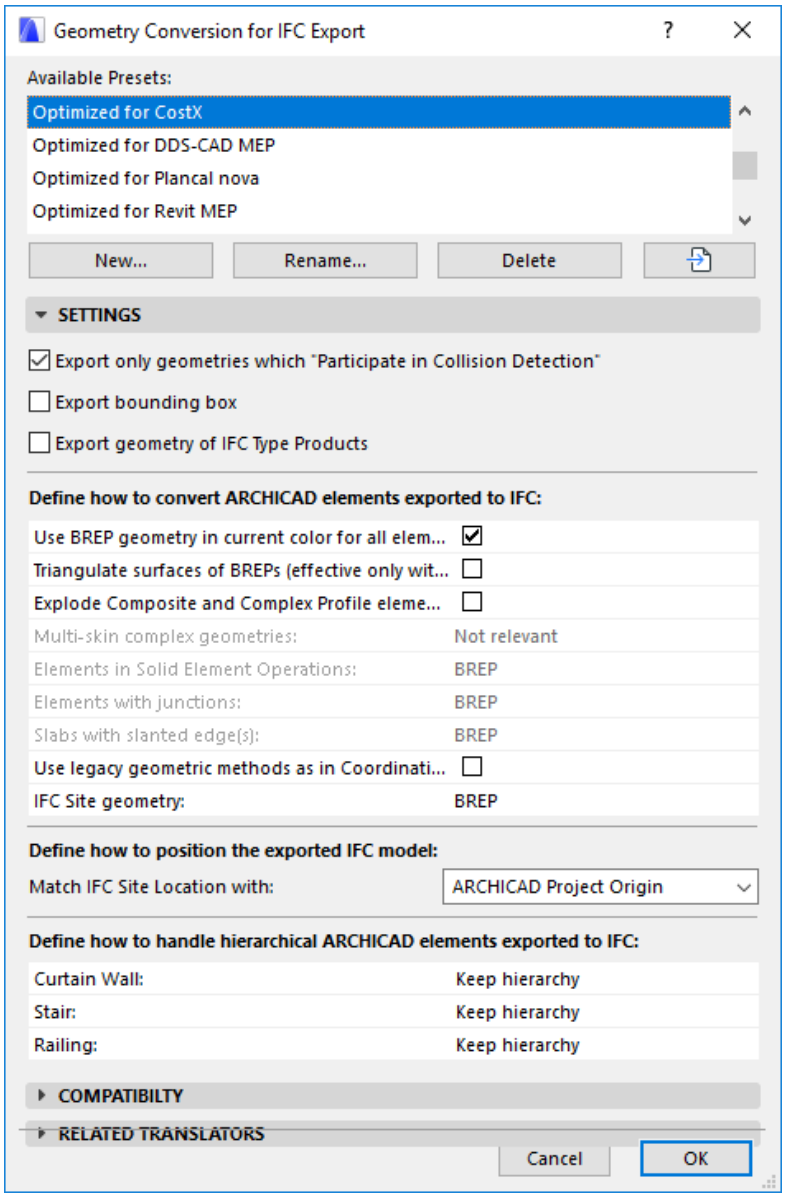


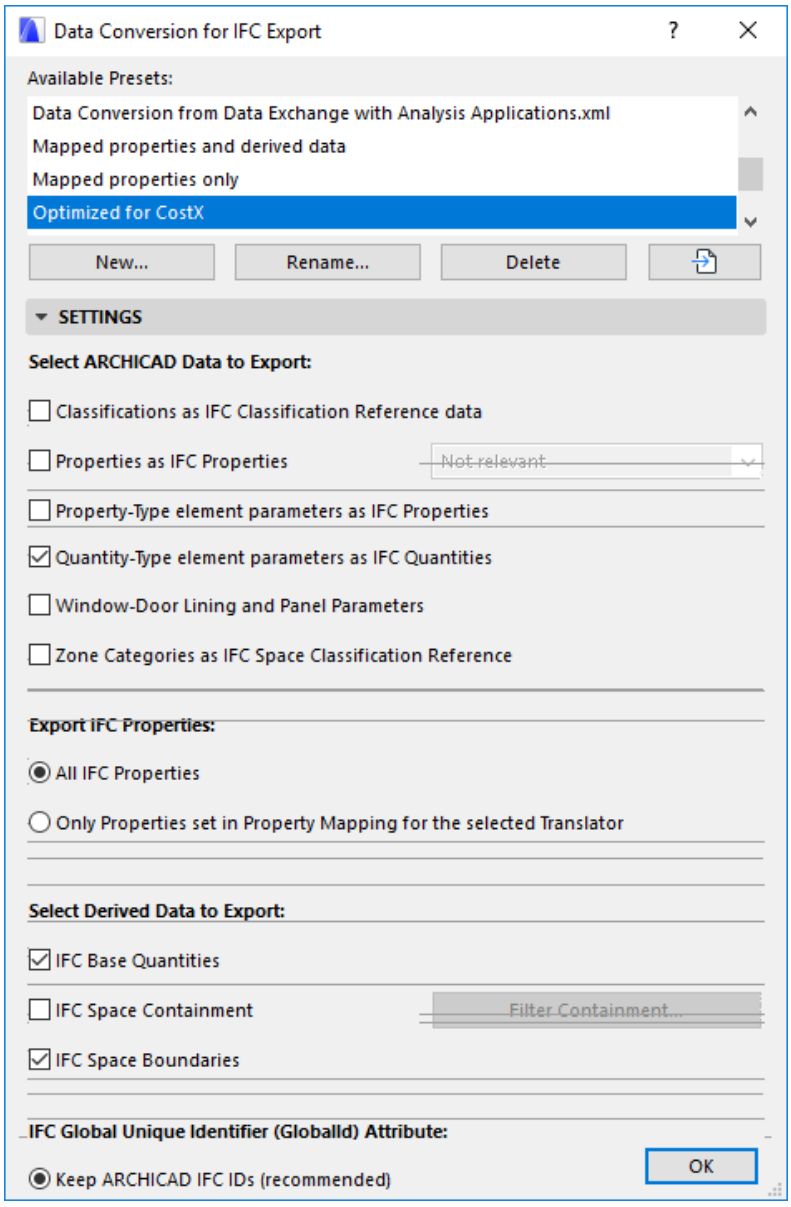
To create a new translator, either use the Create New button or duplicate an existing translator, re-name and edit it as required.

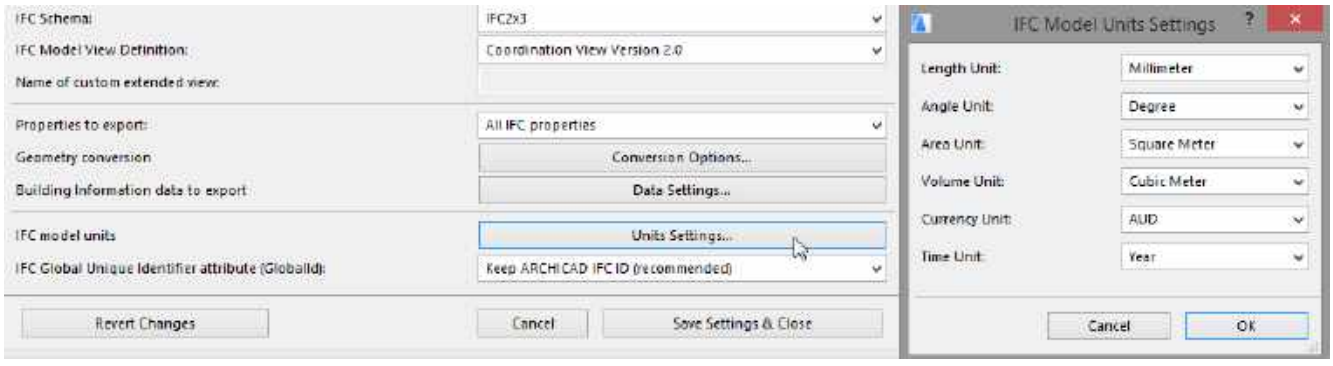


The Data Exchange with RIB iTWO costX® translator settings are as follows:









14 Appendix A - Shared Parameters in Revit®

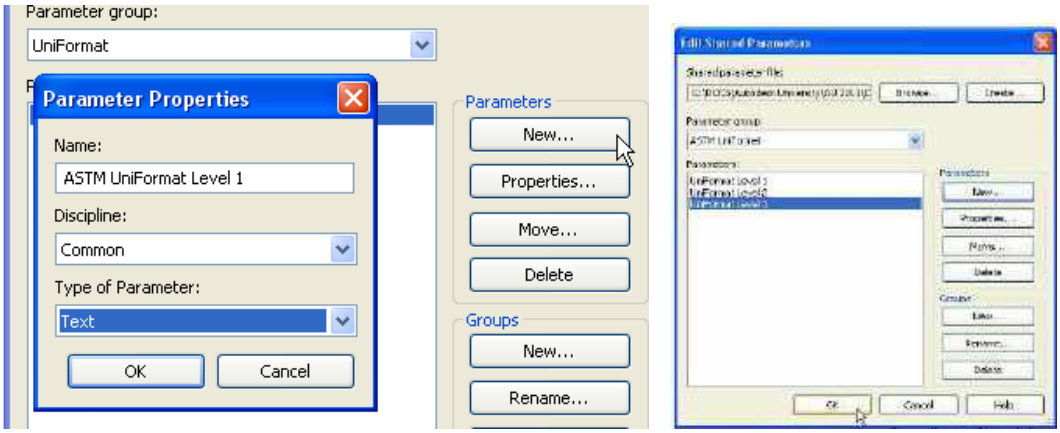
Object property data can be enriched to include additional information by the creation of new Shared Parameters for measurement and estimating purposes. A Shared Parameter which contains UniFormat coding, for example, would allow the object dimensions and quantities to be extracted from the DWFx™ and presented elementally. (This is different to UniFormat Assembly Coding covered in 4 below). Formula-based parameters can also be added to provide additional measurement data such as window areas or downpipe lengths.

14.1 Creating a New Shared Parameter

In the Manage ribbon menu click on Shared Parameters.

In the Edit Shared Parameters box, create a folder (in this case called *ASTM UniFormat*) to hold the parameter file in a suitable location. In the Groups section of the Edit Shared Parameters window click New to create a new parameter group. Enter a name for your group (in this example, *ASTM UniFormat*) then click OK.

Still in the Edit Shared Parameters window click New under the Parameters section. This will create a new shared parameter within the previously created parameters group. Enter a name (in this example *UniFormat level 1*), leave the discipline as Common and use the drop-down menu to select a type of parameter (in this example Text). Click OK.



The new Shared Parameter(s) will be listed in the Edit Shared Parameters window. Click OK to complete the configuration.

14.2 Adding the Shared Parameter to the Project

The new Shared Parameter needs to be added to the project, so from the Manage ribbon click on the Project Parameters button.

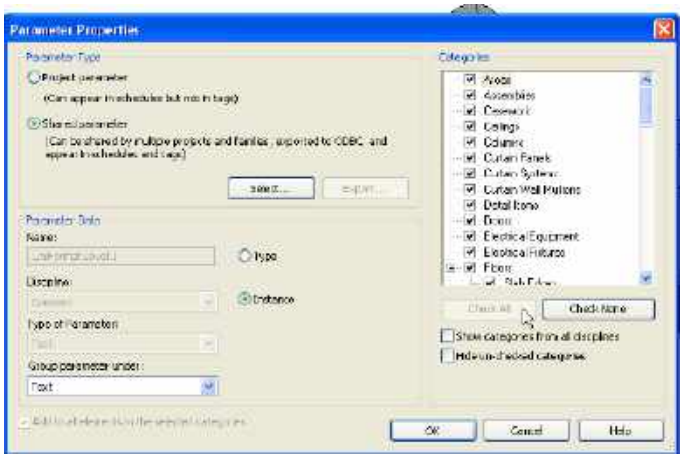
In the Project Parameters window click Add.

In the Parameter Type section of the Parameter Properties window select the Shared parameter option then click Select.

The Shared Parameters window will open. Use the drop-down menu to select the Parameter group (in this example *ASTM UniFormat*) then select the Parameter (*UniFormat Level 1*) and click OK.

Ensure that the Instance option button is selected, then In the Categories section, use the checkbox to select those categories that the parameter applies to (In this example the parameter will be applied to all objects so click the Check All button). Click OK.

Select any other parameters and then click OK in the Parameter Properties box. Then click OK in the Project Parameters window to create the new parameters in the project.



The new Shared Parameters are now available to be applied to the objects within the model.

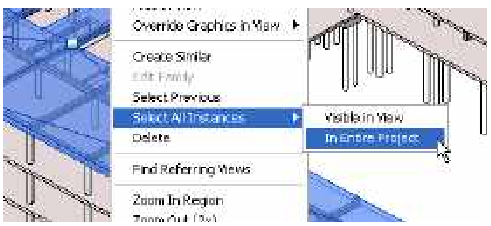
14.3 Applying Shared Parameters to Objects in the Model

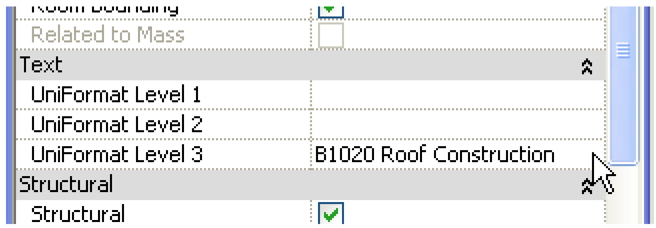
Option 1 – Edit the instance properties

Select an object in the model to display its Instance Properties in the task pane. (In this example the *UniFormat Levels 1, 2 and 3* shared parameters will be listed under the Text heading.)

If there are more than one instance of the same object in the model click the right mouse button and use the Select All Instances option to update them all in one operation.

Click into the field beside the shared parameter (in this example UniFormat Level 3). Type in a suitable entry for the selected object(s) and click Apply.

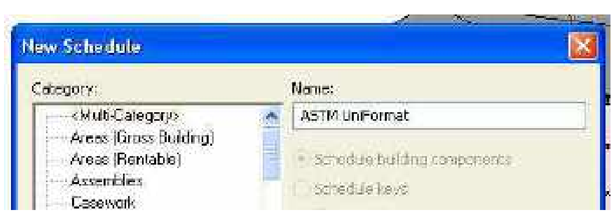




Repeat this process for all objects in the model for which the additional shared parameter information is to be applied.

Option 2 – Enter the parameters in a schedule

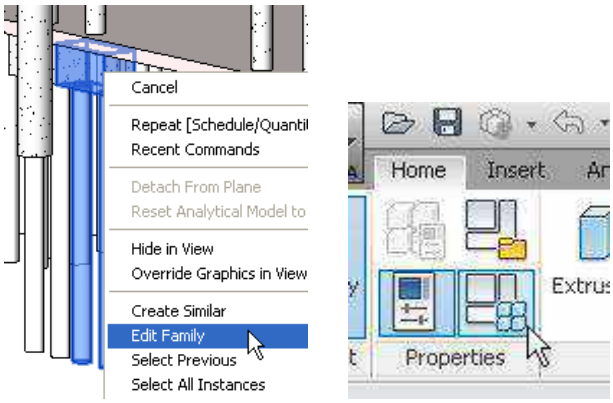
In the View ribbon, create a new Schedule, assign the required properties and enter the relevant details against the objects.



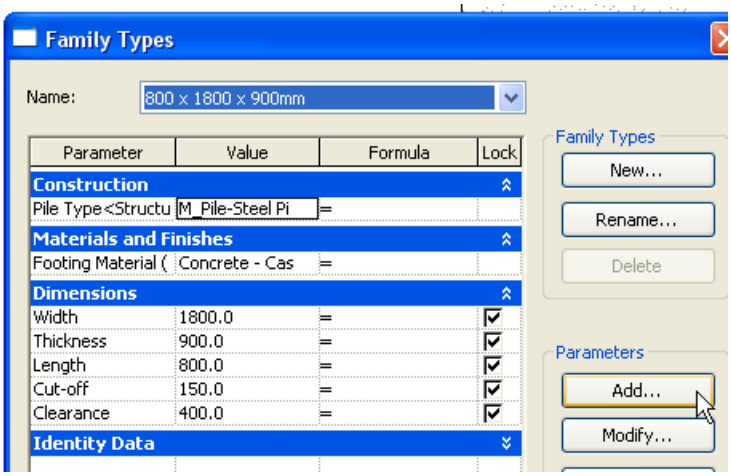
ASTM UniFormat					
Family	Type	Level	UniFormat Level 1	UniFormat Level 2	UniFormat Level 3
M_Concrete-Round-Column	450mm	01 - Entry Level			
M_Concrete-Round-Column	450mm	01 - Entry Level			
UC-Universal Column-Column	356x368x129UC	01 - Entry Level	B SHELL	B10 Super Structure	B1020 Roof Construction
UC-Universal Column-Column	356x368x129UC	01 - Entry Level	B SHELL	B10 Super Structure	B1020 Roof Construction
UC-Universal Column-Column	356x368x129UC	01 - Entry Level	B SHELL	B10 Super Structure	B1020 Roof Construction
UC-Universal Column-Column	356x368x129UC	01 - Entry Level	B SHELL	B10 Super Structure	B1020 Roof Construction
UC-Universal Column-Column	356x368x129UC	01 - Entry Level	B SHELL	B10 Super Structure	B1020 Roof Construction
UC-Universal Column-Column	356x368x129UC	01 - Entry Level	B SHELL	B10 Super Structure	B1020 Roof Construction
UC-Universal Column-Column	356x368x129UC	01 - Entry Level	B SHELL	B10 Super Structure	B1020 Roof Construction
M_Concrete-Rectangular Beam	400 x 800mm				

Option 3 – Edit the Family Type to set default Instance Parameters

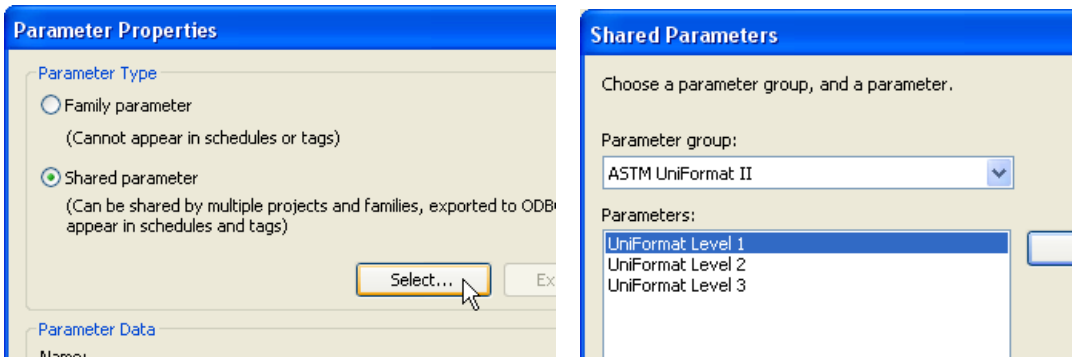
Select an object, right click and select Edit Family. The Edit view for the Family will open. Click the Family Types button in the Properties section of the ribbon.



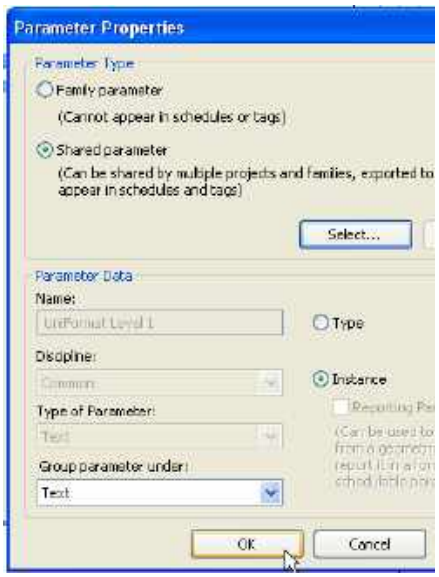
The Family Types edit box will open. Click the Add button in the Parameters section.



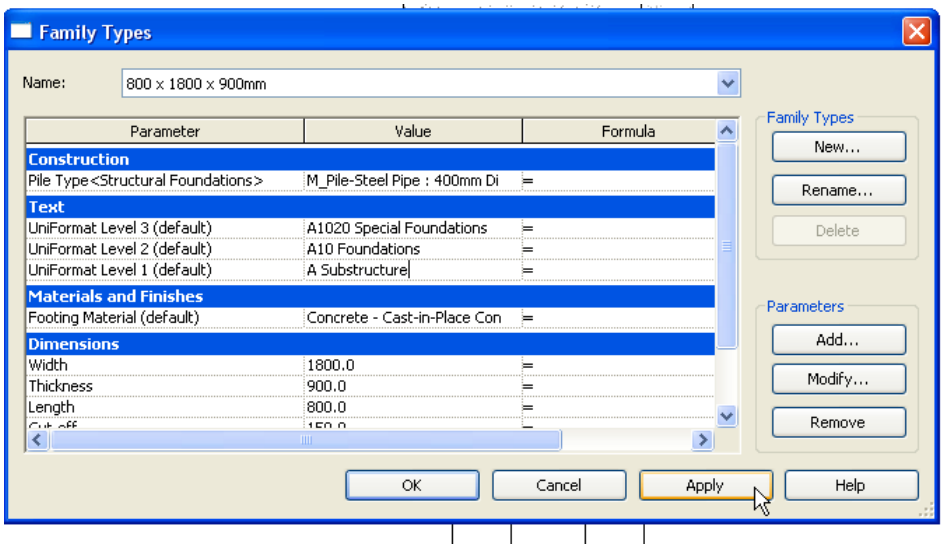
In the Parameter Properties box, check Shared Parameter and click the Select button, then select the required Parameter and click OK.



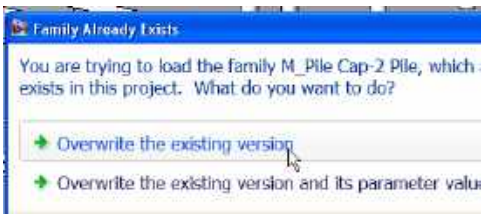
You will return to the Parameter Properties box and the parameter data will be shown. Make sure the Instance option is selected. Click OK.



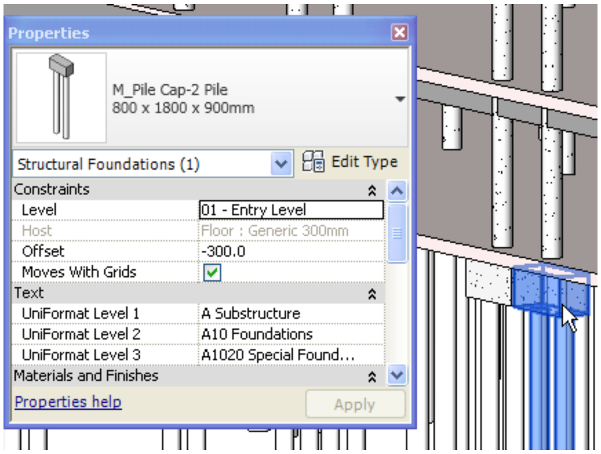
In the Family Types box, enter the values and click Apply and OK.



Now click the Load into Project button in the Family Editor section of the ribbon, and then click Overwrite the Existing Version.



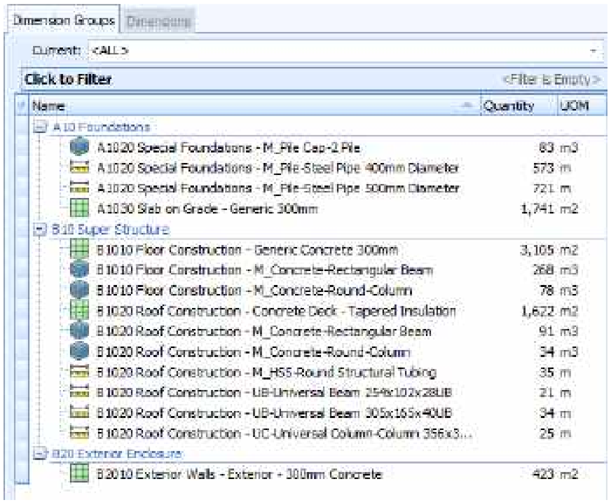
The data has now been added to every instance of the Family Type.



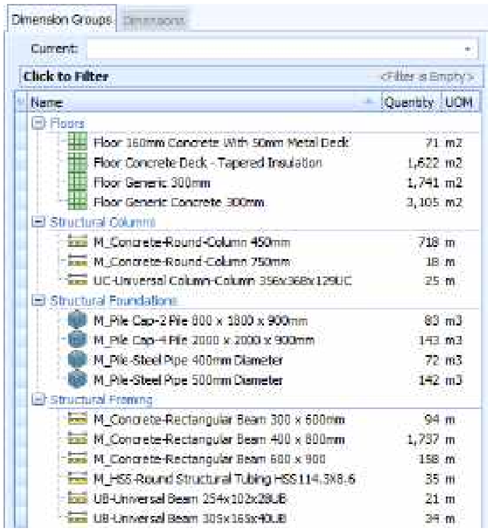
Individual instances which require to have different parameter values can now be edited either by selecting the object and editing its instance properties, or in the schedule.

M_HSS-Round Structural Tubing	HSS114.3X8.6				
M_HSS-Round Structural Tubing	HSS114.3X8.6				
M_HSS-Round Structural Tubing	HSS114.3X8.6				
M_Pile Cap-2 Pile	800 x 1800 x 900m	01 - Entry Level	A Substructure	A10 Foundations	A1020 Special Foundations
M_Pile-Steel Pipe	400mm Diameter	01 - Entry Level			
M_Pile-Steel Pipe	400mm Diameter	01 - Entry Level			
M_Pile Cap-2 Pile	800 x 1800 x 900m	01 - Entry Level	A Substructure	A10 Foundations	A1020 Special Foundations
M_Pile-Steel Pipe	400mm Diameter	01 - Entry Level			
M_Pile-Steel Pipe	400mm Diameter	01 - Entry Level			
M_Pile Cap-2 Pile	800 x 1800 x 900m	01 - Entry Level	A Substructure	A10 Foundations	A1020 Special Foundations
M_Pile-Steel Pipe	400mm Diameter	01 - Entry Level			
M_Pile-Steel Pipe	400mm Diameter	01 - Entry Level			
M_Pile Cap-2 Pile	800 x 1800 x 900m	01 - Entry Level	A Substructure	A10 Foundations	A1020 Special Foundations
M_Pile-Steel Pipe	400mm Diameter	01 - Entry Level			
M_Pile-Steel Pipe	400mm Diameter	01 - Entry Level			
M_Pile Cap-2 Pile	800 x 1800 x 900m	01 - Entry Level	A Substructure	A10 Foundations	A1020 Special Foundations
M_Pile-Steel Pipe	400mm Diameter	01 - Entry Level			

The dimensions may now be extracted and sorted by UniFormat codes.



Quantities in iTWO costX® by UniFormat code

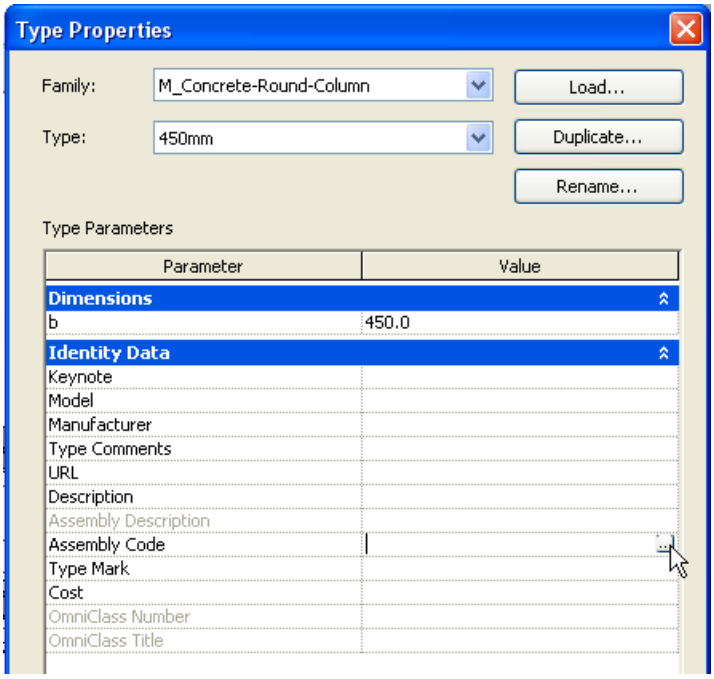


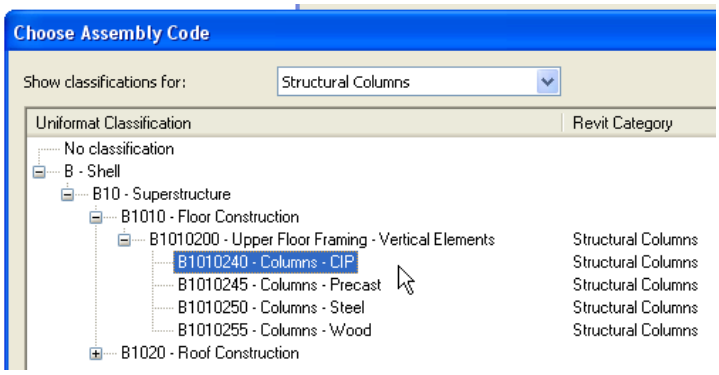
14.4 UniFormat Assembly Codes

All model elements in Revit® include fields for Assembly Code and Assembly Code Description properties. You can populate these fields from a hierarchical list of UniFormat codes drawn from a data file held in the Revit® 2012 Program directory (uniformat.txt).

- Select an object in the model and click on the Edit Type button.

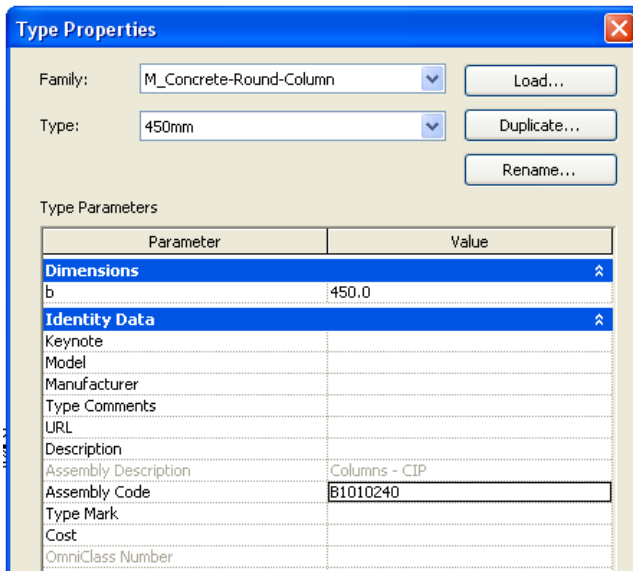
- In the Type Properties box, click the Assembly Code value box, then click on the menu button to open the UniFormat Classification hierarchy. Select a code and click OK.





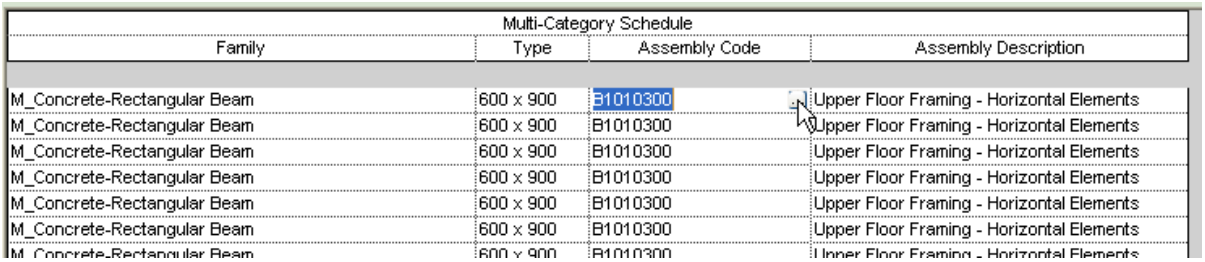
- Alternate classifications are available in the drop-down at the top of the dialog.

- The Assembly Code and its associated Assembly Description will be added into the Type Properties.

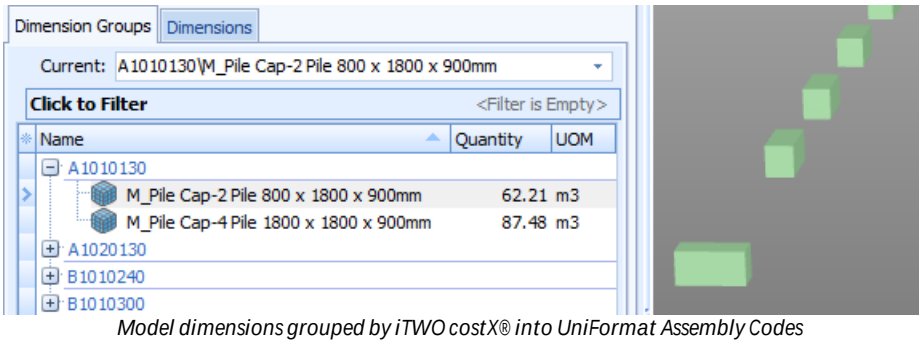


- Click Apply to update the Type properties of all applicable objects then OK to exit the dialog.

- Create a Schedule to check that all objects have been assigned a code. Codes can also be assigned within the Schedule.



- A DWFx™ file exported from the model will include the Assembly Code (but not the Assembly Description) which can be used in iTWO costX® to group the dimensions.



Model dimensions grouped by iTWO costX® into UniFormat Assembly Codes