

# MODELING FOR IFC WITH AUTOCAD ARCHITECTURE

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## I. OBJECTIVE

The objective of this document is to provide general guidelines on the considerations CAD managers and power users/designers using AutoCAD Architecture need to take when producing high quality models that will be shared via the IFC format.

## II. SETTING UP AUTOCAD ARCHITECTURE PROJECT

Beginning with AutoCAD Architecture 2009, IFC export and import were integrated into the AutoCAD Architecture Project Management feature. Therefore it is recommended that you use the Project Management facility to organize your building project.

### A. IFC CONCEPT OF A BUILDING MODEL

#### 1. Project

IFC defines Project to be general. It refers to an activity that will lead to creating products and is not limited to a building project. IfcProject defines the top level container that is exchanged or shared within the AEC/FM project. It also defines the context of all representations within the project that includes default global units used within the model.

#### 2. Site

The Site, represented by IfcSite, is used to provide additional information about the building site and may include the representation of the terrain model for the building site. Beside its Name, Description and Long Name, it may contain the following information:

- i. Geographic reference location in Latitude, Longitude and Elevation format
- ii. Land Title Number
- iii. Site Address

IFC schema allows multiple sites to exist within the Project, but currently it is limited to a single Site by the implementers' agreement.

#### 3. Building

The Building, represented by IfcBuilding, is the main placeholder where the Building Information Model (BIM) data is contained. It may be associated with IfcSite (if it exists) or directly to the IfcProject. Besides its Name, Description and Long Name, IfcBuilding may also contain the following information:

- i. Elevation of reference height, which defines the global context of the elevation above the sea level
- ii. Elevation of Terrain
- iii. Building Address

IFC schema allows the definition of multiple buildings, which can be a cluster of independent or interconnected buildings. It can also be a combination of sections of a complex building that may be composed of towers connected by a podium, for example. As there is limited support for this type of

design within the existing BIM application, the current implementers' agreement is to limit support for only a single building within a project.

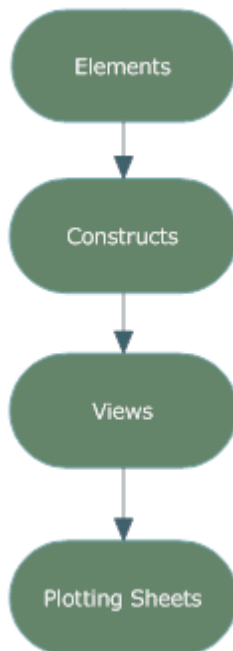
#### 4. Building Story

Building Story, represented by `IfcBuildingStorey`, represents a building story which is a vertical structure normally used within building and construction. It is always part of a Building or Building section. `IfcBuildingStorey` usually does not have its own shape representation, and acts more as a container of all objects within the building story, including Spaces that is the lowest level of container defined in IFC.

## B. AUTOCAD ARCHITECTURE CONCEPT OF A PROJECT

This section only contains a highlight of the concepts within the Drawing Management feature that are relevant to IFC. Please refer to the AutoCAD Architecture User's Guide for the complete descriptions.

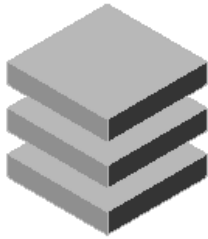
The Drawing Management feature in AutoCAD Architecture introduces the concept of Project, Constructs, Views and Sheets.



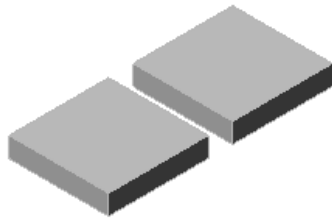
#### 1. Concept of Project

AutoCAD Architecture defines the highest level of drawing management as a project that consists of two parts: the building model and the reports generated from the model. The building model is composed of Constructs and Elements. For IFC export, only the building model is relevant.

Within the project, it also defines Levels and Divisions. Levels and Divisions form a matrix that forms the whole building model.



levels

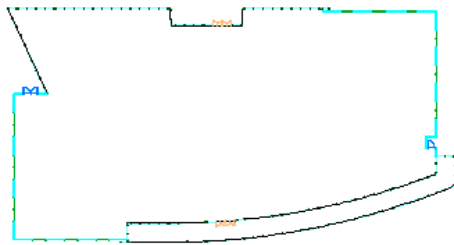


divisions

## 2. Concept of Construct

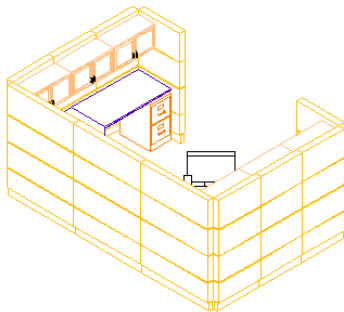
A construct describes one unique portion of a building project and is assigned to a specific level and division within the project. It may represent the building story but usually a construct forms only part of a building story. For example, the first level of your building project may consist of an exterior shell construct, a first-level core construct and a first level interior partition construct.

Constructs are referenced into views.



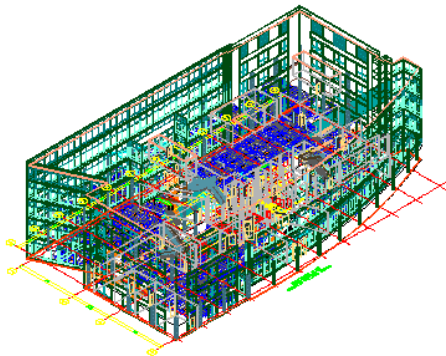
## 3. Elements

Elements are used for pieces of the building that are repeated multiple times. For example, you could use an element to create a repeating design object like a desk/chair combination for multiple cubicles in an office building.



#### 4. Views

A view is a drawing that references a number of constructs to present a specific view of the building project. In an IFC typical scenario, a view of the complete 3D model will be required.



#### 5. Project Standards

Project Standards are a mechanism for you to establish, maintain, and synchronize styles and display settings across an AutoCAD Architecture project. It is important for you to define and create consistent standards that ease the maintenance of the drawings, especially if exchanges are required using IFC.

### C. ROLE OF AUTOCAD ARCHITECTURE PROJECT IN IFC EXPORT AND IMPORT

#### 1. Export

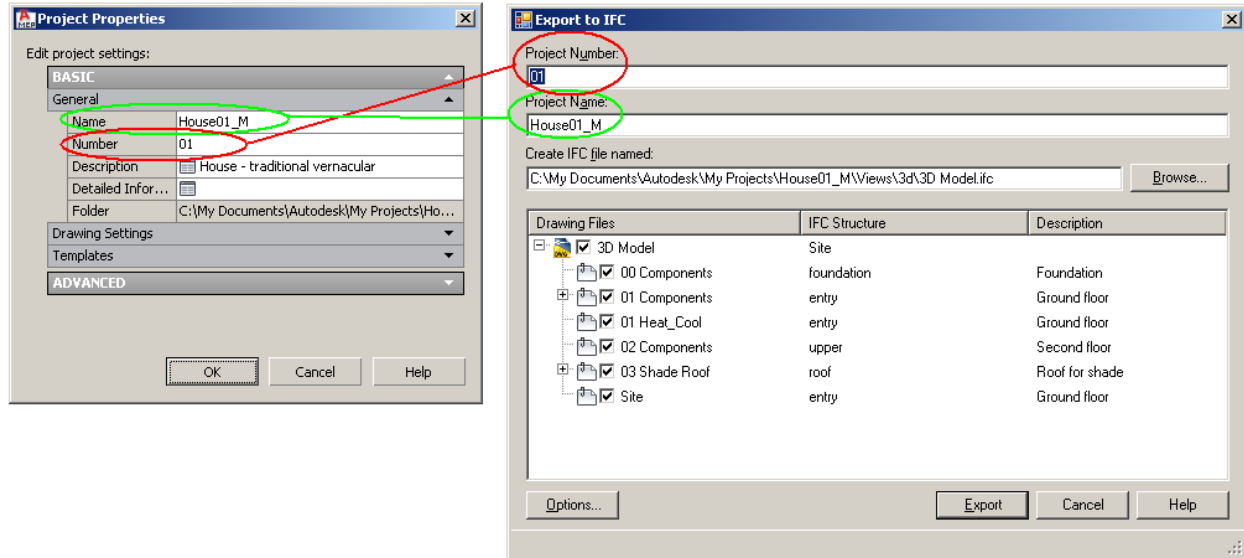
This section describes how IFC export uses information within the AutoCAD Architecture project to create IFC-based building models. While it is possible for you to export directly from any DWG drawing without project, we recommend the use of project to help users be more consistent and productive.

Before you can export the desired building model, you need to make sure two things are in place:

- a. Define the complete 3D Model View and open it.
- b. Ensure that you are in the right Display Configuration. IFC will export according to the Model Display Representation of the current Display Configuration. AutoCAD Architecture writes the information of display configuration and the model display representation is used to export into propertyset PSET\_ACA\_DISPLAY\_SET attached to the project.

For exporting purposes, AutoCAD Architecture has to map its concept of project to the IFC concept of project. Below you will find descriptions on how the mapping will be done:

- a. AutoCAD Architecture Project  
An AutoCAD Architecture project will be mapped directly to IfcProject. Information from the project, such as "Project Name" and "Project Number", will be extracted and exported into IFC.



#### b. Building

The current IFC implementation is restricted to a single building within the project and as AutoCAD Architecture project represents a building project, IfcBuilding will be created automatically using the same information from the project. The export dialog does not show any additional information for Building.

#### c. Site

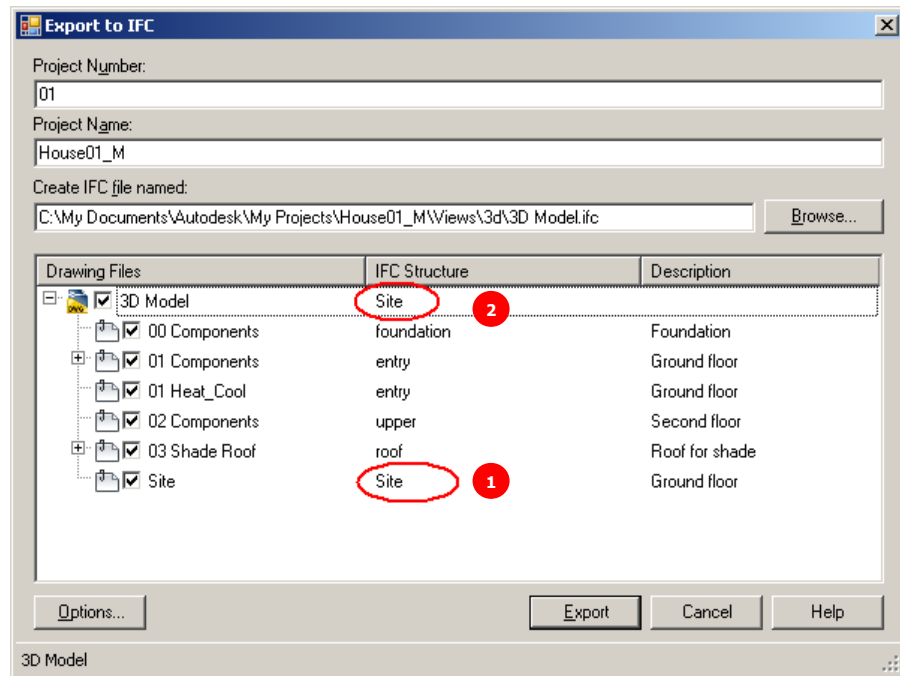
AutoCAD Architecture does not define Site as a specific concept and within a project, you may need to create a drawing that contains Site or terrain representation. There are two important steps you need to know to let Ifcexport understand the concept of Site and assign it appropriately to IfcSite.

##### i. Site drawing

Any Xref drawing in the project can be assigned to Site using an assignment to IFC Structure in the export dialog. You can assign as many drawings as needed to the Site. All 3D objects within the drawings will be exported to IFC and assigned (contained) within IfcSite. For example, it is useful to assign landscape components such as garden bench, lamp post, fence, trees, etc to IfcSite. 1

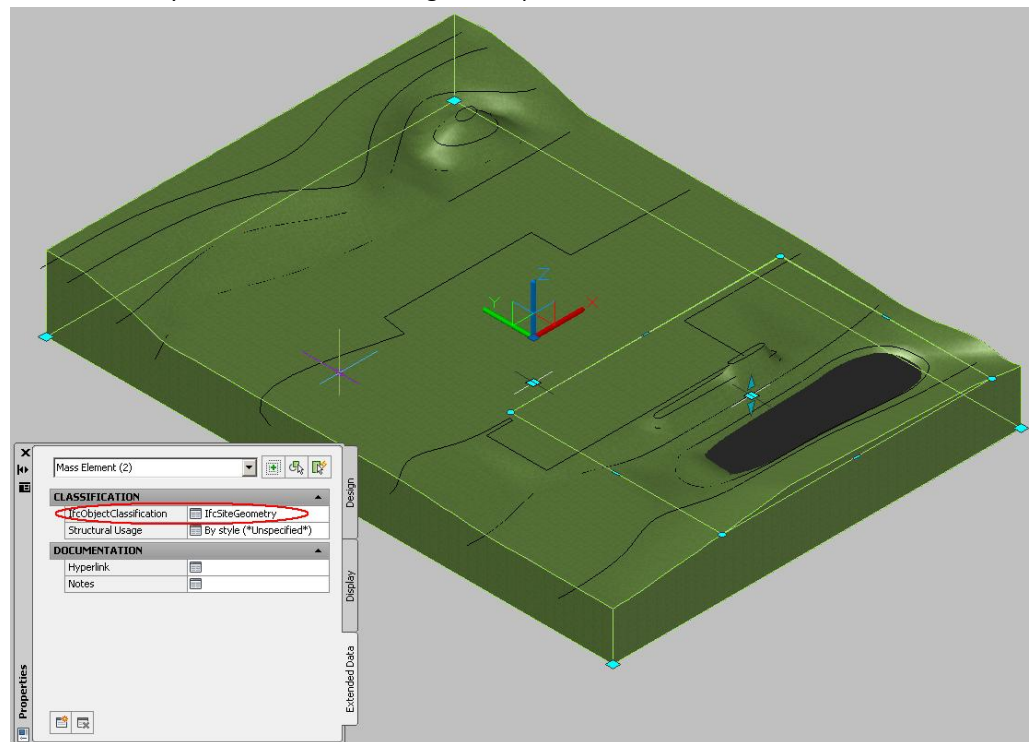
In addition, if the main view contains objects, they will be exported and assigned (contained) within IfcSite. 2





ii. Site geometry

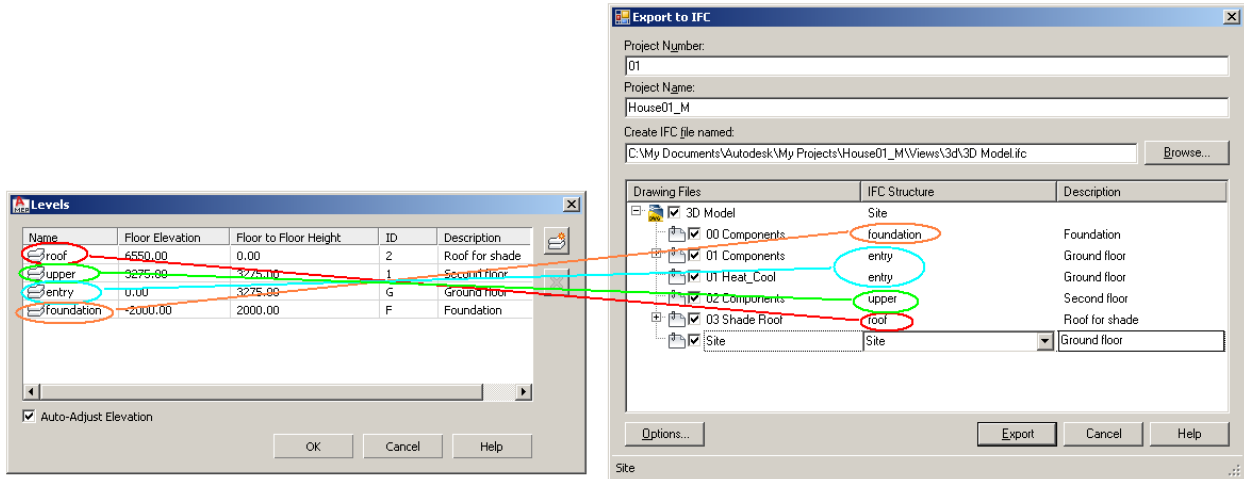
IFC allows geometry representation to be attached to `IfcSite`. If you want to do this, first you have to classify the object(s) that represents the site geometry to `IfcSiteGeometry` (you must copy IFC classification definition from the supplied template). You also need to make sure that the drawing is assigned to Site. Only object(s) classified as `IfcSiteGeometry` within the Site drawing will be processed.



d. Building Story

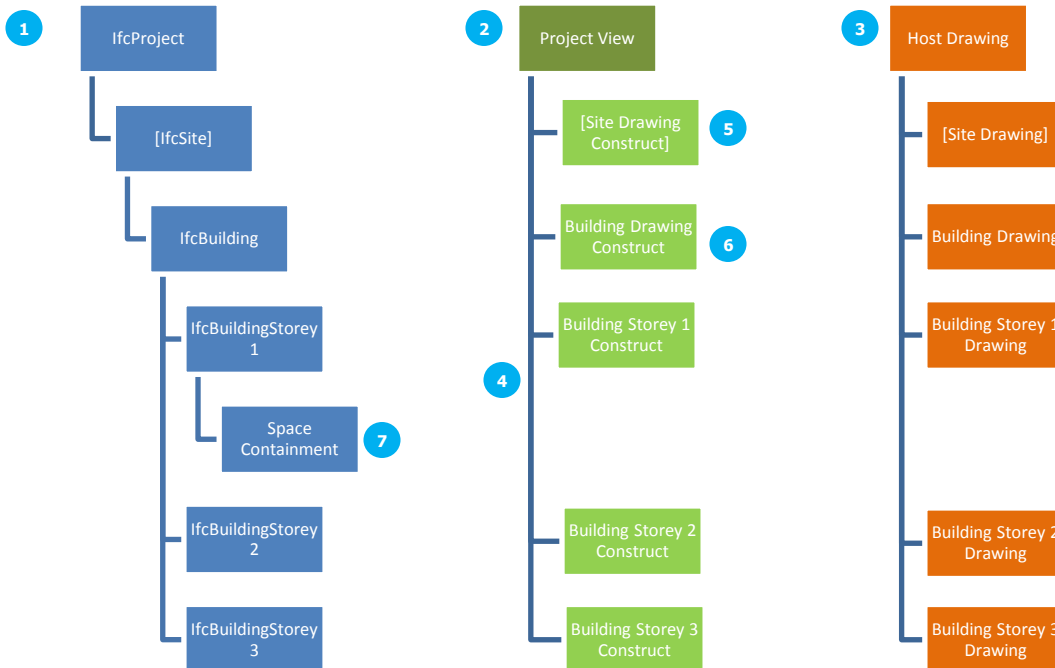
Ifc export will extract the level of information of the Xref structure from the project and automatically assign it together with all child Xrefs in the same Building Story. You are able to override all the assignments manually by changing the IFC Structure assignment.

Note that the Xref structure on the export dialog is hierarchical according to the actual Xref references in the drawing. This means that certain drawings like Element drawings that are referenced more than once will also appear repeatedly and will be exported as distinct elements in the IFC model.



2. Import

When importing an IFC file, you are able to import into a project or just to a set of DWG drawings. The import will create a simple structure like the following:



If you have selected to import into a project, IfcProject will be mapped to the AutoCAD Architecture project **2** and the main or host drawing will be created as a view. The project that you create will have information on Project Name, Project Number and Levels. All Constructs will be assigned to appropriate Levels. The imported AutoCAD Architecture view external reference structure is flat **4** with only one host drawing or view that references all other drawings. IfcSite, IfcBuilding and IfcBuildingStorey containers are each mapped to separate drawings. All objects within their containments are imported into the drawing, but there is no Xref relationship between all of the drawings. This differs slightly from the containment relationship in IFC.

Importing IFC into just a DWG drawing **3** will create the same Xref structure as an AutoCAD Architecture project, except there is no additional information or project created and all the drawings will reside in the same folder.

A Site drawing may not be created if the IFC file does not have IfcSite. **5** Building Drawing Construct is created to hold any objects that may be contained in IfcBuilding **6** in an IFC file. These objects are typically assigned to Site in our export. Space containment will be **7** ignored during import and all objects contained within the space containment will be promoted into the Building Story that contains the space.

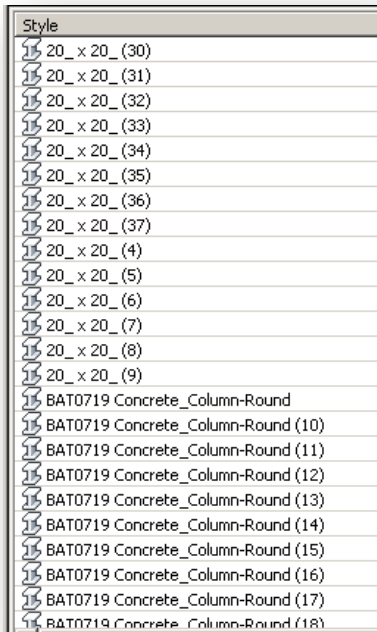
### III. AUTOCAD ARCHITECTURE STYLES

AutoCAD Architecture Styles are well mapped to IFC Type Objects. AutoCAD Architecture makes full use of IFC type objects to export Style information. It benefits from the importing application for its consistency (no redundant information as type object is shared just like style is shared). However, currently not all applications export Type objects or they only do partial support.

Without IFC type objects, there is no clear definition on whether a style of one object is actually the same as another one. AutoCAD Architecture will try to determine as much as possible whether one style of the object is similar to another one. If this is the case, both will share the same style, otherwise a separate style will be created.

### IV. AUTOCAD ARCHITECTURE PROJECT STANDARDS

Project Standards are designed to create consistent styles and display setting and enforce them on all drawings within a project. One of the challenges when processing an IFC file is that it is not always certain about the level of consistency within the file. This situation may result in many different styles created during import for styles that are expected to be the same. IFC import will re-use existing style in the template when it finds style of the same name and content in the IFC file. When inconsistent style is found in the IFC file (i.e. the same name but different content) it creates an incremental style name.



AutoCAD Architecture provides an option to enforce reuse of styles using a template for import. This option is recommended when you are satisfied with the following 3 conditions:

1. You have established a standard and you are reasonably sure that the IFC file complies with the established standard. This could be national standard or even a project standard.
2. You want to enforce consistency of the styles and reduce the need for manual maintenance to correct duplicate styles.
3. The IFC file may not have complete information that AutoCAD Architecture has. For example, layer assignment; an IFC file from Revit may have information on layer assignment for objects, but it does not have the same layer concept as in AutoCAD Architecture where you can control color and other appearances. In this case, you may want to use your template where all the desired settings are already defined and let import match the layer name in the IFC file with layer inside the template.

When the “Use the first style encountered with the same name” import option is selected, import will only match the style name and layer name and re-use what has been defined inside the template. Only when it encounters a style or layer name that is not defined in the template will it create a new one.

## V. MODELING ARCHITECTURAL OBJECTS

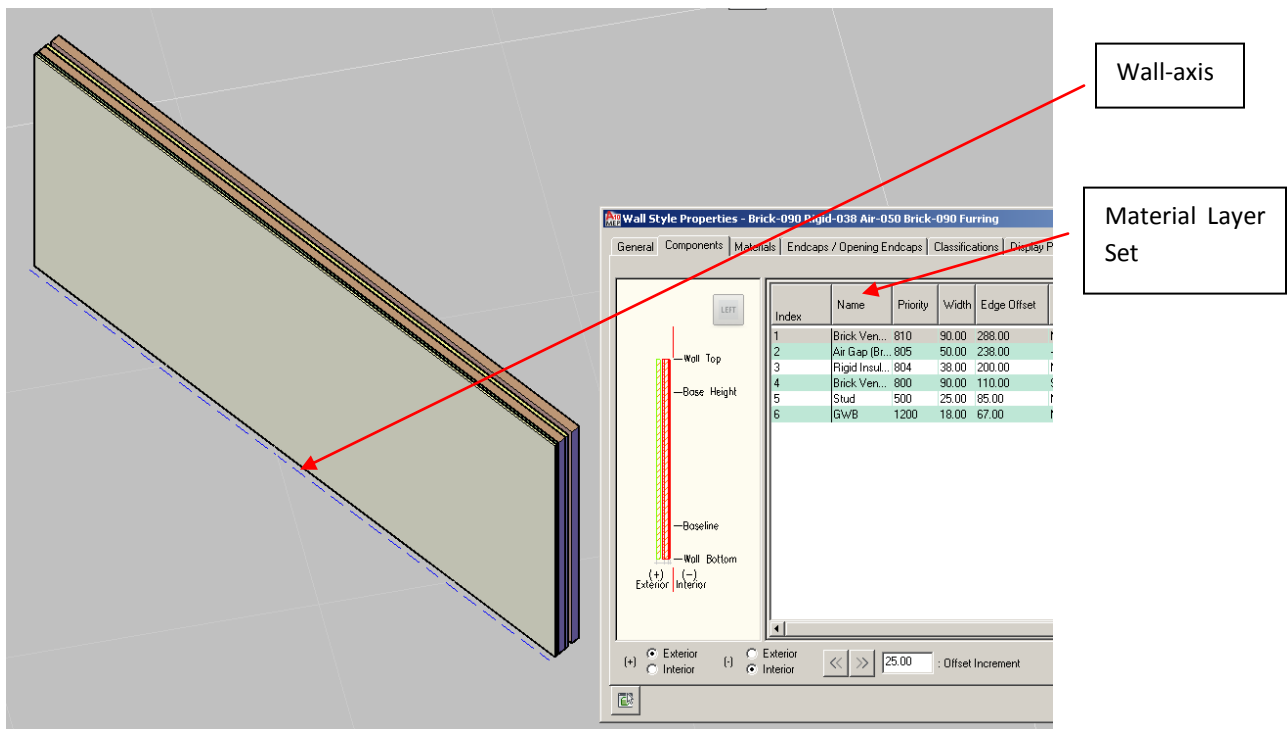
### A. MODELING WALL

Wall is probably the most used object. It is also one of the best defined object specifications in the IFC file. There are several things that you need to know about their impact on the resulting IFC model. These are mainly due to differences on how the objects are being modeled in AutoCAD Architecture and IFC. Sections below describe what will produce a good model in IFC and what to avoid.

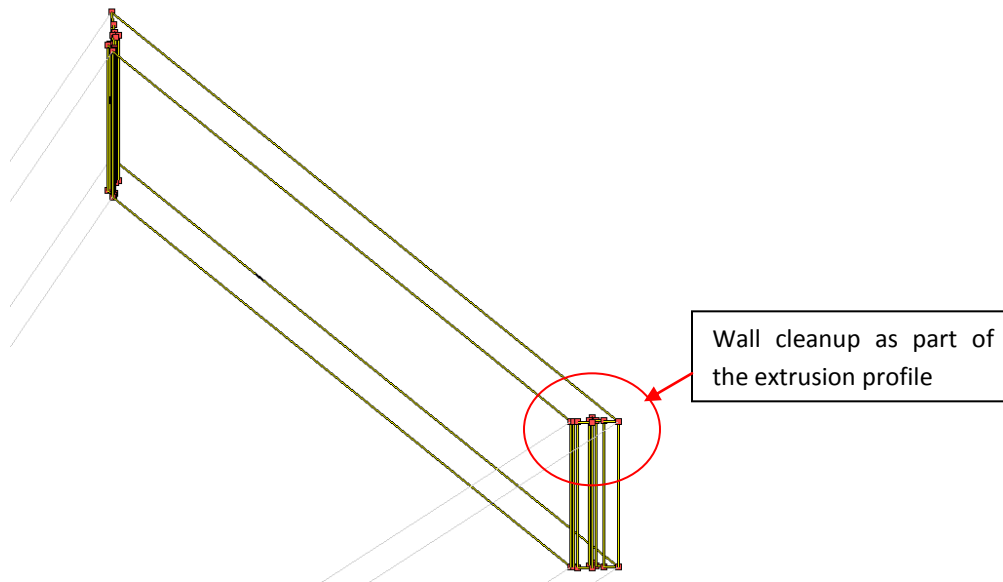
#### WALLS IN IFC

IFC models walls either as `IfcWall` or its more specific type `IfcWallStandardCase`. In general IFC expects explicit geometric representation to be present. This is true for both `IfcWall` and `IfcWallStandardCase`. `IfcWallStandardCase` is more desirable as a wall representation since it allows more parametric description of the wall that allows more intelligent data to be exchanged. In the importing application, `IfcWallStandardCase` usually allows reconstruction of the wall object natively similar to the wall data in the originating application. The parametric information required by `IfcWallStandardCase` includes Wall Axis (baseline in AutoCAD Architecture), wall components and their thickness, offset, material information.

The geometric representation of `IfcWall` and `IfcWallStandardCase` usually is in the form of the net shape of the wall that includes wall cleanup information as part of its geometry.

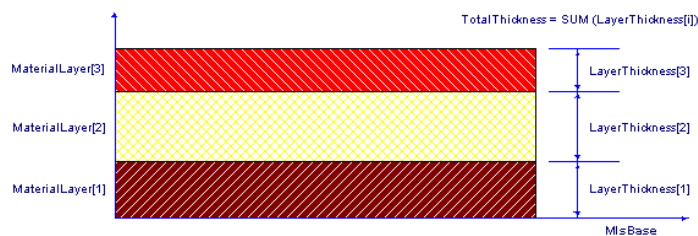


The explicit geometry of the same wall, if it has cleanup with other walls, may look like:



## WALL COMPONENTS

IFC2x3 defines wall layers (wall components in AutoCAD Architecture) only in terms of uniform and non-overlap layers. AutoCAD Architecture on the other hand, allows horizontal and vertical offset that makes components non-uniform and even overlap.

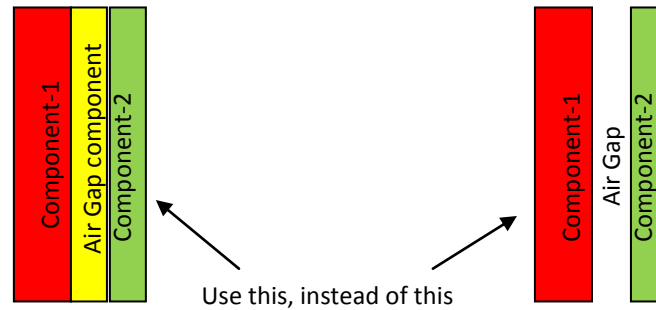


Wall layer (component) information is captured in IFC with `ifcWallStandardCase`. Since it only supports uniform and non-overlap components, it is important for AutoCAD Architecture to minimize using wall style that is not uniform or having an overlap.

When there are walls with non-uniform or overlapped components, IFC export will generate the data as `ifcWall` with aggregation of `IfcBuildingElementParts`. This representation is less optimal as import application is usually unable to re-create the same style. It is, however, still able to have more intelligent representation with each component to have each own material information and in the form of extrusion geometry most of the time.

## AIR GAP

IFC also does not define Air Gap as just a gap between wall components but requires an explicit component to be defined as an Air Gap. Any gap in wall style will be exported as an explicit wall layer in IFC and assigned to an air gap. We recommend that instead of using a real gap between components, you use an explicit component named as Air-Gap.



## WALL CLEANUP

Exporting Wall data into IFC will create 2 types of information: first, parametric information as described by Wall axis (or baseline in AutoCAD Architecture), material layer set (set of wall components) and their offset to the axis; and second, information as explicit geometries of the wall body. The explicit geometries will use wall profile that includes cleanup edges. All known viewers only read the explicit data to build the wall geometry, whereas most importing CAD applications will use the parametric data to rebuild the object and its geometry.

Wall cleanup algorithm works very differently from one BIM application to another. There are a few things you may want to note on AutoCAD Architecture support of Wall cleanup:

1. On import, AutoCAD Architecture will use default wall cleanup behavior that may be different with the originating application
2. AutoCAD Architecture currently does not export wall connection geometry due to the complexity of wall components in the cleanup

## WALL MODIFIERS

IFC defines objects and their representation in an explicit manner. In general, it is difficult to map modifiers to an explicit IFC definition. For example, a body modifier subtract is often used as a free form opening and it gives the effects correctly if it is used in the strict sense of an opening. It can also be misused to perform arbitrary cuts to a body and therefore in IFC, it is not a valid opening. It is therefore recommended that the use of modifiers should be avoided as much as possible.

## PLAN MODIFIER

IFC does not have a matching representation for plan modifier in AutoCAD Architecture and therefore Walls with plan modifier will be exported as a BREP wall in IFC. This is less than optimal since BREP wall has very little use except for maintaining a shape geometrically correct. Therefore, the use of plan modifier should be avoided when modeling for IFC purpose.

## BODY MODIFIER

Modifying a wall body with mass elements as body modifier has the similar effect as the plan modifier, i.e. the wall will be exported in IFC as BREPwall. Therefore, it is also good to avoid using body modifier for altering the geometry of walls.

In the future, we may look into alternatives to improve support for walls with body modifier to avoid generating BREP wall in IFC.

## INTERFERENCE CONDITION

Walls with interference condition will be exported using advanced CSG (subtract) to preserve the original wall information; both parametric (with axis and material layer set) and explicit representation (with extrusion geometry). Currently IFC does not support a link (relationship) between the wall and the interference objects and therefore the interference relationship will be lost and the interference effect is captured explicitly as part of the wall geometry. As the result, the interference object geometry will be duplicated: one for the object itself independent of the wall and the other one as the CSG operand that subtracts the wall.

The ability to recreate the complete wall from CSG geometry depends on the importing application that encounters such data. At this time, it's most likely that the importing application will be creating similar to BREP wall. Therefore the use of interference conditions should be avoided or minimized.

## WALL ENDCAPS

From AutoCAD Architecture 2011, Wall endcaps will be exported as part of the Wall geometry. Similarly Opening endcaps will be exported as part of the Opening geometry. One thing you need to note is that IFC does not support endcap information the same way as AutoCAD Architecture and therefore endcap information will be embedded as part of geometry. This does not allow roundtrip information to be preserved as the original data. The following is the limitation that you will observe if you try to roundtrip the data:

1. Wall endcap:

Since AutoCAD Architecture re-creates Wall using parametric information of IfcWallStandardCase (i.e. Wall axis, Material Layer Set, Material Layer Set Usage), and endcap information is embedded in the IfcWallStandardCase geometry, you will lose the endcap information as you import such data. It will appear to be different with viewers as they take the explicit geometry for display.



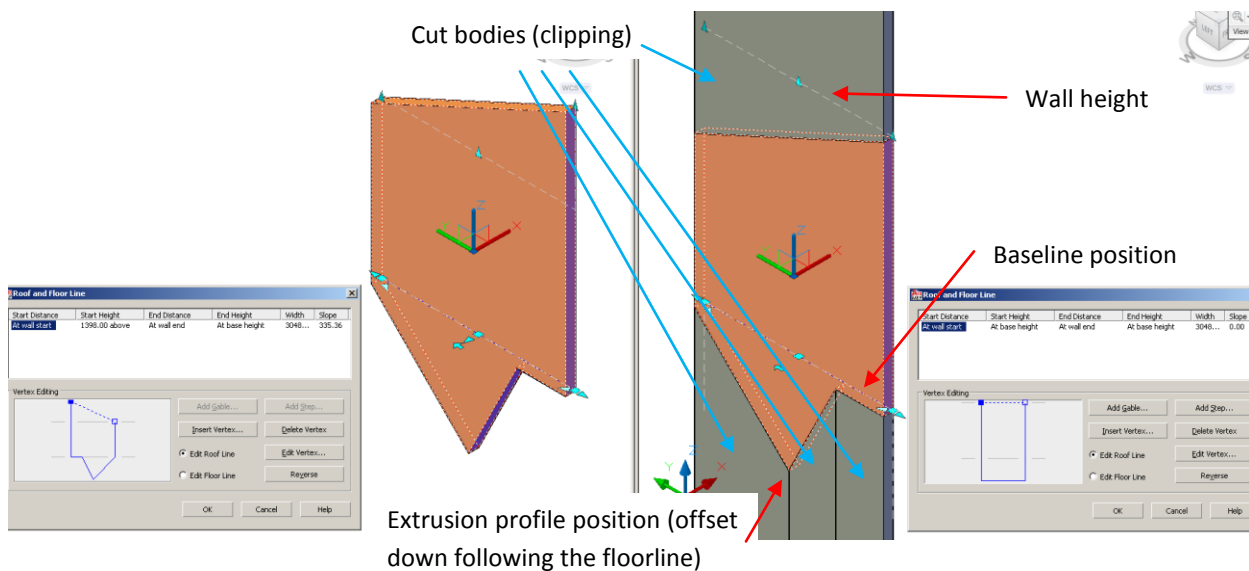
2. Opening endcap:

Opening endcap is exported as part of Opening geometry that does not follow horizontal extrusion. Since AutoCAD Architecture only supports horizontal extrusion as an opening, any non-horizontal extrusion from IFC will be imported as a “cut” to the Wall using body modifier subtraction. This preserves the shape of the Opening but it loses the association with the Wall and the “fill” (i.e. Door or Window). Door or Window in this case will become a standalone Door or Window placed in the correct location.

## ROOFLINE AND FLOORLINE

Roofline and Floorline in AutoCAD Architecture may extend or cut wall body as the final result, without changing the baseline and the base wall height. The same wall in IFC has to be represented in a slightly different way because of the limitation of current implementation agreement that restricts the use of only Extrusion and Clipping geometries for Wall.

When there is roofline and/or floorline, IFC export will determine the lowest point of the Wall (including floorline) and the highest point of the roofline (including roofline). The geometry extrusion of the wall will start at the lowest point (the geometry profile) and it will be extruded to the highest point of the Wall. The roofline and floorline will be achieved using clipping.

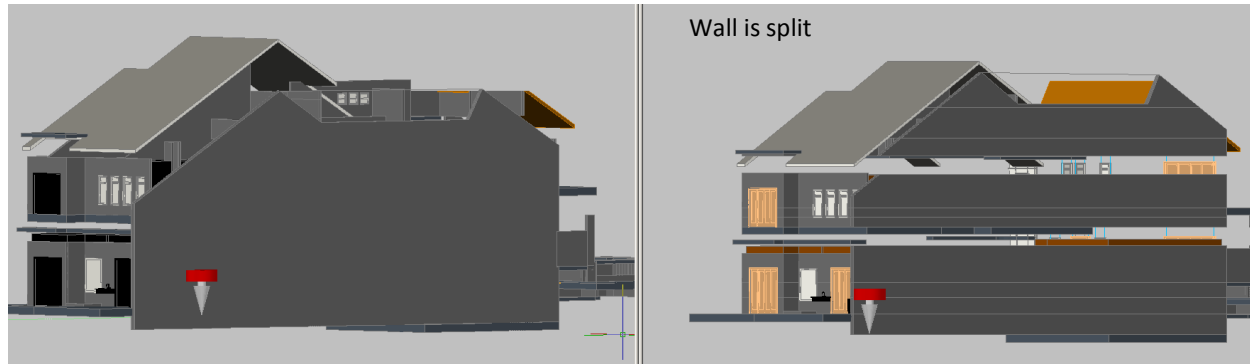


## ARC WALL

While in general, Arc wall is processed the same way as linear wall, the behavior of arc walls differ from the linear walls for walls with floorline or roofline. Due to the definition of roofline or floorline, which is one-dimensional, the cut effect of roofline or floorline to the arc wall does not follow the cut body geometry and therefore arc walls with roofline and floorline are exported with BREP geometry.

## WALL THAT SPANS MULTIPLE BUILDING STORIES

Many consumers of IFC files downstream rely on the knowledge of objects within the containership of a building story. The use of wall that spans more than one story usually causes a problem to these applications. There is no easy way to determine the relationship and to find a portion of the wall that is relevant within a particular building story. While it may be appealing to the designer to use such a wall, we recommend that this type of wall be avoided and that the wall should be broken into individual stories.



## B. MODELING DOOR

There is no special modeling recommendation for Door in AutoCAD Architecture for IFC. AutoCAD Architecture always generates both parametric data for the Door, i.e. panel and lining information, and the explicit geometry of the Door.

One potential inconsistency that may occur in AutoCAD Architecture is when you use custom block to override Door geometry. In this case, the Door parametric information will follow the original Door properties, but the geometry will be of the custom block. Make sure you update the parametric information of the Door according to the explicit geometry in the custom block to ensure consistency of data. The parametric data affected will be the overall height and width of the door, swing operation and direction, opening percentage, size of the panels, frame depth and width.

## C. MODELING WINDOW

Similar to the Door, there is no special modeling recommendation for Window in AutoCAD Architecture for IFC.. AutoCAD Architecture will generate both parametric information and the explicit geometry for Window. Other notes applicable to Door are applicable to Window, too.

## D. MODELING DOOR AND WINDOW ASSEMBLY

Door and Window Assembly does not have associated objects in current IFC. AutoCAD Architecture tries to match the object to either IfcDoor or IfcWindow depending on whether there is any door as part of the assembly. The assembly will be exported as IfcDoor if there is a Door in it, otherwise it will be IfcWindow. Since in both cases it is not a real single Door or Window, there will be limited parametric information available for this type of Door or Window.

## E. MODELING CURTAIN WALL

One of the challenges in data exchange is that it is difficult to agree on how to model a certain object. Curtain Wall is one of the examples that are without a clearly defined common way to model the object. Therefore, in the current IFC implementation Curtain Wall does not have the same level of specifications as the previous few objects. There are a few agreements that cover Curtain Wall:

1. In the most primitive mode, a Curtain Wall is created as single BREP geometry. There is no parametric information that will accompany it.
2. In slightly higher specifications, the Curtain Wall is created as an aggregate of its components, that are typically composed of (but not limited to):
  - a. Door
  - b. Window
  - c. Member
  - d. Plate
  - e. BuildingElementProxy
  - f. Nested Curtain Wall (1 level nest only)

AutoCAD Architecture exports Curtain Wall as an aggregate of one or many of Door, Window, BuildingElementProxy, nested Curtain Wall.

For best results, you should create individual Windows, Doors for the infill as they will be exported as Windows and Doors aggregated into the Curtain Wall. Other types of infill may be created as just a BuildingElementProxy.

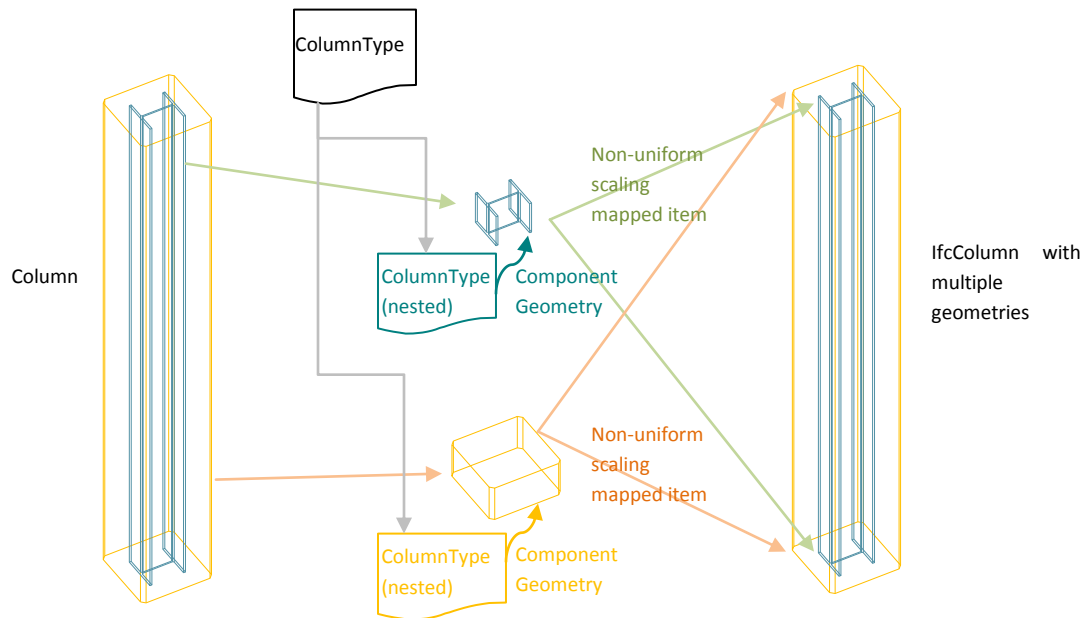
## F. MODELING STRUCTURAL MEMBERS

Beam, Column and Member are three distinct building elements in IFC that represent AutoCAD Architecture structural member objects. A structural member that is a type Column will be exported as IfcColumn, Beam will be exported as IfcBeam and Brace will be exported as IfcMember.

### STRUCTURAL MEMBER COMPONENTS

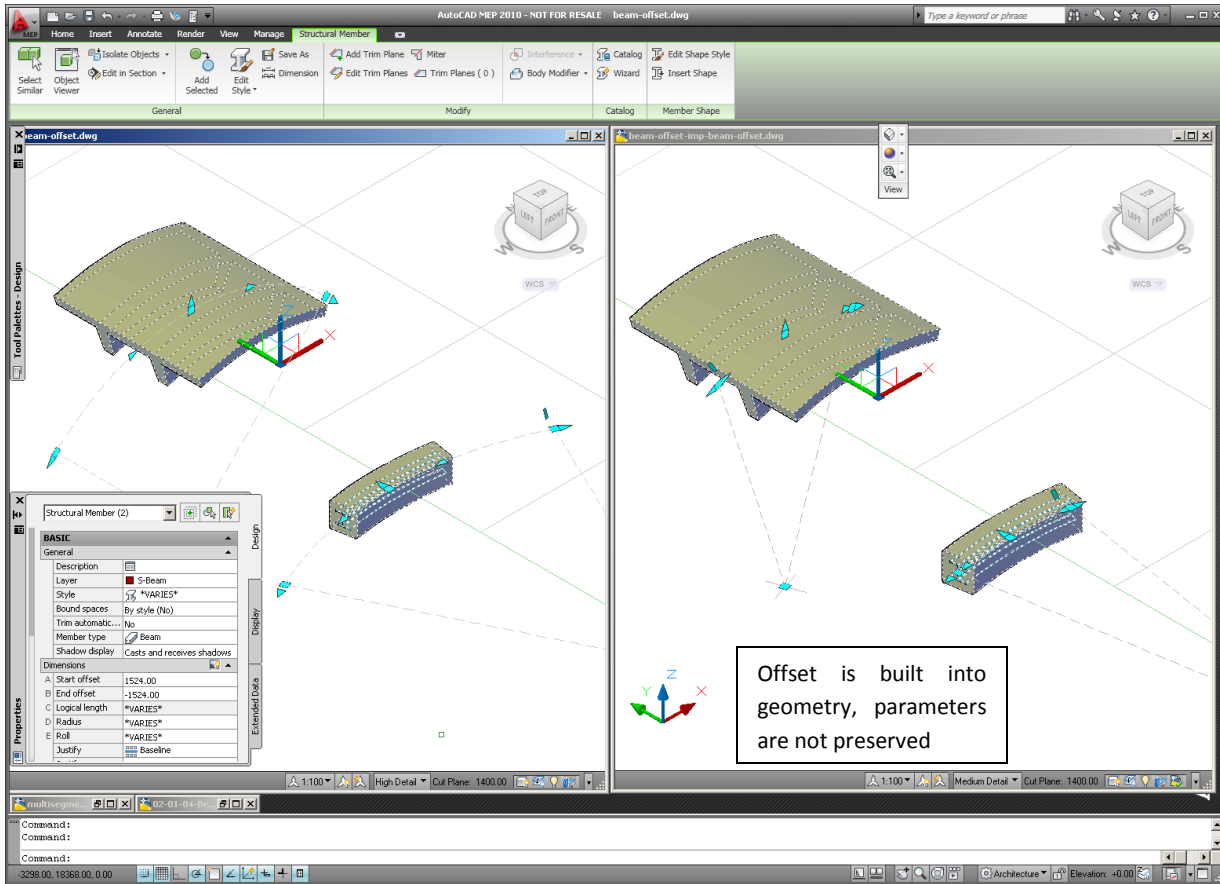
IFC currently supports only structural members with a single component. AutoCAD Architecture will export a multi-component structural member as a single component IFC object with multiple geometries linked to nested IFC

types. This allows other applications, some of which are yet to support an IFC type object, to read the geometry representation correctly.

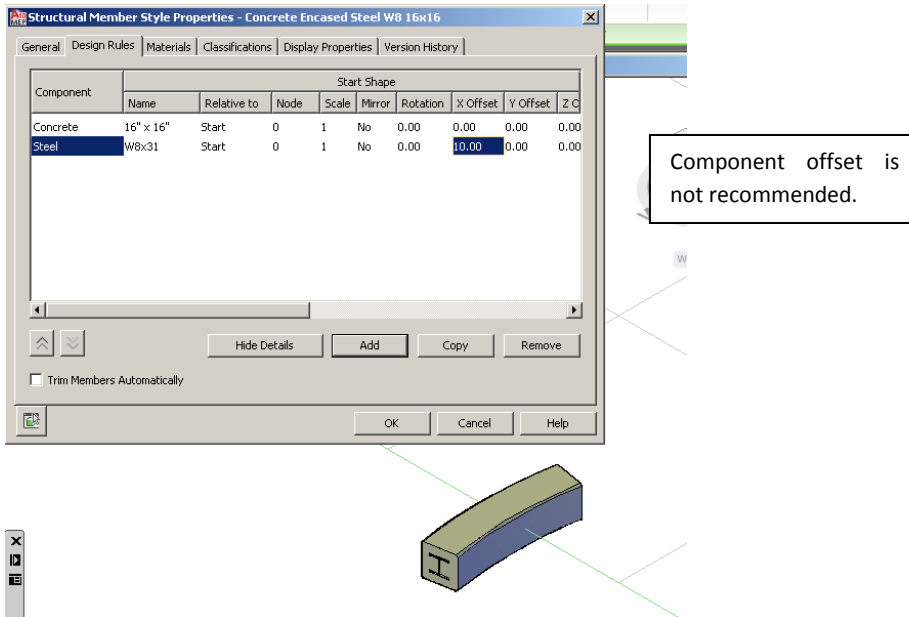


#### OFFSET, CURVE SEGMENT AND MULTI-SEGMENT

AutoCAD Architecture handles Start and End Offset of Structural member object. The offset will be built into the object geometry in IFC and information of offset as an additional parameter in AutoCAD Architecture will not be preserved.

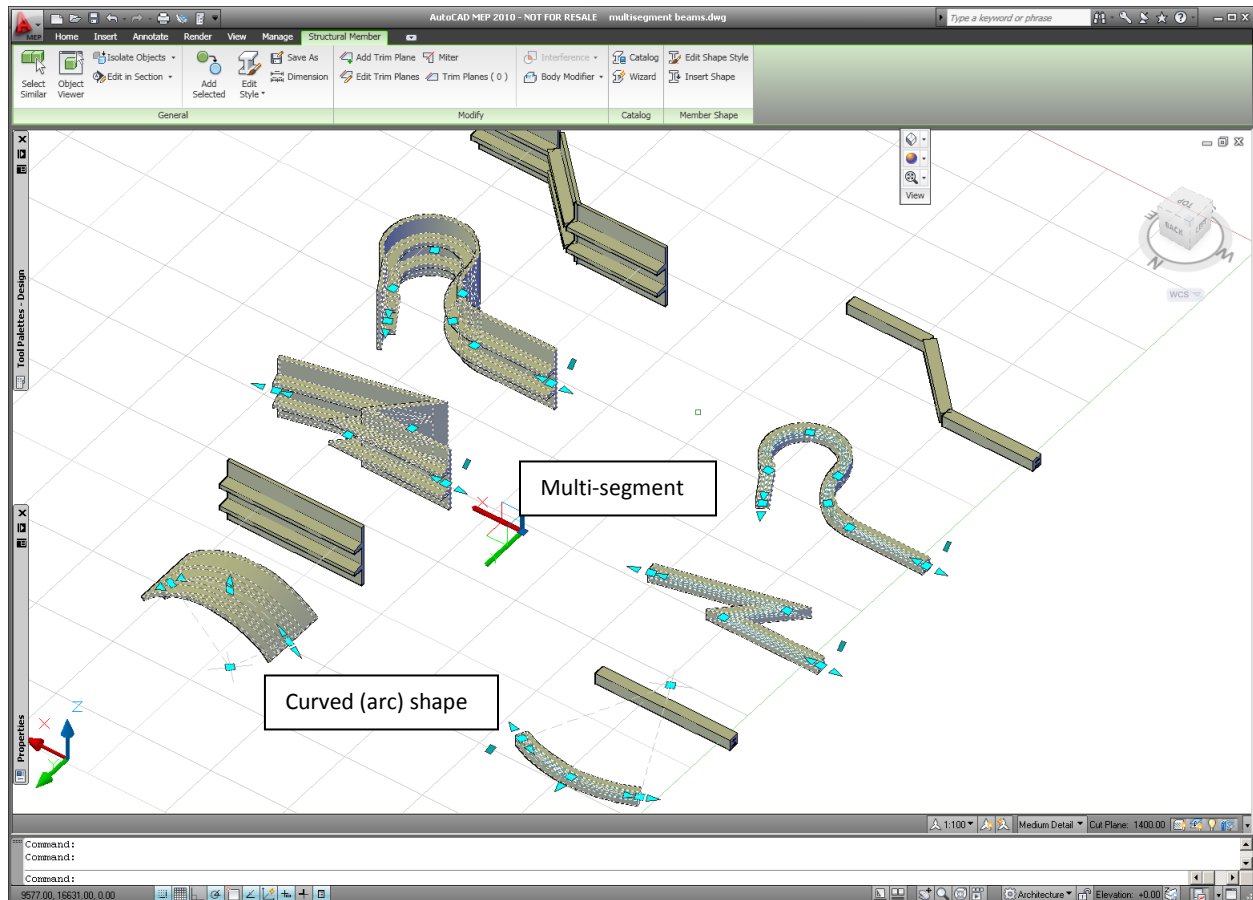


However, it is not recommended to use a component offset for multi-component structural members. This is due to the current limitation of the IFC model that does not support multi-component structural member. Any multi-component structural member with component offset will be exported as BREP.



Curved structural members (arc shape) will be exported using Advanced Swept Solid. Please note that not all applications today support this type of geometry.

A multi-segment structural member (as one structural member) will also make use of Advanced Swept Solid in the basic structural member profile along the curve. This type of representation is not yet supported by all applications.



## TRIM PLANE

Trim plane applied to any structural member class (beam, column, brace) will be preserved nicely in IFC with the use of a similar representation of clipping (with the use of unbounded half-space geometry).

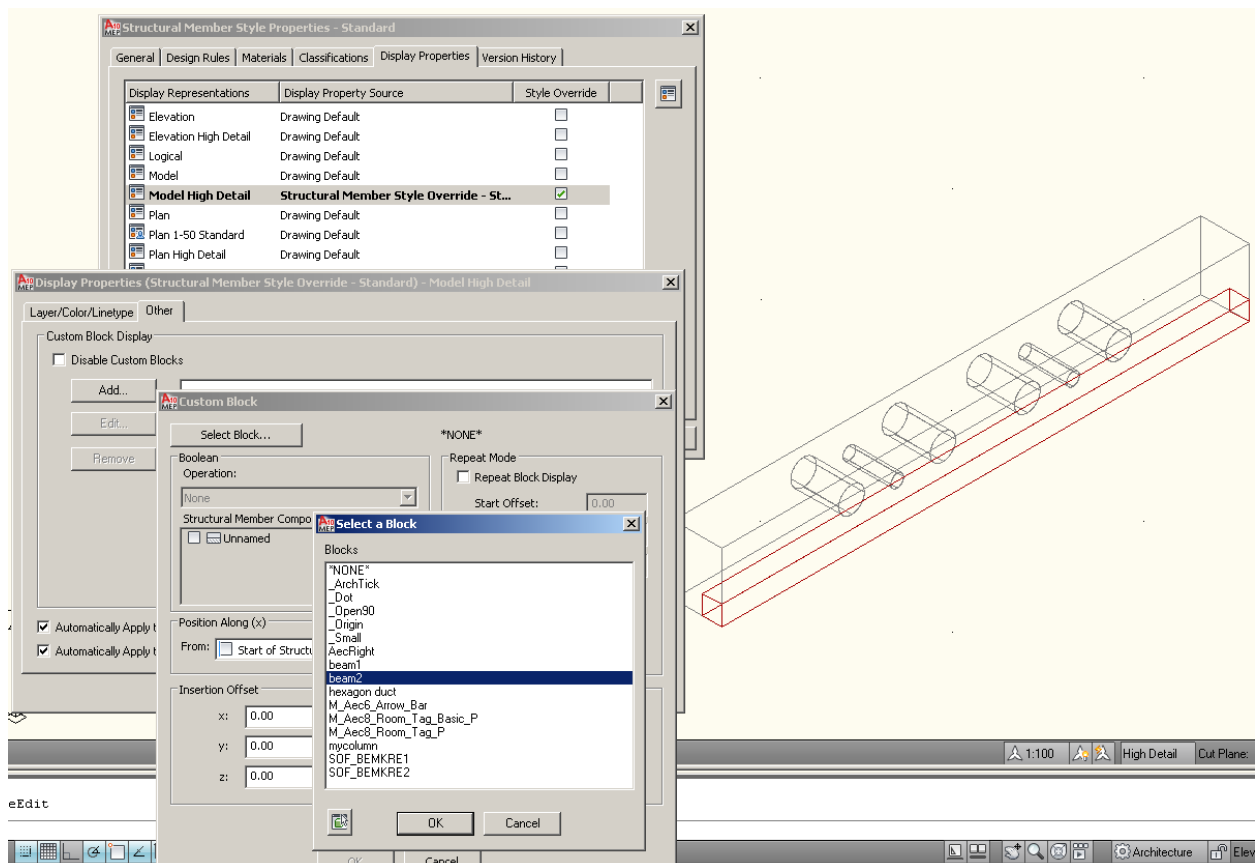
## MASS ELEMENT AND BODY MODIFIER

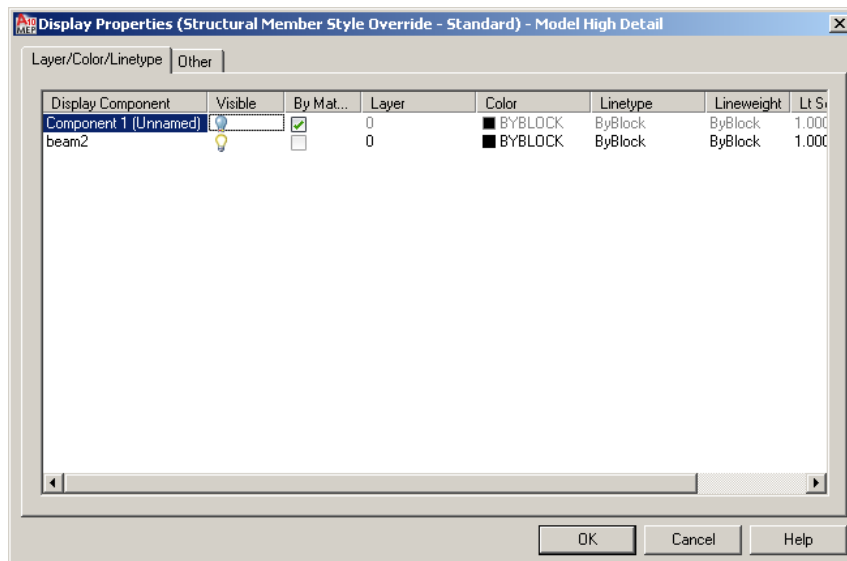
Many times, users use Mass Element for structural members of various shapes. Mass Element will be considered as an undefined object and will be exported as a non-intelligent `IfcBuildingElementProxy`. With less specification, Mass Element cannot be classified as `IfcColumn`, `IfcBeam` or `IfcMember`, which are more highly specified.

There are two ways to make the Mass Element a structural member: i.e. by using Body Modifier or by using the Custom Block override. The best option seems to be the Custom Block override since you will be able to create a

dedicated style and re-use the style for multiple instances of the same type of structural member. To enable this you can perform the following steps:

1. Identify unique cases of the structural member shapes.
2. Create the desired structural member shapes using Mass Elements.
3. Convert the Mass Elements into blocks.
4. Create unique style for each of the shapes.
5. Use Display override on the style using the appropriate block and turn off the original style shape.





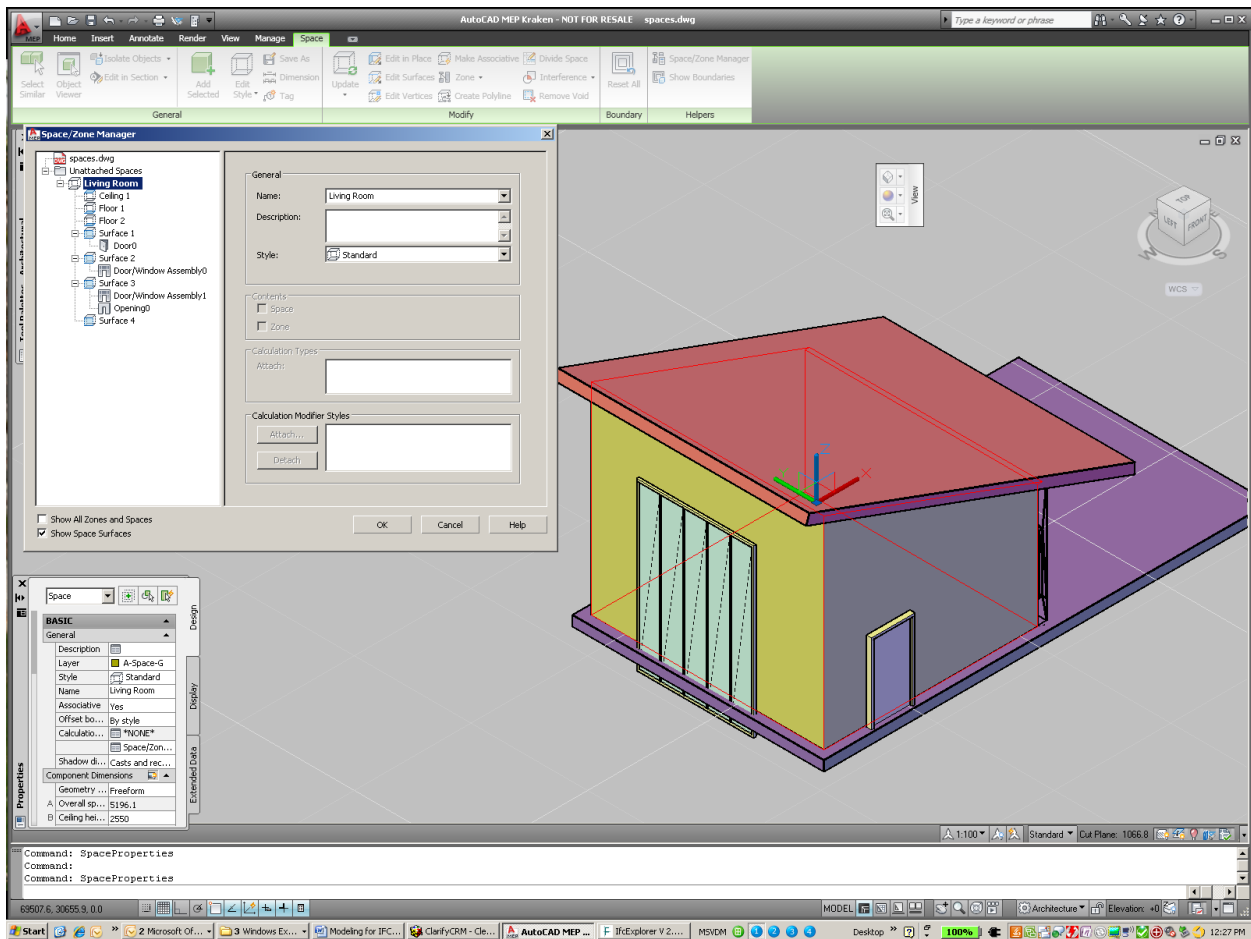
The use of Body Modifier will be more practical if you do not re-use the object many times (best to use for 1 or 2 instances). In this case, the use of Body Modifier will be more appropriate, reducing the overhead of creating styles.

## G. MODELING SPACE

For good modeling in general, all spaces within a building should be modeled as Space objects in 3D. In AutoCAD Architecture, that can be achieved by creating the spaces using the space creation command. It is recommended that you use the space auto generate command. This will ensure that all enclosed areas are “filled” with space. It will also ensure that it generates space boundary information correctly (refer to Exporting Space Boundary for more information). This condition needs to be met to ensure export of a good quality of IFC model.

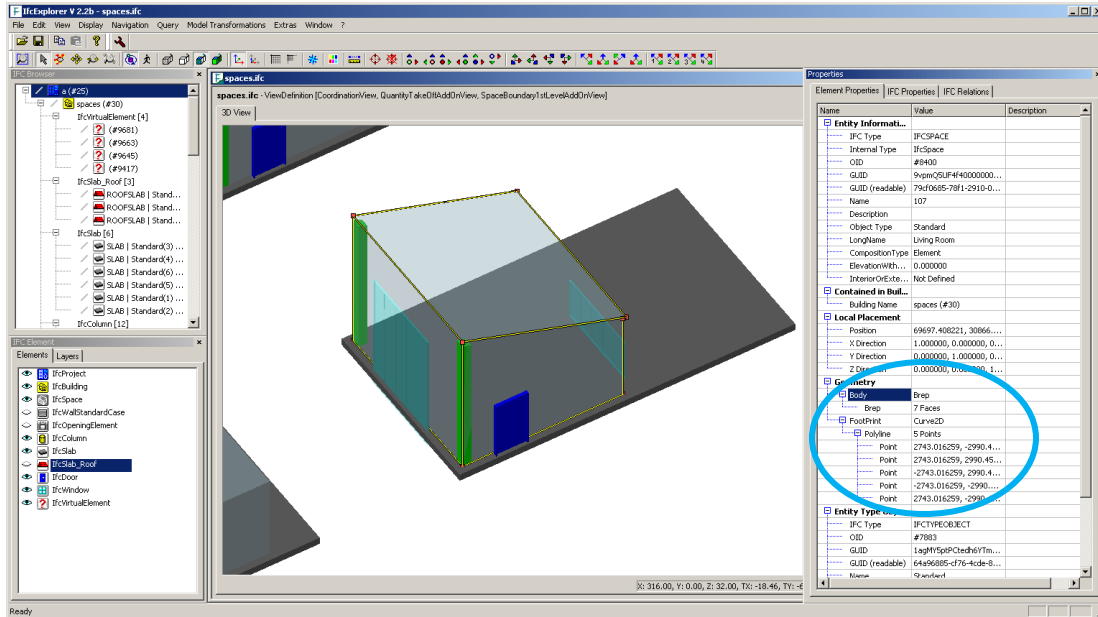
AutoCAD Architecture allows a space to be created either of type extrusion or free form, which is selectable on the property panel during creation of the space. If you need an exact shape of the space that also includes the correct vertical shape, for example when the top part is cut by a roof, you will need to choose free form space. Please note that virtual space boundary (explained in “Handling Virtual Space Separation” below) will only work for extrusion space. For the purpose of energy simulation, you may need to ensure that the complete space boundary information is exported. In this case, free form space with enclosed area in both horizontal and vertical direction will be needed to produce space boundary in all the space surfaces, both horizontal and vertical direction.





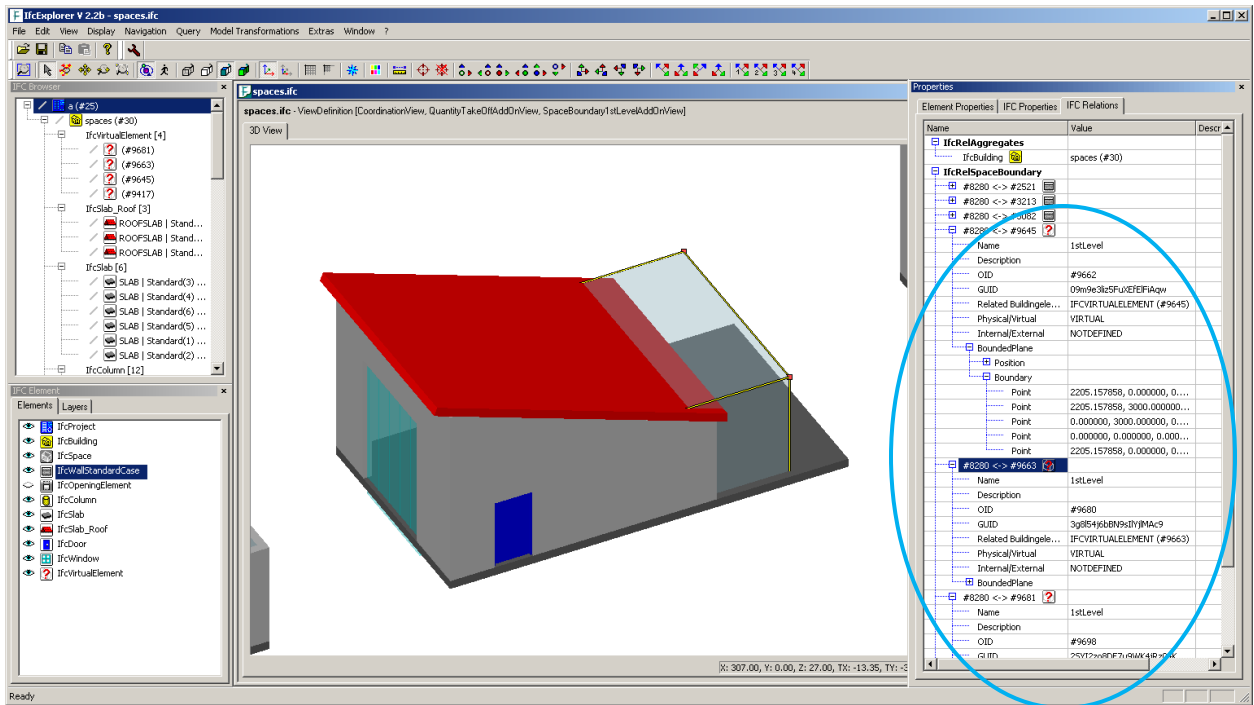
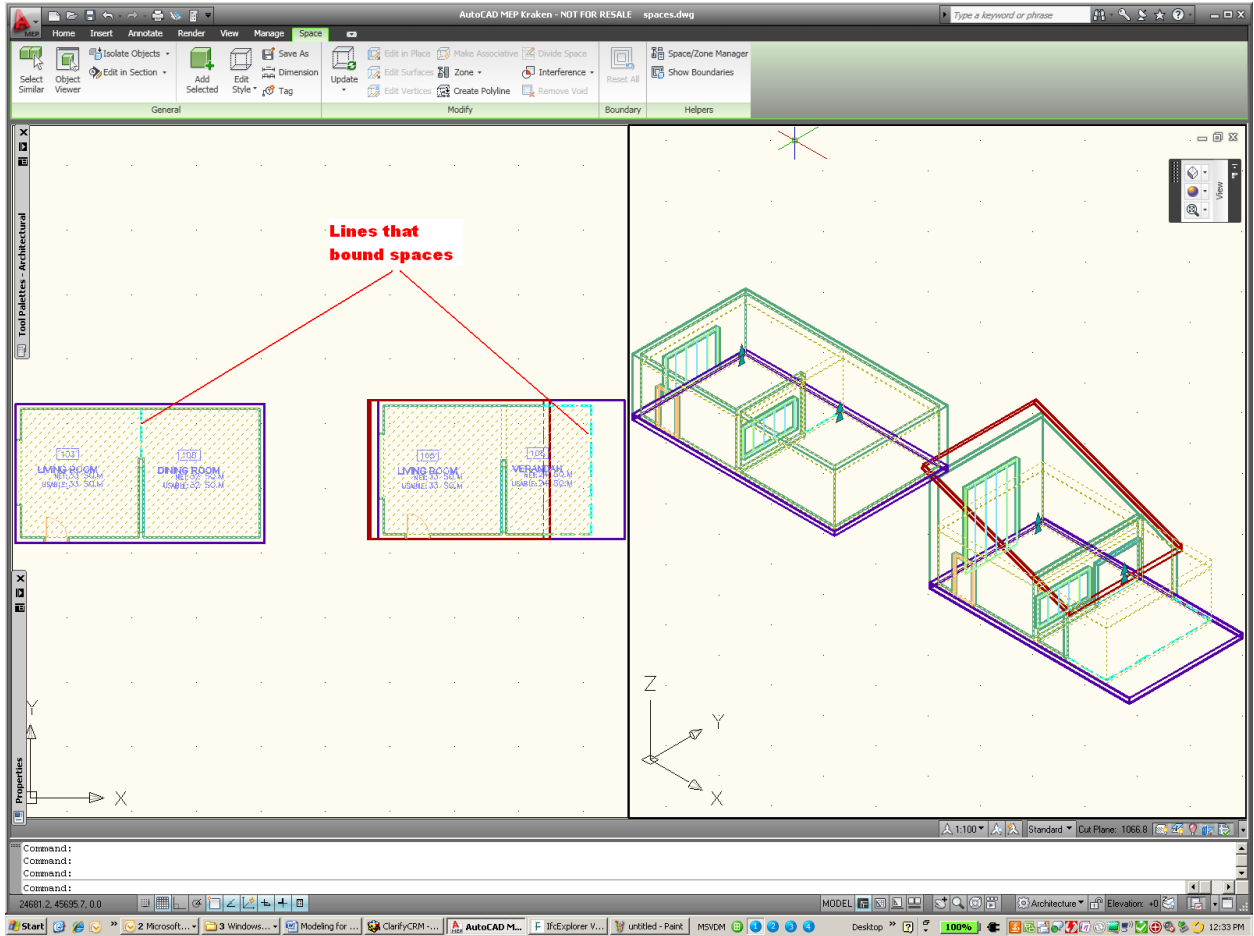
## FREEFORM SPACE

Freeform space will be exported to IFC with BREP geometry. At the same time, for every space with BREP geometry, footprint information which describes the basic space profile is also exported. Since BREP type geometry has very restricted use beside their precise form, it is recommended to limit the use of freeform space to that which is absolutely necessary.



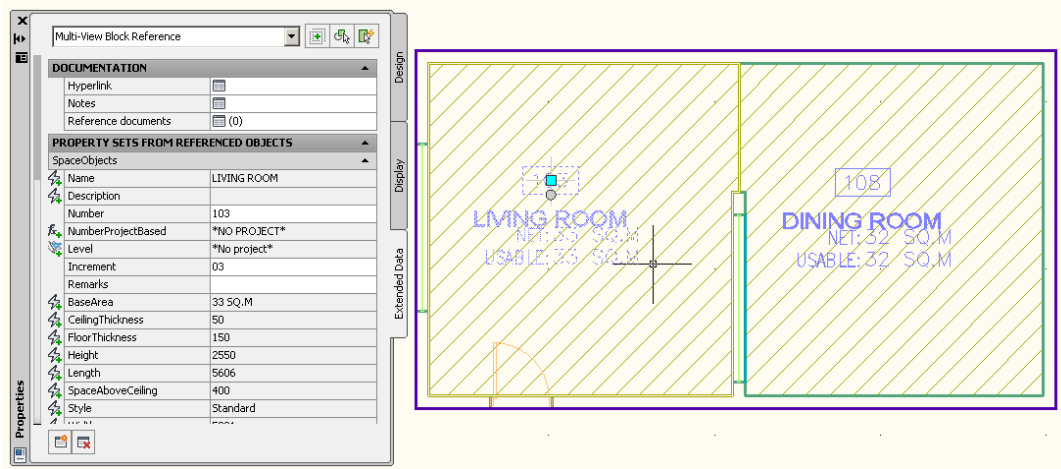
## HANDLING VIRTUAL SPACE SEPARATION

The first criteria to enable space auto-generate to recognize the enclosed spaces is to ensure that all spaces are actually enclosed (see first figure below). In a situation where there is a need for virtual space separation, you can use a line that is set to act as space boundary (the second figure below). The boundary line can also be used to create a virtual boundary when a space opens to real open space.



## THE USE OF ROOM TAG

For good modeling, a room tag should be created using the space object and not as text or label in the drawing. Room tag displays the intelligent room information that is linked to the space object itself. It gives 2 advantages: first, it dynamically displays the space information, which changes when the property of the space is changed; second, the information will be exported to an IFC file as part of the Building Information Model that can be exchanged.



## INTERFERENCE CONDITION

For every space that has interference condition, export to IFC will generate a CSG geometry with all the geometry of the interfering objects as subtractive operands. The basic space extrusion will provide basic extrusion information from which a profile can be derived.

## SPACE NAME AND NUMBER

Space Name and Number as used in space tag (see above), are important information that most users would like to use and exchange. Space name is exported as `IfcSpace.LongName` as agreed by the implementers, while `IfcSpace.Name` is also used for Space number when it is present. In AutoCAD Architecture, space number is not a standard attribute, but it is part of typical space tag based on values in SpaceObjects property set. This property set definition can be obtained from the US Metric or Imperial template. Property Number in the SpaceObjects property set is mapped to `IfcSpace.Name`, unless it is overridden by `IfcBaseProperty.Name`.

## H. MODELING ZONE

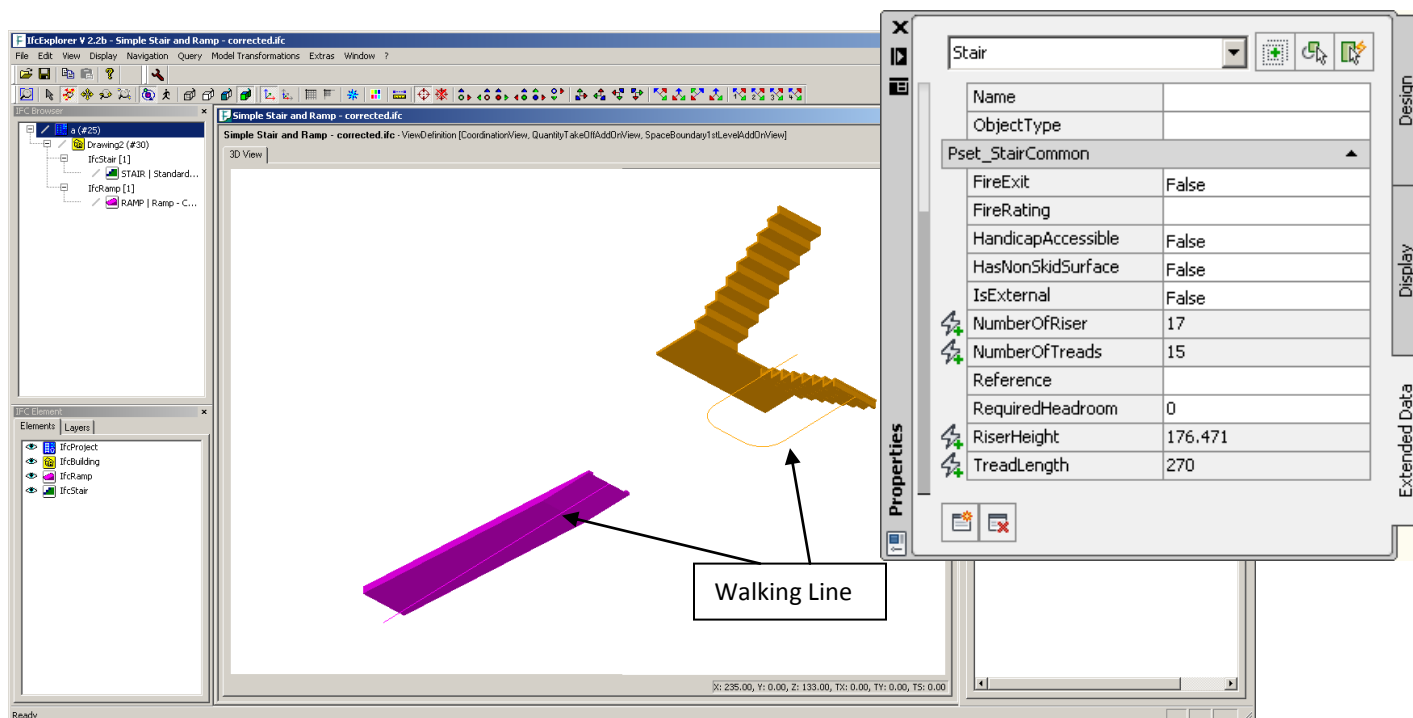
AutoCAD Architecture's Zone object maps directly to IfcZone object. From AutoCAD Architecture 2011, Ifcexport supports the export of Zone object to IfcZone. It works with Zone that includes spaces from different drawings (Xref) as well as nested Zone (i.e. Zone inside the Zone). There is no special care you need to take to get the Zone exported. Please note however that the Zone will not have any geometric information in the IFC file and there is no support for import of IfcZone at the moment.

## I. MODELING STAIR AND RAMP

AutoCAD Architecture uses the same object for both Stair and Ramp, differentiated by the style used. Due to limited support of parameterization in IFC implementation, both Stair and Ramp will be exported as a simple IfcStair or IfcRamp object with BREP geometry.

### ADDITIONAL INFORMATION FOR STAIR: PROPERTY SET

Additional important information being exported and that may be important for other importing applications are 2D Walking Line and some of the stair properties, e.g. number of tread, number of Risers, tread length and riser height, that can be automatically filled-in using the supply IFC propertyset definition. To ensure the property information is exported, attach Pset\_StairCommon property set supplied with IFC content to the stair.



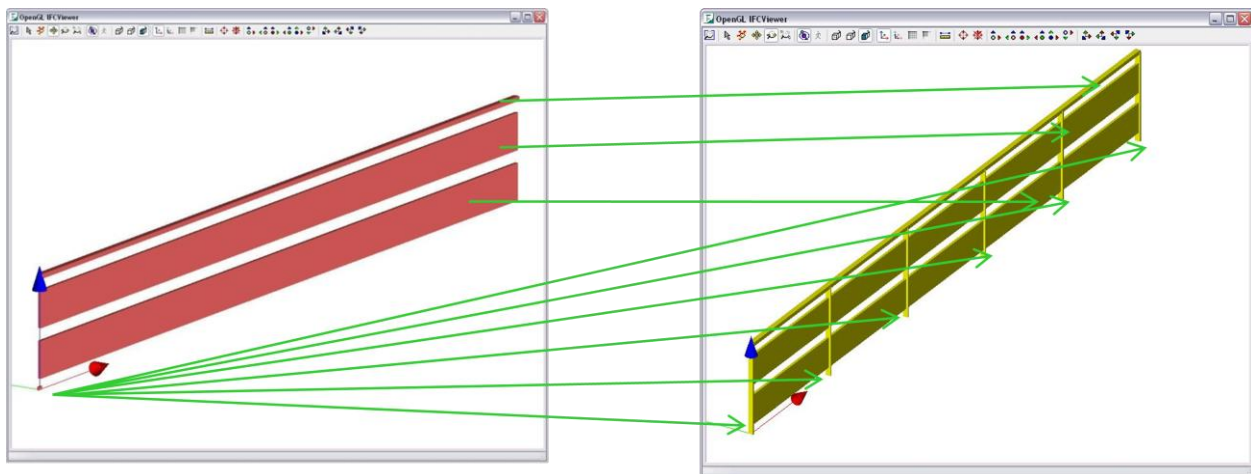
## J. MODELING RAILING

One unique feature about railing is that it is made of many repeated components. AutoCAD Architecture exports the repeated components using one geometry representation and maps it to various instances of the same component in the railings. The components are:

1. First Post
2. Last Post
3. Dynamic Post
4. Baluster
5. Rails

Using as many repeated shapes and simpler shapes as possible (simple extrusion) will improve the IFC representation of Railing. Each of the different components will be linked by nested style (similar to the Structural Member) that identify various types of components.

AutoCAD Architecture exports the railing in a similar manner as Structural Member.



## K. MODELING ROOF

### TWO TYPES OF ROOF

There are 2 types of roof that can be modeled in AutoCAD Architecture, - . one whole roof system as a Roof object, or individual slabs that form a roof using Roof Slab object(s). Both types are similarly supported in IFC as IfcRoof and IfcSlab with PredefinedType="Roof" respectively. You may form a more complex roof system using Roof object, but there are less options to perform other modifications. Roof Slab, on the other hand, allows more modifications and style assignments. There is one way conversion from Roof to become a set of Roof Slab.

## EXPORTING ROOF OBJECT

Beginning with AutoCAD Architecture 2011, in accordance to IFC implementation agreement, the Roof object will be exported to IFC as an aggregation (collection) of Roof Slabs. Each of the Roof components will be represented as one Roof slab. It is identical to running a command in AutoCAD Architecture to convert Roof to Roof Slabs.

## L. MODELING SLAB AND ROOF SLAB

### SLAB COMPONENTS

Similar to Wall, you should avoid overlapping components as there are no equivalent representations in IFC. As a result, the slab will be exported as BREP.

Other components, i.e. Fascia and Soffit, will not be exported as part of the slab in IFC since there is no equivalent representation defined in IFC. You will see that in IFC, both Fascia and Soffit are a generic `IfcBuildingElementProxy` with name: Fascia or Soffit accordingly.

### HOLES IN THE SLAB

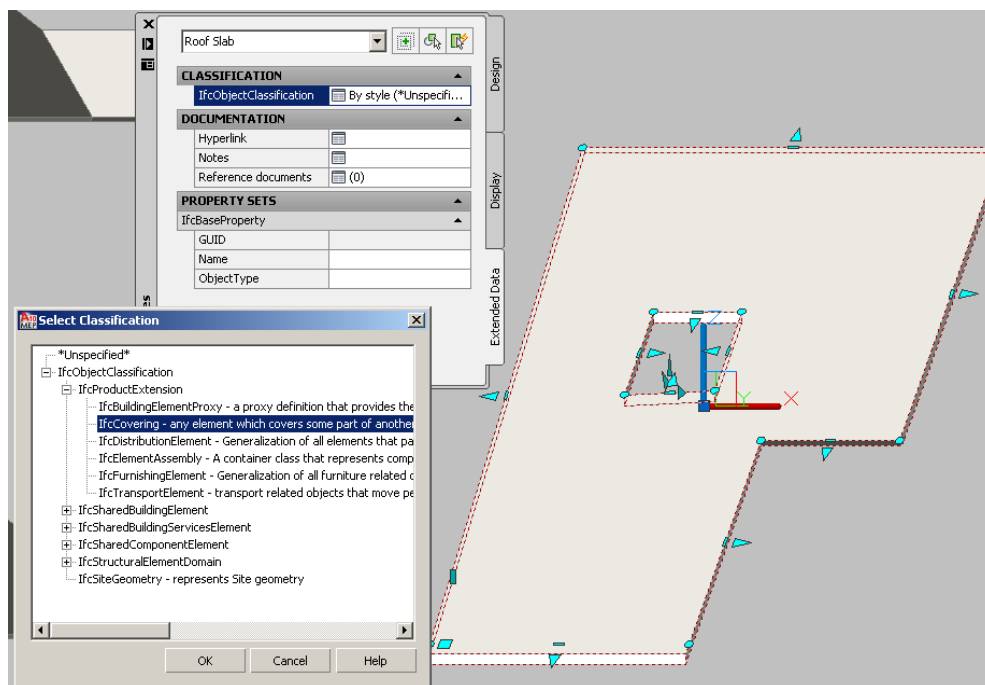
Due to differences in the definition of holes in AutoCAD Architecture and IFC, i.e. holes are defined as Openings in IFC. Only a simple slab type with extrusion and holes that are of square cut and zero angle can be represented in IFC as slab with extrusion and opening as extrusion. Any other type of slabs, such as plumb cut, overhang with plumb cut, and holes with angle are going to be exported as BREP geometry. Unless they are necessary, you should avoid the use of plumb cut and angled edges.

### ROOF SLAB

Roof slab is similar to a slab which is generally sloped. In addition, a roof slab usually has the edge defined using plumb cut. This type of slab cannot be easily mapped into IFC representation that supports only perpendicular extrusion or non-perpendicular extrusion with clipping. Therefore, a roof slab in most cases will be exported as BREP in IFC.

## VI. MASS ELEMENT, MV-BLOCK AND CLASSIFICATIONS

Recognizing that there are many other objects that you can create within AutoCAD Architecture which do not fall into the category of architectural object, AutoCAD Architecture by default exports them (as long as they are 3D objects) as `IfcBuildingElementProxy`. This object does not serve much purpose except for conveying geometry and visual fidelity. AutoCAD Architecture goes a little further by providing a means for you to assign this type of object to a specific IFC entity. Not all IFC entities are supported for classification because some objects are well defined and require certain parametric information, which is missing from generic objects. Within AutoCAD Architecture, you could assign any object (not limited to Mass Element and MV-Block) to the available IFC entity. Upon export this specific IFC entity will be created instead of the default `IfcBuildingElementProxy`, along with its attached property sets.



## LOCATION OF CLASSIFICATION

The classification definition is available in all of the supplied IFC templates described in the section about Property Set above. You should not modify the content since AutoCAD Architecture will not recognize the changes made to it, apart from what is already defined.

## VII. ADDITIONAL NOTES ON AUTOCAD MEP

### CLASSIFICATION

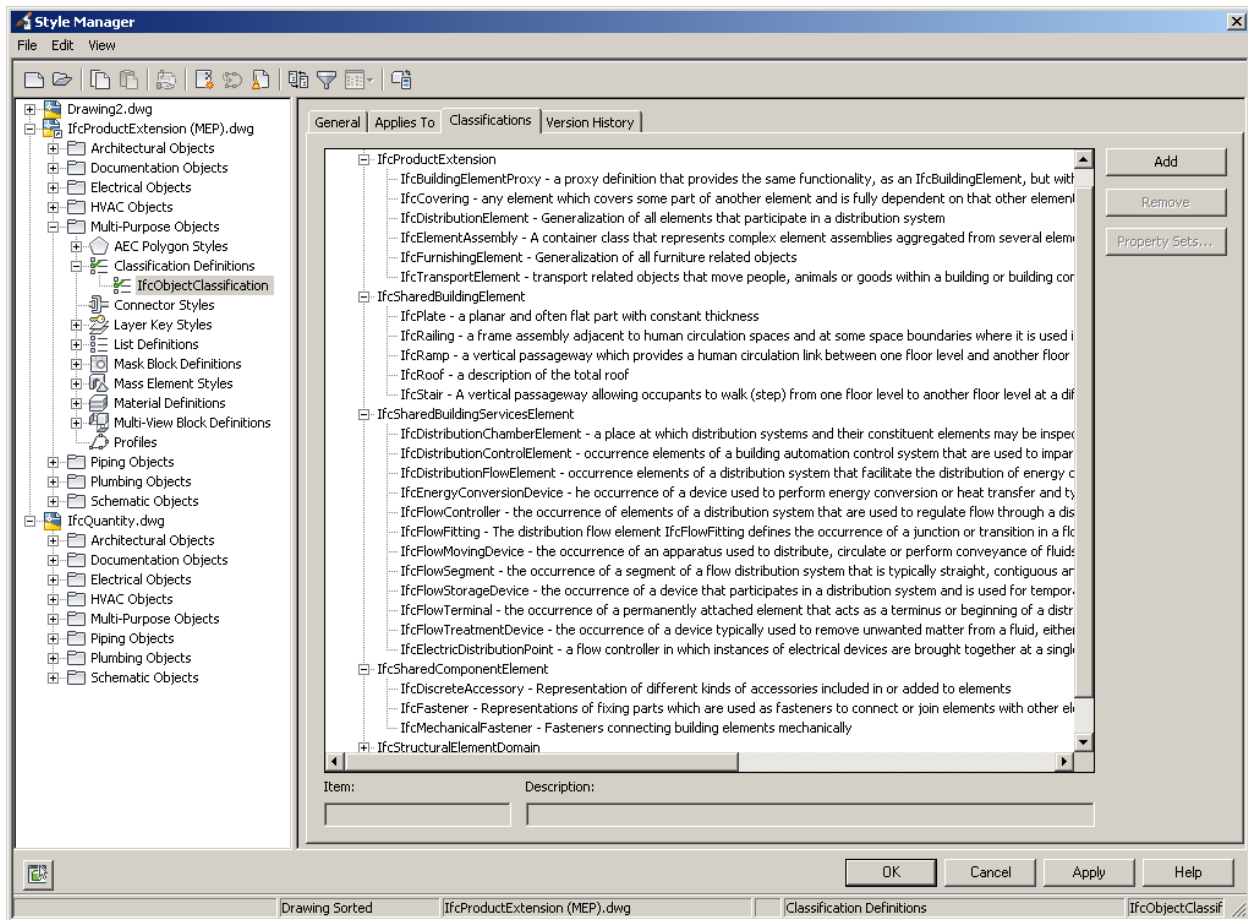
As of release 2011 there is only limited support to export IFC in AutoCAD MEP. When you are using AutoCAD MEP, you are able to export your drawing without a missing object, but all MEP objects will be exported only as `IfcBuildingElementProxy`. Only their geometry and property sets are preserved.

Starting in AutoCAD Architecture 2009 (hence AutoCAD MEP 2009), you may use classification to identify MEP objects as their appropriate entity in IFC.

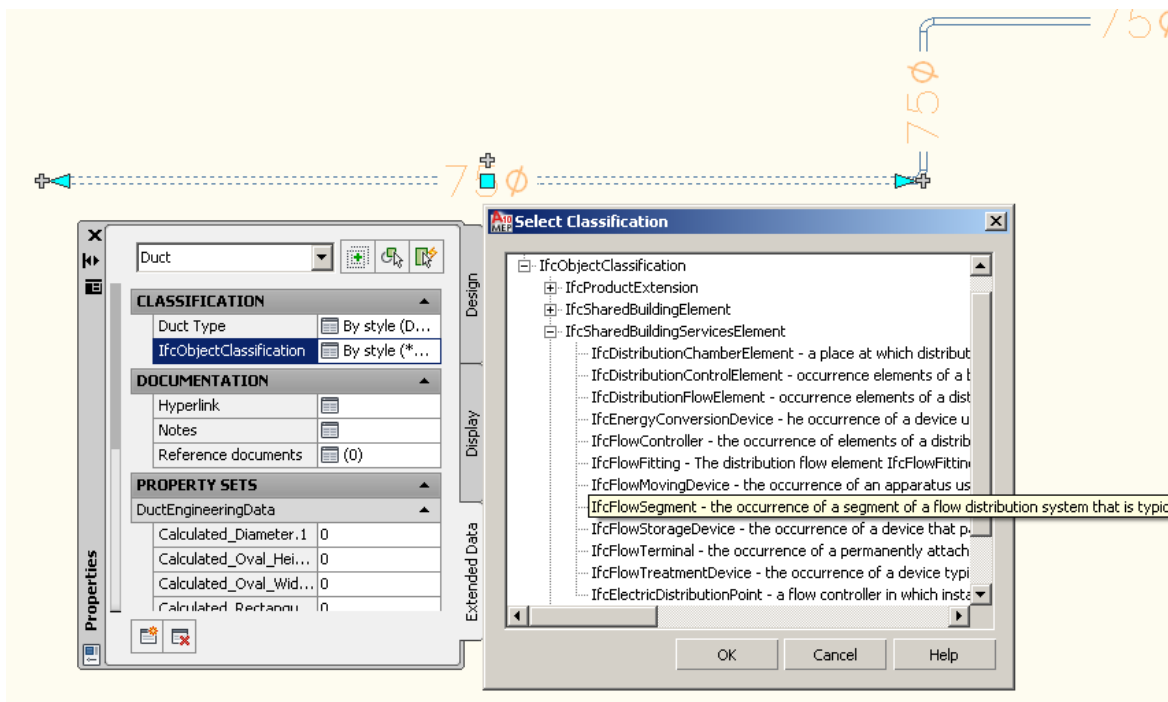
The first step is that you need to copy the `IfcObjectClassification` from the supplied template. You will find the template in the Content folder under Style. You can open “`IfcProductExtension (MEP).dwg`” or “`IfcSharedBldgElements (MEP).dwg`” to copy the classification. This is not a full list of IFC objects. Some of the well-defined objects are removed from the list. You are not allowed to modify the list as AutoCAD Architecture may not recognize the added/changed classification.



In AutoCAD Architecture 2011 the templates have been combined into one file “IfcPropertySet\_Definitions (MEP).dwg” in the Content folder under Style. You should open this file to obtain IfcObjectClassification definition and copy it to your current drawing.



Once you do that, you may assign the classification to object(s) in AutoCAD MEP to the appropriate IFC entity.



## VIII. EXPORTING SPACE BOUNDARY

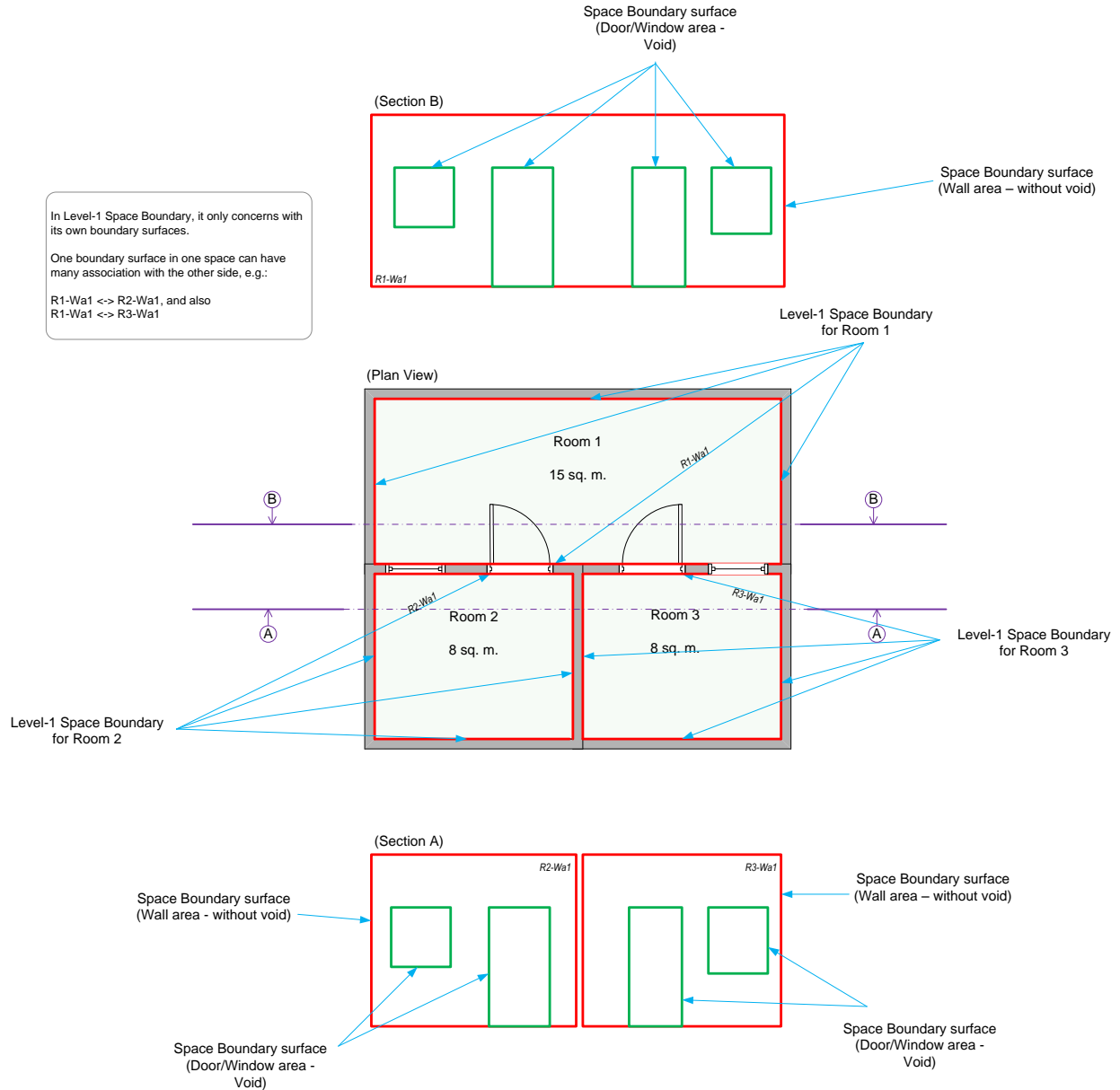
Space boundary is important information required by energy analysis software to perform energy simulation. There are two levels of space boundary information known simply as 1<sup>st</sup> level and 2<sup>nd</sup> level space boundaries. Below is a simple diagram explaining the two levels of space boundary.

## 1<sup>ST</sup> LEVEL SPACE BOUNDARY

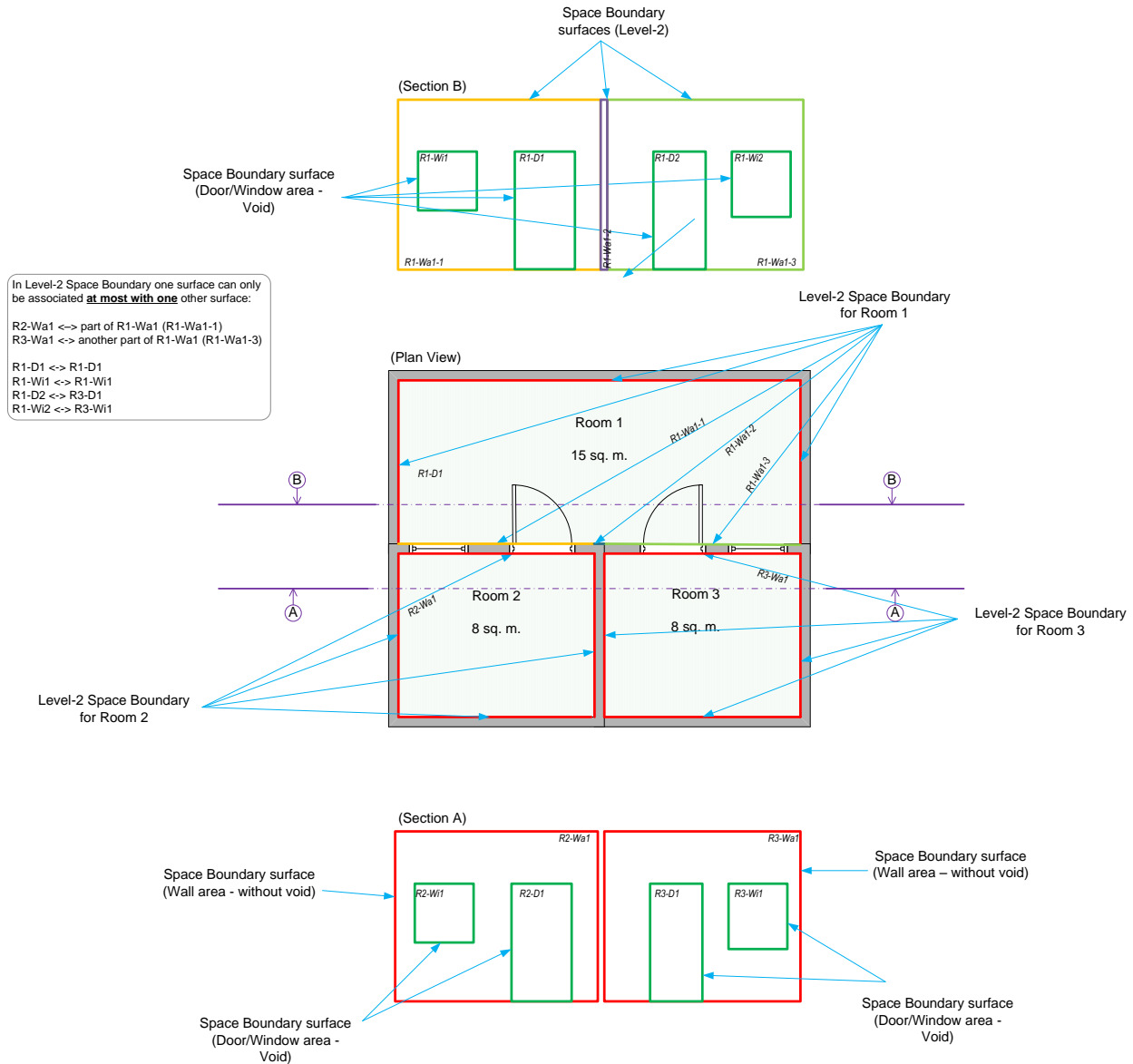
In Level-1 Space Boundary, it only concerns with its own boundary surfaces.

One boundary surface in one space can have many association with the other side, e.g.:

R1-Wa1 <-> R2-Wa1, and also  
R1-Wa1 <-> R3-Wa1



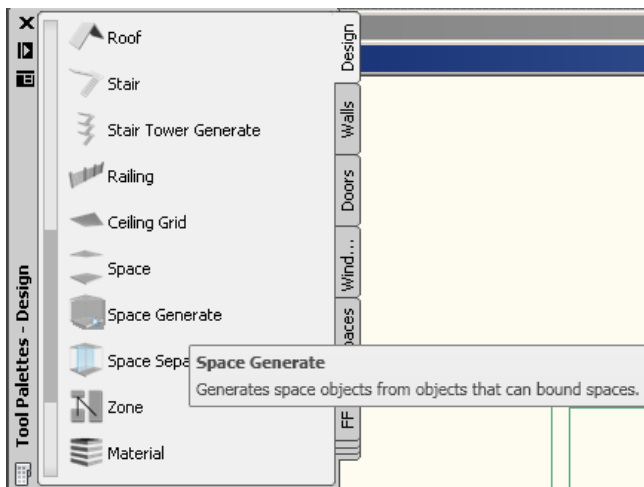
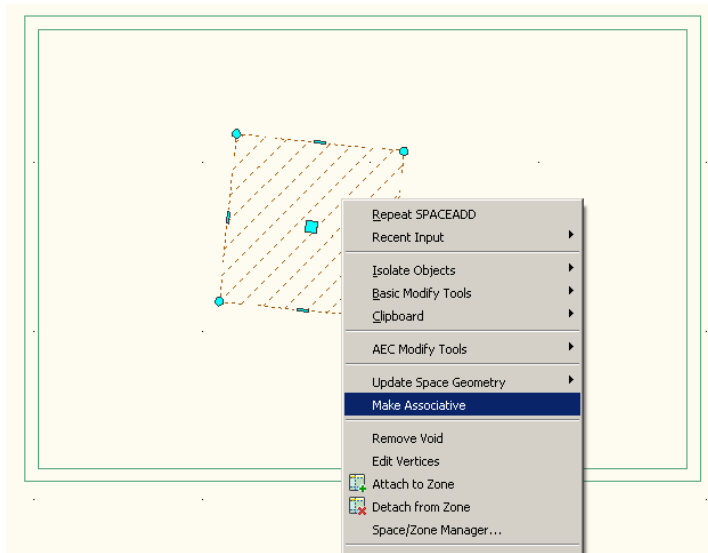
## 2<sup>ND</sup> LEVEL SPACE BOUNDARY



### SPACE BOUNDARY SUPPORT IN AUTOCAD ARCHITECTURE

Starting with AutoCAD Architecture 2010, export of space boundary information is supported. It supports 1<sup>st</sup> level space boundary for now. The support is automatic and you do not have to take any extra steps. However, it is important to note that the space boundary can only be created on spaces that are made associative. This can be achieved two ways:

- For existing space objects that may not be correctly associated, select the space(s), right click and choose "Make Associative"
- For a new space to be created, use Space Generate tool to automatically generate the spaces.



Starting in AutoCAD Architecture 2011, an additional enhancement is extending the support of space boundary detection to include freeform space and non-associative spaces. To make sure that space boundary detection works as intended, all spaces must be created “tight”, i.e. without gap between the space and its boundary. This can be achieved using the Generate Space tool and the freeform option for tight boundary at all directions (horizontal and vertical). You must ensure that the space is airtight to allow AutoCAD Architecture to correctly generate freeform space that fits into its boundaries in all directions.

AutoCAD Architecture uses Wall baseline as a basis for cleanup and connections. Depending on the Wall style, typically, a baseline is somewhere in the middle of the wall. This creates a small space boundary at the top of the wall, where the wall meets the roof. While this is technically correct space boundary information, you may want to eliminate this part as it does not really give additional and meaningful information for the space boundary. For best results of space boundary, our recommendation is to design your wall carefully and use wall justification that justifies walls on the inside.

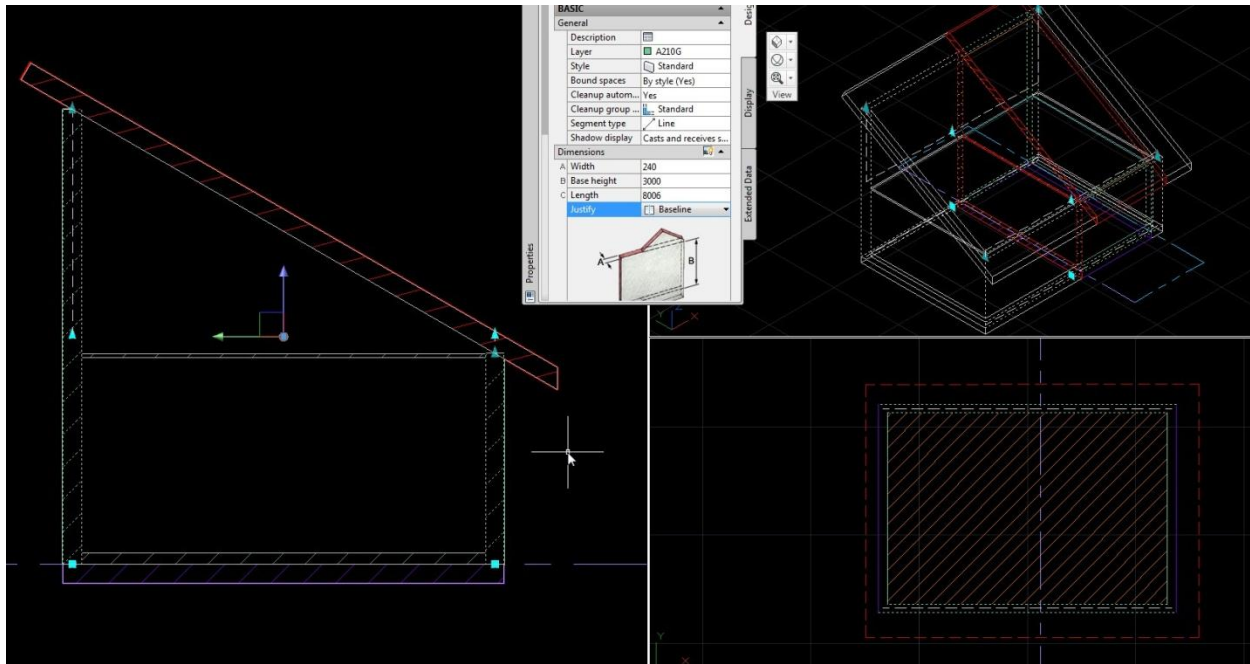


FIGURE 1 - TYPICAL WALL JUSTIFICATION (BASELINE)

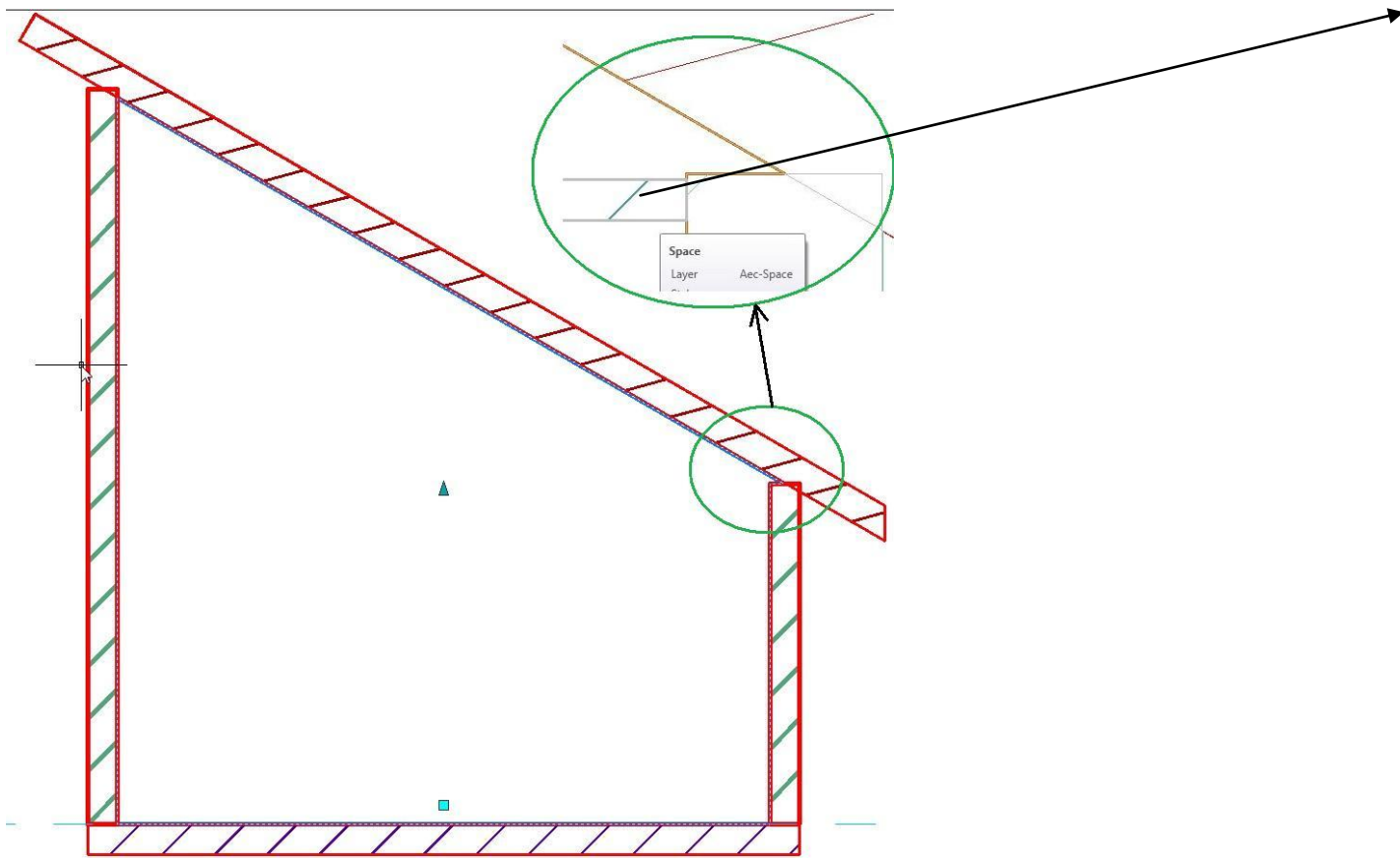


FIGURE 2 – SMALL SECTION OF SPACE BOUNDARY AT THE TOP OF THE WALL

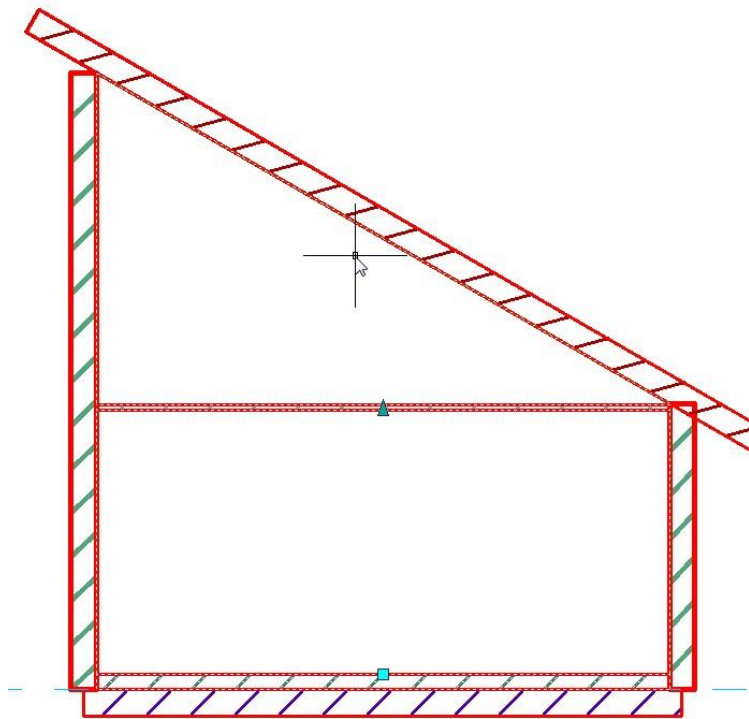
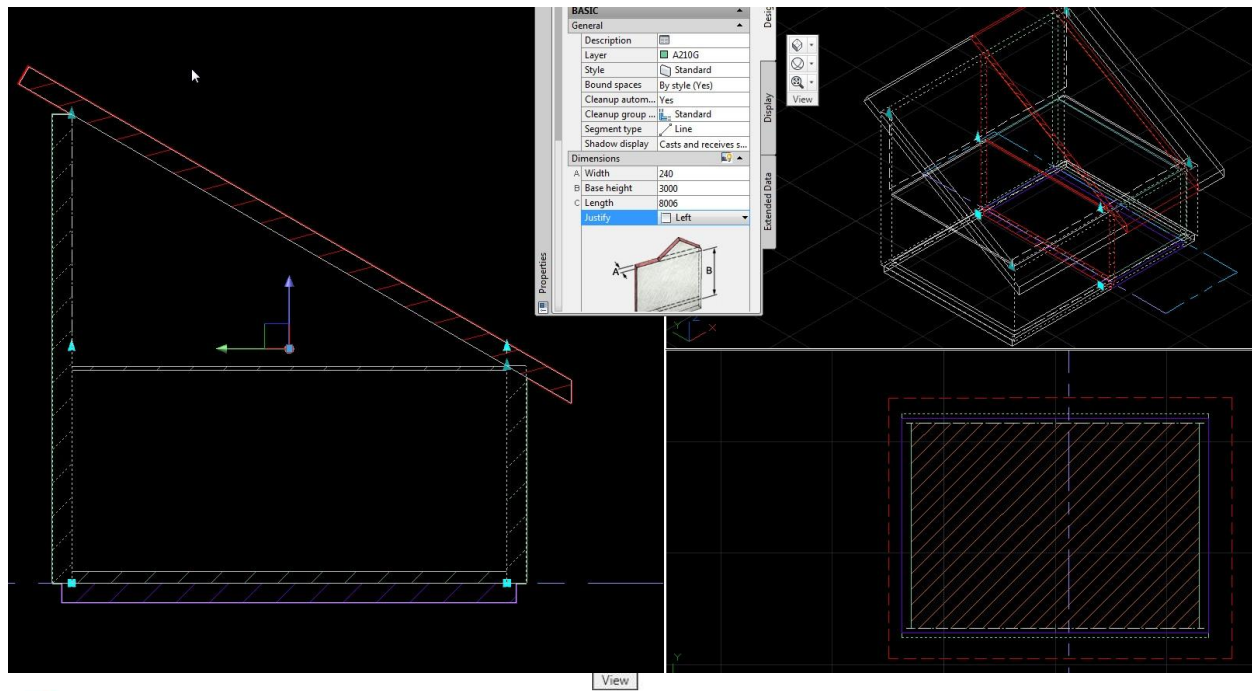
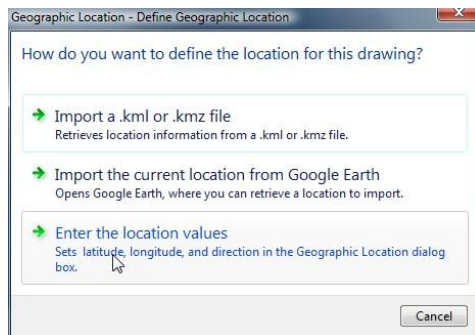
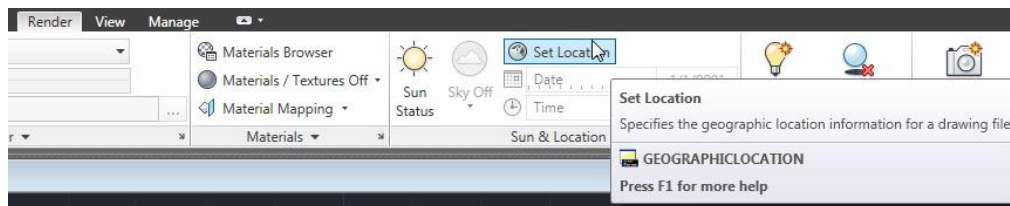


FIGURE 3 - USING WALL JUSTIFICATION ON THE INSIDE FINISH OF THE WALL REMOVES THE SMALL SECTION OF SPACE BOUNDARY

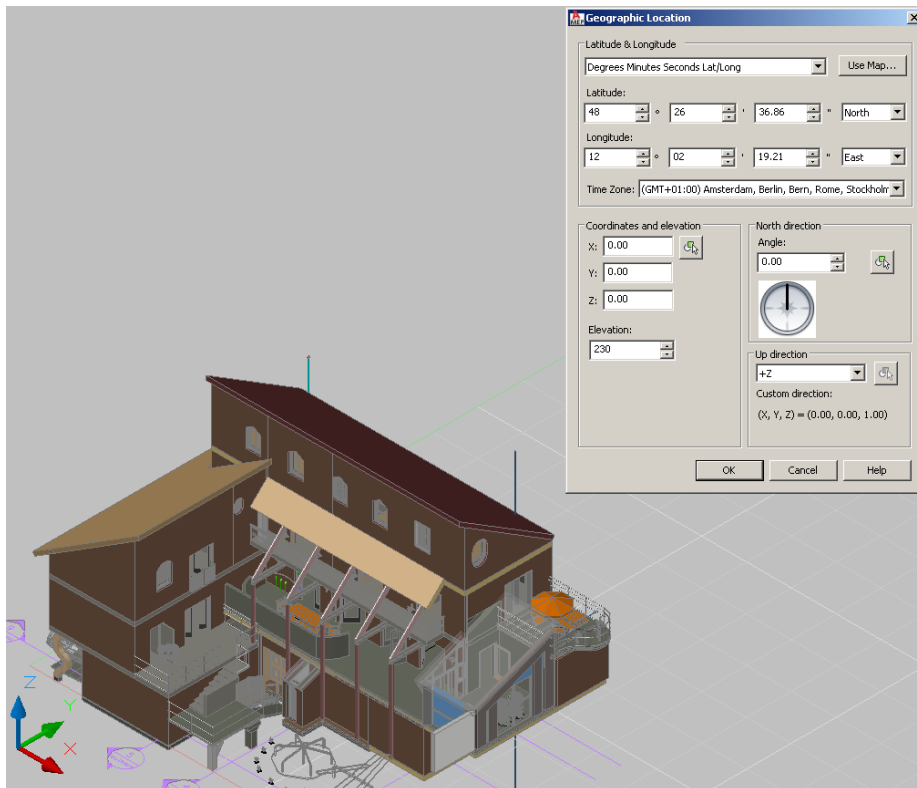
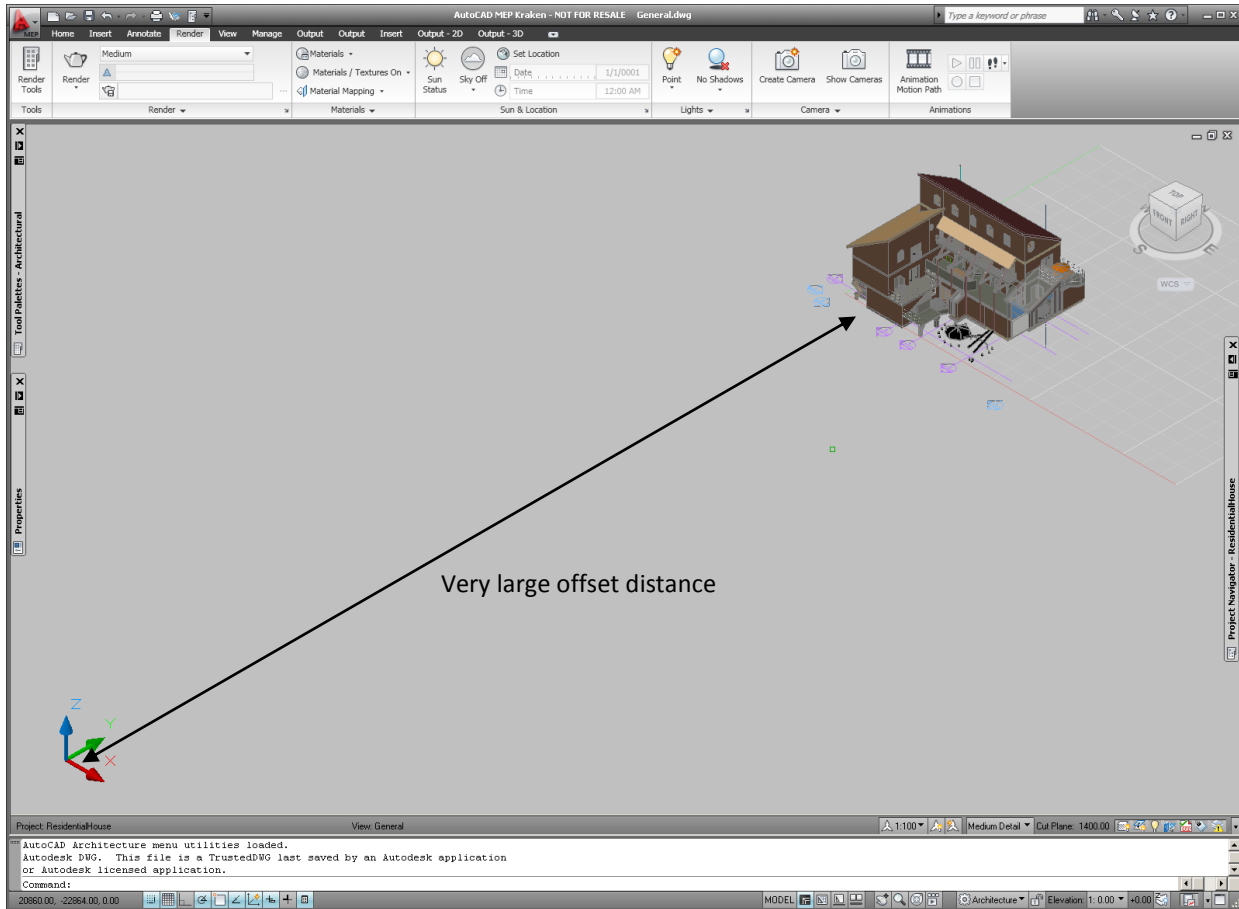
## IX. PLACEMENT AND GEO-REFERENCE

It is a practice in some countries that design drawings must be done on a coordinate location relative to the country reference coordinates. Therefore, if a building is located 320km away from the reference coordinates, it will be positioned at 320,000,000 mm (if the standard unit is mm). This practice is not recommended since the majority of applications will have a problem of geometric precision when an object is located very far from the origin. To be able to create the building close to the origin and still preserve the relative location to the reference coordinates, it is recommended that the Geo-reference feature is used so that the building can be placed correctly relative to the reference coordinates.

In AutoCAD Architecture, this can be achieved by assigning the correct geographical location using Longitude, Latitude and Elevation values. These values will be exported as part of IfcSite information and will be preserved upon export and import. To set the values, you can access AutoCAD functionality to set location from the Ribbon, and then select “Enter the location values” when a dialog box appears. You may set the Latitude, Longitude, Elevation and North direction values. They will be exported to IFC file.







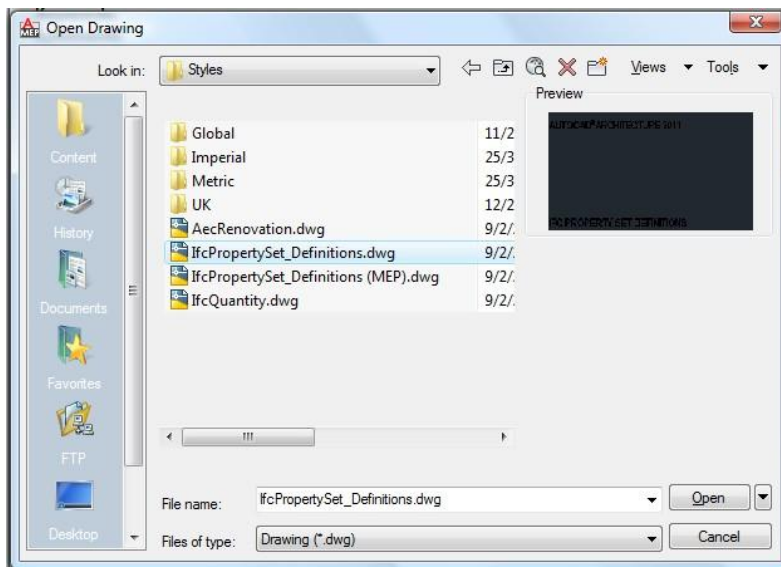
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## X. PROPERTY SET

Property set is important both in AutoCAD Architecture and IFC. There are IFC pre-defined property sets that are usually named starting with PSet\_xxx. You are able to define your own property set that contains specific information not part of the standard. AutoCAD Architecture supports exporting and importing of such property sets. You should consult local authorities to see what standard has been defined in your area. Examples of such property sets are those defined by GSA (in the US) for compliance to GSA BIM requirements. Often applications, including AutoCAD Architecture, create specific property sets upon export to keep certain application-specific information. AutoCAD Architecture creates such property sets that can be recognized with the name starting with Pset\_ADT\_xxx. These property sets will not be preserved upon import as they only contain information relevant to the application for export/import purposes only.

### LOCATION OF IFC PSET

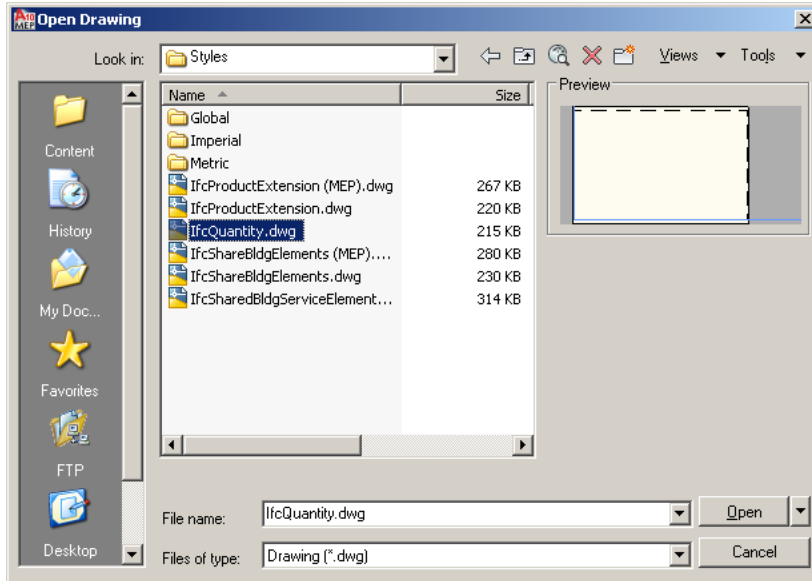
AutoCAD Architecture has pre-defined all IFC standard property sets that can be obtained from the supplied template that are provided in \Content\Styles. The file name is "IfcPropertySet\_Definitions.dwg" for AutoCAD Architecture and "IfcPropertySet\_Definitions (MEP).dwg" for AutoCAD MEP. They contain an IFC property set definition that is not for type objects. The two files contain the same definitions, but the MEP version has been assigned to MEP objects in addition to Architectural objects whenever applicable.



Prior to AutoCAD Architecture 2011, the property set definitions are located in several templates that are grouped according to IFC schema domains. They are:

In AutoCAD Architecture: IfcProductExtension.dwg  
IfcShareBldgElements.dwg

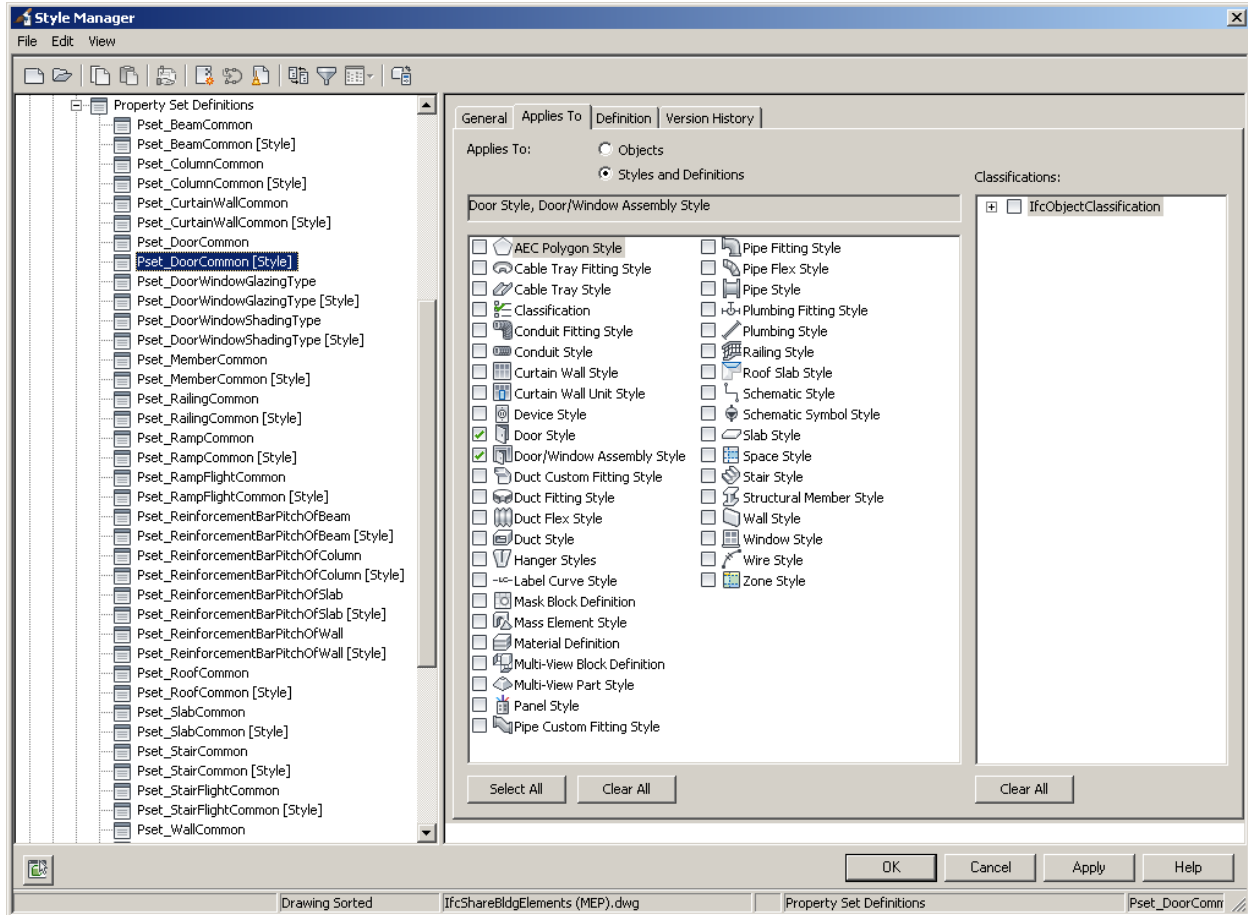
In AutoCAD MEP: IfcProductExtension (MEP).dwg  
IfcShareBldgElements (MEP).dwg  
IfcSharedBldgServiceElements.dwg



## STYLE BASED PROPERTY SET

IFC does not differentiate style that is attached to a type object or to the instance, unlike in AutoCAD Architecture. You will see in the supplied definition an identical property set definition for each of the IFC property sets, e.g. "Pset\_DoorCommon" and "Pset\_DoorCommon [Style]". They both have exactly the same definitions, but they are applicable to the object and the style in AutoCAD Architecture. The "[Style]" suffix will be removed during export and creates the same property set for both object and type (style) in IFC. It will be added again as a suffix if the property set is imported back into AutoCAD Architecture.

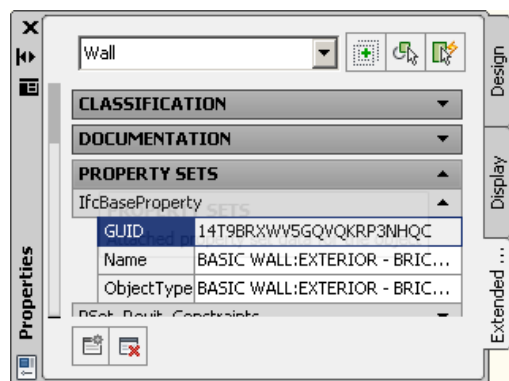
You can use the same approach if you need to support or define your own property set that has to be applicable both for the object and type in IFC.



## XI. GLOBALLY UNIQUE ID (GUID)

GUID is important information in IFC as it is the way to uniquely identify a building element. Maintaining a consistent GUID and preserving it will allow the element to be tracked throughout its lifecycle. AutoCAD Architecture generates GUIDs during export for new drawings. It is able to generate a GUID consistently as long as there is no structural change in the drawing, e.g. changing (adding or removing) an XRef from the drawing. However, the GUID is not stored in the drawing to ensure that an export would not alter the drawing.

For import, AutoCAD Architecture has to preserve the GUID of the building element so that it can be queried and remains consistent even if the object is re-exported. When importing an IFC file, each object will have a propertyset `IfcBaseProperty` attached to it with one of the properties (write protected) being GUID. The same GUID will be used for export as long as there is no duplicate found during export.



Please note that only the physical building elements are required to have their GUID preserved.

## NAME AND OBJECTTYPE

Every building element in IFC has its own Name and ObjectType attributes. These are not attributes that map to standard AutoCAD Architecture objects. To allow you to manually enter these attribute values or to preserve the values upon import and re-export, AutoCAD Architecture extends IfcBaseProperty to include additional properties for Name and ObjectType. These are generic input fields for you to enter desired values. Whenever these properties are set, they will take the highest priority upon export and will override any other assignment (if any, e.g. Name for Space object).

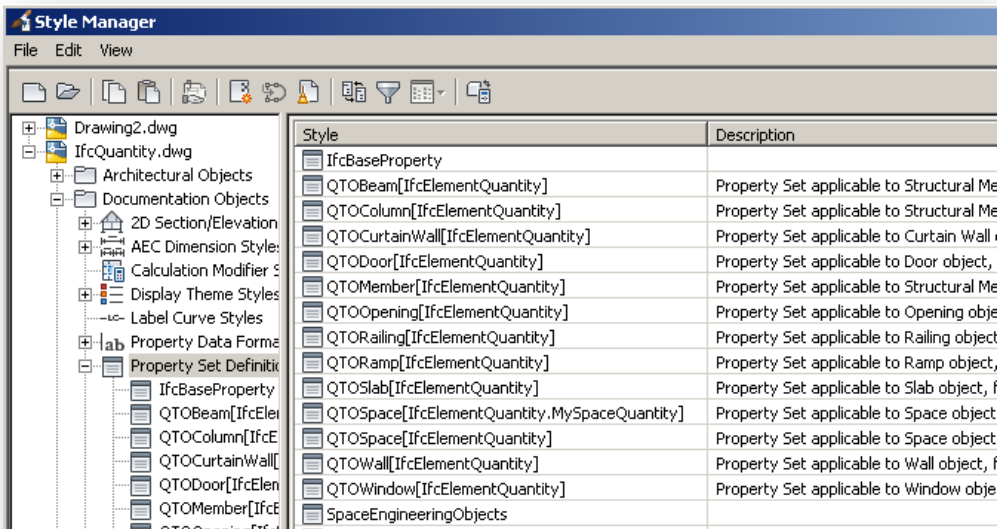
## XII. EXPORTING QUANTITIES

### USE OF PROPERTY SET

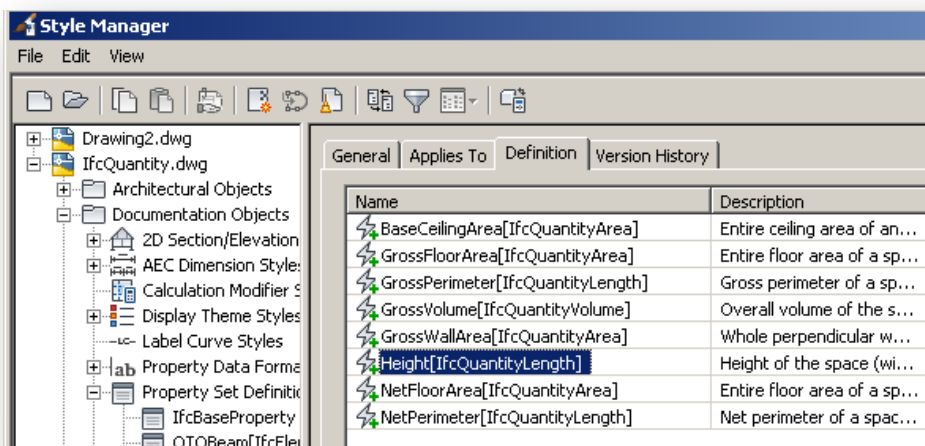
Quantity information from the model can be exported automatically into relevant IFC quantity related entities, e.g. IfcElementQuantity and IfcQuantityArea. In AutoCAD Architecture, you can achieve this by using specially tagged property and property sets. When you combine the use of these properties and AutoCAD Architecture automatic property, you can get the quantity information effortlessly.

The first step to enable this is to create a specially tagged property set (use [IfcElementQuantity] tag) as a suffix to a regular property set. For example: QTOSpace[IfcElementQuantity]. The special tag will be processed and removed during export and IfcElementQuantity entity with name QTOSpace will be generated.

The second step is to define each of the properties for which you want the quantity information to be exported. The quantity name needs to be tagged to indicate what type of quantity is desired from among 6 different quantities in IFC:



1. IfcQuantityCount - for count measure
2. IfcQuantityWeight - for weight measure
3. IfcQuantityLength - for length measure
4. IfcQuantityArea - for area measure
5. IfcQuantityVolume - for volume measure
6. IfcQuantityTime - for time measure



One example of such a quantity is: Height[IfcQuantityLength]. This property is defined as an automatic property, which will have the value automatically populated by AutoCAD Architecture. Similar to the property set name, the [IfcQuantityLength] tag will be removed during export and what you will get is an IfcQuantityLength instance with the name Height.

To make this feature work for you, it is recommended that you use automatic properties, or with the combination of a formula that will derive the quantity information directly from the model. Use other type of properties only

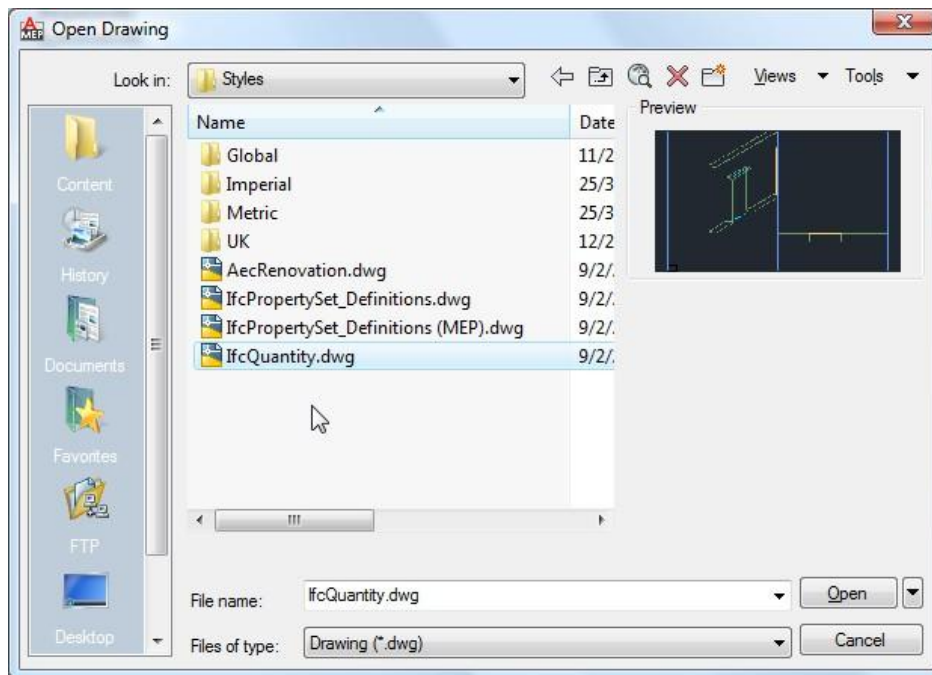
when AutoCAD Architecture does not provide the specific value that is required. When doing this, you need to be careful about the consistency of quantity value to your application or user.

## IFCELEMENTQUANTITY NAME

In many cases, the property set name will follow the localized language or standard terms, while the IFC standard name for the quantity may be fixed to follow a specific naming convention. AutoCAD Architecture allows you to override the name by specifying the name as part of the tag. For example: QTOSpace[IfcElementQuantity.BaseQuantities] will create IfcElementQuantity entity with BaseQuantities as the name instead of QTOSpace.

## SAMPLE QUANTITY

Your AutoCAD Architecture installation comes with a sample DWG that contains the predefined property sets with tags according to the current known requirements for basic Quantity information by the IFC community. It is located in the Content directory, under Style.



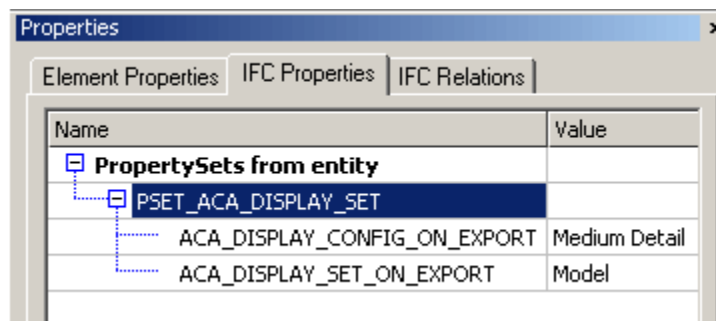
You can achieve GSA area quantity requirements the same way as above. The supplied template for GSA contains the same definition as described here.

### XIII. NOTES ON DISPLAY REPRESENTATIONS

#### HOW DOES EXPORT DECIDE TO CHOOSE DISPLAY REPRESENTATION?

AutoCAD Architecture allows you or the application to define different display sets, each with different settings. In some cases, the setting turns off certain objects in certain views, e.g. Model view. IFC is 3D model-based information and AutoCAD Architecture always takes 3D objects from the model space as the basis of export. This may give an appearance of inconsistent export result when you use different display configuration on the same model during export. To assist you to ascertain which display configuration is used, AutoCAD Architecture export will create a special property set attached to IfcProject that describes which display configuration is active when export is done and from which model view the export takes the information.

Note that AutoCAD Architecture export will always take the model view of the active display configuration.



### XIV. NOTES ON LAYER

#### LAYER PROPERTIES

Information on layer is exported into IFC. Only name and color of the layers are exported. Since IFC relates layer by the building element/object, not all layer definitions in AutoCAD Architecture will be exported. Only those that contain 3D objects will be included.

#### HOW ABOUT FREEZE LAYER?

Similar to AutoCAD Architecture, IFC has a placeholder to keep the status of layer: On/Off, Frozen, or Blocked. Unlike an object that is turned off by the display configuration, which is not going to be exported, all objects within the layers, regardless of the status, will always be exported with the associated layer status set accordingly. This means that only the application that handles the status of layers will be able to deal with the desired display result. One of the applications is AutoCAD Architecture itself. When you export a drawing which has objects in the layers that are off, they will be visible in most of the other applications but not in AutoCAD Architecture.



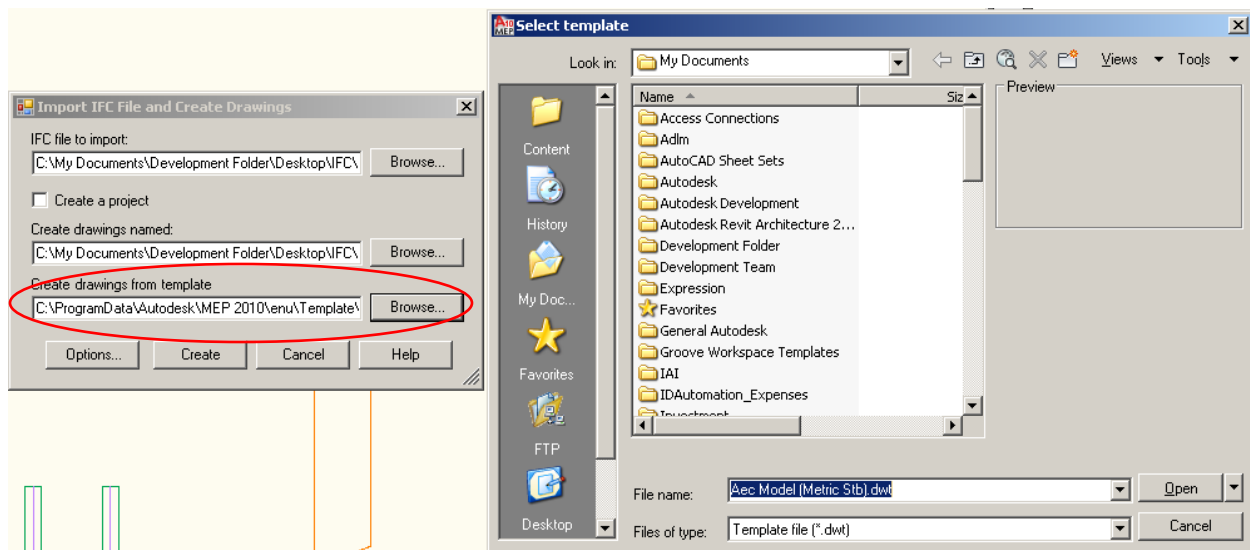
You need to ensure that you use the correct setting to achieve the special purpose you may have by hiding certain objects. If you do not want to see certain objects completely, you need to make sure it is turned off in the Model space of the active display configuration set rather than hiding it using layer properties.

## XV. IMPORTING IFC

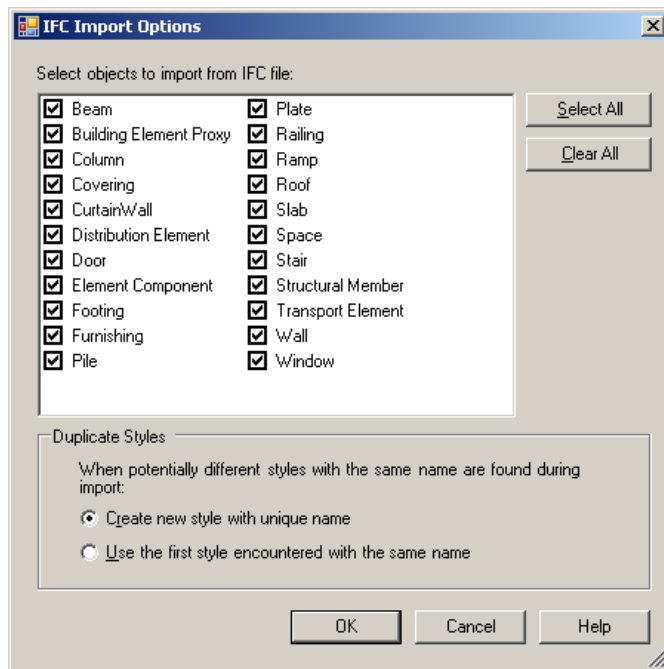
There are a few things you need to know to have your IFC file imported in the manner you expect. There are several options that you can select to control the certain behavior of import.

### A. USING TEMPLATES

In many cases, a project will have project standards and their associated templates to create a drawing. If you are certain that the drawing follows the standard, you may want to use your project template as the drawing template of import so that you can force the drawing to be created consistently with the styles and other settings as defined in the template.



## B. OPTIONS



There are 2 sets of options you can use to control the import:

1. Selective import. You can filter which architectural objects you want to import by selecting the appropriate choices. Remember that the selection is remembered in the registry so that it will continue to take effect in the next export and even the next session of AutoCAD Architecture.
2. Handling duplicate styles. As mentioned above, you can import an IFC file that you are reasonably confident of following your standard, using a template. You may even take one step further in enforcing the style by choosing the option to 'Use the first style encountered with the same name'. With this option, you tell AutoCAD Architecture to use the style found in the template regardless of what is in the IFC file whenever it finds a style with the same name.

## C. CLASSIFIED OBJECTS

When AutoCAD Architecture imports an IFC file, there are 2 situations when an object cannot be created as an equivalent object in AutoCAD Architecture:

1. There is not enough information to re-create the equivalent object in AutoCAD Architecture. For example, a stair object in AutoCAD Architecture requires a lot of parametric information which is not available in IFCStair. Because of this, AutoCAD Architecture will import IFCStair as an Mv-block that is classified as IFCStair. The classification allows you to identify the original object apart from its visual clue. This also helps AutoCAD Architecture to re-export the object back to IFCStair. This is applicable to other objects with similar situations, i.e. Ramp, Railing, and Roof.
2. The object is not an AutoCAD Architecture native object. This is applicable to a wide range of IFC objects that do not correspond to any AutoCAD Architecture objects, e.g. Covering, Pile, all MEP objects. AutoCAD Architecture will import all those objects as Mv-block classified as their original IFC entity.

## XVI. BATCH EXPORT AND IMPORT

Starting in AutoCAD Architecture 2010, you are able to use a script to run export or import. This will be useful when you need to run a batch process. Several things you need to note are:

1. In general, this dialog-less option is very similar to the dialog counterpart, except that the dialog is now represented in the form of a command prompt. Typical to a command prompt, you need to be familiar with the sequence and prepare the correct information to make sure it works as desired.
2. Due to the limitation of the runtime of the script in an AutoCAD environment that requires it to run within a single document, (whereas AutoCAD Architecture IFC import will need to open multiple documents as it processes the IFC file), you may run into trouble when there is a prompt in the process when AutoCAD Architecture is processing different documents. This may happen when AutoCAD Architecture detects a different unit in the IFC file and the template. The only solution to this is to ensure that this situation will not occur by making sure that you use the correct template with the same unit as the IFC file being imported.

## XVII. ROUNDRIP ISSUES

### POSSIBILITIES AND LIMITATION OF ROUNDRIP SCENARIOS

Roundtrip issues have been a challenge to most applications and, up to this point, the expectation for roundtrip is fairly low due to two reasons:

1. There is not much of a business case to support this. It is much more assured to import native format than to go through the translation process that guarantees loss of information.
2. It is currently not required as part of the IFC certification process.

AutoCAD Architecture, however, has been working hard to ensure an acceptable quality of roundtrip scenario. We built in the process in our development to ensure that we can import what we export. However, this does not guarantee exact re-creation of all AutoCAD Architecture objects when you perform export and import through IFC. The minimum roundtrip requirements are:

1. The object is geometrically preserved. It has to maintain its geometry correctness and placed at the correct location. This also implies that the geometry does not have to be the same type as the original one. For example, if the original type is an extrusion geometry, the imported geometry may be BREP as long as visual fidelity is maintained.
2. No missing object.
3. Only information that is part of standard exchange can be reliably preserved (mainly during export) and guaranteed imported back. In some cases, the application keeps its specific data in property sets. However, this data can be obsolete over time if the file has gone through many hands and hence is not reliable.

Using AutoCAD Architecture to perform roundtrip operations will generally follow the diagram below. While the imported drawing is not exactly the same as the original drawing, subsequent re-export and re-import will roughly maintain the same quality and information.

