# Import of IFC BIM models to IDA Indoor Climate and Energy 4

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# IFC Import

## *Introduction*

It is possible to create building geometry directly in IDA Indoor Climate and Energy 4 (IDA ICE), but quite often it will save time to import geometry from an already existing 3D building information model (BIM). Today most 3D architectural CAD applications can export models into the Industry Foundation Classes (IFC) data format[1], and IDA ICE can import these files. However, please note that IDA ICE does not require that the entire building is defined in this way. It is often optimal to draw a problematic part of the building manually.

IDA ICE imports the geometry for any solid object, but most crucial for simulation are walls, windows, doors and roofs. IDA ICE requires that spaces with correct heights have been defined in the BIM and imports the composition of the building into building storeys. In addition, IDA ICE can import styles for walls, windows and materials when these are available.

This document describes some details and potential pitfalls in the IFC import process.

## About the IFC format

The purpose of the IFC format is to enable exchange of intelligent building data between applications. In addition to geometry, IFC files contain important information about the type, properties and relationships of objects and composition of the building.

IFC is developed by International Alliance for Interoperability (IAI, also known as BuildingSMART), a world wide consortium aiming to define the requirements for software interoperability in the AEC/FM industry. Many leading software suppliers are committed to release IFC compliant solutions. More information about IAI can be found at http://buildingsmart.com and http://cic.vtt.fi/niai .

The IFC specification can be found at http://buildingsmart-tech.org/specifications

The IFC model is specified using the EXPRESS language and the file format for IFC files is Step P21(ISO 10303 part 21) defined by ISO  (see more about ISO at https://www.iso.org/home.html)

## *What is imported to IDA ICE?*

### Building composition

In IDA ICE, buildings are composed of building storeys. IDA ICE imports the list of building storeys and the list of objects contained by each building storey.

### Spaces

IDA ICE imports all necessary spaces. Mostly they are used to produce simulated zones. Some spaces can be used to provide the explicit shape for building storeys.  It is for the user to decide which of the spaces that should be converted into simulated zones, whether a few space should be merged into a single zone, and whether to use the largest space on a storey to define the storey's shape.

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[1] Supported releases are: IFC2x, IFC2x2 and IFC2x3

### Building element geometry

The position and geometry of walls, roof slabs, windows and doors are imported. Sometimes, complex shapes (especially curtain walls) will be simplified to suite IDA ICE (see "How is information from IFC interpreted in IDA ICE").

Other building elements (e.g. staircases, columns, railings) are imported mainly without simplification for visualization and calculation of shading.

### Styles

The names of wall, window and material styles are imported. These names can be very useful for attaching the same set of simulation properties to all objects with the same name, so that for example a certain window style in the IFC model automatically gets a given set of glazing data in the simulation model.

## What is not imported to IDA ICE?

Any data that is irrelevant to the simulation or that is not currently understood by IDA ICE, such as information about the building owner, is ignored. This information will make the files larger and more time consuming to read but will not otherwise harm the import process.

## How is IFC interpreted by IDA ICE?

### Measure system

Internally, IDA ICE uses SI-units. An IFC file may use another unit system, but should then always also contain a relationship to the SI unit system, which makes unit conversions possible.

### Ground level and elevation

IDA ICE requires at least one building in the IFC file. The building defines the ground level. Internally, IDA ICE assumes that the ground level is at zero elevation of the building's local coordinate system.

Each building storey defines its own elevation (building storey's elevation property) relative to the ground level. If this information is missing, IDA ICE calculates the elevation of the building storey from the origin of the building storey's local coordinate system.

### Geometry of walls, windows and doors

Walls with the following characteristics are imported without modifications:

- Vertical
- Constant thickness
- Center line (axis) is a straight line.

The bottom of a wall should be horizontal. Informally speaking, a "good" wall should be a vertical box, possibly with a more complex top center line.

If walls have more complex geometry, IDA ICE attempts to simplify them. For example, a curved wall is usually splitted into a few straight walls. For walls without axis or with non-constant thickness the simplification may not always succeed.

Wall layers are assumed to have the same thickness all over the wall.

Windows and doors are converted to rectangular parallelepipeds (shoe boxes); their lowest edges are parallel to the bottom edges of the wall that contains them.

## Internal and external walls and faces

It is crucial for an energy simulation to know correctly the geometry of each building storey. The faces of the storey should go along the outer faces of the external walls contained by that building storey. Each face should reach from the bottom of the storey to the bottom of the next storey or to the covering roof.

The geometry should be given in ifc either explicitly or by marking walls as external or internal ones so that external walls form an outline of a building storey that encircles all other walls.

The explicit geometry description can be taken from a so called grosspace, that is the largest space that contains all the spaces on the same building storey. It happens, if indeed there is the grosspace on the storey and the IFC import option "Use grosspaces" is on.

Otherwise IDA ICE tries to calculate the outline based on the relative geometrical positions of all external walls. If this calculation fails, IDA ICE tries to calculate the outline using all walls. If even this calculation fails, the user may have to edit the building shape manually. Imported spaces and walls will still be useful.

## Spaces and zones

Spaces are imported as prisms (http://en.wikipedia.org/wiki/Prism_(geometry)) with constant vertical height. IDA ICE may merge vertices that are connected with a side shorter than 0.5m to avoid short walls. Such a merging can sometimes cause skewed walls (nonrectangular corners) even if there are no skewed spaces. A skewed wall can also occur because of non-uniform wall thickness.

Some spaces are converted by the user to simulation zones. Several adjacent spaces that lie at the same level and have the same height can be merged into a single simulation zone. When a zone is created from a single space, its border coincides with the border of the space. When a zone is created from several adjacent spaces, its outer border is a polygon that envelops all the spaces.

The can be spaces not meant to be used as zones, for example, grosspaces. They can be easily sorted out. Just check the option "Keep intersecting spaces" is not chosen. Then for each pair of intersecting spaces the larger one will not be imported. This option doesn't affect the usage of the grosspace shape to give the shape for a building storey.

Every IFC wall that lies along a zone border at the same level as the zone is included in the set of zone walls. If a wall lies along the zone border only partly, then only an appropriate part of the wall is included in the set of zone walls. If an IFC-wall is either external or a zone wall, then all doors and windows that belong to the IFC wall and lie within the borders of a zone are also imported to zone walls. The wall orientation is used for avoiding an import of the same window or door into two adjacent zones.

## Mapping styles to properties

When a zone is created in IDA ICE, it is necessary to provide some additional information, including wall and window constructions and material properties. One can consider an imported style name of a wall, a window or a material as a clue to such information. The user can map each style name imported from IFC to an appropriate construction or property in an IDA ICE database. If a style name is not mapped, then a default construction or property set will be used. (Note that also the default can be mapped).

## Checklist for IFC import into IDA ICE 4.0

IDA ICE attempts to generate a meaningful geometrical simulation model from an IFC file. This process puts some special requirements on the contents of the IFC file.

Here are some typical situations that can cause; (1) *A complete failure* (denoted with red text), (2) *A partial loss of data* (denoted with orange text) or (3) *An interpretation that is not exact* (denoted with green text).

| | Requirement | Explanation and clarification | What happens if not |
|---|---|---|---|
| 1 | IDA ICE 4.0 supports IFC of versions 2x, 2x2 and 2x3 | IFC 1.51 and 2.0 are not supported from IDA ICE 4 | No import of unsupported versions |
| 2 | At least one **IFC Project** in the IFC file | The project is needed for establishing the units used in the data | No import if no project. Takes the first one if more than a single project is found. |
| 3 | At least one **IFC Building** in the file | The building is used to establish the ground level | No import if no building. The user can select which building to import if more than a single building is found. |
| 4 | At least one **IFC BuildingStorey** in the building | IDA ICE imports each storey and its building elements separately and tries to make a building section from a storey | No import if no storey |
| 5 | At least 4 walls on one of the building storeys. | There is nothing to simulate without walls. | No import if no storey with >3 walls |
| 6 | All walls, windows and doors should be contained by a single building storey | IDA ICE does not support objects that are contained by multiple storeys | The wall, window or door is not imported |
| 7 | a) Any window or door should be contained by a wall via an opening. b) The local coordinate system of an opening should refer to the local coordinate system of the walls containing it | Otherwise IDA ICE can't place a door or a window at the proper place. | The window or door is not imported |
| 8 | Any window or door should lie completely within wall borders | IDA ICE does not support windows and doors that are | The window or door is ignored partly or |

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| Requirement | | Explanation and clarification | What happens if not |
|---|---|---|---|
| | | completely or partly outside a wall | entirely |
| 9 | A building storey footprint should not contain holes | IDA ICE can calculate only the outer contour for storeys. | Any hole in the storey footprint is ignored |
| 10 | A space should have an explicitly given footprint without holes | IDA ICE uses only prismatic zones with a cutted top. | Any hole in the space shape is ignored<br><br>A space without a footprint is ignored. |
| 11 | In IFC 2x2 and higher, a wall should have an explicitly given center-line axis. | A wall is not "smart" without direction. | Tries to derive an axis by using wall-shape. |
| 12 | The building roof should cover every building storey that is not covered by another building storey | | Missing parts for a non-plate horizontal roof should be inserted manually. |
| 13 | Walls should be vertical, have constant thickness and be linear or circle arcs. | Only this kind of walls can be used for simulation in IDA ICE | Tries to simplify a more complex shape to a shape of a given type. |
| 14 | There is a limit to the complexity of objects. | For very complex geometries a single object may be described by a single line of a size (number of symbols) exceeding 32K | Tries to understand a long line anyway but without warranty |
| 15 | Building storeys should not intersect each other | IDA ICE supports only non-intersecting storeys | Cuts storeys into smaller non-intersecting pieces |
| 16 | There is a limit to the complexity of cut geometry (a geometric shape is cut by several cutting planes) | Such a shape description is indirect and the actual geometry needs to be calculated. The result can be unpredictable. | Cuttings are applied until the calculation fails. If calculation fails, the last result before failure is used. |
| 17 | A building storey should not have more than 1500 walls | Calculation for a storey needs too much memory if the number of walls is big. | The calculation of the external walls and the outline of the storey is skipped, the outline is replaced with a rectangle |
| 18 | There is a limit to the complexity of brep geometry: a polyhedron should not have more than 2000 sides. | Calculation for a polyhedron needs too much memory if the number of sides is big. In practice such a detailed | The object is ignored. |

| Requirement | | Explanation and clarification | What happens if not |
|---|---|---|---|
| | | description of shape has no value for a simulation. | |