Madaster IFC Import Process

Technical description of the processing of IFC files within the Madaster platform

Made for	Version	Date
Madaster users	4.13	8 November 2022

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1 Introduction

This document explains the processing of IFC files within Madaster and as such provides insight on how IFC files should be prepared for optimal use in the Madaster-platform. You'll find how the geometric properties, classification coding, construction phasing and material parameters are retrieved.

In general, the IFC Import Process in Madaster can be divided into two successive steps:

1. Reading/extracting the data fields from an IFC file.
2. Matching IFC elements by: (a.) Madaster Element Properties or (b.) Search Criteria.

These steps are shown in detail in the flowchart below and explained on the following pages.

Process top elements

For each top element in the IFC the following process is used:
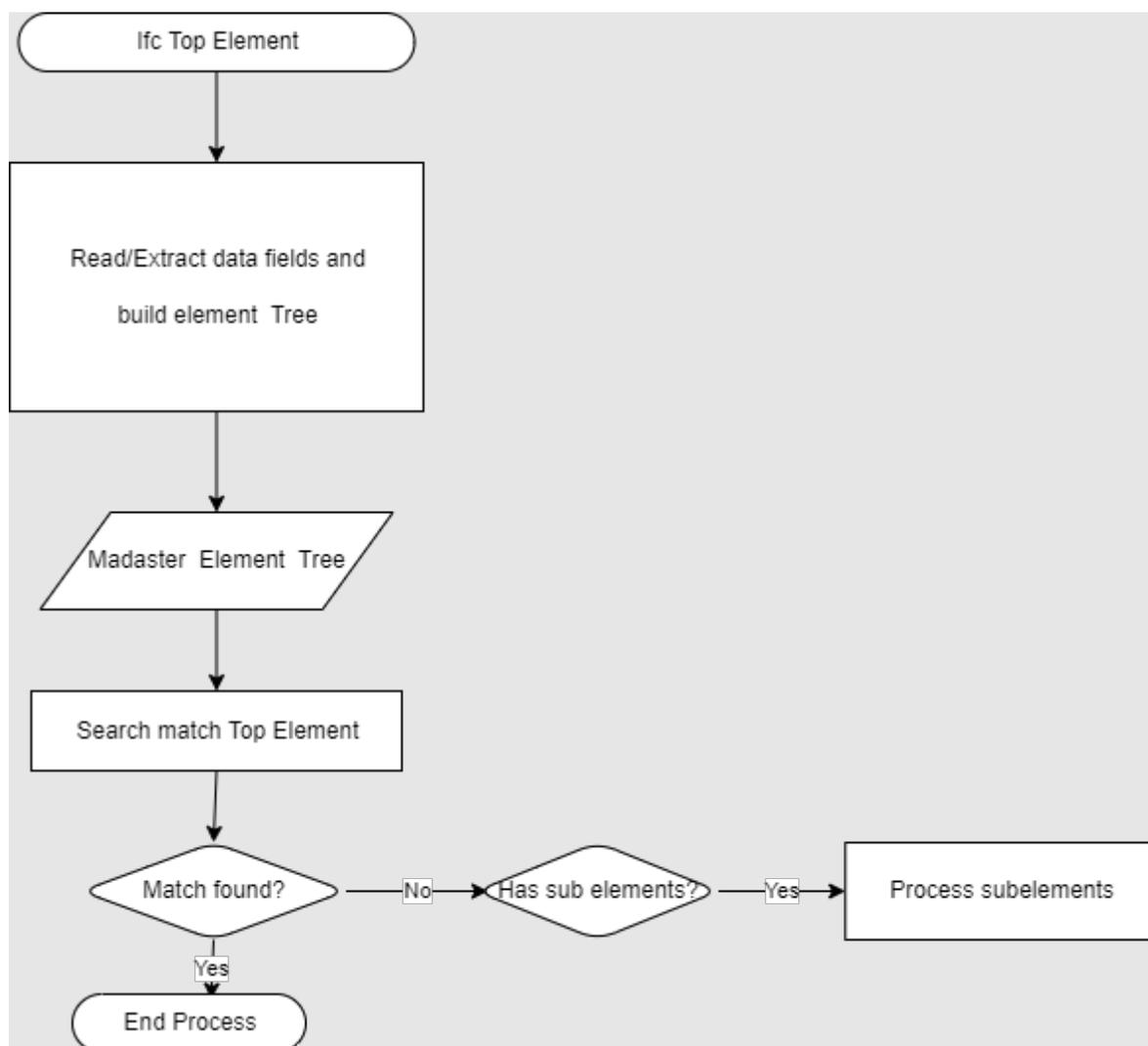
Process sub elements

For each sub element in the IFC the following process is used:
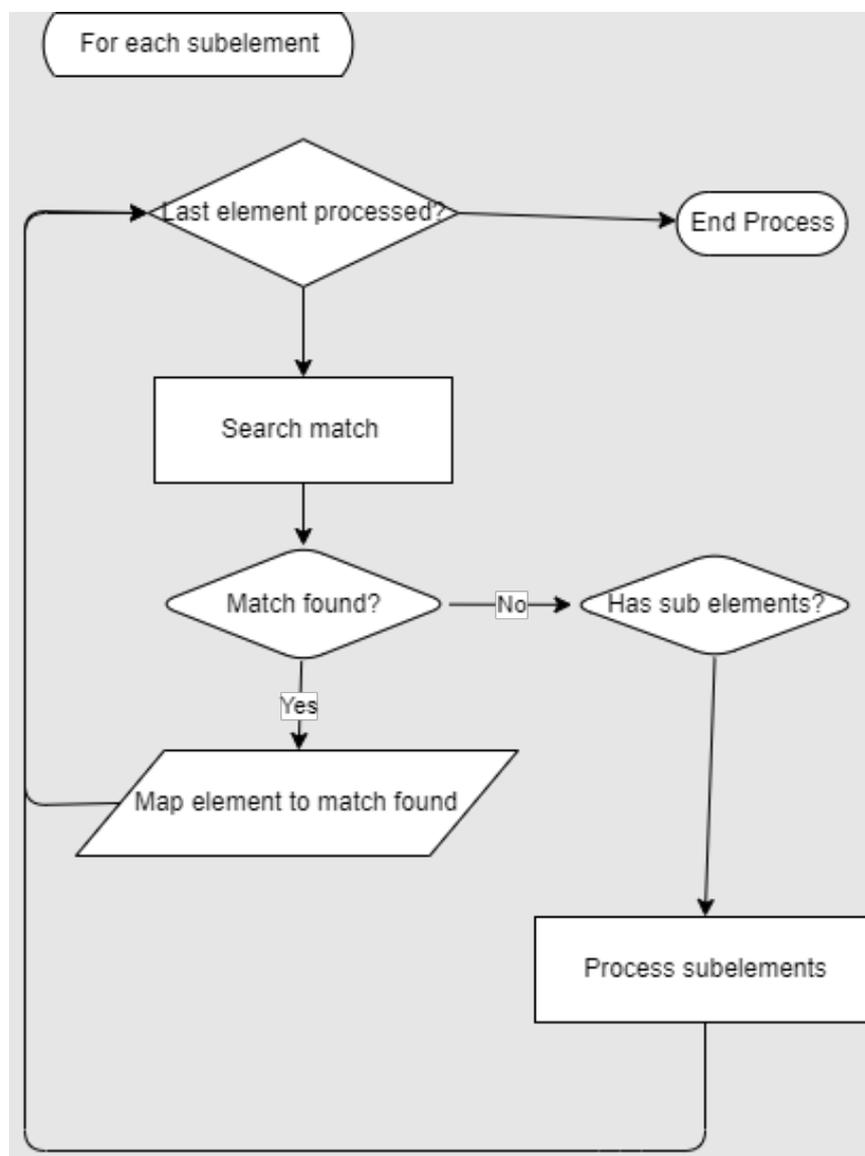
Process Search Match
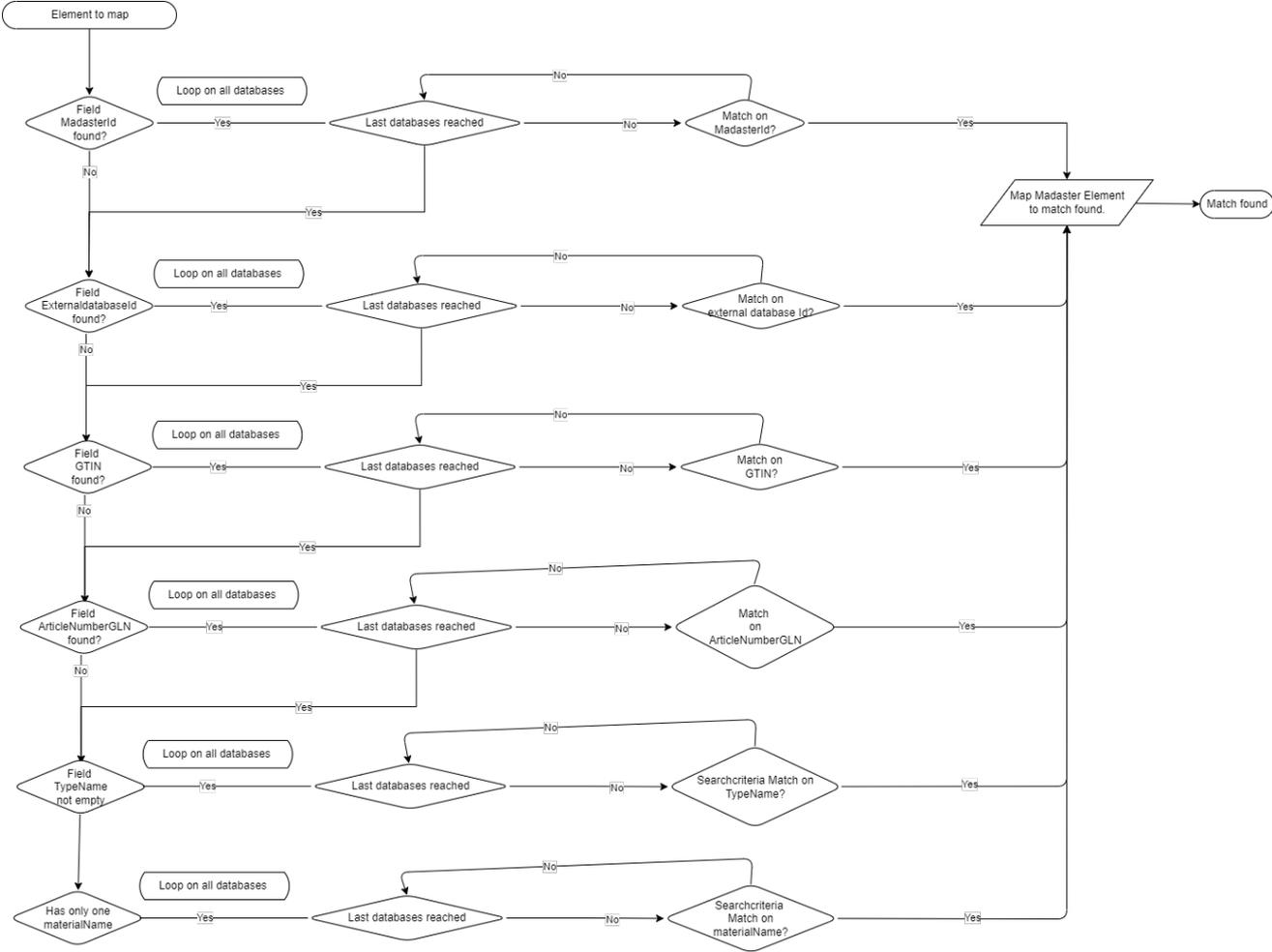
Order of matching on search criteria

```
┌─────────────────┐
│ Equals          │  Yes   ┌──────────────┐
│ case sensitive  ├───────►│ return match │
│ match?          │        └──────────────┘
└────────┬────────┘
      No │
         ▼
┌─────────────────┐
│ equals          │  Yes   ┌──────────────┐
│ match?          ├───────►│ return match │
└────────┬────────┘        └──────────────┘
      No │
         ▼
┌─────────────────┐
│ Starts with     │  Yes   ┌──────────────┐
│ match ?         ├───────►│ return match │
└────────┬────────┘        └──────────────┘
      No │
         ▼
┌─────────────────┐
│ Contains        │  Yes   ┌──────────────┐
│ Exact Word      ├───────►│ return match │
│ match?          │        └──────────────┘
└────────┬────────┘
      No │
         ▼
┌─────────────────┐
│ contains        │  Yes   ┌──────────────┐
│ case sensitive  ├───────►│ return match │
│ match ?         │        └──────────────┘
└────────┬────────┘
      No │
         ▼
┌─────────────────┐
│ contains        │  Yes   ┌──────────────┐
│ match?          ├───────►│ return match │
└────────┬────────┘        └──────────────┘
      No │
         ▼
┌─────────────────┐
│ Ends with match?│  Yes   ┌──────────────┐
│                 ├───────►│ return match │
└────────┬────────┘        └──────────────┘
      No │
         ▼
   ┌──────────────┐
   │ no match     │
   │ found        │
   └──────────────┘
```
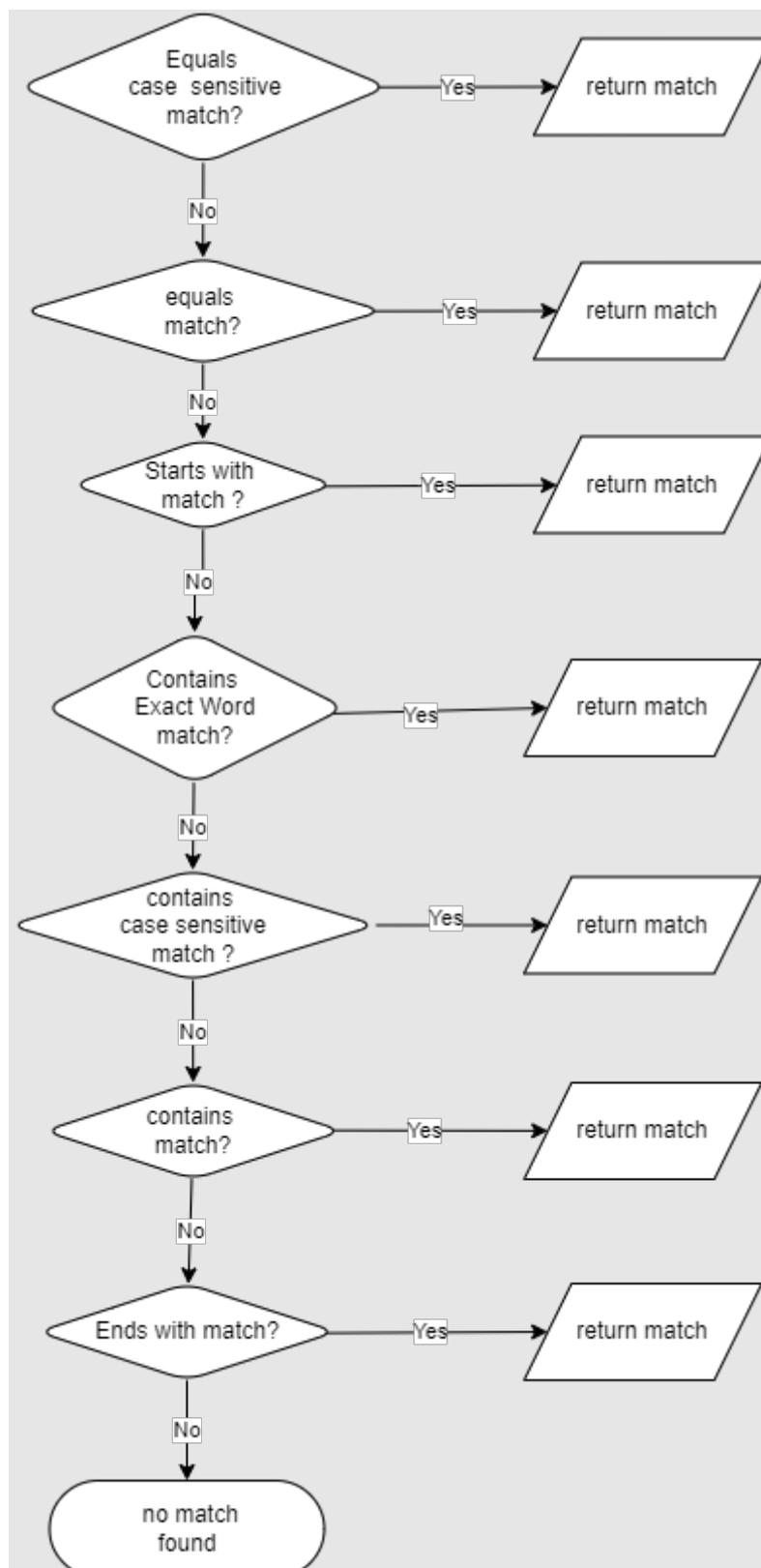
2 Reading/extracting the data fields from an IFC file.

2.1 Madaster Property set (Pset_Madaster)

If the property set with the name: Pset_Madaster is present on an IFC element and the properties below are entered within this data set, then these values of the properties are prioritized within Madaster. Other properties are then ignored.

Property Name	Property Type	Madaster Element	Description
MaterialOrProductId	IfcText	MadasterId	Unique identifier of a material or product within a Madaster database.
externaldatabaseId	IfcText	externaldatabaseId	Unique identifier of a material or product in an external database also connected to Madaster.
GTIN	IfcText	GTIN	
ArticleNumberGLN	IfcText	ArticleNumberGLN	The articleNumber|GLN combination.
MaterialOrProductName	IfcText	MaterialName	When filled, Madaster will use this material/product name to map to search criteria's (overrides the material information explained earlier).
Volume	IfcVolumeMeasure	Volume	
Area	IfcAreaMeasure	Area	
Length	IfcLengthMeasure	Length	
Width	IfcLengthMeasure	Width	
Height	IfcLengthMeasure	Height	
Depth	IfcLengthMeasure	Depth	
Weight	IfcMassMeasure		Not used yet.
Classification	IfcText	Classification	Code of the used classification method.
Phase	IfcText	Phase	
DetachabilityConnectionType	IfcText	DetachabilityConnectionType	See list of possible values in Detachability section 1

DetachabilityConnectionTypeDetail	IfcText	DetachabilityConnectionTypeDetail	See list of possible values in Detachability section 1
DetachabilityAccessibility	IfcText	DetachabilityAccessibility	See list of possible values in Detachability section 2
DetachabilityIntersection	IfcText	DetachabilityIntersection	See list of possible values in Detachability section 3
DetachabilityProductEdge	IfcText	DetachabilityProductEdge	See list of possible values in Detachability section 4

2.2 Detachability (disassembly)

The detachability indication in Madaster is based on the revised (2.0) version of the uniform measurement method for detachability, as described in the report 'Circular Buildings – a measurement methodology for disassembly potential 2.0', which was developed and tested by a consortium of, among others, the Dutch Green Building Council, Netherlands Enterprise Agency and W/E Adviseurs on behalf of the Ministry of the Interior and the Transition Agenda Circular Building Economy.

1. Property **DetachabilityConnectionType** and **DetachabilityConnectionTypeDetail** are used to indicate the type of connection

DetachabilityConnectionType		DetachabilityConnectionTypeDetail	
Possible values	Explanation	Possible values	Explanation
DryConnection	Dry Connection	Unknown	
DryConnection	Dry Connection	None	None
DryConnection	Dry Connection	Click	Click connection
DryConnection	Dry Connection	Velcro	Velcro connection
DryConnection	Dry Connection	Magnetic	Magnetic connection
AddedConnectionConnection	Connection with added elements	Unknown	
AddedConnectionConnection	Connection with added elements	BoltAndNut	Bolt and Nut connection
AddedConnectionConnection	Connection with added elements	Spring	Spring connection
AddedConnectionConnection	Connection with added elements	Corner	Corner joints
AddedConnectionConnection	Connection with added elements	Screw	Screw joints
DirectConnection	Direct integral connection	Unknown	

DirectConnection	Direct integral connection	Peg	Peg
DirectConnection	Direct integral connection	Nail	Nailing
SoftChemicalConnection	Soft chemical compound	Unknown	
SoftChemicalConnection	Soft chemical compound	Sealant	Sealant
SoftChemicalConnection	Soft chemical compound	Foam	Foam joint (PUR)
HardChemicalConnection	Hard chemical compound	Unknown	
HardChemicalConnection	Hard chemical compound	Glue	Adhesive bonding
HardChemicalConnection	Hard chemical compound	Dump	Poured connection
HardChemicalConnection	Hard chemical compound	Weld	Weld joint
HardChemicalConnection	Hard chemical compound	Concrete	Cementitious bond
HardChemicalConnection	Hard chemical compound	ChemicalAnchor	Chemische anchors

2. Property *DetachabilityAccessibility*

Possible values	Explanation
Accessible	Freely accessible without additional actions
PartialNoDamage	Accessible with additional actions that do not cause damage
PartialWithRepairableDamage	Accessible with additional operations with fully repairable damage
PartialWithDamage	Accessible with additional operations with partially repairable damage
NotAccessible	Not accessible - irreparable damage to the product or surrounding products

3. Property ***DetachabilityIntersection***.

Possible values	Explanation
None	No intersections - modular zoning of products or elements from different layers
Incidental	Occasional intersections of products or elements from different layers
Complete	Full integration of products or elements from different layers

4. Property ***DetachabilityProductEdge***

Possible values	Explanation
Open	Open - no obstacle to the (intermediate) removal of products or elements
Overlapping	Overlap - partial obstruction to (intermediate) removal of products or elements
Closed	Closed - complete obstruction to (intermediate) removal of products or elements

2.3   Default data fields for GTIN of Article number

Some manufacturer databases available within the Madaster platform contain GTIN, ArticleNumber and/or GLN information.

As described in the flow charts (first section of this document), Madaster matches on these properties. If not defined in the PSet_Madaster, these properties are retrieved from the default IFC properties as explained in the tables below, depending on the IFC version used (IFC2x3 or IFC4).

IFCv2.3:

Property set	Property Name	Madaster Element	Explanation
Pset_ManufacturerTypeInformation	ArticleNumber	ArticleNumberGLN	Field ArticleNumber GLN is specified as [ArticleNumber]|[GLN]
		GTIN	When ArticleNumber is 8, 13 or 14 characters long.
Pset_ManufacturerTypeInformation	Manufacturer	ArticleNumberGLN	GLN part of the field.
Pset_ManufacturerTypeInformation	ModelReference	ArticleNumberGLN	When ArticleNumber is empty, this field is used as ArticleNumber in the part of the Madaster ArticlNumberGLN element.

IFCv4:

Property set	Property Name	Madaster Element	Explanation
Pset_ManufacturerTypeInformation	GlobalTradeItemNumber	GTIN	Global Trade Item Number of the product.
Pset_ManufacturerTypeInformation	ArticleNumber	ArticleNumberGLN	Field ArticleNumber GLN is specified as [ArticleNumber]|[GLN]
		GTIN	When GlobalTradeItemNumber property is empty and ArticleNumber is 8, 13 or 14 characters long.
Pset_ManufacturerTypeInformation	Manufacturer	ArticleNumberGLN	GLN part of ArticleNumberGLN
Pset_ManufacturerTypeInformation	ModelReference	ArticleNumberGLN	When ArticleNumber data field is empty: ArticleNumber part of ArticleNumberGLN

2.4   Classification

The Madaster platform supports all local classification codes and the international OmniClass table 21 classification code. See below paragraphs for details.

First, all references of the element are searched for the type: IfcClassificationReference or IfcExternalReference. If no value is found in the IfcClassificationReference or IfcExternalReference, Madaster looks at the layer of the ifcElement and tries to match it to the classification.

2.4.1   The Netherlands

- **NL/SFB** classification code

When a property of this type is found, the system tries to match the value of this property against the 2-digit and / or 4-digit NL/SfB coding list.

Identification	Location	Quantities	Material	Relations	Classification	Hyperlinks
Classification		Source		Reference		Name
ARCHICAD Classification NED...		From IFC		Wand		
NL/SfB (4 cijfers)		From IFC		16.12		FUNDATIE BALKEN

Fig: Example of 4-digit NL/SfB coding on element.

2.4.2   Germany

- **DIN 276** classification code

When a property of this type is found, the system tries to match the value of this property against the 3-digit DIN276 coding list.

Klassifikation	Quelle	Referenz
DIN 276 Classification	Aus IFC	363

Fig: Example of DIN 276 coding on element.

2.4.3   Belgium

- **BB/SFB** classification code

When a property of this type is found, Madaster tries to match the value of this property against the 2-digit and/or 4-digit BB/SfB coding list.

Classification	Source	Reference	Name
BB/SfB	From IFC	21.3	NIET-DRAGENDE BUITE…

Fig: Example of 4-digit BB/SfB coding on element. (Optional for Revit-users: change the name of your classification to BB-SfB in Revit if you want the naming 'Uniformat Classification' to change to 'BB-SfB')

- **NL/SFB** classification code

When a property of this type is found, the system tries to match the value of this property against the 2-digit and / or 4-digit NL/SfB coding list.

Classification	Source	Reference	Name
ARCHICAD Classification NED…	From IFC	Wand	
NL/SfB (4 cijfers)	From IFC	16.12	FUNDATIE BALKEN

Fig: Example of 4-digit NL/SfB coding on element.

2.4.4   Switzerland

- **eBKP** classification code

When a property of this type is found, the system tries to match the value of this property against the eBKP coding list (1-letter followed by 4-digits, e.g., E 02.03).

Klassifikation	Quelle	Referenz	Name
eBKP-H Classification	Aus IFC	E02.04	Wand

Fig: Example of 4-digit eBKP coding on wall element.

2.4.5   Norway

- **NS 3451** classification code

When a property of this type is found, the system tries to match the value of this property against the 3- or 4-digit NS 3451 coding list.

IFC Element	IfcWall
Predefined Type	STANDARD
Tag	639196
GUID	0Gzm2x4df1LP7GRecSH9$I
Uniformat Classification	231, Bærende yttervegger

Fig: Example of 3-digit NS 3451 code on element.

2.4.6   International

- **OmniClass table 21** classification code

When a property of this type is found, the system tries to match the value of this property against the 6 digit and/or 8 and/or 10-digit OmniClass table 21 coding list.

Identification	Location	Quantities	Material	Profile	Relations	Classification	Hyperlinks	BaseQuantities	BaseQuantities_Ec
Classification						Source		Reference	
Omniclass Classification						From IFC		21-02 10	

Fig: Example of a 6-digit OmniClass coding on an element

2.5   Geometrical properties

2.5.1   Volume

For each element the area first tries to read the IfcQuantityVolume named "NetVolume" from the collection of type: IfcElementQuantity. If no value can be found here, all property sets of the element will be searched for a property with the name: "NetVolume".

If there are multiple property sets of the type IfcElementQuantity with a property "NetVolume", then the first one, by order of appearance in the file, is chosen. If no property with this naming convention can be found, the same process is repeated for properties with the following naming convention and in the following order until a value can be found:

- NetVolume
- Volume
- GrossVolume

Depending on the material composition, the volume is calculated in some scenarios by multiplying the material thickness by the material surface. For more information see section "Material".

Analytical Properties	BaseQuantities	Constraints	Construction	Dimensions
Property	**Value**			
GrossFootprintArea	0.13 m2			
GrossSideArea	2.20 m2			
GrossVolume	0.220 m3			
Height	2,064.00 mm			
Length	1,330.00 mm			
Width	100.00 mm			

Fig: Example of volume property within BaseQuantities property set.

2.5.2 Surface area

For each element, the area first tries to read the IfcQuantityAreaproperty named "NetArea" from the collection of type: IfcElementQuantity. If no value can be found, all property sets of the element will be searched for a property with the name: "NetArea".

If there are multiple property sets of the type IfcElementQuantity with a property "NetArea" then the first one, by order of appearance in the file, is chosen. If no property with this naming convention can be found, the same process is repeated for properties with the following naming convention and in the following order until a value can be found:

- NetArea
- NetSideArea
- NetSurfaceAre
- GrossSideArea
- TotalSurfaceArea
- GrossSurfaceArea
- OuterSurfaceArea
- CrossSectionArea
- TotalArea
- GrossArea

2.5.3 Length

For each element, for the length, the area first tries to read the IfcQuantityLength property named "Length" from the collection of type: IfcElementQuantity. If no value can be found, all property sets of the element will be searched for a property with the name: "Length".

When there are multiple property sets of the type IfcElementQuantity or multiple properties with the name "Length", the first property is chosen.

2.5.4 Width

For each element, for the length, it first tries to read the IfcQuantityLength property named "Width" from the collection of type: IfcElementQuantity. If no value can be found for this, all property sets of the element will be searched for a property with the name: "Width".

When there are multiple property sets of the type IfcElementQuantity or multiple properties with the name "Width", the first property is chosen.

2.5.5   Height

For each element, the length first tries to read the IfcQuantityLength property named "Height" from the collection of type: IfcElementQuantity. If no value can be found for this, all property sets of the element will be searched for a property with the name: "Height".

If there are multiple property sets of the type IfcElementQuantity or multiple properties with the name "Height", the first property is chosen.

2.5.6   Depth

For each element, for the length, it first tries to read the IfcQuantityLength property named "Depth" from the collection of type: IfcElementQuantity. If no value can be found for this, all property sets of the element will be searched for a property with the name: "Depth".

If there are multiple property sets of the type IfcElementQuantity or multiple properties with the name "Depth", the first property is chosen.

2.5.7   Weight

For each element, for the length, it first tries to read the IfcQuantityWeight property from the collection of type: IfcElementQuantity.

When there are multiple property sets of the type IfcElementQuantity or multiple properties of the type "IfcQuantityWeight", the first property is chosen.

2.5.8   Geometrical properties nested families

Madaster can read out nested families if they are properly inserted in a BIM file. This is what the IFC file should look like and how Madaster reads it out:

In the IFC (see pic):
1. Define base quantity (m2/m3) of the entire element
2. Define Thickness for each layer

In Madaster (see pic)
1. Area read out in Madaster as defined in the respective property set e.g., here Qto_BaseQuantities
2. With the Thickness shown in the IFC file, Madaster can derive the volume for the specific material layer e.g., 6,46 x 0.07 = 0.45m^3

IFC file:
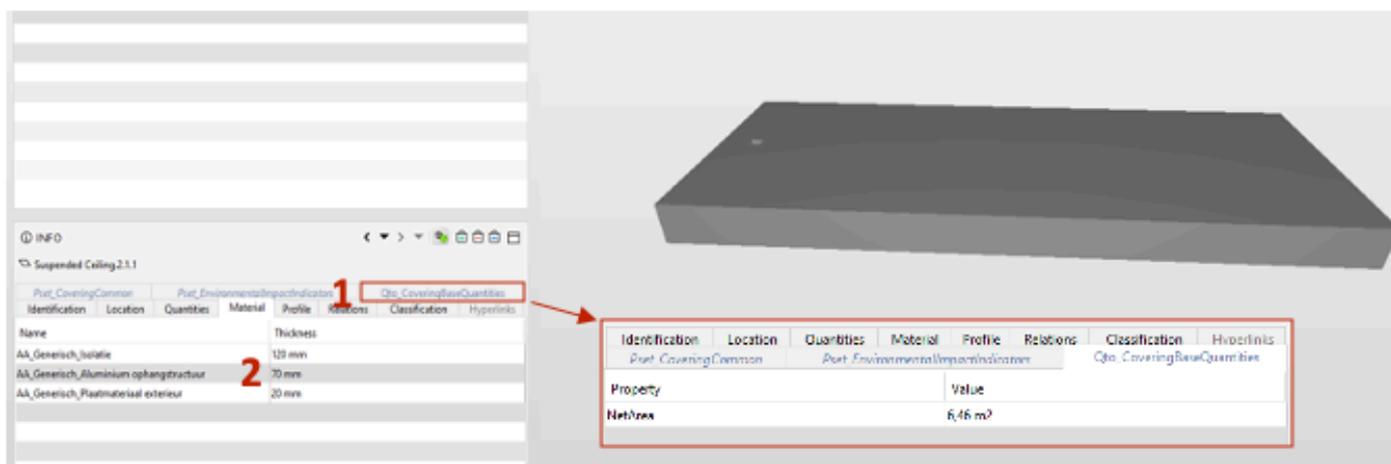
Grouped elements/nested families:

1. Define base quantity (m²/m³ of the entire element)
2. Define Thickness for each layer

> The number of layers is not limited. You just need to make sure that each layer in your element has a defined thickness.

Madaster (enrichment view):

Example detailed information per material layer:

NOTE for Archicad users: If you want to create a nested family for a door or window in IFC with Archicad you can't use this workflow. Archicad considers a door and window as one element. Therefor you need to draw the door and window in 3D in Archicad and add the different layers to the window/door by hand. Then IFC recognizes the door/window as a nested family with the different layers.

2.5.8.1   If thickness is not defined

1. If Thickness of a layer is not defined, the layers will appear as one element in Madaster.
2. Due to the double naming, e.g., *glass & Aluminum*, Madaster is unable to identify a unique corresponding material, hence no match can be found.

IFC file:

Madaster (enrichment view):

2.6   Material

For each element, the material is retrieved via the IfcMaterialSelect relationship. And depending on the characterization of the related material property, different scenarios are handled for the following characterizations:

2.6.1   IfcMaterialLayerSetUsage

If the material property is of type IfcMaterialLayerSetUsage then an attempt is made to get IIfcMaterialLayerSet. And here it is checked whether this list contains multiple elements and whether the thickness (Thickness) property has been entered. If this is the case and the value of the property Thickness is greater than 0 mm, the element is split into the number of materials in the layerset.

Identification	Location	Quantities	Material	Profile	Relations	Classification	Hyperlinks
Name			Thickness				
Steen - Baksteen			100.00 mm				
Lucht			40.00 mm				
Isolatie - Kunststof hard			100.00 mm				
Steen - Kalkzandsteen C			100.00 mm				

Fig: Example of a material specification with layerSet

The volume of these materials is then calculated as follows:

Volume = Area * Thickness of layer.

If the property Thickness is 0 or not filled in, then multiple materials are specified on the element and the volume remains from the volume proportions as specified above. The field "Name" of the property is used for naming the material.

2.6.2   IfcMaterialLayerSet

If the material property is of type IfcMaterialLayerSet, then it is checked whether the list contains multiple layers. And whether the "Thickness" property has been entered. If this is the case and the value of the property Thickness is greater than 0 mm, the element is split into the number of materials in the layerset.

The volume of these materials is then calculated as follows:

Volume = Area * Thickness of layer.

If the property Thickness is 0 or not filled. Then multiple materials are specified on the element and the volume remains from the volume proportions as specified above. The field "Name" of the property is used for naming the material.

2.6.3 IfcMaterialList

If the material property is of type IfcMaterialList, multiple materials are specified on the element and the volume remains from the volume proportions specified above. The field "Name" of the property is used for naming the material.

2.6.4 IfcMaterial

If the material property is of type "IfcMaterial" then the property is taken from the field "Name" of the property.

Identification	Location	Quantities	Material	Profile	Relations	Classification	Hyperlinks
Name							
Beton gewapend prefab							

Fig: Example material specification without file set.

2.6.5 Material naming of nested families

For materials to be matched correctly with a database in Madaster all layers should have a clear material name e.g., generic_insulation, generic_alumimium, generic_Plate material.

IFC file:
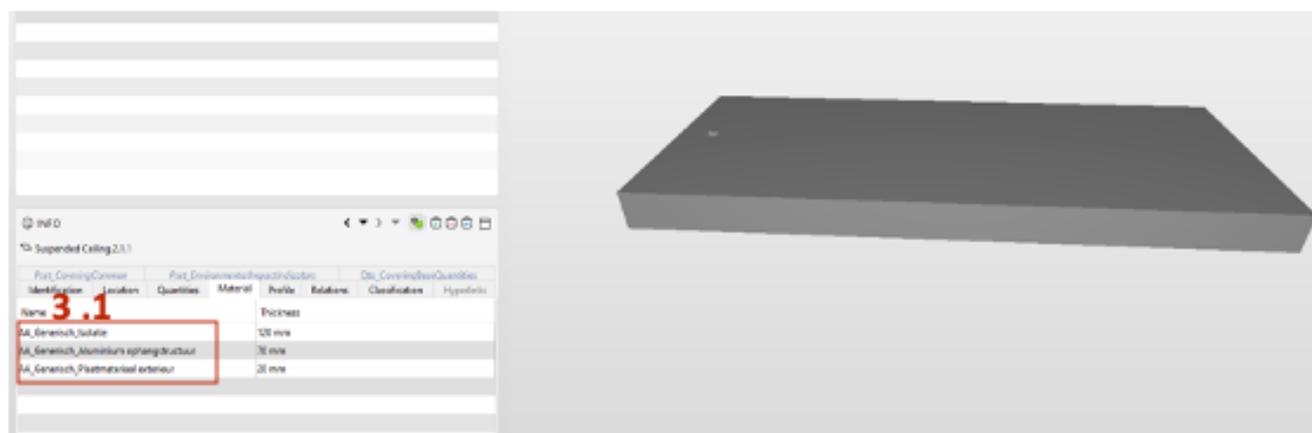
For all Elements:

3.1: Give a clear Material Name in all Layers

Madaster (enrichment view):

3.1: A clear material name is necessary for Madaster to match corresponding material information from the database.

It is possible to create a product in your own database on Madaster to get a match without having to change the "material name" you use at your company. Take the Type Name (3.2) as shown in the picture:

IFC file:
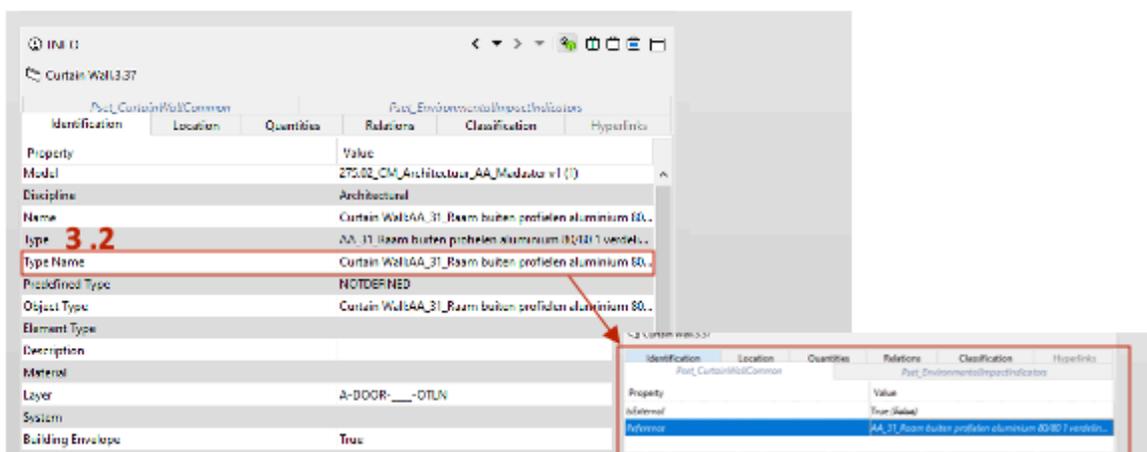
For all Elements:

3.2: Use the Name of the entire element, which is indicated as Type Name, and set up a corresponding "product" on Madaster yourself containing the material information of different layers.

You can then copy this Type name and add a product in your database. Give a name to the product, add the materials of the product, and add the Type name in the search criteria for matching in Madaster on the Type level also tick the checkbox "Criterion valid for ifcElement typename". (More on how to create a product in your database you can find on docs.madaster.com):

Linking an element in Madaster by adding a product:

3.2: Set up your own product in your database containing the different material layers: Aluminium Frame, Glazing etc.

Setting the search criteria to be the same as the name of the element, Madaster is able to match the information.
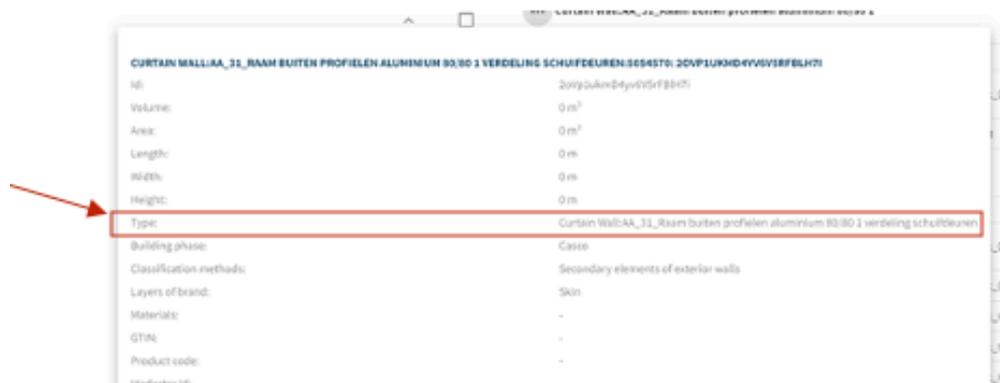
2.7   Building phase

For each element, the build stage is taken from the property with one of the following naming conventions (this is case sensitive):

- Phase Created
- Renovation Status
- Phase

AC_Pset_RenovationAndPhasing	ArchiCADProperties	ArchiCADQuantities	BaseQuantities
Property		Value	
Renovation Status		Existing	

Fig: Example of phase in Archicad CAD-application

Graphics	Identity Data	Other	Phasing	Pset_WallCommon	Structural
Property			Value		
Phase Created			Nieuw		

Fig: Example of phase in Revit CAD-application

Then the values from these properties are matched as follows:
- Demolition
    - o Demolition
    - o To be demolished
    - o Sloop
    - o Rückbau
    - o Riving

- New
    - o Nieuw,
    - o New,
    - o Nieuwe materialen,
    - o Neue materialien,
    - o Virgin materials,
    - o Jomfruelige materialer,
    - o Nye,
    - o Einbau,
    - o Ny

- Casco
    - o Casco,
    - o Leeg,
    - o Existing,
    - o Bestaand,
    - o Rohbau,
    - o Råbygg,
    - o Zwischenstand,
    - o Mellomstatus

The matching is performed on the entire sentence / word and is not case sensitive. If there is no matching with the categories above, the element will be mapped to "Casco".

The construction phase "Existing" and "Final" are calculated using the above phase according to the following calculation:
- Existing = Demolition + Casco
- Final = Casco + New

2.8 Building number ("split building" feature)

The "split buildings" function offers the possibility in Madaster to draw up individual building files and passports based on a prepared IFC file with several buildings/homes. This makes it superfluous to prepare IFC models per object in IFC prior to being entered in Madaster, to subsequently prepare a building file (including materials passport) for this.

To make use of this function, a property set and name must be defined in the IFC file per element (is flexible) in which an individual construction number is recorded (e.g., A02).

It is also possible to assign several construction numbers (separated by a comma) to one IFC element. For example: A02, A03, A04, A05. Based on the number of construction numbers, the Madaster system will assign them proportionally in percentages. In the image below there is 1 IFC element, which is assigned to 4 construction number, because of which these construction numbers in Madaster are assigned "(25%)".

Note: it is not (yet) possible to read out a deviating percentage per construction number in Madaster (e.g., 1 IFC element with assignment to 2 construction numbers according to ratio: 70% vs. 30%).

2.9   Matching elements on search criteria

If materials are specified per element, they are automatically validated during data upload in Madaster against (linked with) materials and products that are known within the selected Madaster database(s). These can be found in the Madaster navigation menu under "Databases & suppliers". If available, company account specific databases can also be selected during this import process. Each material and/or product can be provided with search criteria per language:

Fig: Example of search criteria in material/product in Madaster

When importing an IFC file, the materials of each element are matched against these search criteria(s). This involves checking whether the material of an element matches one of the search criteria at product/material level in the selected languages.

Search criteria on product/material level can be configured in several ways:
- Equals the search criterion (Case sensitive)
- Equals the search criterion
- Starts with the search criterion
- Contains exact word[1]
- Contains the search criterion
- Contains the search criterion (Case sensitive)
- Ends with the search criterion

(Also, a search criterion can be matched against TypeName of an IFC element when the checkbox "Criterion valid for ifcElement typename" is ticked.)

And runs sequentially as long as no match is found:

1. Against the "Equals" criteria (case sensitive)
2. Against the "Equals" criteria
3. Against the "Starts with" criteria
4. Against the "Contains exact word" criteria
5. Against the "Contains" criteria contained (case sensitive)
6. Against the "Contains" criteria
7. Against the "Ends with" criteria

If multiple matches are found in step 3, 5, 6 or 7, the longest match (largest number of matching characters) will be used.

When multiple materials are added to an IFC element without a thickness (Thickness) then the matching of this element will be done by matching the concatenation of the material names against search criteria which are valid for ifcElement typename (if the checkbox "Criterion valid for ifcElement typename" is ticked on the search criteria).

If no products and/or materials are linked, they can be manually linked to the element via the enrichment screen in Madaster. Any new materials and/or products can also be created here. (More on how to create a product in your database you can find on docs.madaster.com)

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[1] The materialname/typename to be matched is split on spaces and tabs and the following characters:, ;()-_
if one of the resulting words is equal to the criterion (case sensitive), there is a match.