Modeling Guide for 3D Objects

Part 2: Modeling of Buildings (LoD1, LoD2 and LoD3)

SIG3D Quality Working Group

Version 2.0.0 EN as of November 2013

http://www.sig3d.org
http://en.wiki.quality.sig3d.org

Document History

Version	Date	Author(s)	Remarks
1.0.0	May 2012	SIG 3D - Quality Working Group ; © 2012-2014 Special Interest Group 3D (SIG3D) of the Spatial Data Infrastructure Germany (GDI-DE)	First public version (in German only)
2.0.0 EN	November 2013	SIG 3D - Quality Working Group ; © 2013-2014 Special Interest Group 3D (SIG3D) of the Spatial Data Infrastructure Germany (GDI-DE) / EC, KHH	English version;

Modeling Guide for 3D Objects - Part 2: Modeling of Buildings (LoD1, LoD2, LoD3)

Table of Content

1" Introduction ....3"
1.1" Scope ....3"
1.2" Target Group ....3"
1.3" Prior Knowledge Required ....3"
1.4" Further References ....3"
1.5" Document Conventions ....4"
2" Definitions und Determinations ....4"
2.1" Level of Detail (Building, BuildingPart) ....4"
2.1.1" Definitions of SIG 3D: ....4"
2.2" Reference Coordinate System ....5"
2.3" Model Structure ....5"
2.4" Heights ....6"
2.5" Terrain Intersection Line ....8"
2.6" Overhanging Building Elements ....9"
2.7" Closed Coverage Type ....10"
2.8" Addresses ....11"
2.9" Codelists ....12"
2.10" Generic Attributes ....13"
2.11" Geometry ....14"
2.12" File Extension ....14"
3" Modeling ....15"
3.1" Base Modeling ....15"
3.1.1" Building (*bldg:Building*) ....15"
3.1.2" Building Part (*bldg:BuildingPart*) ....18"
3.1.3" Building Installations (*bldg:BuildingInstallation*) ....21"
3.1.4" Ground Surfaces (*bldg:GroundSurface*) ....24"
3.1.5" Wall Surfaces (*bldg:WallSurface*) ....26"
3.1.6" Roof Surfaces (*bldg:RoofSurface*) ....29"
3.1.7" Outer Floor Surfaces(*bldg:OuterFloorSurface*) ....31"
3.1.8" Outer Ceiling Surface(*bldg:OuterCeilingSurface*) ....33"
3.1.9" Virtual Boundary Surface (*bldg:ClosureSurface*) ....35"
3.1.10" Doors (bldg*:Door*) ....36"
3.1.11" Windows (*bldg:Window*) ....38"
3.2" Extended Modeling ....40"
3.2.1" Balconies ....40"
3.2.2" Loggias ....42"
3.2.3" Passages ....45"
3.2.4" Dormers / Gable (Dormer Gable) ....48"
3.2.5" Arcades / Architraves ....50"

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

1 Introduction

1.1 Scope

- The modeling recommendations are usually independent from the recording method. That means that this document is **not** a recording manual.
- This document describes the modeling of 3D objects on the basis of **existing information**. In case of lacking information, in particular in case of missing height information, objects must **explicitly not** be modeled. For example, if all relevant information on balconies is available, this document provides recommendations for a standardized modeling. Otherwise balconies must not be modeled.
- Recommendations are related to the Open Geospatial Consortium (OGC) standard **CityGML version 1.0 and 2.0**.
- This document refers to **national (German) and European standards** (AdV, INSPIRE) and can only be partially generalized.
- This document is restricted to the **outer shell** of buildings, i.e. building modeling up to LoD3

1.2 Target Group

- Modeler
- Data holder
- Developer

1.3 Prior Knowledge Required

- GML: Geography Markup Language
- CityGML: Application schema for GML for the representation, storage, and exchange of virtual 3D city and landscape models
- ALKIS: Official German Land Registry Information System

1.4 Further References

- CityGML 1.0 Specification
- CityGML 2.0 Specification
- Modeling Guide for 3D Objects - Part 1: Basics (Rules for Validating GML Geometries in CityGML)
- GeoInfoDok V 6.0 - Modeling of the geoinformation of the official surveying and mapping of Germany (Main Document, in German only)

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

- ALKIS feature catalogue with building information (in German only)

1.5 Document Conventions

- **Features** are written in *italic characters* with the corresponding name space in ***bold characters*** .
- **Examples** are written in fixed width.
- **Online references** to other internal or external pages and documents are written in blue.
- A statement which is not valid for all **Levels of Detail** (LoD) is noted as (LoD[1234][+]), e.g. a notation with (LoD1) is only valid for LoD1, a notation (LoD2+) is valid for all LoDs from LoD2 and above.

2 Definitions und Determinations

2.1 Level of Detail (Building, BuildingPart)

2.1.1 Definitions of SIG 3D:

- LoD0
  - For every building or building part the footprint or roof outline is represented by a horizontal polygon with a well defined absolute and constant height.
- LoD1
  - For every building or building part the generalized outer shell is represented by exactly one prismatic extrusion solid. Ground, floor and roof surfaces must be horizontal, lateral boundary surfaces must be vertical.
- LoD2
  - For every building or building part the geometrically simplified outer shell is represented by horizontal resp. vertical outer surfaces and simplified roof shapes. All kind of surfaces (e.g. ground surfaces, wall surfaces, roof surfaces, outer ceiling surfaces, outer floor surfaces, virtual closure surfaces) and additional building elements (e.g. building installations like balkonies, dormers and chimneys) may be represented as semantic objects.
- LoD3
  - For every building or building part the geometrically detailed outer shell is represented by detailed outer surfaces and detailed roof shapes. All kind of surfaces (e.g. ground surfaces, wall surfaces, roof surfaces, outer ceiling surfaces, outer floor surfaces, virtual closure surfaces) and additional building elements (e.g. building installations like balkonies, dormers and chimneys) may be more detailly represented as semantic objects. In respect to LoD2 doors and windows can be modeled as planar thematic objects.
- LoD4
  - For every building or building part the geometrically detailed outer shell and interior is represented by detailed outer and inner surfaces and detailed roof shapes. All kind of surfaces (e.g. ground surfaces, inner and outer wall surfaces, inner and outer roof surfaces, outer ceiling surfaces, outer floor surfaces, virtual closure surfaces) and additional movable and non movable building elements (e.g. building installations like balconies, dormers, chimneys, interior and furniture) may be represented with greater detail as semantic objects.

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

2.2 Reference Coordinate System

CityGML 2.0 strongly recommends the specification of a reference coordinate system. For a meaningful use of data a valid reference coordinate system is imperative, therefore a valid reference coordinate system must be defined for each instance file:

- A reference coordinate system must be defined as **three dimensional** (usually position and height reference system --> see Compound Coordinate Reference System).
- A reference coordinate system should **not** be changed within an instance file.
- A reference coordinate system should be defined once within <gml:Envelope>.

Recommendations for Germany: *ETRS89 / UTM / Reference ellipsoid GRS80 + DHHN92*

CityGML Example:

```
<gml:boundedBy>
  <gml:Envelope srsDimension="3" srsName="urn:adv:crs:ETRS89_UTM32*DE_DHHN92_NH">
  --> see Compound Coordinate Reference System
     <gml:lowerCorner srsDimension="3">458868.0 5438343.0 112.0 </gml:lowerCorner>
     <gml:upperCorner srsDimension="3">458892.0 5438362.0 117.0 </gml:upperCorner>
  </gml:Envelope>
</gml:boundedBy>
```

ALKIS Example:

```
<gml:boundedBy>
   <gml:Envelope srsName="urn:adv:crs:ETRS89_UTM32">
      <gml:pos>367456.554 5718128.391</gml:pos>
      <gml:pos>367505.094 5718091.143</gml:pos>
   </gml:Envelope>
</gml:boundedBy>
```

see also Modeling Guide for 3D Objects - Part 1

2.3 Model Structure

The use of *core:CityModel* is not regulated explicitly in the specification and in the schema. The multiple use of *core:CityModel* is compliant to the schema and will be validated. In order to avoid conflicts while importing CityGML models, it is recommended to use **exactly one** instance of *core:CityModel* as **root element**.

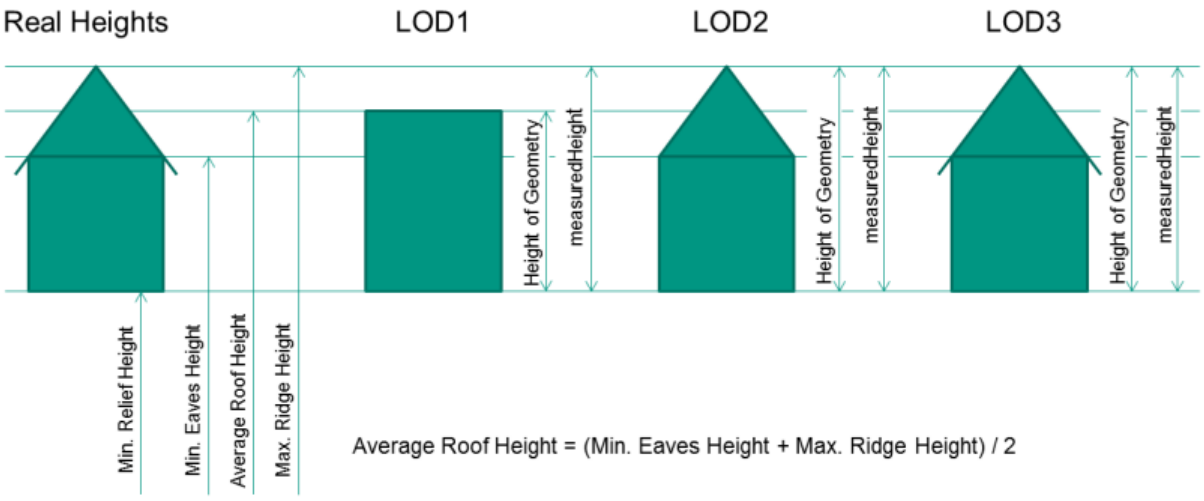
© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

2.4 Heights

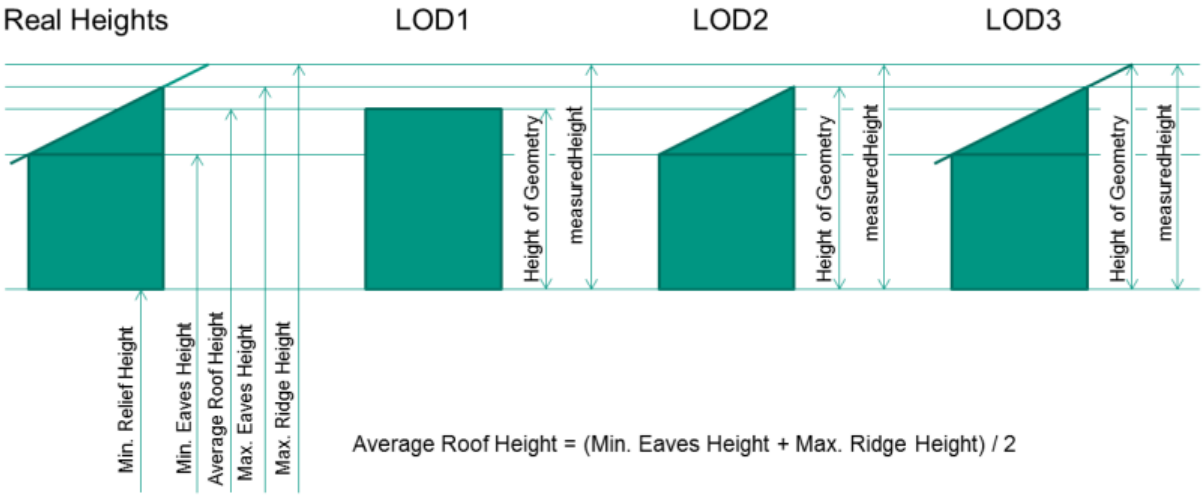
The *measuredHeight* is the **measured** or **computed** difference between the lowest terrain intersection point and the highest roof point with the following properties:

- the *measuredHeight* is a **simple** attribute and so can not be specified and/or qualified any further;
- the *measuredHeight* is **always** related to the **real** building;
- the *measuredHeight* is **independent of the LoD** of the building;
- the **computation** of the *measuredHeight* should always base on the terrain model with the **highest available resolution**.

The following heights are valid for flat roofs, outshot roofs, gable roofs, hip roofs, jerkinhead roofs, mansard roofs, pyramid roof, shed roof, shells and domes:

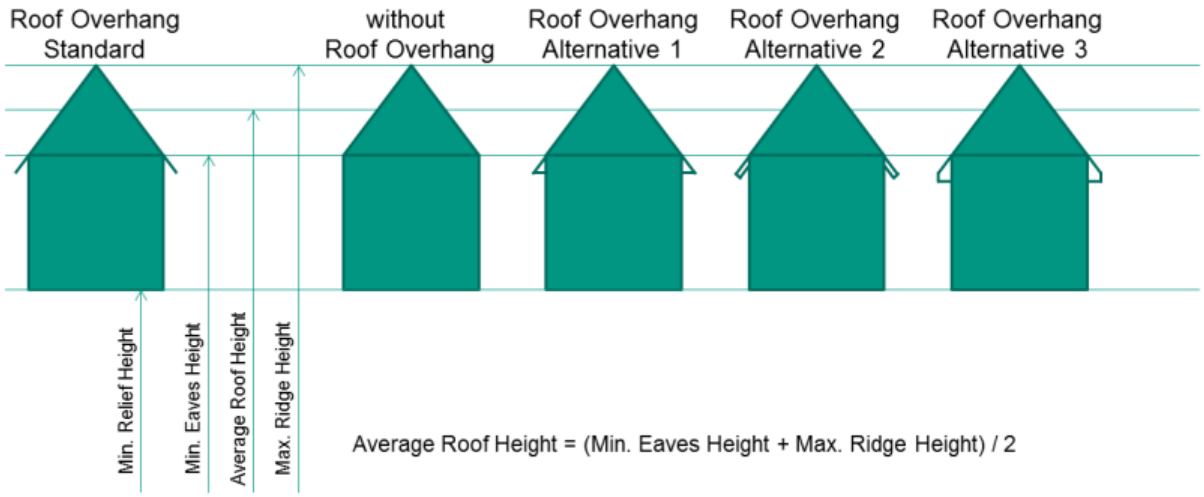


The following heights are valid for all kind of shed roofs:



© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

The following heights are valid for different roof overhangs:



If absolute heights for the noted values are needed, they have to be defined as generic attributes (dimensioned *gen:measureAttribute*):

- *<gen:measureAttribute name="min height surface"><gen:value uom="#m">Value</gen:value></gen:measureAttribute>*
- *<gen:measureAttribute name="min height eaves"><gen:value uom="#m">Value</gen:value></gen:measureAttribute>*
- *<gen:measureAttribute name="max height eaves"><gen:value uom="#m">Value</gen:value></gen:measureAttribute>*
- *<gen:measureAttribute name="max height ridge"><gen:value uom="#m">Value</gen:value></gen:measureAttribute>*

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

2.5 Terrain Intersection Line

In CityGML the terrain intersection line is an attribute of a building or building part. It is generated by intersection of the building or building part with the terrain and has the following properties:

- a terrain intersection line can be **measured** or **calculated** ;
- if a terrain intersection line is calculated, the terrain model with the **highest resolution available** should be used;
- a terrain intersection line is an **attribute** of the **building or building part**;
- outer building installations (*bldg:BuildingInstallation*) are **taken into account** from a terrain intersection line (see **Figure A**);
- a terrain intersection line is a result of the intersection of buildings in the respective LoD and the most accurate available terrain. In CityGML it has no relation to the terrain used in a visualization and its resolution and accuracy.
- a terrain intersection line may consist of **several independent parts**;
- a terrain intersection line **need not be closed**;
- a terrain intersection line which does not exist in reality will **not be taken into account** (e.g. in the case of building parts).

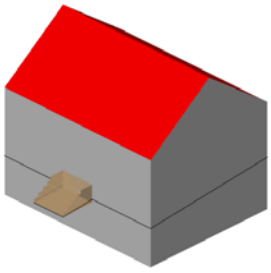


Figure A

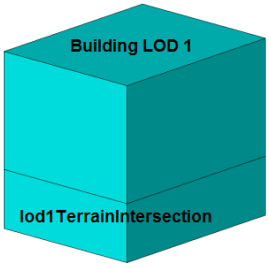


Figure B

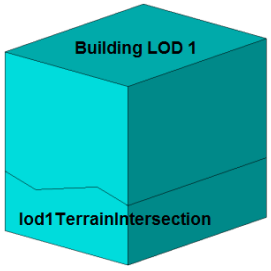


Figure C

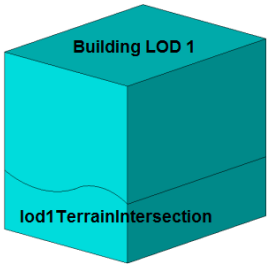


Figure D

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

2.6 Overhanging Building Elements

Overhanging or projecting building elements are defined as **parts** of roofs, walls etc, which should **not be considered in the volume calculation of the building**. Overhanging or projecting building elements are modeled as follows:

- always as from the volume-forming building element separated surface element(s) (see **Figure A**)
- always as a surface element, if the thickness of the building element is less than 0.5 m (see **Figure B**)
- always as a solid element, if the thickness of the building element is greater than 0.5 m (see **Figure B**)
- in LoD2 always as a surface element, if the thickness of the building element is less than 0.5 m
- in LoD2 always as a solid element, if the thickness of the building element is greater than 0.5 m
- in LoD3 always in the best accuracy based on available information.

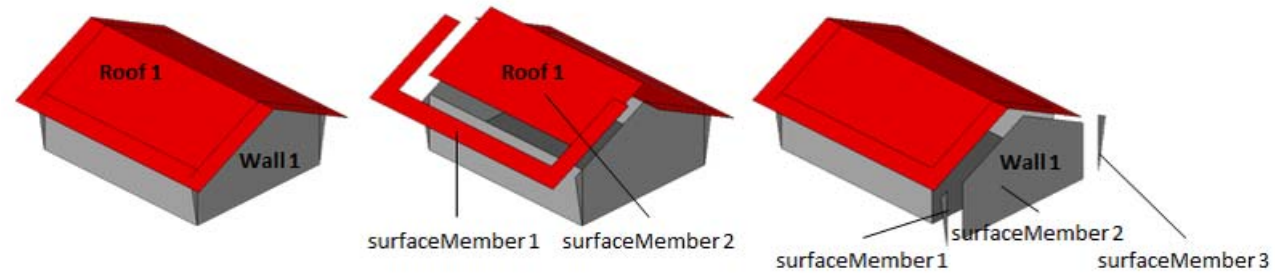


Figure A

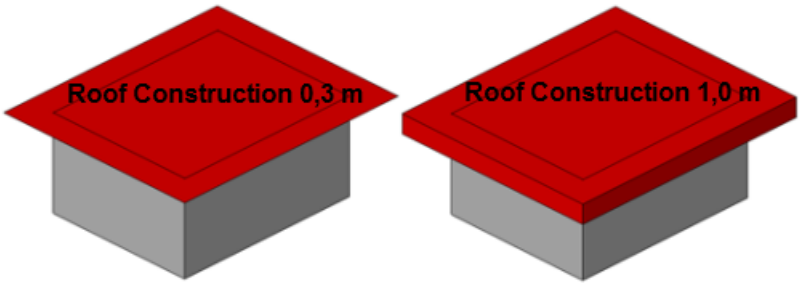
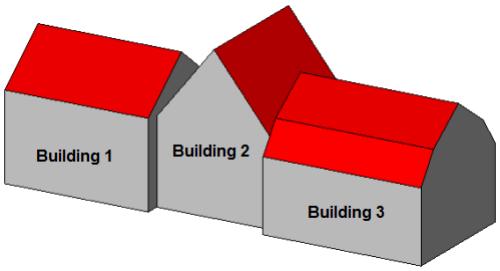


Figure B

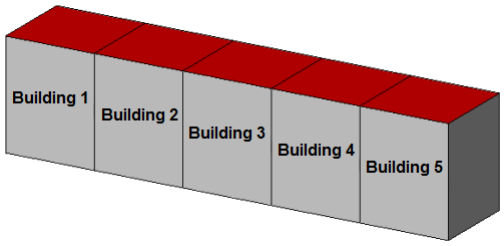
2.7 Closed Coverage Type

Buildings as parts of closed coverage type (applies to semi-detached and terrace houses also) can be modeled as follows:

- Buildings that are **separated within the land register** should be modeled as **separate buildings**.

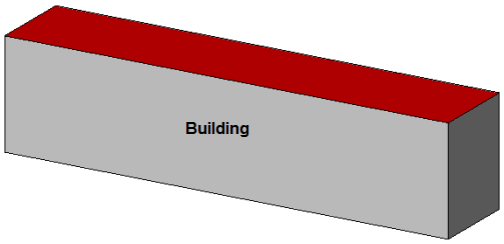


Separate buildings of closed coverage type

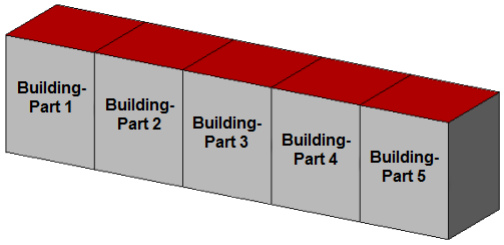


Terrace houses as separate buildings

- Buildings that are **united within the land register** should be modeled as **one single building** which can be subdivided into building parts (e.g. row of buildings, semi-detached or terrace houses).

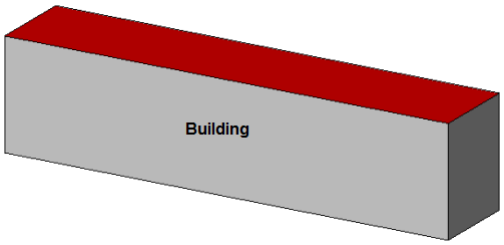


Terrace houses as one single building



Terrace houses as building parts

- Buildings **without any land register information** and for which the building detection provides **no usable structures** (e.g. based on flights) should be modeled as **one single building**.



Terrace houses as one single building

The modeling of **boundary surfaces** between buildings must satisfy the following geometric resp. semantic conditions:

- Common boundary surfaces may only **be referenced within a building via Xlink** (building-building part resp. building part - building part).

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

2.8 Addresses

- The CityGML specification allows to assign an address both to a building (*bldg:Building*, *bldg:BuildingPart*) as well as to a door (*bldg:Door*). It is recommended **always to assign an address to a building** (in any LoD) because doors are not available in LoD1 and LoD2.
- It is recommended to use the complete **postal address**.
- **Multiple addresses** can be assigned to one building.
- **Umlauts** are allowed in addresses (z.B. Würzburg☺, Wuerzburg☺, Würzburg and Wuerzburg mixed ☹).

General example:

```
Street:          Hermann-von-Helmholtz-Platz
Number:          1
Zip Code:        76344
City:            Eggenstein-Leopoldshafen
```

CityGML example:

```
<core:Address>
   <core:xalAddress>
      <xAL:AddressDetails>
         <xAL:Locality Type="Town">
            <xAL:LocalityName>Eggenstein-Leopoldshafen</xAL:LocalityName>
            <xAL:Thoroughfare Type="Street">
               <xAL:ThoroughfareNumber>1</xAL:ThoroughfareNumber>
               <xAL:ThoroughfareName>Hermann-von-Helmholtz-Platz</xAL:ThoroughfareName>
            </xAL:Thoroughfare>
            <xAL:PostalCode>
               <xAL:PostalCodeNumber>76344</xAL:PostalCodeNumber>
            </xAL:PostalCode>
         </xAL:Locality>
      </xAL:AddressDetails>
   </core:xalAddress>
</core:Address>
```

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

2.9 Codelists

Codelists for the CityGML 2.0 standard are available at "http://www.sig3d.org/codelists/standard".

The recommendations for codelists in this modeling guide refer to the proposal of the SIG3D. These codelists are availabe (in German only) at "http://www.sig3d.org/codelists/Handbuch-SIG3D" and relate to ALKIS.

This modeling guide refers to the following codelists:

- Building resp. building part (*bldg:Building / bldg:BuildingPart*)
  - class http://www.sig3d.org/codelists/Handbuch-SIG3D/building/2.0/CL-V1.0/_AbstractBuilding_class.xml
  - function http://www.sig3d.org/codelists/Handbuch-SIG3D/building/2.0/CL-V1.0/_AbstractBuilding_function.xml
  - usage http://www.sig3d.org/codelists/Handbuch-SIG3D/building/2.0/CL-V1.0/_AbstractBuilding_usage.xml
  - roofType http://www.sig3d.org/codelists/Handbuch-SIG3D/building/2.0/CL-V1.0/_AbstractBuilding_roofType.xml

- Building installations (*bldg:BuildingInstallation*)
  - function http://www.sig3d.org/codelists/Handbuch-SIG3D/building/2.0/CL-V1.0/BuildingInstallation_function.xml

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

2.10 Generic Attributes

Generic (user defined) attributes may be used to represent attributes which are **not covered explicitly by the CityGML schema**. Generic attributes must be used with care; they shall only be used if there is no appropriate attribute available in the overall CityGML schema. Otherwise, problems concerning semantic interoperability may arise. Interoperability of generic attributes is **reduced to attribute values** which can only be interpreted semantically by additional information. The following attribute types are defined:

- *stringAttribute* - for arbitrary strings
- *intAttribute* - for dimensionless integer numbers
- *doubleAttribute* - for dimensionless floating point numbers
- *dateAttribute* - for dates with integer-valued year, month and day representation in the format YYYY-MM-DD (e.g. 2013-03-08)
- *uriAttribute* - represents a Uniform Resource Identifier Reference (URI) (e.g. a link to a document or a web site)
- *measureAttribute* - for dimensioned values (CityGML 2.0)

Attributes can be combined in CityGML 2.0 by generic attribute sets ***genericAttributeSet*** with an optional ***codeSpace***. If the ***codeSpace*** attribute is present, then its value should identify an authority for the set, such as the organisation or community who defined its content. The generic attribute set may contain arbitrary generic attributes.

CityGML Examples

```
<gen:stringAttribute name="construction">
   <gen:value>concrete</gen:value>
</gen:stringAttribute>
<gen:intAttribute name="entries">
   <gen:value>3</gen:value>
</gen:intAttribute>
<gen:doubleAttribute name="floor area ratio FAR">
   <gen:value>0.33</gen:value>
</gen:doubleAttribute>
<gen:dateAttribute name="approval date">
   <gen:value>2012-03-09</gen:value>
</gen:dateAttribute>
<gen:uriAttribute name="website ">
   <gen:value>http://www.sig3d.org</gen:value>
</gen:uriAttribute>
<gen:measureAttribute name="building width">
   <gen:value uom="#m">10.00</gen:value>
<gen:measureAttribute>
<gen:genericAttributeSet name="Base Quantities">
   <gen:measureAttribute name="Height">
      <gen:value uom="#m">9.00</gen:value>
   </gen:measureAttribute>
   <gen:measureAttribute name="Area">
      <gen:value uom="#m2">80.00</gen:value>
   </gen:measureAttribute>
   <gen:measureAttribute name="Volume">
      <gen:value uom="#m3">720.00</gen:value>
   </gen:measureAttribute>
</gen:genericAttributeSet>
```

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

2.11 Geometry

There is **no GML Profile** for CityGML. This means that CityGML instance files will validate with every GML geometry. The specification **restricts** the usage of GML geometry classes (CityGML 2.0 Annex D "Overview of employed GML3 geometry classes). CityGML references to the following geometry classes (**CityGML 2.0 Annex D**):

Abstract Classes	Instantiated Classes	Further Limitations
gml:_Solid	*gml:**Solid***	only *gml:OrientableSurface*, *gml:Polygon*, *gml:CompositeSurface*, *tex:TexturedSurface* (obsolete)
	*gml:**CompositeSolid***	no restriction
gml:_Surface	*gml:**Polygon***	only *gml:**LinearRing*** and *gml:**Ring*** exclusively with *gml:LineString* or *gml:CompositeCurve*
	*gml:**OrientableSurface***	no restriction
	tex:TextureSurface	obsolete
	*gml:**CompositeSurface***	only *gml:OrientableSurface*, *gml:Polygon*, *gml:CompositeSurface* *tex:TexturedSurface* (obsolete)
	*gml:**TriangulatedSurface***	no restriction
	*gml:**Tin***	no restriction
gml:_Curve	*gml:**LineString***	no restriction
	*gml:**CompositeCurve***	*gml:LineString* and *gml:CompositeCurve* only
gml:_GeometricPrimitive	*gml:**Point***	no restriction
gml:_Coverage	*gml:**RectifiedGridCoverage***	no restriction
gml:_AbstractGeometricAggregate	*gml:**MultiSolid***	no restriction
	*gml:**MultiSurface***	only *gml:OrientableSurface*, *gml:Polygon*, *gml:CompositeSurface*, *tex:TexturedSurface* (obsolete)
	*gml:**MultiCurve***	only *gml:LineString* and *gml:CompositeCurve*
	*gml:**MultiPoint***	no restriction
	*gml:**GeometricComplex***	restricted to connected linear networks
	*gml:**MultiGeometry***	restrictrions see allowed geometry types

In order to keep the instance files small and to ensure an optimal editability of models, maximum flat polygons should be used, if appropriate with holes (inner rings).

2.12 File Extension

It is recommended to use *.gml as file extension to distinguish CityGML files from other XML files.

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

3 Modeling

3.1 Base Modeling

The base modeling includes the modeling of the **building resp. building part** itself in LoD1, with appropriate **boundary surfaces** in LoD2 and LoD3 and with **windows and doors** in LoD3. In addition, the basic modeling covers the general use of **building installations**.

3.1.1 Building (*bldg:Building*)

3.1.1.1 Definition

SIG3D: A free-standing self-supporting construction that is roofed, usually walled, and can be entered by humans and is normally designed to stand permanently in one place. It is intended for human occupancy (for example: a place of work or recreation), habitation and/or shelter of humans, animals or things.

ISO: Provision of shelter for its occupants or contents as one of its main purposes; usually partially or totally enclosed and designed to stand permanently in one place

3.1.1.2 CityGML Feature

bldg:Building

3.1.1.3 Geometry

gml:Solid see Modeling Guide - Part 1

It is recommended to use ***gml:Solid*** depending on the LoD in the following way :

- In LoD1 a solid directly contains the bounding geometry (**Figure A**)
- In LoD2 and LoD3 a solid contains external references (Xlinks) to the bounding geometry (wall surfaces, roof surfaces, ground surfaces, outer ceiling surfaces, outer bottom surfaces and closure surfaces as well as doors and windows) (**Figure B**) (see also conformance requirement no. 4 in chapter 10.3.9 of the CityGML V2.0 specification)

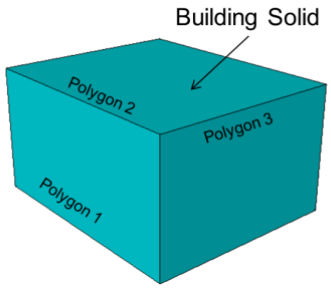


Figure A

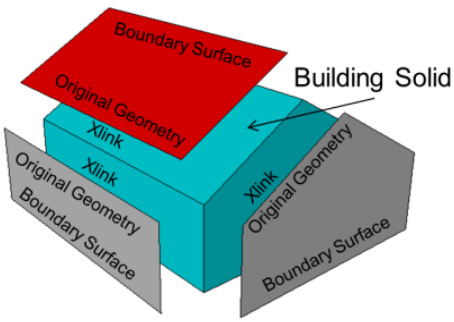


Figure B

gml:MultiSurface **(not recommended)**

gml:MultiCurve **(not recommended)**

3.1.1.4 Attributes

gml:id (mandatory)
from GML version 3.2 onwards an id is mandatory

gml:name (recommended, if available in the underlying land register)
'name' is the proper name or the name of the building.

bldg:class (LoD1, LoD2, LoD3)
The attribute *bldg:class* allows an unspecified classification of the building;
no suggestion from the SIG3D;

bldg:function (LoD1, LoD2, LoD3) (recommended)
The 'function' of a building is the predominantly functional significance of the building at the date of data collection (principle of dominance);
see also in the SIG3D code lists.

bldg:usage (LoD1, LoD2, LoD3) (conditionally recommended)
The 'usage' of a building describes the use of the building and contains the respective percentage usage share of the total use.

bldg:yearOfConstruction (LoD1, LoD2, LoD3) (recommended)
The 'yearOfConstruction' is the year of completion of the construction or alteration of the building;

bldg:yearOfDemolition (LoD1, LoD2, LoD3)
The 'yearOfDemolition' is the year of deconstruction of the building;

bldg:roofType (LoD1, LoD2, LoD3) (recommended)
'Roof type' describes the characteristic shape of the roof;
see also in the code list of the SIG3D

bldg:measuredHeight (LoD1, LoD2, LoD3) (recommended)
'Measured height' is the difference in [m] between the highest point of the roof structure and the defined footprint of the building; see also Heights

bldg:storeysAboveGround (LoD1, LoD2, LoD3) (recommended, if available in the underlying land register)
'storeys above ground' is the number of above-ground floors

bldg:storeysBelowGround (LoD1, LoD2, LoD3) (recommended, if available in the underlying land register)
'storeys below ground' is the number of underground floors

bldg:storeysHeightsAboveGround (LoD1, LoD2, LoD3)
Height between two consecutive floors of the above-ground floors

bldg:storeysHeightsBelowGround (LoD1, LoD2, LoD3)
Height between two consecutive floors of the underground floors

bldg:lodXSolid (LoD1, LoD2, LoD3)
LoDX geometry (volume)of the building

bldg:lodXMultiSurface (LoD1, LoD2, LoD3) (not recommended)
LoDX geometry (surface) of the building

bldg:lodYMultiCurve (LoD2, LoD3) (not recommended)
LoDY geometry (curve) of the building

bldg:lodXTerrainIntersection (LoD1, LoD2, LoD3)
LoDX geometry (curve) of the terrain intersection line of the building

bldg:outerBuildingInstallation (LoD2, LoD3)
Relation to LoD2/LoD3 building installation

bldg:boundedBy (LoD2, LoD3)
Relation to boundary surfaces (wall surfaces, roof surfaces, ground surfaces, outer ceiling surfaces, outer floor surfaces and closure surfaces)

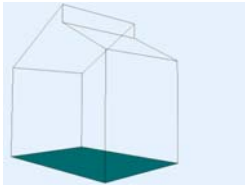
bldg:consistsOfBuildingPart (LoD1, LoD2, LoD3)
Relation to LoD1/LoD2/LoD3 building parts

bldg:address (LoD1, LoD2, LoD3)
Relation to one or more building addresses

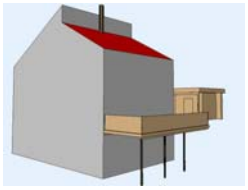
© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

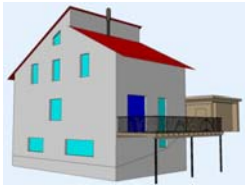
3.1.1.5 Examples

Real Building


CityGML LOD0

CityGML LOD1


CityGML LOD2


CityGML LOD3

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

3.1.2 Building Part (*bldg:BuildingPart*)

3.1.2.1 Definition

SIG3D: A building part is a sub-division of a building that is homogeneous related to its physical, functional or temporal aspects and may be considered as a building.

The subdivision of a building can be done by different criteria, e.g.

- structural like number of floors, roof type, height, construction method,
- administrative like building function, ownership, year of construction.

Building parts (*bldg:BuildingParts*) must satisfy the following conditions (necessary conditions):

- A building part **always** has a relation (bldg:consistsOfBuildingPart) to **exactly one** building:
- Buildings and building parts **touch each other** planar or linear-shaped,
- Building parts must be **"connected to ground"** and can have the following **properties** (for example, storeys are no building parts):
  - Building parts may have different **building attributes** (e.g. function, roof type),
  - Building parts may have an address that **differs** from the address of the building,
  - The geometry of building parts (*bldg:BuildingParts*) must be modeled in a way that both the **volume** and the **surfaces** of the boundary surfaces (wall surfaces, roof surfaces and ground surfaces) correspond to the real conditions (see chapter Building Part/Geometry),
  - If a building part is emphasized as the **main part of the building**, its semantics and geometry can be modeled in the parent building,
  - Building parts will not be subdivided into further building parts.

3.1.2.2 CityGML Feature

bldg:BuildingPart

3.1.2.3 Geometry

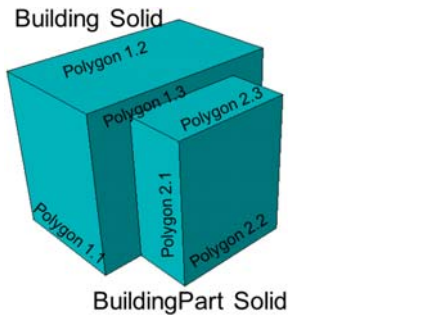
gml:Solid

see also Modeling Guide for 3D Objects - Part 1

It is recommended to use ***gml:Solid*** depending on the LoD in the following way :

- In LoD1 a solid directly contains the bounding geometry (**Figure A**)
- In LoD2 and LoD3 a solid contains external references (Xlinks) to the bounding geometry (wall surfaces, roof surfaces, ground surfaces, outer ceiling surfaces, outer bottom surfaces and closure surfaces as well as doors and windows). **Surfaces, which do not exist in reality** are modeled as closure surfaces (**Figure B**).
- In LoD2 a solid contains external references (Xlinks) to the real bounding geometry. **Surfaces, which do not exist in reality** are modeled as closure surfaces and assigned directly to the building part (**Figure C**).

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)



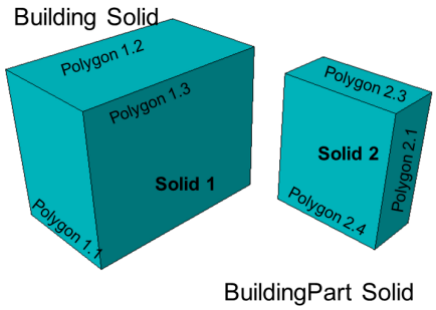


Figure A

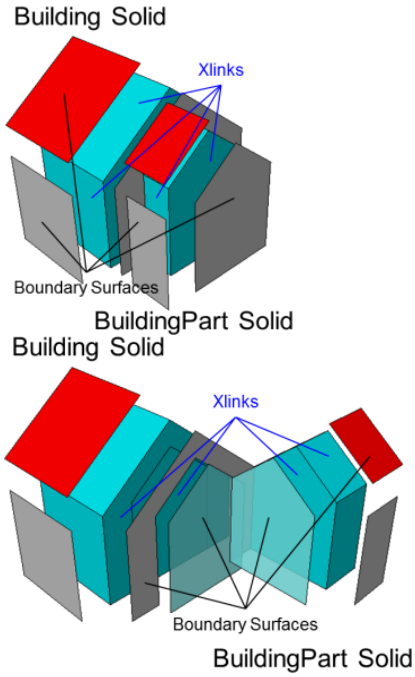


Figure B

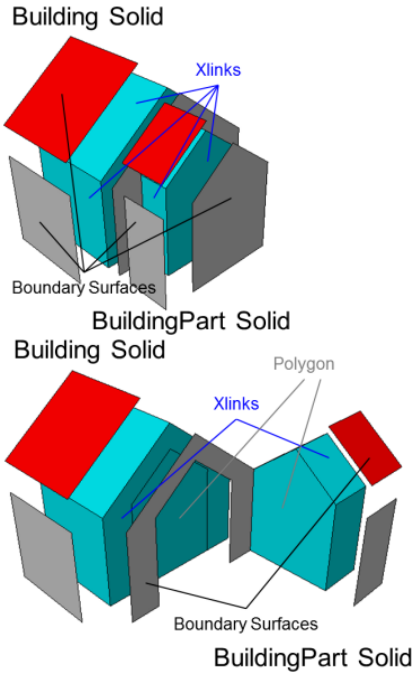


Figure C

bldg:boundedBy (LoD2, LoD3)

Relation to boundary surfaces (wall surfaces, roof surfaces, ground surfaces, outer ceiling surfaces, outer floor surfaces and closure surfaces)

gml:MultiSurface **(not recommended)**

gml:MultiCurve **(not recommended)**

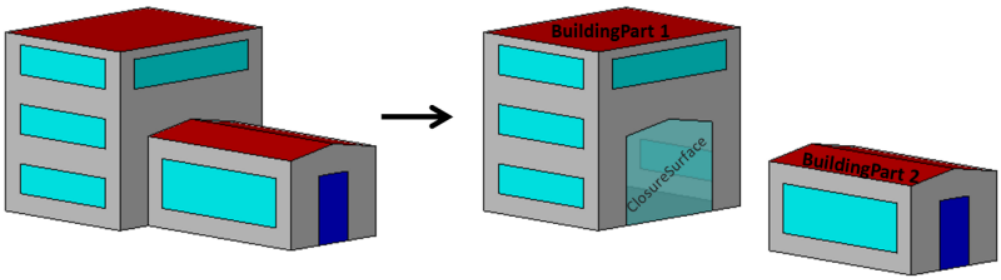
3.1.2.4 Attributes

Since the building part is derived from the building, all attributes of the building are also available for the building part (see also Building Attribute).

Exception: *bldg:consistsOfBuildingPart*

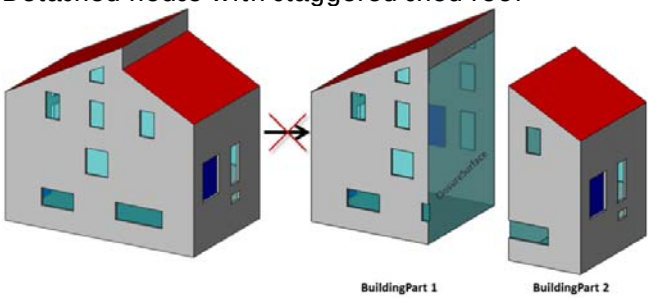
3.1.2.5 Examples

Office with factory hall



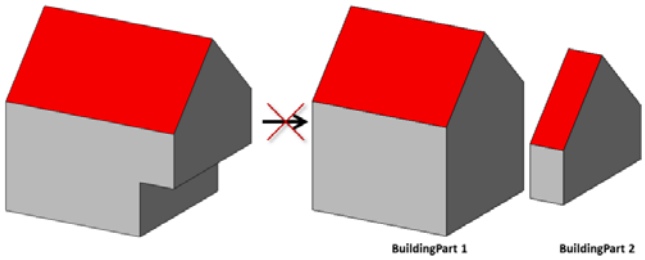
"structurally distinct" building parts → "Office" as function of BuildingPart 1 ; "Factory Hall" as function of BuildingPart 2

Detached house with staggered shed roof



No "structurally distinct" building parts → roofType "staggered shed roof"

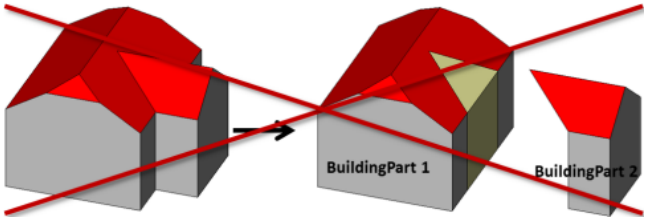
House with a projecting floor



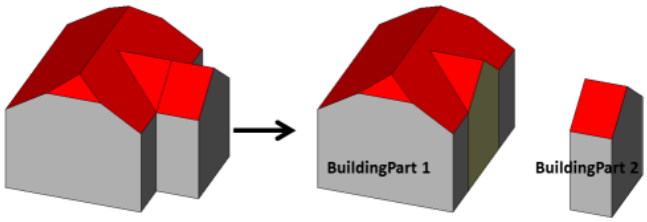
No "structurally distinct" building parts; 1 building part not "connected to ground"

Examples with overarching building parts

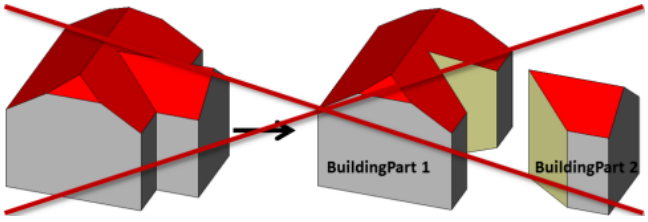
Variant 1



Variant 2



Variant 3



© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

3.1.3 Building Installations (*bldg:BuildingInstallation*)

3.1.3.1 Definition

SIG3D: Permanently installed parts of the buildings outer shell which are accessory for the building structure including loggia, dormer, etc. Doors and windows are modeled by the corresponding CityGML classes.

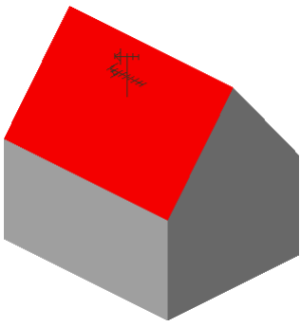
3.1.3.2 CityGML Feature

- **LOD1:** not available
- **LOD2:** *bldg:BuildingInstallation*
- **LOD3:** *bldg:BuildingInstallation*

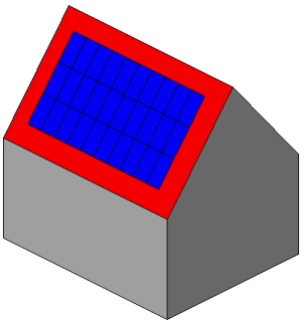
3.1.3.3 Geometry

gml:Geometry

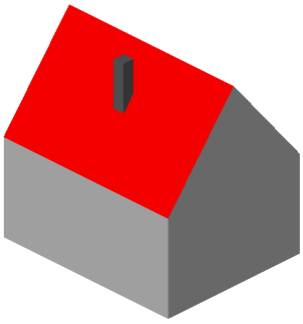
gml:Geometry allows **points**, **lines**, **areas**, **volumes** as well as any combination of these elements.
The use of points is **not recommended**.
The use of lines is only **recommenced under certain circumstances**, because not all applications are able to process this geometry.



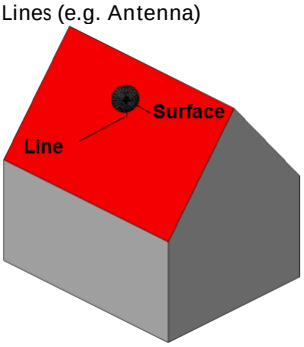
Lines (e.g. Antenna)



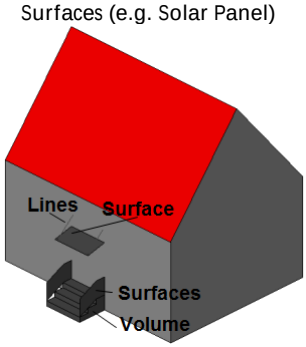
Surfaces (e.g. Solar Panel)



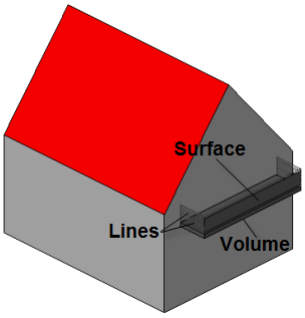
Volumes (e.g. Chimney)



Lines and surfaces (e.g. satellite dish)



Lines and surfaces resp. surfaces and volumes (e.g. stair and porch)

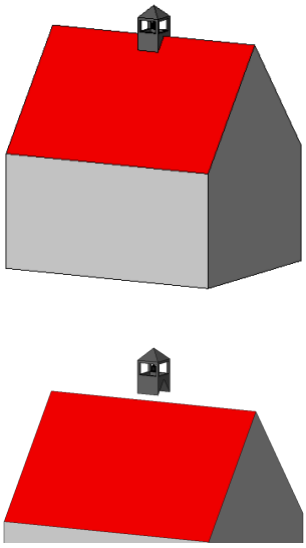


Lines, surfaces und volumes (e.g. balcony)

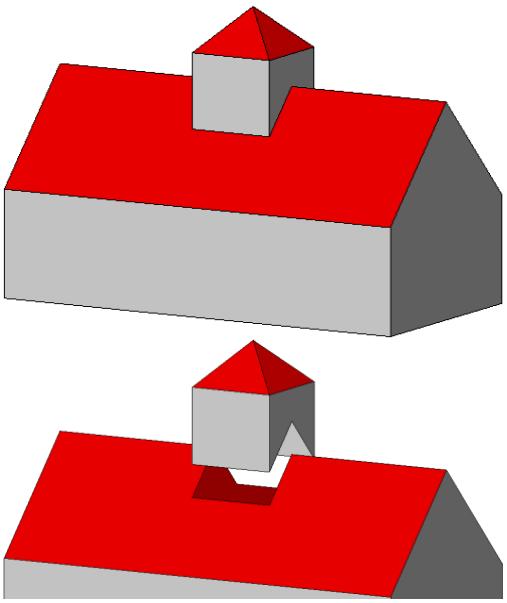
© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

bldg:boundedBy (LoD2, LoD3)

Relation to boundary surfaces (wall surfaces, roof surfaces, ground surfaces, outer ceiling surfaces, outer floor surfaces and closure surfaces) see also Extended Modeling



Building with a small ridge turret (modeled as a building installation with geometry)



Building with a tower (modeled as a building installation with boundary surfaces)

3.1.3.4 Attributes

gml:id (mandatory)

from GML version 3.2 onwards an id is mandatory

bldg:class (LoD2, LoD3) (not recommended)

The attribute *bldg:class* allows an unspecified classification of the building installation; no suggestion from the SIG3D;

bldg:function (LoD2, LoD3) (recommended)

The 'function' of a building installation is the predominantly functional significance of the building installation at the date of data collection (principle of dominance); see also in the SIG3D code lists.

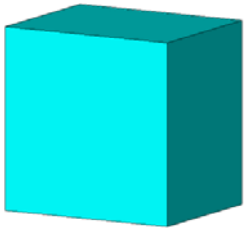
bldg:usage (LoD2, LoD3) (not recommended)

no suggestion from the SIG3D;

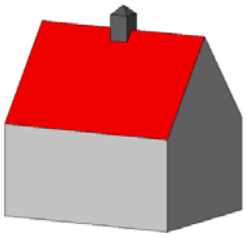
bldg:lodXGeometry (LoD2, LoD3)

LoDX geometry of the building installation;

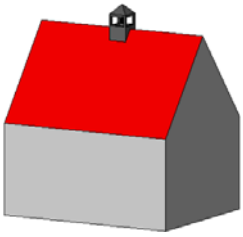
3.1.3.5 Examples



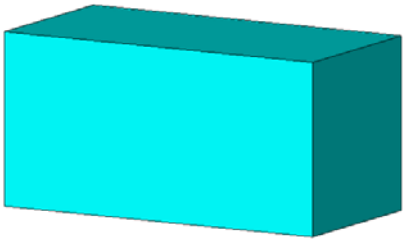
LoD1: no building installation



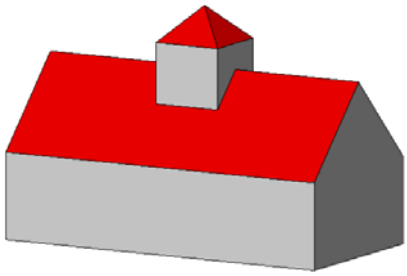
LoD2: simplified building installation



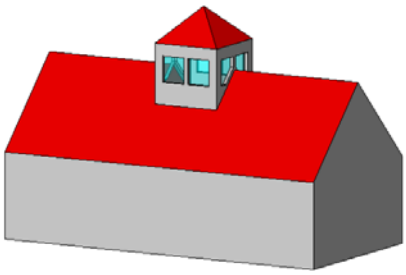
LoD3: detailed building installation



LoD1: no building installation



LoD2: simplified building installation



LoD3: detailed building installation

3.1.4 Ground Surfaces (*bldg:GroundSurface*)

3.1.4.1 Definition

SIG3D: Exterior, lower boundary surface of a building, building part or building installation against soil or water (e.g. foundation).

3.1.4.2 CityGML Feature

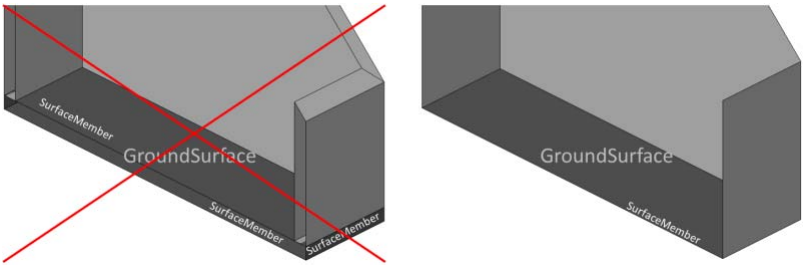
- **LoD1:** not available
- **LoD2:** *bldg:GroundSurface*
- **LoD3:** *bldg:GroundSurface*

3.1.4.3 Geometry

gml:MultiSurface

see also Modeling Guide for 3D Objects - Part 1

- A **ground surface** consists only of surfaces which are **visible from the outside** of the building, building part or building installation.



- The **elevation** of the ground surface depends on the availability of data:
  - If there is information available about cellars, the elevation of the ground surface is set to the lower edge of the floor of the cellar (**Figure A**);
  - If the ground surface of the building, building part or building installation is generated by an intersection with the terrain, the elevation of the (horizontal) ground surface is set to the lowest absolute height of the corresponding terrain intersection line (**Figure B**);
  - It is not recommeded to generate the ground surface of the building, building part or building installation directly from an intersection with the terrain (**Figure C**);

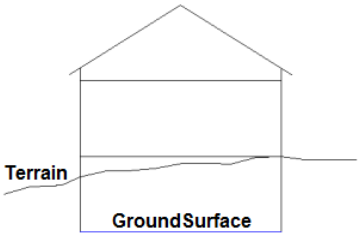


Figure A

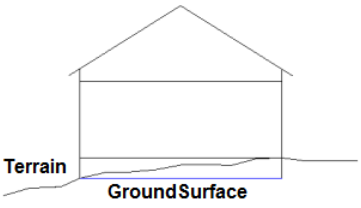


Figure B

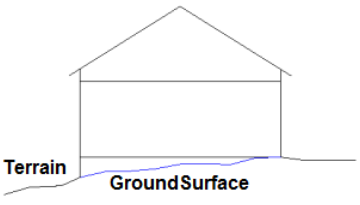


Figure C

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

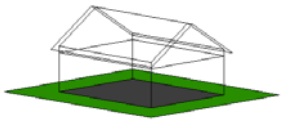
3.1.4.4 Attribute

bldg:lod2MultiSurface
points to the LoD2 surface geometry of the base area

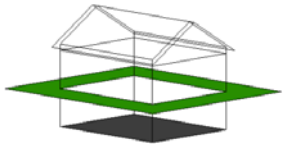
bldg:lod3MultiSurface
points to the LoD3 surface geometry of the base area

bldg:opening not recommended
points to a CityGML feature *bldg:Opening* (*bldg:Door* (see doors) or *bldg:Window* (see windows))

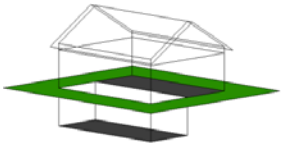
3.1.4.5 Examples



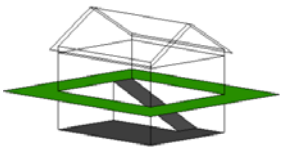
Building without cellar and one floor slab (One bldg:GroundSurface)



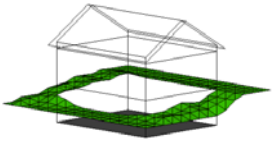
Building with cellar and one floor slab (One bldg:GroundSurface)



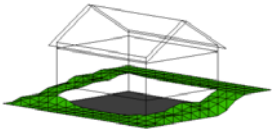
Building with partial cellar and two different floor slabs (Two bldg:GroundSurface)



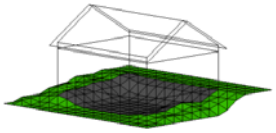
Building with cellar and ramp (Two bldg:GroundSurface)



Building with ground surface at lower edge of floor cellar (One bldg:GroundSurface)



Building with ground surface at lowest absolute height of the corresponding terrain intersection line (One bldg:GroundSurface)



Building with ground surface based on intersection with the terrain (One bldg:GroundSurface) not recommended

3.1.5 Wall Surfaces (*bldg:WallSurface*)

3.1.5.1 Definition

SIG3D: A wall surface is an exterior, lateral boundary surface of a building, building part or building installation.
ISO: A wall is a vertical construction that bounds or subdivides a space and usually fulfils a loadbearing or retaining function.

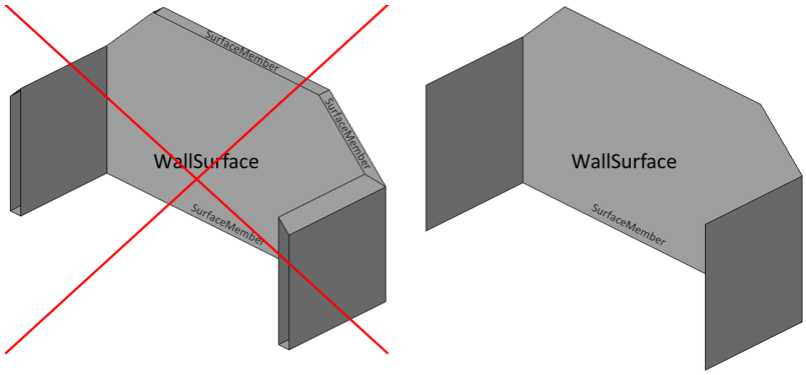
The normals of the wall surfaces should generally lie in the horizontal (up to 45 degrees).

3.1.5.2 CityGML Feature

- **LoD1:** not available
- **LoD2:** *bldg:WallSurface*
- **LoD3:** *bldg:WallSurface*

3.1.5.3 Geometry

gml:MultiSurface
see also Modeling Guide for 3D Objects - Part 1

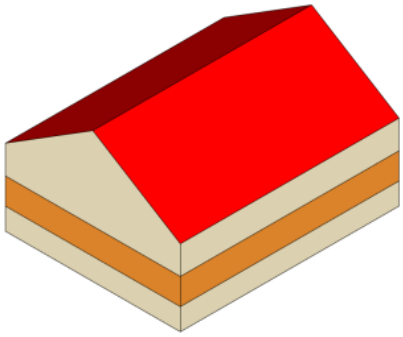


- A **wall surface** surface consists only of surfaces which are **visible from the outside** of the building, building part or building installation.

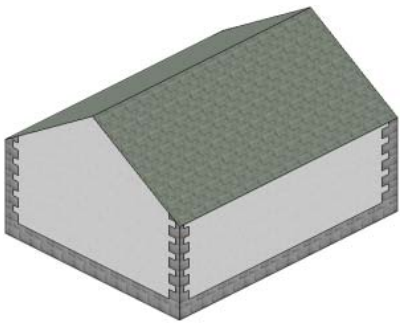
- **Wall projections**, which do not limit the volume of the building will be modeled according to the rules for

Cantilevered building elements.

- A **wall surface** *must* consist of **several surfaces (SurfaceMember)** if :
  - a wall surfaces has different **colors** or **textures**

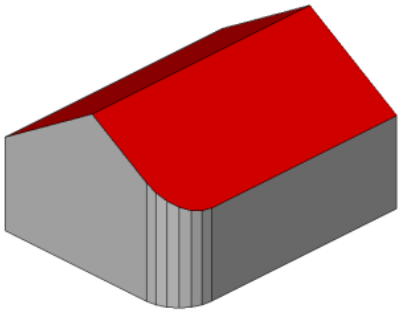


4 wall surfaces with 3 areas each (1 area in "orange"; 2 areas in "beige")(4 bldg:WallSurface)

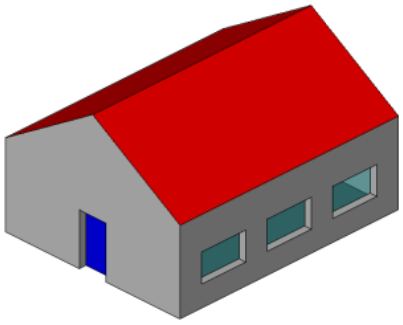


4 wall surfaces with 2 areas each (1 area with texture "plaster"; 1 area with texture "sandstone") (4 bldg:WallSurface)

- a wall surface is **nonplanar**

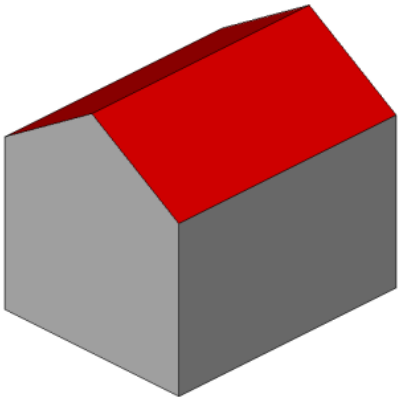


5 wall surfaces; 4 wall surfaces with 1 surface each and 1 wall surface (circular wall) with 6 surfaces (4 bldg:WallSurface)

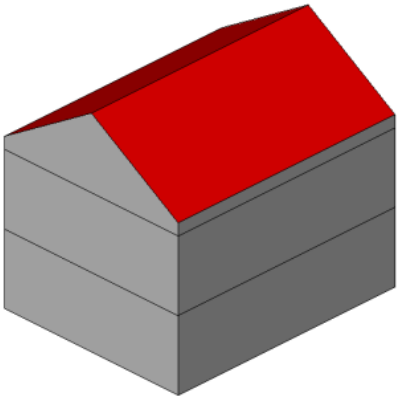


Front wall as 1 wall surface consisting of 4 surfaces (revealing areas); right wall as 1 wall surface consisting of 13 surfaces (12 revealing areas)

- A **wall surface** *might* consist of **several surfaces (SurfaceMember)** if :
  - it is intended to indicate a **storey structure**



4 wall surfaces with 1 surface each (4 bldg:WallSurface)



4 wall surfaces with 3 surfaces each (ground floor, upper floor and top floor) (4 bldg:WallSurface)

3.1.5.4 Attributes

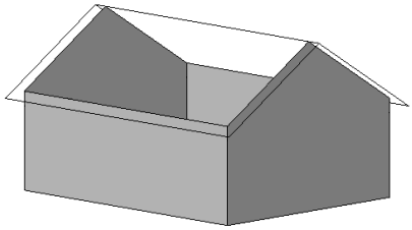
bldg:lod2MultiSurface
: points to the LoD2 surface geometry of the wall

bldg:lod3MultiSurface
: points to the LoD3 surface geometry of the wall

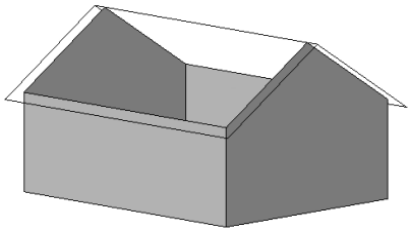
bldg:opening
: points to a CityGML feature *bldg:Opening* (*bldg:Door* (see doors) or *bldg:Window* (see windows))

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

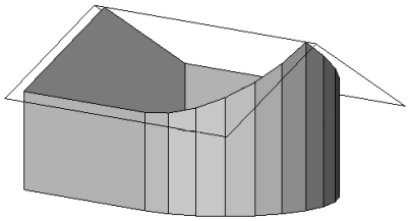
3.1.5.5 Examples



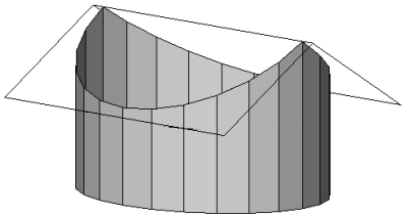
A wall surface with 4 surfaces (1 bldg:WallSurface) not recommended



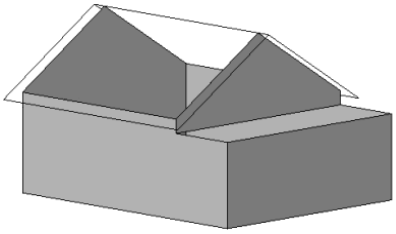
4 wall surfaces with 1 surface each (4 bldg:WallSurface)



4 wall surfaces (3 planar walls with 1 surface each and 1 circular wall with 12 surfaces) (4 bldg:WallSurface)



1 wall surface with elliptic or circular layout (1 bldg:WallSurface)



5 wall surfaces by staggered facades (5 bldg:WallSurface)

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

3.1.6 Roof Surfaces (*bldg:RoofSurface*)

3.1.6.1 Definition

SIG3D: A roof surface is a exterior, upper boundary surface of a building, building part or building installation, whose primary function is to protect from the effects of weather. **ISO:** A roof is a construction that encloses a building from above

The normals of a roof should generally lie in the vertical.

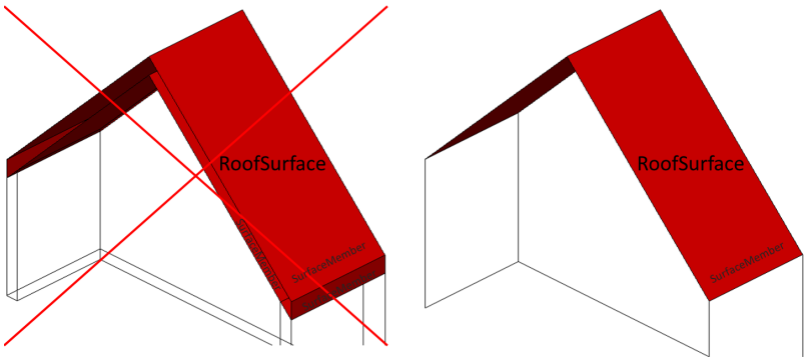
3.1.6.2 CityGML Feature

- **LoD1:** not available
- **LoD2:** *bldg:RoofSurface*
- **LoD3:** *bldg:RoofSurface*

3.1.6.3 Geometry

gml:MultiSurface
see also Modeling Guide for 3D Objects - Part 1

- A **roof surface** surface consists only of surfaces which are **visible from the outside** of the building, building part or building installation.



- **Roof projections**, which do not limit the volume of the building will be modeled according to the rules for **cantilevered building elements**.

3.1.6.4 Attributes

bldg:lod2MultiSurface
points to the LoD2 surface geometry of the roof

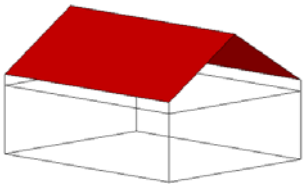
bldg:lod3MultiSurface
points to the LoD3 surface geometry of the roof

bldg:opening
points to a CityGML feature *bldg:Opening* (*bldg:Door* (see doors) or *bldg:Window* (see windows))

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

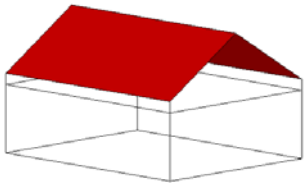
3.1.6.5 Examples

Gable Roof



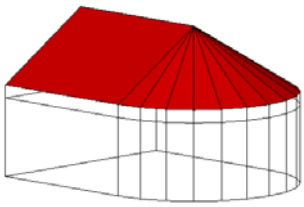
1 roof surface with 2 surfaces (1 bldg:RoofSurface) not recommended

Gable Roof



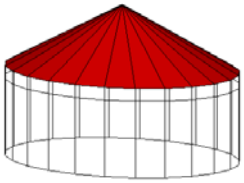
2 roof surfaces with 1 surface each (2 bldg:RoofSurface)

Mixed Roof



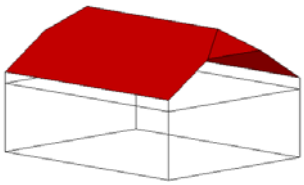
3 roof surfaces (2 planar roof surfaces with 1 surface each and 1 conical roof area with 12 surfaces) (3 bldg:RoofSurface)

Tent Roof



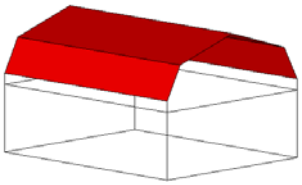
1 conical roof area with 24 surfaces (1 bldg:RoofSurface)

Jerkinhead Roof



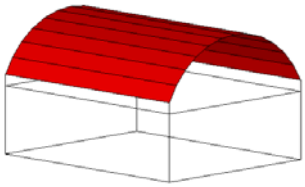
4 roof surfaces (4 bldg:RoofSurface)

Gambrel Roof



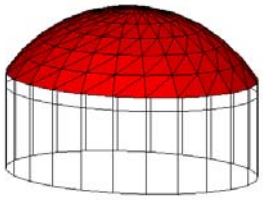
4 roof surfaces (4 bldg:RoofSurface)

Arch Roof



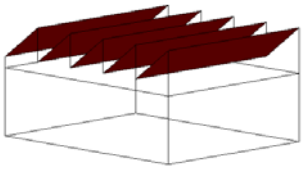
1 roof surface with 12 surfaces (1 bldg:RoofSurface)

Dome Roof



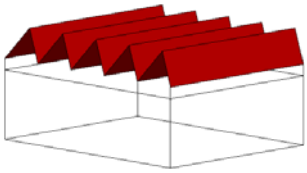
1 roof surface with 264 surfaces (1 bldg:RoofSurface)

Shed Roof I



5 roof surfaces (5 bldg:RoofSurface)

Shed Roof II



10 roof surfaces (10 bldg:RoofSurface)

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

3.1.7 Outer Floor Surfaces(*bldg:OuterFloorSurface*)

3.1.7.1 Definition

SIG3D: Exterior, upper boundary surface of a building, building part or building installation which is not a roof.

The normals of an outer floor surface should generally be vertical directed upwards.

3.1.7.2 CityGML Feature

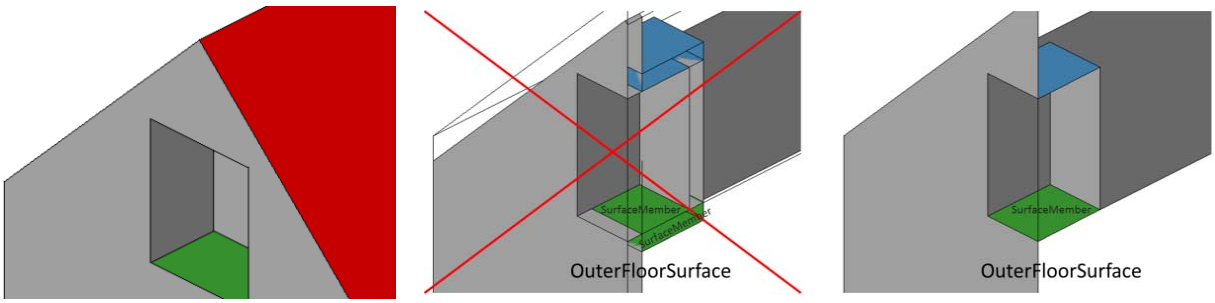
- **LoD1:** not available
- **LoD2:** *bldg:OuterFloorSurface*
- **LoD3:** *bldg:OuterFloorSurface*

3.1.7.3 Geometry

gml:MultiSurface

see also Modeling Guide for 3D Objects - Part 1

- An outer floor surface consists only of surfaces which are **visible from the outside** of the building, building part or building installation.



3.1.7.4 Attributes

bldg:lod2MultiSurface

points to the LoD2 surface geometry

bldg:lod3MultiSurface

points to the LoD3 surface geometry

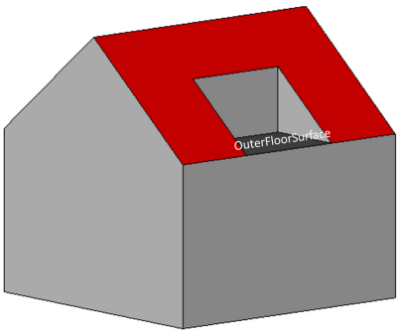
bldg:opening

points to a CityGML feature *bldg:Opening* (*bldg:Door* (see doors) or *bldg:Window* (see windows))

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

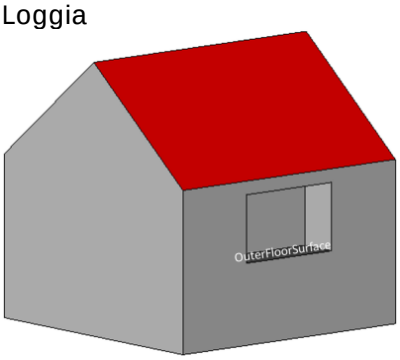
3.1.7.5 Examples

Roof terrace



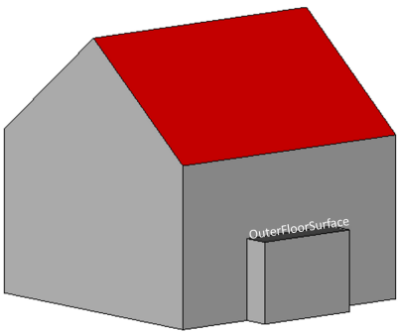
1 OuterFloorSurface

Loggia



1 OuterFloorSurface

Roof terrace



1 OuterFloorSurface

3.1.8 Outer Ceiling Surface(*bldg:OuterCeilingSurface*)

3.1.8.1 Definition

SIG3D: Exterior, lower boundary surface of a building, building part or building installation against air.

The normals of an outer ceiling surface should generally be vertical directed downwards.

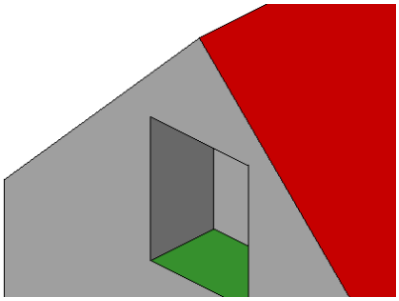
3.1.8.2 CityGML Feature

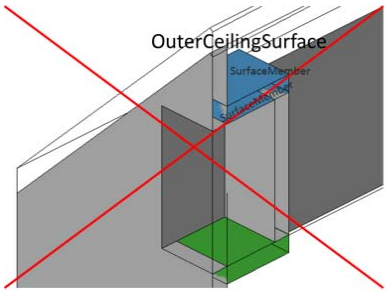
- **LoD1:** not available
- **LoD2:** *bldg:OuterCeilingSurface*
- **LoD3:** *bldg:OuterCeilingSurface*

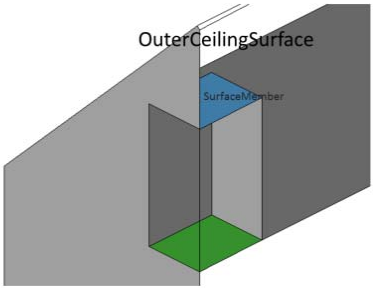
3.1.8.3 Geometry

gml:MultiSurface
see also Modeling Guide for 3D Objects - Part 1

- An **outer ceiling surface** consists only of surfaces which are **visible from the outside** of the building, building part or building installation.







3.1.8.4 Attributes

bldg:lod2MultiSurface
points to the LoD2 surface geometry

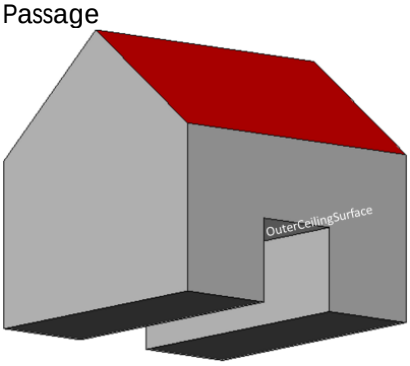
bldg:lod3MultiSurface
points to the LoD3 surface geometry

bldg:opening
points to a CityGML feature *bldg:Opening* (*bldg:Door* (see doors) or *bldg:Window* (see windows))

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

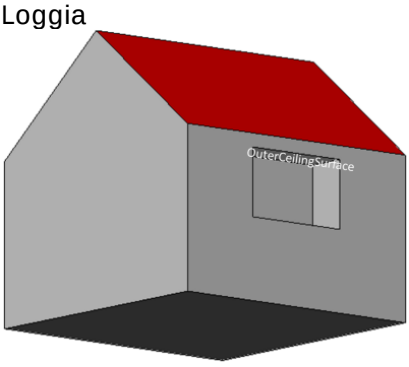
3.1.8.5 Examples

Passage



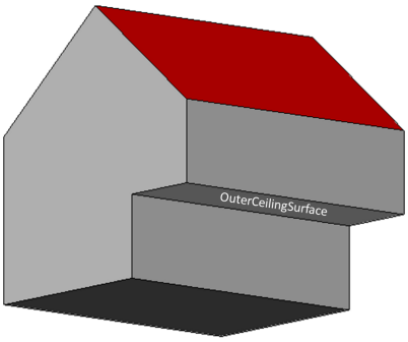
1 OuterCeilingSurface

Loggia



1 OuterCeilingSurface

Cantilevered floor



1 OuterCeilingSurface

3.1.9 Virtual Boundary Surface (*bldg:ClosureSurface*)

3.1.9.1 Definition

SIG3D: Exterior or interior boundary surface providing virtual boundaries, typically used to seal holes in volumetric objects.

3.1.9.2 CityGML Feature

- **LoD1:** not available
- **LoD2:** *bldg:ClosureSurface*
- **LoD3:** *bldg:ClosureSurface*

3.1.9.3 Geometry

gml:MultiSurface
see also Modeling Guide for 3D Objects - Part 1

- A **closure surface** consists only of virtual (imaginary) surfaces which are **visible from the outside** of the building, building part or building installation.

3.1.9.4 Attributes

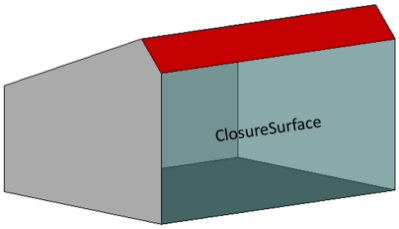
bldg:lod2MultiSurface
points to the LoD2 surface geometry

bldg:lod3MultiSurface
points to the LoD3 surface geometry

bldg:opening not recommended
points to a CityGML feature *bldg:Opening* (*bldg:Door* (see doors) or *bldg:Window* (see windows))

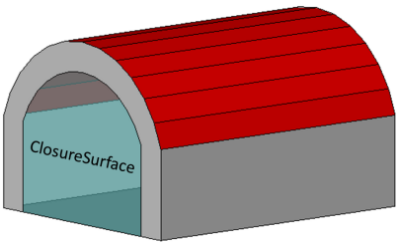
3.1.9.5 Examples

Open barn



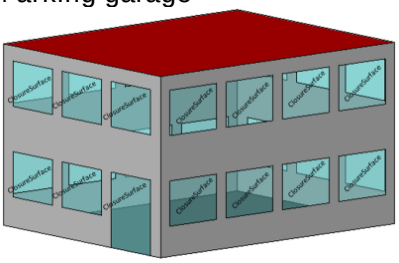
1 ClosureSurface

Railway platform hall



2 ClosureSurface

Parking garage



28 ClosureSurface

3.1.10 Doors (bldg:*Door*)

3.1.10.1 Definition

ISO 6707-1: Construction for closing an opening intended primarily for access or egress or both.

3.1.10.2 CityGML Feature

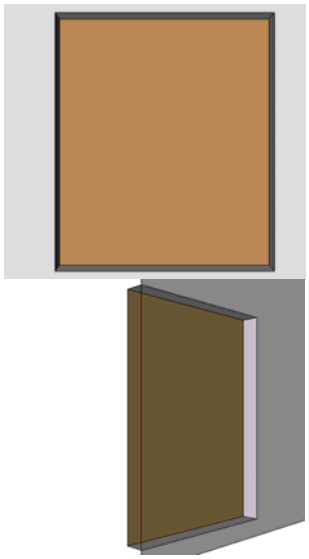
- **LoD1:** not available
- **LoD2:** not available
- **LoD3:** *bldg:Door*

3.1.10.3 Geometry

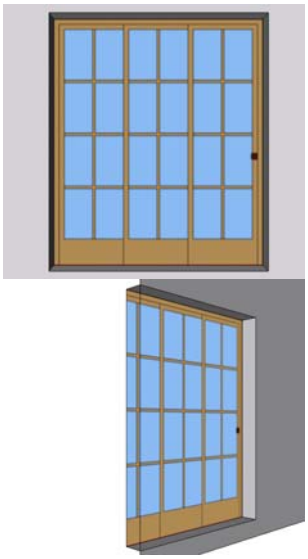
gml:MultiSurface

see also Modeling Guide for 3D Objects - Part 1

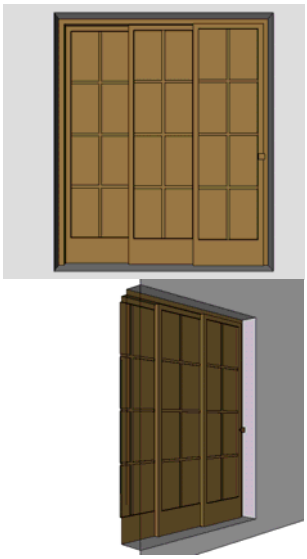
- A **door** consists only of surfaces which are either **visible from the outside** of the building, building part or building installation (case A, B or C) or consists of **solids** (case D).



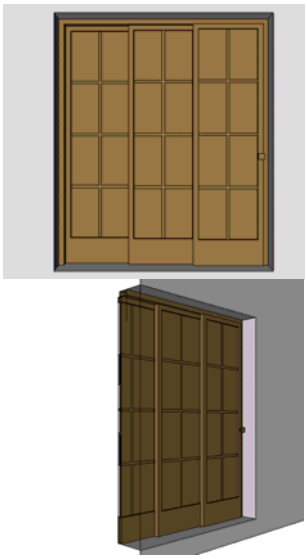
Case A (Door as a simple surface)



Case B (Door as a textured surface)

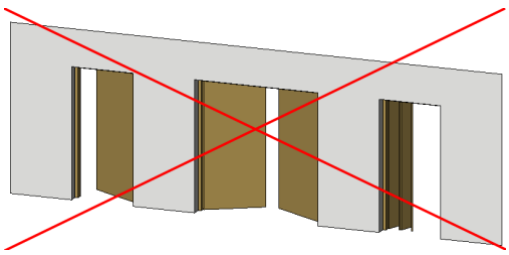


Case C (Door modeled in detail with surfaces only visible from the outside)

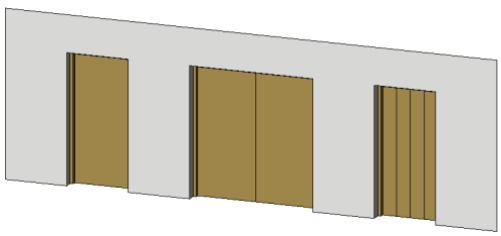


Case D (Door as a solid)

- In order to ensure a closed outer shell of the building, the doors should **not** be modeled **in an opened state** (case A) but **in closed condition** (case B).



Case A (Doors opened)



Case B (Doors closed)

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

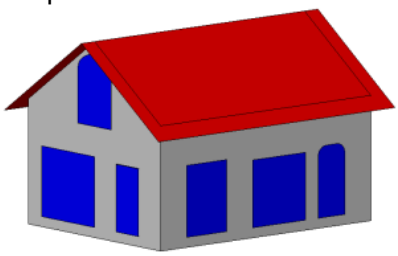
3.1.10.4 Attributes

bldg:lod3MultiSurface
points to the LoD3 surface geometry

bldg:address
points to the address of the door

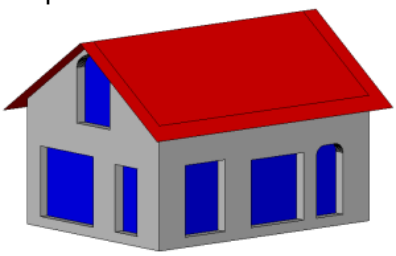
3.1.10.5 Examples

Simple Doors



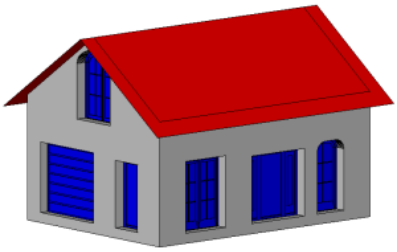
Number of Polygons (Complete Model) = 19

Simple Doors with Embrasure



Number of Polygons (Complete Model) = 128

Doors modeled in detail



Number of Polygons (Complete Model) = 3498

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

3.1.11 Windows (*bldg:Window*)

3.1.11.1 Definition

SIG3D: Construction for closing an opening in a wall or roof, primarily intended to admit light and / or provide ventilation (cf. ISO 6707).

3.1.11.2 CityGML Feature

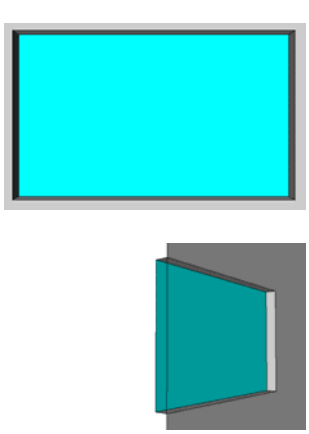
- **LoD1:** not available
- **LoD2:** not available
- **LoD3:** *bldg:Window*

3.1.11.3 Geometry

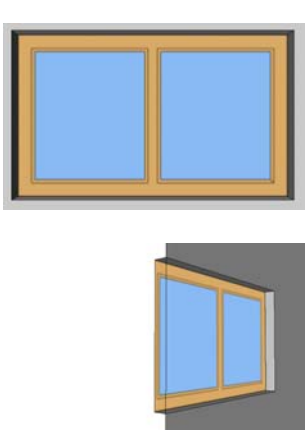
gml:MultiSurface

see also Modeling Guide for 3D Objects - Part 1

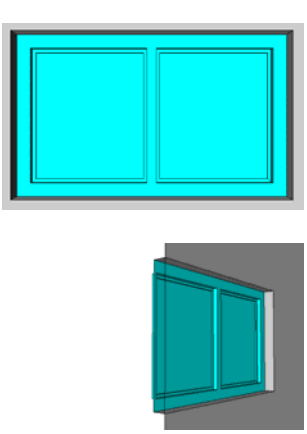
- A **window** consists only of surfaces which are either **visible from the outside** of the building, building part or building installation (case A, B or C) or consists of **solids** (case D).



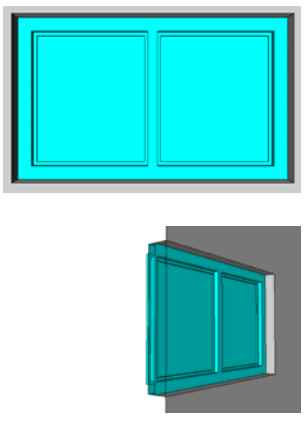
Case A (Window as a simple surface)



Case B (Window as a textured surface)

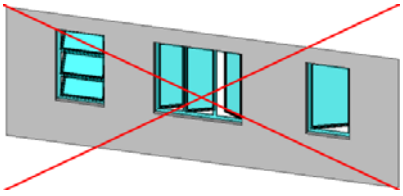


Case C (Window modeled in detail with surfaces only visible from the outside)

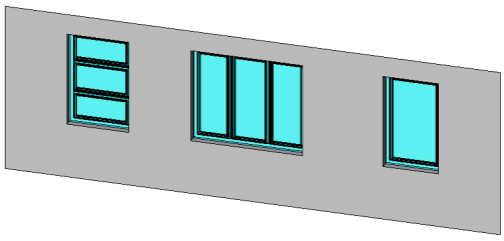


Case D (Window as a solid)

- In order to ensure a closed outer shell of the building, the windows should **not** be modeled **in an opened state** (case A) but **in closed condition** (case B).



Case A (Windows opened)



Case B (Windows closed)

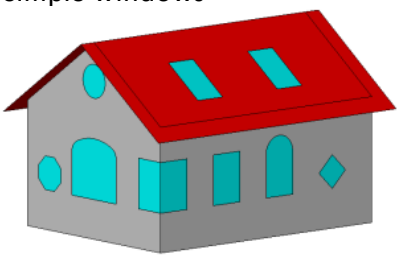
© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

3.1.11.4 Attributes

bldg:lod3MultiSurface
points to the LoD3 surface geometry

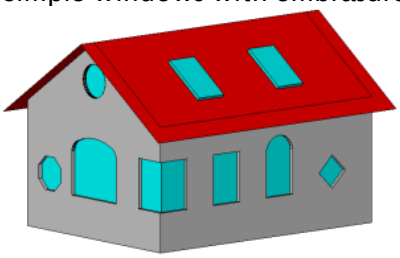
3.1.11.5 Examples

Simple windows



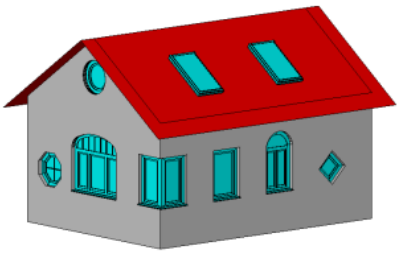
Number of Polygons (Complete Model) = 28

Simple windows with embrasure



Number of Polygons (Complete Model) = 412

Windows modeled in detail



Number of Polygons (Complete Model) = 6269

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

3.2 Extended Modeling

The Extended Modeling covers the modeling of frequently appearing **architectural building components** which significantly form the building's outer appearence. These building components are modeled as **building installations** as a general rule.

3.2.1 Balconies

3.2.1.1 Definition

SIG3D: A **Balcony** is a platform attached to a building which lies above the terrain level and projects from the building structure. It is supported by columns or console brackets, and enclosed with a balustrade [cit. en. Wikipedia]. The word's origin lies in the Italian word "balcone", which itself originates from the old-high-german word "balcho".

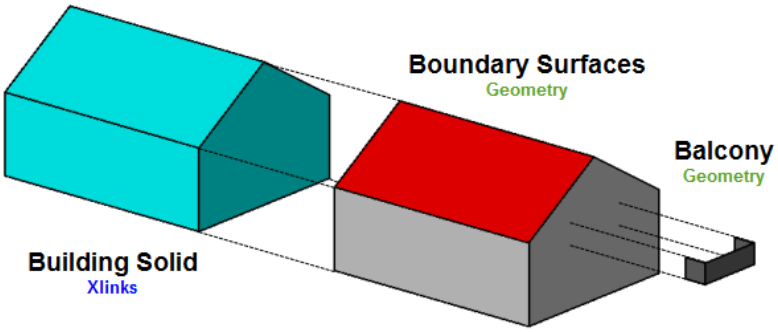
3.2.1.2 CityGML Feature

- **LOD1:** not available
- **LOD2:** *bldg:BuildingInstallation*
- **LOD3:** *bldg:BuildingInstallation*

3.2.1.3 Geometry

- ***gml:Geometry*** **recommended**
  - **Threshold LOD2:**
    - Modeling only, if the balcony's depth >= 0.5 m;
      - Plane ground-area, if the component's thickness <= 0.5 m;
      - Plane side-walls, if the component's thickness <= 0.5 m;
  - **Threshold LOD3:**
    - Modeling only, if the balcony's depth >= 0.2 m;
      - Plane ground-Area, if the component's thickness <= 0.2 m;
      - Plane side-walls, if the component's thickness <= 0.2 m;
  - **Modeling principle**
    - The building contains all geometry-containing border surfaces.
    - The balcony is modeled as a **Building Installation with Geometry**. That is without semantic differentiation.
    - The building's volume references (Xlink) to the corresponding boarder surfaces.

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)



Modeling principle of a balcony

- ***bldg:boundedBy*** **not recommended**

3.2.1.4 Attributes

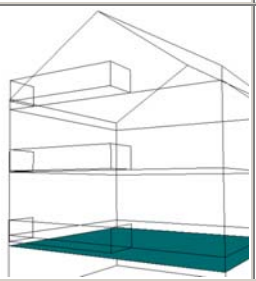
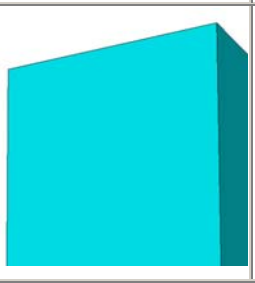
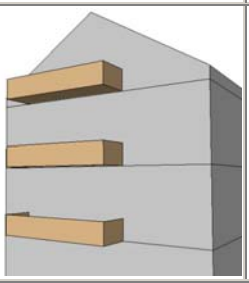
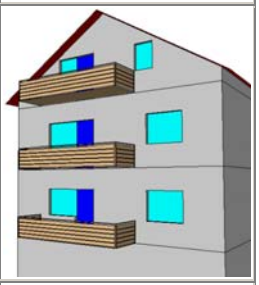
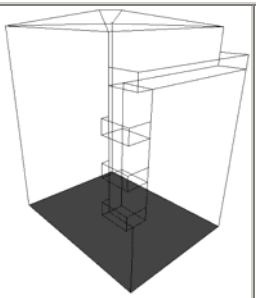
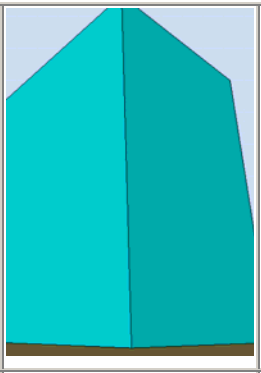
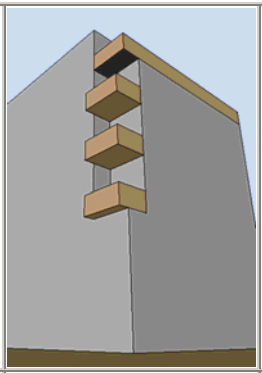
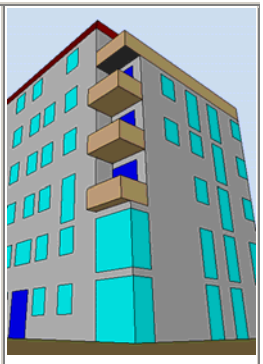
bldg:function

Balcony *(1000); see SIG 3D Codelistrecommendation for* bldg:BuildingInstallation --> function

bldg:boundedBy

not recommended: A Balcony is considered as **one** building component which is semantically not subdivided any further.

3.2.1.5 Examples

Real Building	CityGML LOD0	CityGML LOD1	CityGML LOD2	CityGML LOD3
				
	CityGML download	CityGML download	CityGML download	CityGML download
				
	CityGML download	CityGML download	CityGML download	CityGML download
Above terrain level, partly projected from the building structure, not bounded by 3 walls --> Balcony (no Loggia)				

3.2.2 Loggias

3.2.2.1 Definition

SIG3D: A **Loggia** is an enclosed on top exterior room within the building footprint, which is surrounded by **3** walls at full storey height. From an architectonical point of view, a **Loggia** (from the Italian) is a room within a building, which opens to the exterior area by means of archs or other constructional appliances. At ground floor level, Loggias create a passage between the interior area and the exterior area. At upper floor levels, Loggias are used as connection passages or as outdoor seating.

3.2.2.2 CityGML Feature

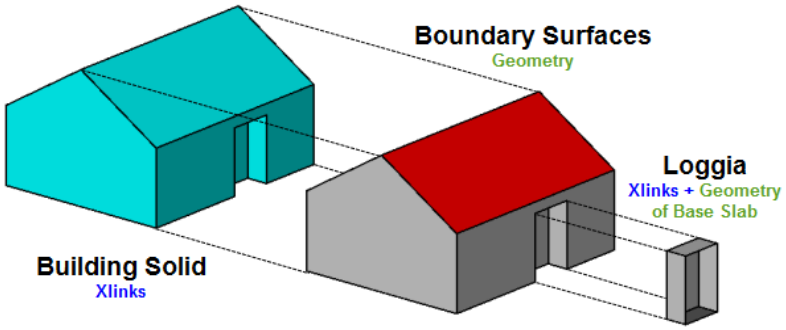
- **LOD1:** not available
- **LOD2:** *bldg:BuildingInstallation*
- **LOD3:** *bldg:BuildingInstallation*

3.2.2.3 Geometry

- ***gml:Geometry*** **not recommended**

- ***bldg:boundedBy*** **recommended**
  - **Threshold LOD2:**
    - Modeling only, if the Loggia's depth >= 0.5 m;
  - **Threshold LOD3:**
    - Modeling only, if the Loggia's depth >= 0.2 m;
  - **Modeling Principle**

    - The building contains all geometry-containing boundary surfaces
    - The Loggia (BuildingInstallation) **references (Xlink)** to the building's corresponding boundary surfaces. If the Loggia's floor is not part of the exterior building structure, it will be modeled as boundary surface at the building installation.
    - The building's volume references (Xlink) to the building's corresponding boundary surfaces.



Modeling Principle of a Loggia

3.2.2.4 Attributes

bldg:function

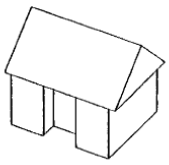
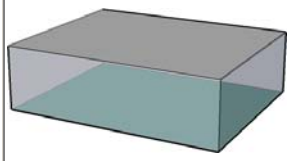
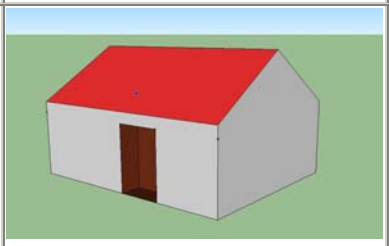
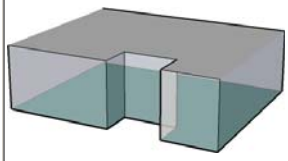
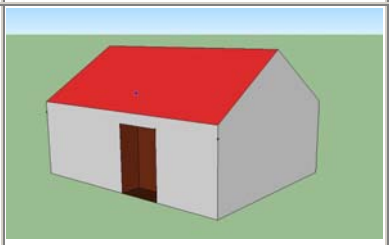
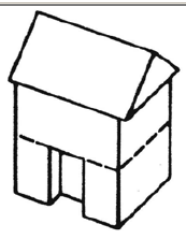
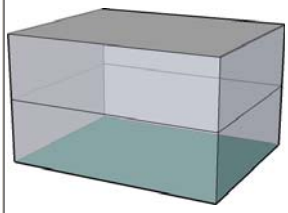
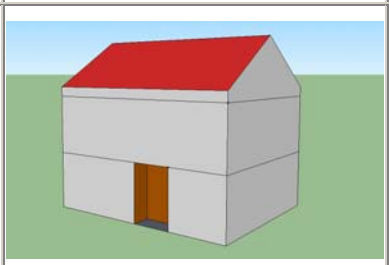
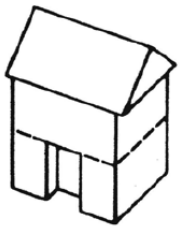
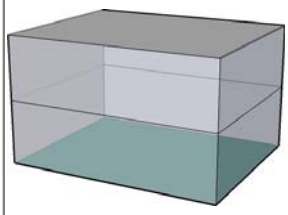
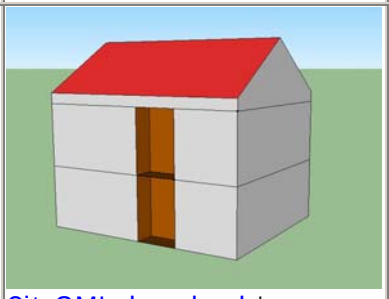
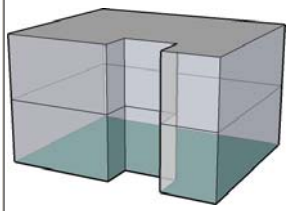
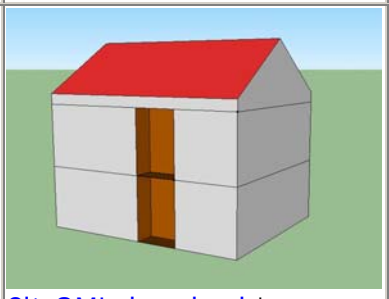
Loggia (1001); see SIG 3D Codelist recommendation for *bldg:BuildingInstallation --> function*

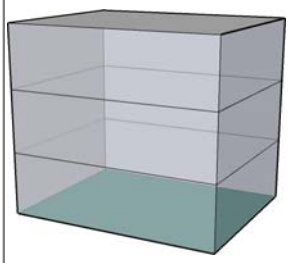
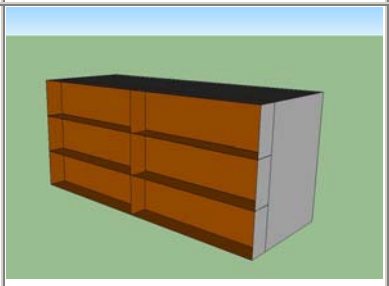
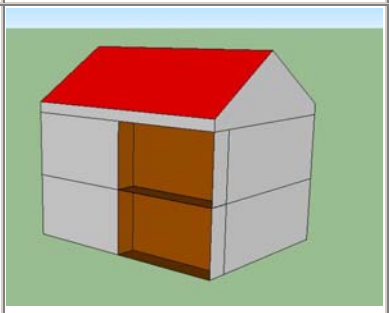
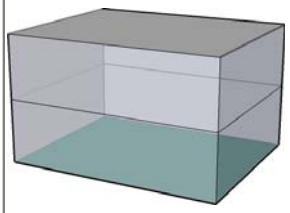
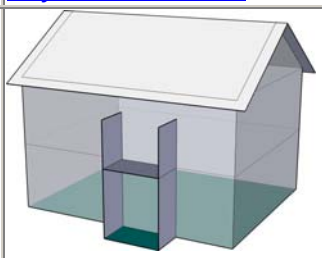
bldg:boundedBy

recommended: A Loggia is considered as a building component which semantically consists of the building's boundary surfaces and possibly an exterior floor surface.

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

3.2.2.5 Examples

Real Building	CityGML LOD0	CityGML LOD1	CityGML LOD2	CityGML LOD3
 Interior Loggia			 CityGML download	
			 CityGML download	
 Partly set back ground floor			 CityGML download *	
 Multi-storey building with interior Loggias			 CityGML download *	
			 CityGML download *	

Real Building	CityGML LOD0	CityGML LOD1	CityGML LOD2	CityGML LOD3
			 CityGML download *	
Loggias across half the front-width (row house)		[[	 CityGML download *	
Projecting Loggias			 CityGML download *	

* In this example, the geometry is modeled within the `lod2Solid` but not within the specified `BoundarySurface` elements (opposed to the standard)!

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

3.2.3 Passages

3.2.3.1 Definition

SIG3D: An open **Passage** is a part of a building at ground level for **vehicles** to drive through the building. It is bounded by walls and a roof.

3.2.3.2 CityGML Feature

- **LoD1:** not available
- **LoD2:** *bldg:BuildingInstallation*
- **LoD3:** *bldg:BuildingInstallation*

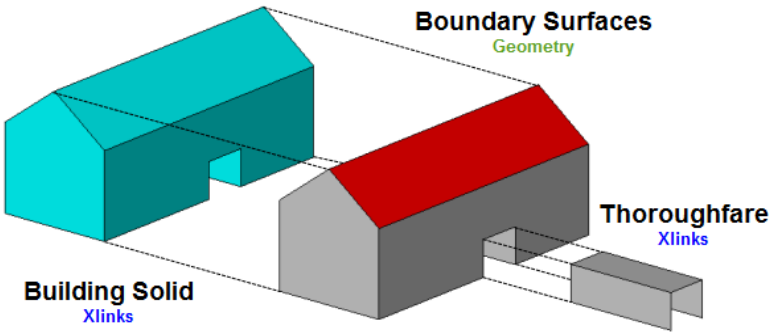
3.2.3.3 Geometry

gml:Geometry **not recommended**

bldg:boundedBy **recommended**

- Threshold LOD2 / LOD3:
  - Modeling only, if the passage's depth and height >= 2 m;

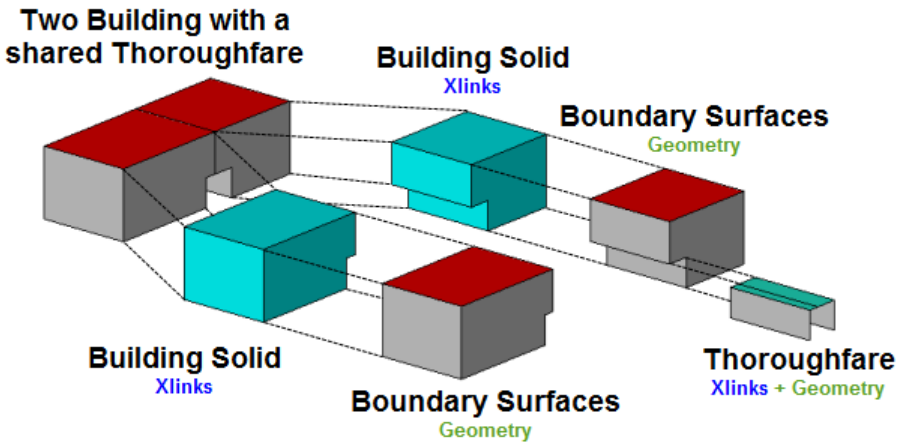
- **Modeling Principle** (passage in a building)
  - The building contains all geometry-containing boundary surfaces.
  - The passage (BuildingInstallation) **references (Xlink)** to the building's corresponding boundary surfaces.
  - The building's volume references (Xlink) to the building's corresponding boarder surfaces.



Modeling principle of a passage

- **Modeling Principle** (Shared passage through two buildings)
  - Each building contains all geometry-containing boundary surfaces
  - The passage (BuildingInstallation) is assigned to the building which contains the greater part of the passage. The passage **references (Xlink)** to the building's corresponding boarder surfaces and complements the passage with bounding geometry at the BuildingInstallation.
  - The building's volume references (Xlink) to the building's corresponding boarder surfaces.

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)



Modeling principle of a shared passage

- **Note:** The modeling of buildings with a closed building construction is described in Chapter 3.7

3.2.3.4 Attributes

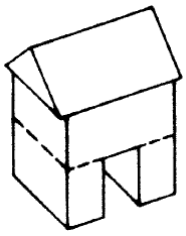
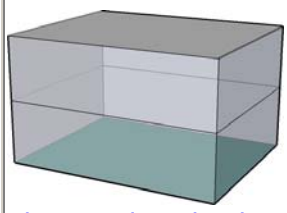
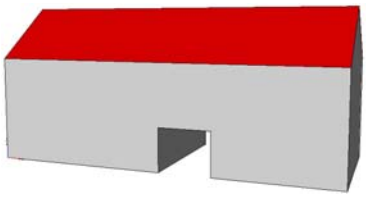
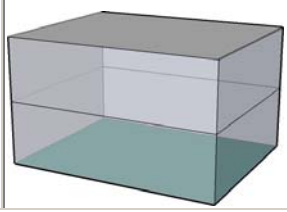
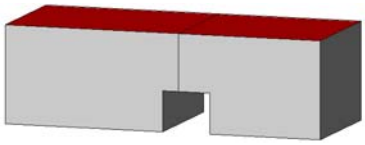
bldg:function

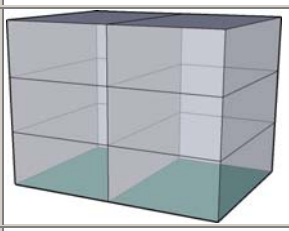
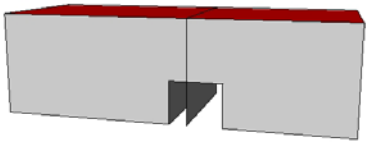
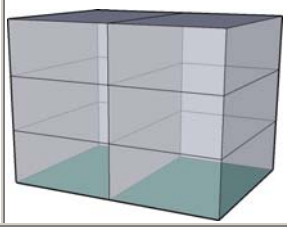
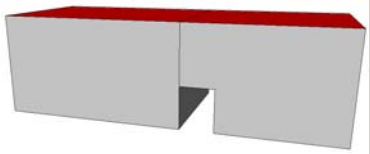
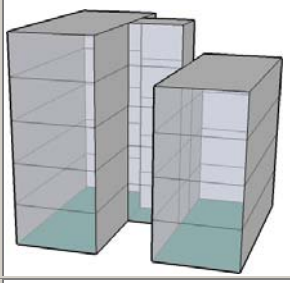
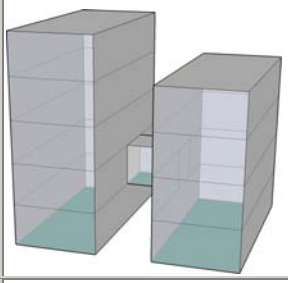
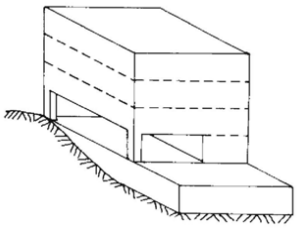
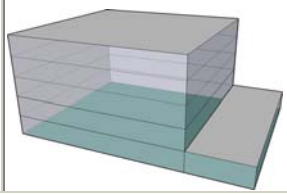
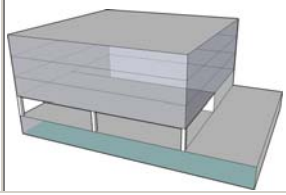
- Passage(1002); see SIG 3D codelist recommendation for *bldg:BuildingInstallation --> function*

bldg:boundedBy

- recommended: A passage is considered as a building component which semantically consists of the building's boundary surfaces and possibly an exterior floor surface.

3.2.3.5 Examples

Actual Example	CityGML LoD0	CityGML LoD1	CityGML LoD2	CityGML LoD3
 Passage inside of a building		 CityGML download	 CityGML download	
Two buildings with a shared passage			 CityGML download	

Actual Example	CityGML LoD0	CityGML LoD1	CityGML LoD2	CityGML LoD3
Two buildings with separate passages			 CityGML download	
Two buildings with onesided passage			 CityGML download	
Two buildings with a connection section				
 Upper floor passage				

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

3.2.4 Dormers / Gable (Dormer Gable)

3.2.4.1 Definition

SIG3D: SIG3D: A **dormer'** is a structural element of a building that protrudes from the plane of a sloping roof surface. Dormers are used, either in original construction or as later additions, to create usable space in the roof of a building by adding headroom and usually also by enabling addition of windows [Wikipedia].
A **dormer** does not lie on the same plane as the building's exterior wall. The dormer (or the dormer's footprint) has a minimum offset of 0,5 m and lies inside the building's footprint.

SIG3D: The **dormer gable** is a one or more story installation of a sloping roof surface. It consists of a gable and its own roof. The dormer gable follows the exterior wall's building line. That represents the difference between a dormer gable and a gable, because a gable does not have to follow the building line. The roof of dormer gable is often designed as a ridge roof. The ridge follows cross to the main roof's ridge. So the rainwater pipes continue in an orthogonal way to each other.
Note: The **dormer gable** is not modeled as a part of the building installation, but as a building's boundary surface itself.

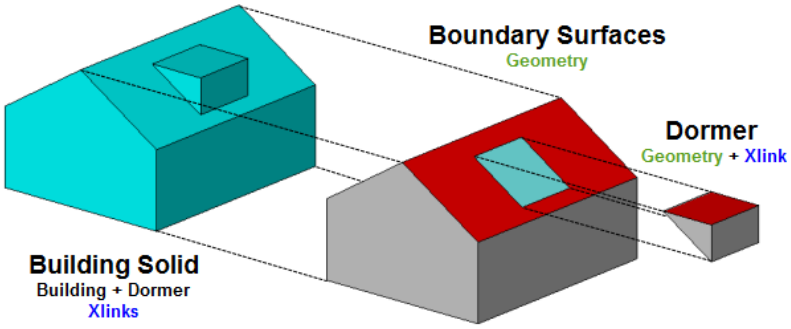
3.2.4.2 CityGML Feature

- **LOD1:** not available
- **LOD2:** *bldg:BuildingInstallation*
- **LOD3:** *bldg:BuildingInstallation*

3.2.4.3 Geometry

- ***gml:Geometry*** **not recommended**
- ***bldg:boundedBy*** **recommended**
  - Threshold LOD2:
    - Modeling only, if the dormer's height >= 2 m;
  - Threshold LOD3:
    -
  - **Modeling Principle**
    - The building contains all geometry-containing boundary surfaces of the building structure. To close the building's volume, a ClosureSurface is modeled into the roof's gap.
    - The dormer (BuildingInstallation) **contains all geometry-containing boundary surfaces** of the dormer. To close the volume, either a ClosureSurface is modeled or it is closed by referencing to the building's corresponding ClosureSurface (Xlink to OrientableSurface).
    - The building's volume, the building structure's volume and the volume of the dormer (**CompositeSolid**) reference (Xlink)to the corresponding boundary surfaces of the building structure and dormer.

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)

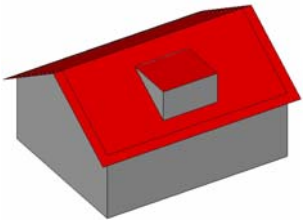


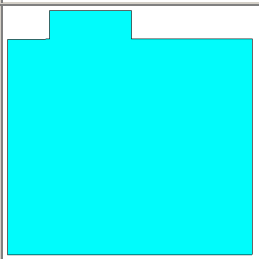
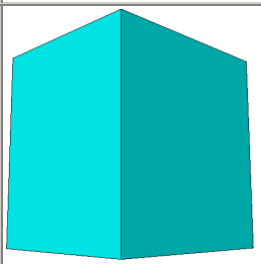
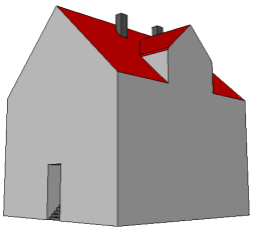
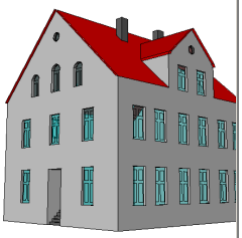
Modelling Principle of a dormer

3.2.4.4 Attributes

- ***bldg:function***
  Dormer (1003); see SIG 3D codelists recommendation for *bldg:BuildingInstallation --> function*
- ***bldg:boundedBy***
  recommended: A dormer is considered as a building component which semantically consists of the building's boundary surfaces.

3.2.4.5 Examples

Actual Example	CityGML LOD0	CityGML LOD1	CityGML LOD2	CityGML LOD3
			 CityGML download	

Real Building	CityGML LOD0	CityGML LOD1	CityGML LOD2	CityGML LOD3
	 CityGML download	 CityGML download	 CityGML download	 CityGML download

3.2.5 Arcades / Architraves

3.2.5.1 Definition

SIG3D: An arcade is a succession of arches, each counter thrusting the next, supported by columns or piers, or a covered walk enclosed by a line of such arches on one or both sides. In warmer or wet climates, exterior arcades provide shelter for pedestrians.[Wikipedia]

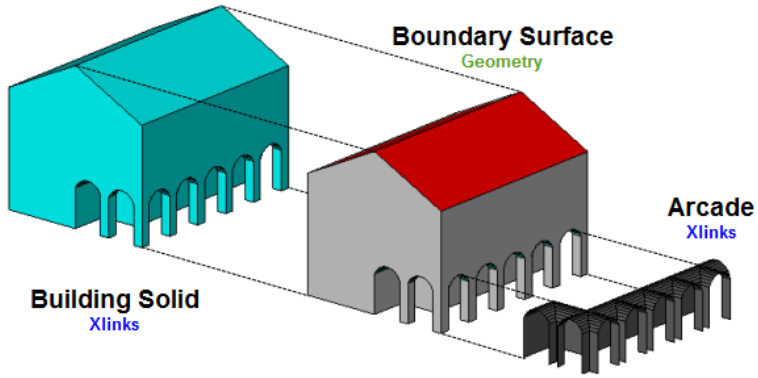
SIG3D: An **architrave** (from Italian architrave, from Greek ἀρχι, archi- and Latin trabs, bar) is the lintel or beam that rests on the capitals of the columns. It is an architectural element in Classical architecture. In the ancient world, it was also called Epistyl because it was commonly built on pillars.[Wikipedia]

3.2.5.2 CityGML Feature

- **LOD1:** not available
- **LOD2:** *bldg:BuildingInstallation*
- **LOD3:** *bldg:BuildingInstallation*

3.2.5.3 Geometry

- ***gml:Geometry*** **net recommended**
- ***bldg:boundedBy*** **recommended**
  - **Threshold LOD2:**
    - Threshold-values for the modelling of beams: all sides of the beam's BoundingBox are >= 0.5 m
  - **Modelling principle**
    - The building contains all geometry-containing boundary surfaces
    - The Arcade (BuildingInstallation) **references (Xlink)** to the building's corresponding boundary surfaces
    - The building's volume references (Xlink) to the building's corresponding boundary surfaces



Modelling principle of an arcade

Attributes

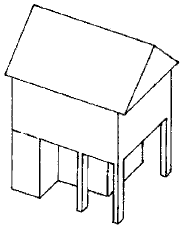
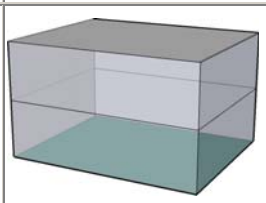
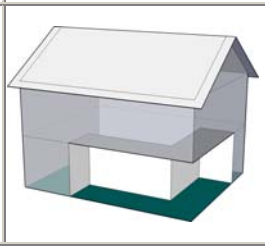
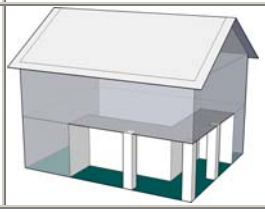
bldg:function

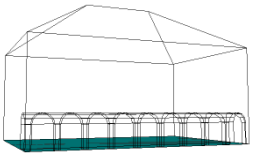
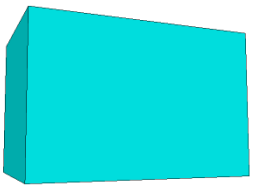
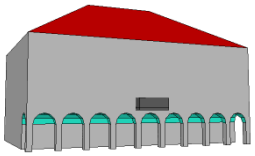
Arcade (1009); see SIG 3D codelist recommendation for *bldg:BuildingInstallation --> function*

bldg:boundedBy

recommended: An Arcade is considered as a building component which semantically consists of the building's boundary surfaces.

3.2.5.4 Examples

Actual example	CityGML LOD0	CityGML LOD1	CityGML LOD2	CityGML LOD3
				
				

Real Building	CityGML LOD0	CityGML LOD1	CityGML LOD2	CityGML LOD3
	 CityGML download	 CityGML download	 CityGML download	CityGML download

© 2012-2014 Special Interest Group SIG3D of the German Spatial Data Infrastructure (GDI-DE)