PROJECT: ECOLOGICAL AND INNOVATIVE TECHNOLOGIES FOR RECOVERING INDUSTRIAL AREAS FROM LCA AND ENERGY EFFICIENCY POINT OF VIEW

2020-1-RO01-KA203-080223

BUILDING INFORMATION MODELING

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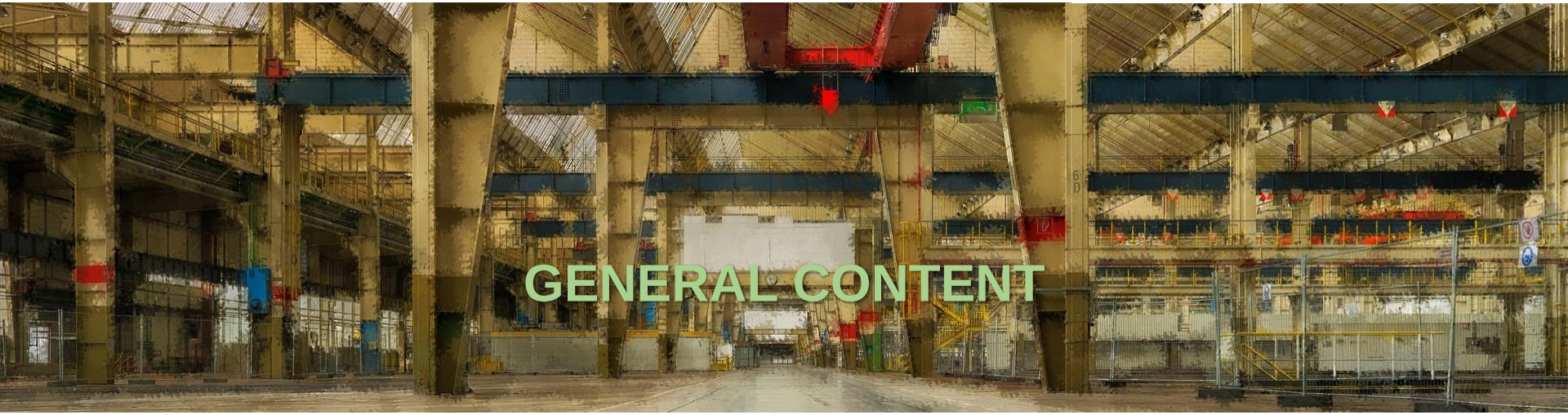


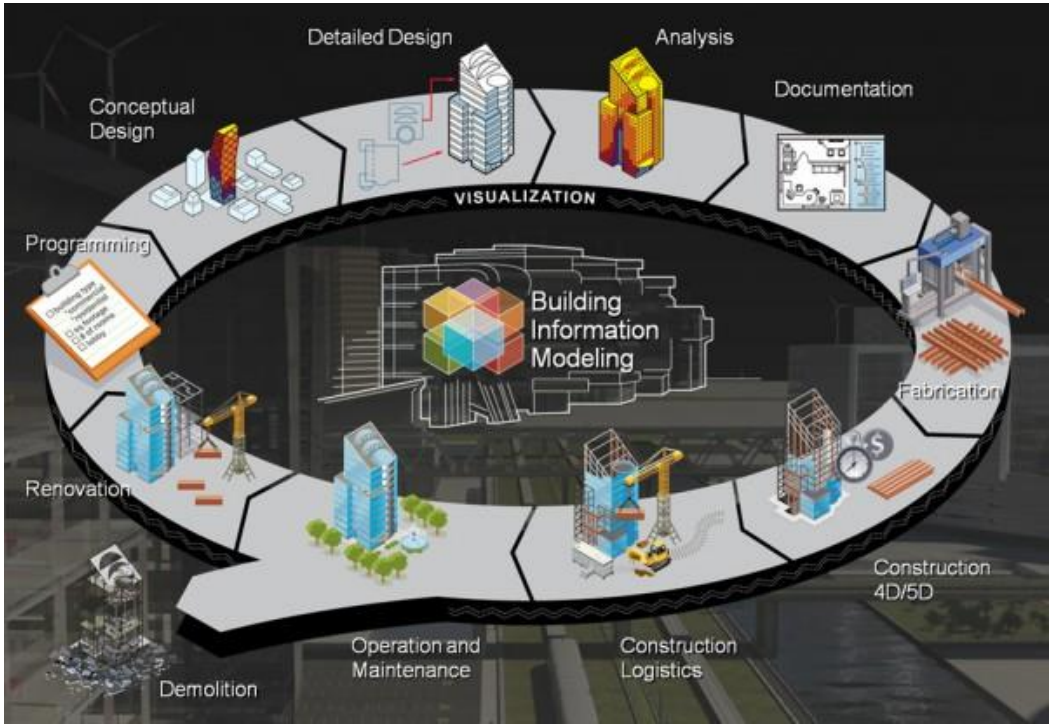
GENERAL CONTENT

1. BIM METHODOLOGY
2. BIM BASICS APPLIED TO LCA
3. LEVELS OF DEVELOPMENT (LOD)
4. ENVIRONMENTAL IMPACT CATEGORIES
5. LOD600

1. BIM METHODOLOGY

METHODOLOGY

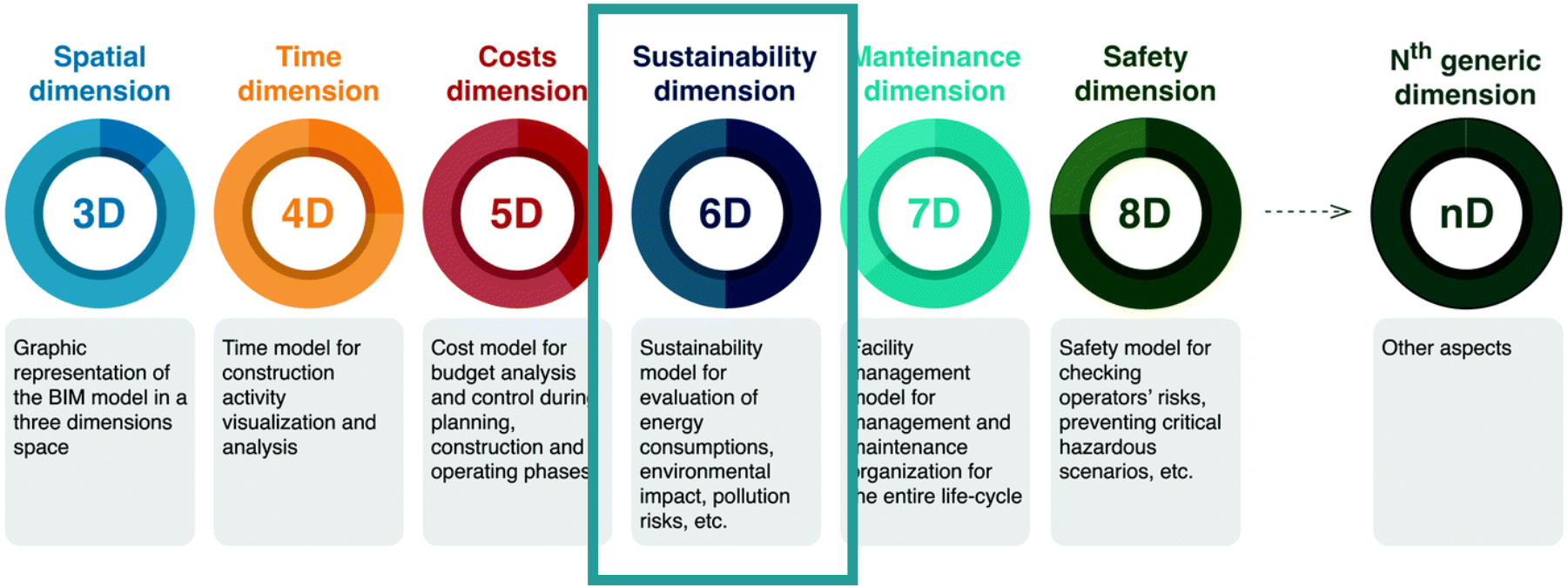
Building Information Modeling (BIM) is a collaborative working methodology for the creation and management of a construction project.
Its objective is to centralise all the project information in a digital information model created by all its agents:



1. BIM METHODOLOGY

BIM DIMENSIONS

BIM is the evolution of traditional plan-based design systems, as it incorporates geometric (3D), time (4D), cost (5D), environmental (6D), maintenance (7D), health and safety (8D), etc.



1. BIM METHODOLOGY

ADVANTAGES OF THE BIM METHODOLOGY

- **BIM platforms automatically update the information that is edited in any part of the model**. This means that if an element is modified in a floor plan, it is automatically modified in the sections, elevations and 3D views, just as if a feature is modified in a listing, it automatically changes throughout the project. **There is no possibility of human error. The information is always consistent.**

- As all the agents work on a single model, **there is no possibility of loss of information due to lack of coordination between versions** handled by different professionals.

- By establishing this method of working in parallel, all the agents can propose from the beginning the options they consider most convenient for the project, directly involving the whole organisation. **The project is developed in real time in a coordinated manner in a collaborative environment**, always under the supervision of the client.

- **BIM allows any required information to be always available**, both design and technical, costs, execution deadlines, maintenance, etc. It also allows modifications to be made in real time that will automatically update all these parameters, increasing the degree of personalisation and adaptation of the project to the client's needs.

- **Facility management tasks become much more efficient**, as all the real information on the asset is available on demand.

2. BIM BASICS APPLIED TO LCA

CURRENT SITUATION

Environmental problems arising from the construction sector require tools to evaluate proposals that help to curb the consumption of resources and environmental impact.

Life Cycle Assessment (LCA) is recognised as one of the most valid methods for the environmental analysis of buildings, although its application is complex and its standardisation and simplification is necessary to make it operational, also in the design phase.

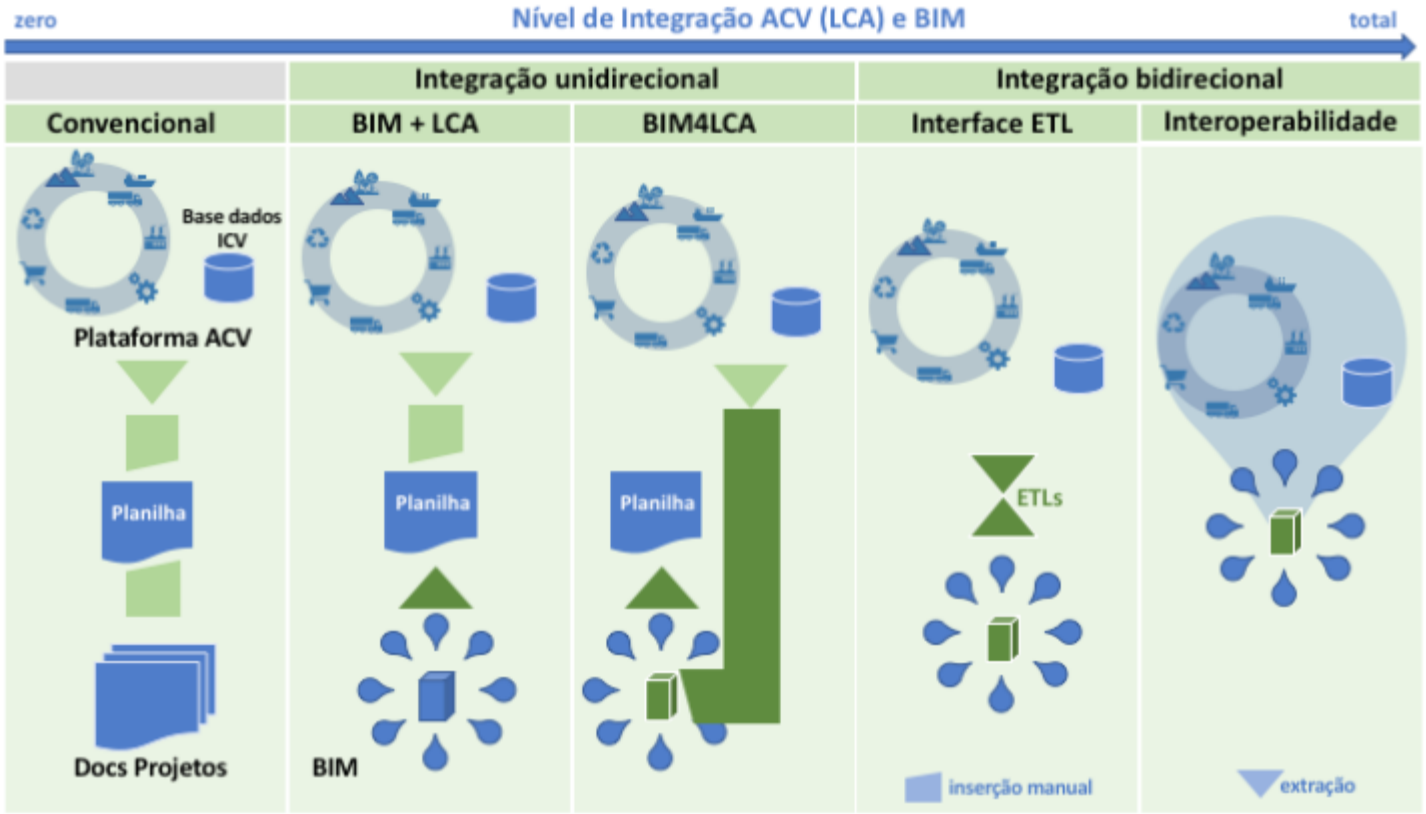
The integration of LCA into BIM platforms simplifies the environmental impact assessment process. Currently, there is a scarcity of literature and development of simulation tools based on BIM models and linked to LCA for obtaining environmental impact results.

It is therefore necessary to standardise LCA implemented in BIM platforms in order to simplify the process and obtain environmental impact results in real time from the design phase.

2. BIM BASICS APPLIED TO LCA

CURRENT SITUATION

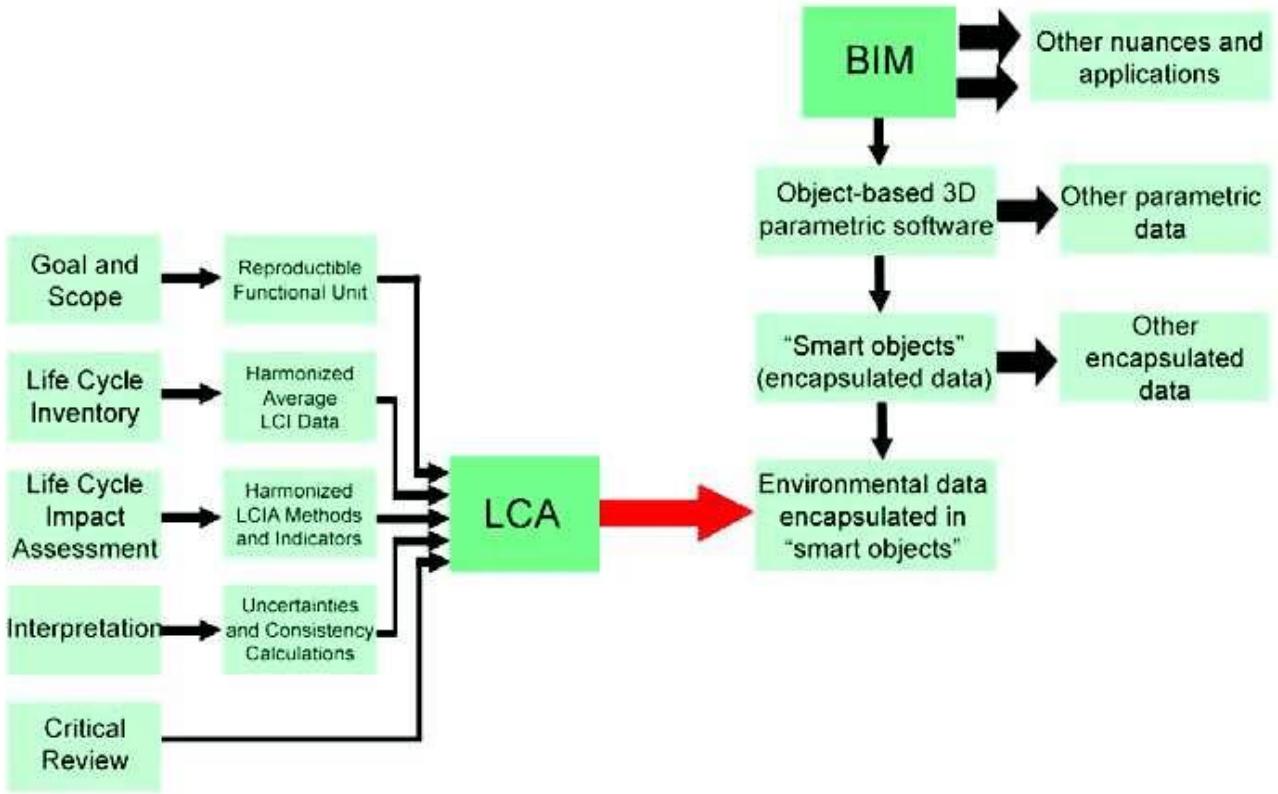
Today, the LCA of the building is unfortunately not a factor of choice, but rather an outcome. It is still difficult for the actors involved in a building project to rely on LCA in their choices. However, developers of BIM software and solutions will play an important role in integrating LCA into digital models.



2. BIM BASICS APPLIED TO LCA

CHARACTERISTICS OF BIM IN ACV CALCULATION

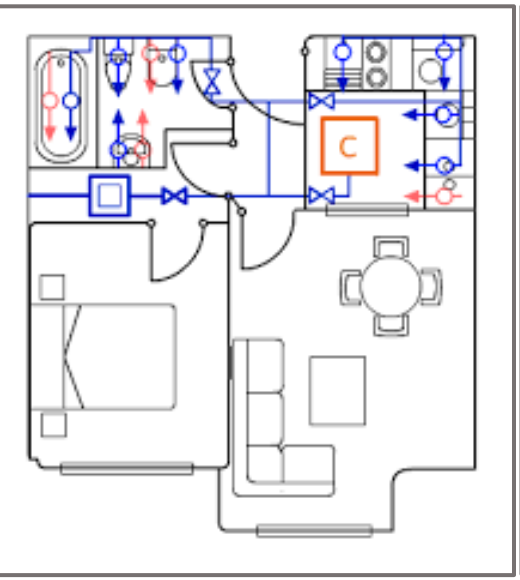
From a building modelled in BIM it is possible to calculate the LCA potentially without even changing the software environment. Therefore, LCA in BIM should be more automatic, more systematic and easier to achieve, allowing multidisciplinary teams in architectural projects to establish different scenarios from the point of view of the environmental impact of the building.

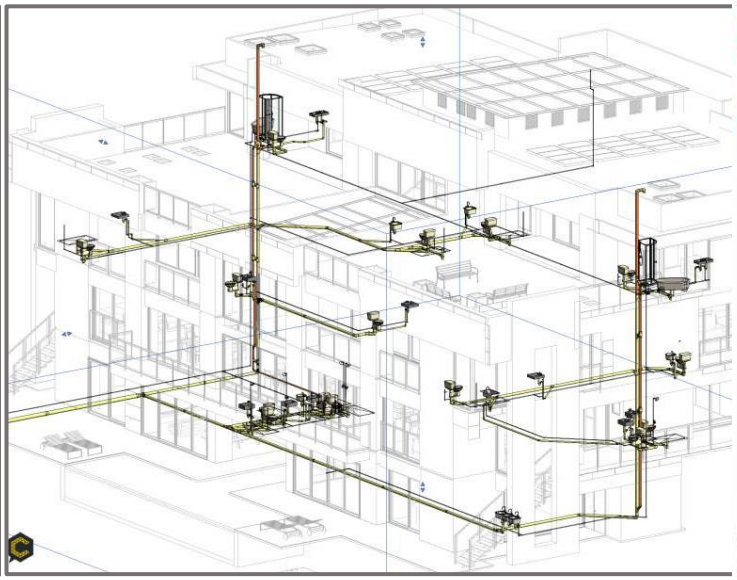


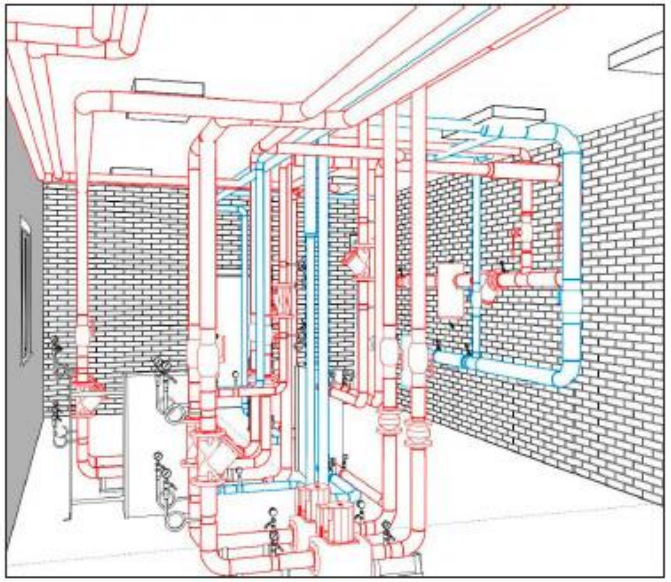
3. LEVELS OF DEVELOPMENT (LOD)

BASIC CONCEPTS

Expectations and understanding of what BIM is vary greatly. While there is obviously a common consensus for those immersed in the BIM methodology, most of the construction industry is still struggling to understand what they will produce, issue and receive when working with BIM.







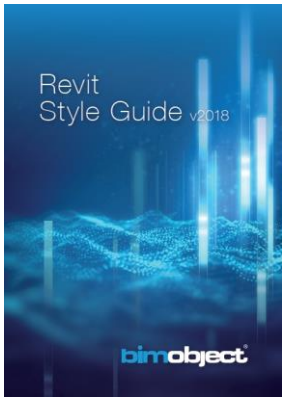
3. LEVELS OF DEVELOPMENT (LOD)

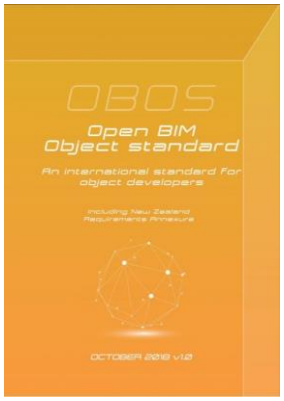
BIM OBJECTS and STANDARDS

BIM Objects are geometric models made with parametric software in a way that allows their attributes to be modified.

- When we talk about BIM objects, we always refer to open formats.
- However, in the case of the term Families, we refer to BIM Objects that we create with a specific tool: Autodesk Revit.

Covers of Revit Style Guide v2018, NBS BIM Object Standard and OBOS (Open BIM Object Standard).





3. LEVELS OF DEVELOPMENT (LOD)

CIC BIM PROTOCOLS

Regarding the stage of development of these BIM objects, the BIM CIC protocols in the UK detail a 'Model Production and Delivery Table', more commonly known as a 'Responsibility Matrix', to clarify what information will be produced at any given stage and by whom. In short, it assigns a LoD (level of detail) code to each building component or system at each progressive stage of the project so that the whole team knows what to expect.

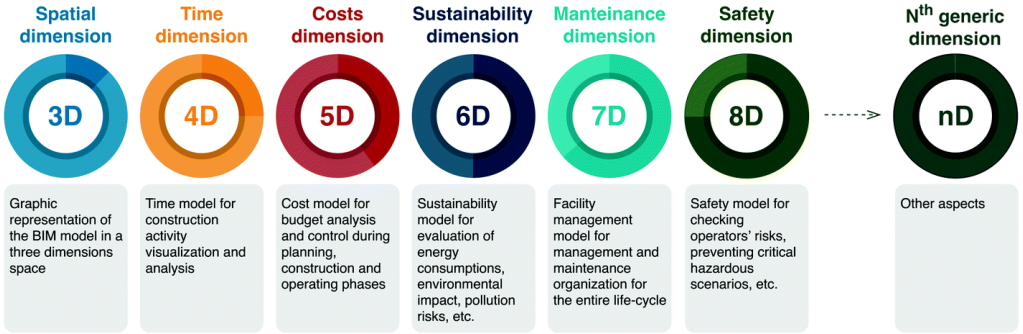
The basic codes differ between the US and UK conventions, which only serves to confuse the issue further.

For this reason, it is vitally important to differentiate properly between the following concepts.

3. LEVELS OF DEVELOPMENT (LOD)

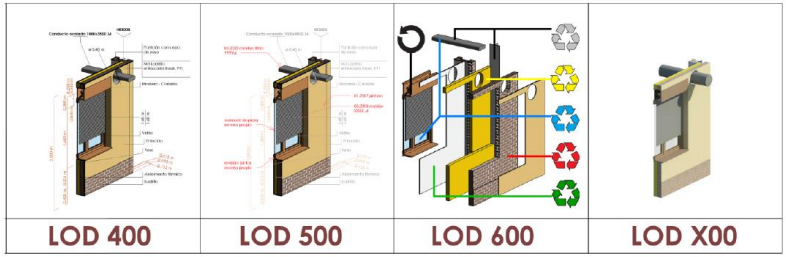
IT IS IMPORTANT TO DIFFERENTIATE BETWEEN:

BIM DIMENSIONS



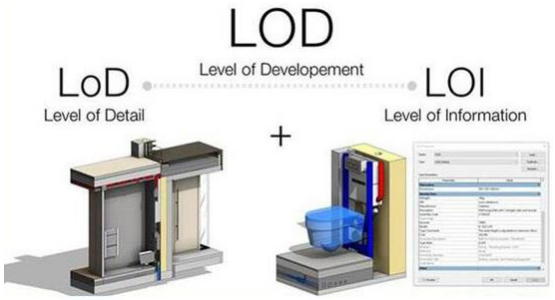
LEVELS OF DEVELOPMENT (LOD)

American standard. Only referred to BIM objects. No time factor.



LEVELS OF INFORMATION (LOI)

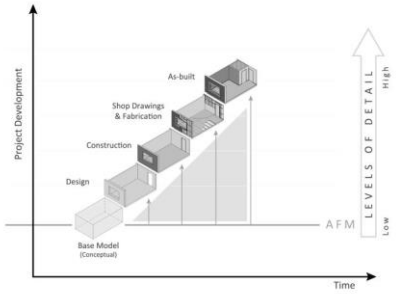
LEVELS OF DETAIL (LoD)



British Standard

BIM

LEVEL OF MODEL DEFINITION (LOMD)



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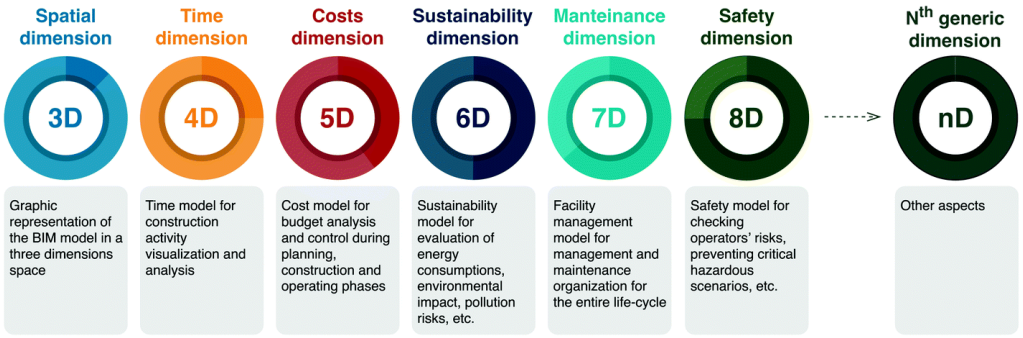
IT IS IMPORTANT TO DIFFERENTIATE BETWEEN:

BIM DIMENSIONS



LEVELS OF DEVELOPMENT (LOD)

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LEVELS OF INFORMATION (LOI)

LEVELS OF DETAIL (LOD)

British Standard

LEVEL OF MODEL DEFINITION (LOMD)

NAME OF THE COURSE

BIM

3. LEVELS OF DEVELOPMENT (LOD)

BIM DIMENSIONS

1D = The idea:
We start from an idea - a house for example - and define the initial conditions, the location; we make some initial estimates - surface area, volumetry and costs; we establish the execution plan, etc.

2D = The sketch:
We prepare the software for modelling; we project the first lines, etc.

3D = Information model of the building:
From all the information gathered, we generate the 3D model that will serve as the basis for the rest of the project's life cycle. It is more than a graphic representation of the idea. The 3D model is not only visual but incorporates all the information that will be needed for the following BIM phases -dimensions-.

4D = Time:
To what could so far be considered static, the dimension of time is added. So, we can define the phases of the project, establish its time planning; as well as simulate time parameters - life cycle, sun, wind, energy, etc. - and we can also simulate the time parameters - life cycle, sun, wind, energy, etc.

3. LEVELS OF DEVELOPMENT (LOD)

BIM DIMENSIONS

5D = Cost:
This is the cost control and cost estimation of the project. The main objective of this dimension is to improve the profitability of the project.

6D = Sustainability or Simulation:
Sometimes called Green BIM or Green BIM, it consists of simulating the possible alternatives of the project to finally arrive at the optimal alternative. And all this before 'laying the first brick'.

7D = Operation and Maintenance or Instruction Manual:
This could be said to be the manual to be followed during the life of the project, once built, for the use and maintenance of the project -inspections, repairs, maintenance, etc.-.

8D = Health and Safety:
The use of BIM and Lean together not only produces an increase in the productivity of construction projects, but also means an improvement in the quality of the preventive measures that can be adopted in the construction phase. All this results in an increase in the quality of Health and Safety at work, better controlling risks and creating a better workplace for workers.

3. LEVELS OF DEVELOPMENT (LOD)

IT IS IMPORTANT TO DIFFERENTIATE BETWEEN:

BIM DIMENSIONS

LEVELS OF DEVELOPMENT (LOD)

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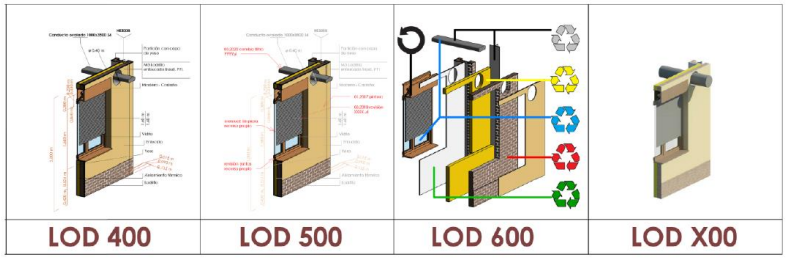

LEVELS OF INFORMATION (LOI)

LEVELS OF DETAIL (LOD)

British Standard

LEVEL OF MODEL DEFINITION (LOMD)

BIM

3. LEVELS OF DEVELOPMENT (LOD)

LEVELS OF DEVELOPMENT (LOD)

The LOD as Level of Development defines the level of development or information maturity that **an element of the model** possesses, and this is the part of a component, construction system or building assembly.

It should be clarified that the LOD does not refer to the entire project and is not linked to the development or construction phase.

Source: https://muralit.es/lod-nivel-de-desarrollo/

3.4. LEVELS OF INFORMATION (LOI)

IT IS IMPORTANT TO DIFFERENTIATE BETWEEN:

BIM DIMENSIONS

LEVELS OF DEVELOPMENT (LOD)

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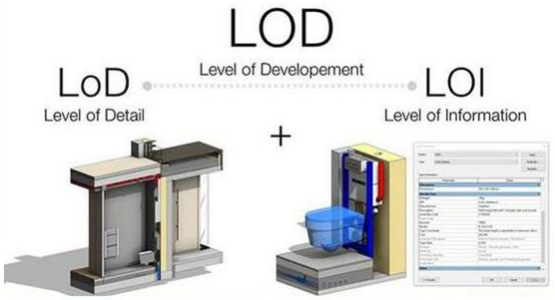
LEVELS OF INFORMATION (LOI)

LEVELS OF DETAIL (LoD)



British Standard

BIM

LEVEL OF MODEL DEFINITION (LOMD)

3. LEVELS OF DEVELOPMENT (LOD)

LEVELS OF INFORMATION (LOI)

This is the amount of non-modelled information that a BIM object has. For example, a family has its types and within these types it can have a huge number of parameters that can range from something as simple as height and width to as complex as a mathematical formula that changes the spacing of the elements depending on the occupancy of the room, they are in.

LOI can be tables, specifications and parametric information.

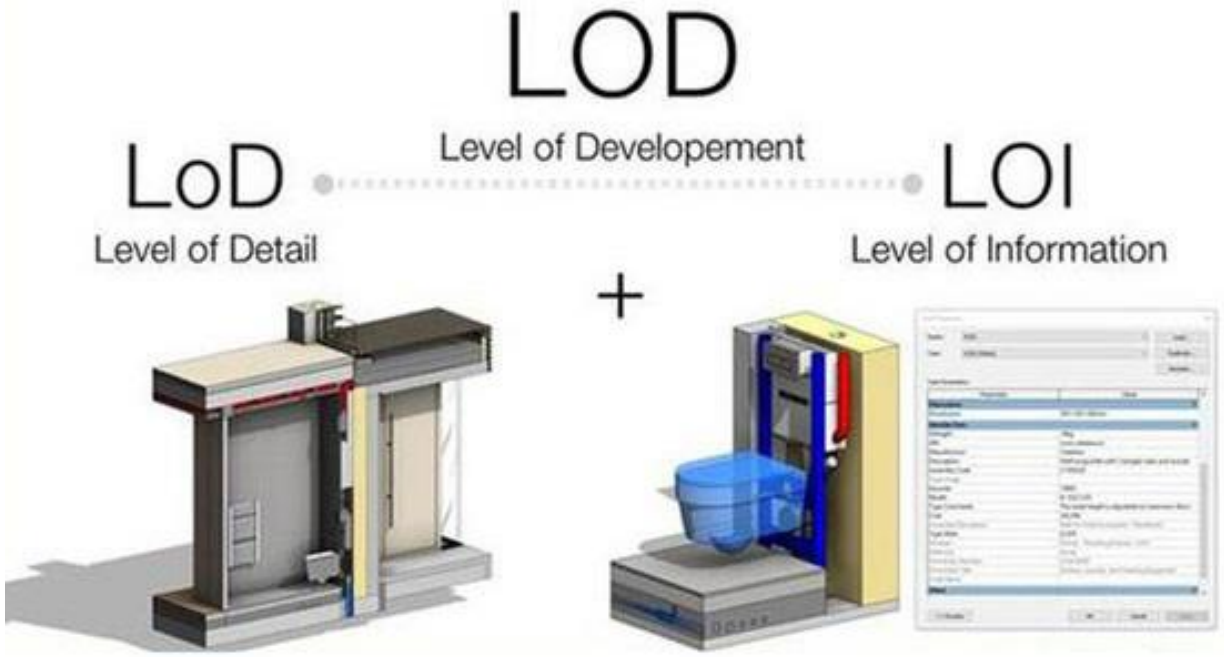
Source: https://sktalleres.com/bim-lod-100-200-y-300/

3. LEVELS OF DEVELOPMENT (LOD)

LEVELS OF DETAIL (LoD)

➢ The term LOD (Level of Development) is sometimes misinterpreted as Level of Detail (LoD). The Level of Detail (LoD) essentially refers to the amount of graphical detail included in the model element. However, the LOD is a measure of the amount of information and the quality of the information.

➢ Roughly speaking, we could say that the LOD for the American standard is the sum of LOI and LoD of the British standard.



Source: https://sktalleres.com/bim-lod-100-200-y-300/

3.6. LEVEL OF MODEL DEFINITION (LOMD)

IT IS IMPORTANT TO DIFFERENTIATE BETWEEN:

BIM DIMENSIONS

LEVELS OF DEVELOPMENT (LOD)

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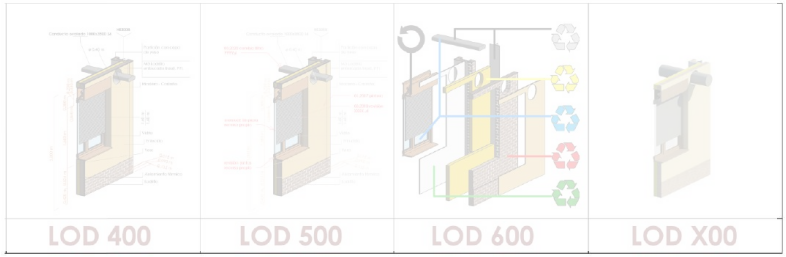
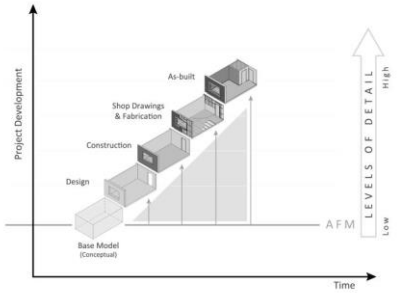


LEVELS OF INFORMATION (LOI)

LEVELS OF DETAIL (LOD)

British Standard

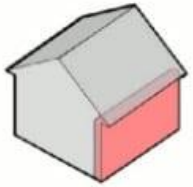
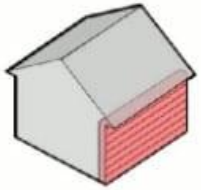
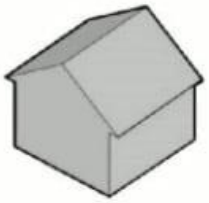
LEVEL OF MODEL DEFINITION (LOMD)



3. LEVELS OF DEVELOPMENT (LOD)

LEVEL OF MODEL DEFINITION (LOMD)

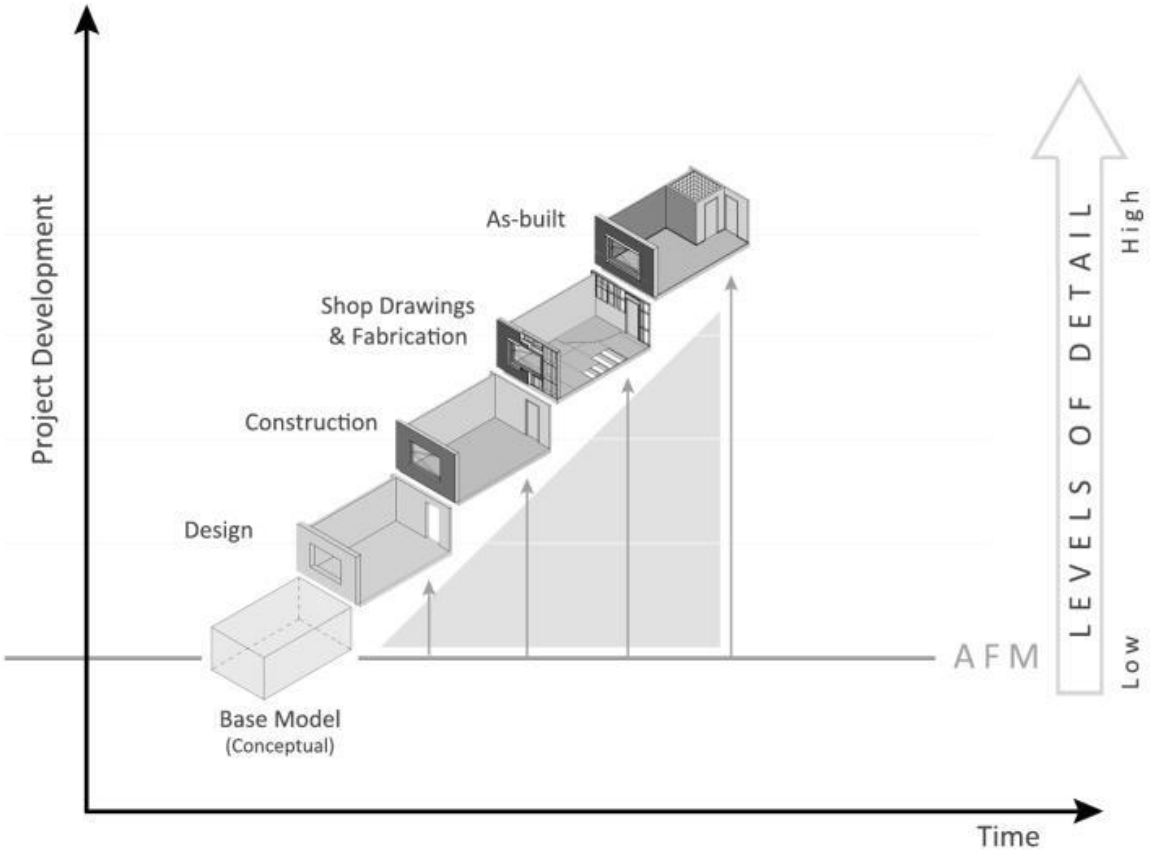
Sometimes the term LoD (Level of Detail) is used to refer to the model, and not to the elements that make it up. But this leads to confusion and other authors use the term LOMD when referring to the model (the project to be executed) instead of the elements that make it up (the BIM objects that make up the project graphically).

LOMD1 PREPARATION & BRIEF	LOMD2 CONCEPT DESIGN	LOMD4 DEVELOPED DESIGN	LOMD4 TECHNICAL DESIGN	LOMD5 CONSTRUCTION	LOMD6 HANDOVER
					
• A model communicating the performance requirements and site constraints	• A conceptual or massing model intended for whole building studies including basic areas & volumes, orientation, cost	• Generalized systems with approximate quantities, size, shape, location and orientation.	• Production, or pre-construction, "design intent" model representing the end of the design stages. • Modelled elements are accurate and coordinated, suitable for cost estimation and regulatory compliance checks.	• an accurate model of the construction requirements and specific building components, including specialist sub-contract geometry and data.	• An "as built" model showing the project as it has been constructed. The model and associated data is suitable for maintenance and operations of the facility.

3. LEVELS OF DEVELOPMENT (LOD)

LEVEL OF MODEL DEFINITION (LOMD)

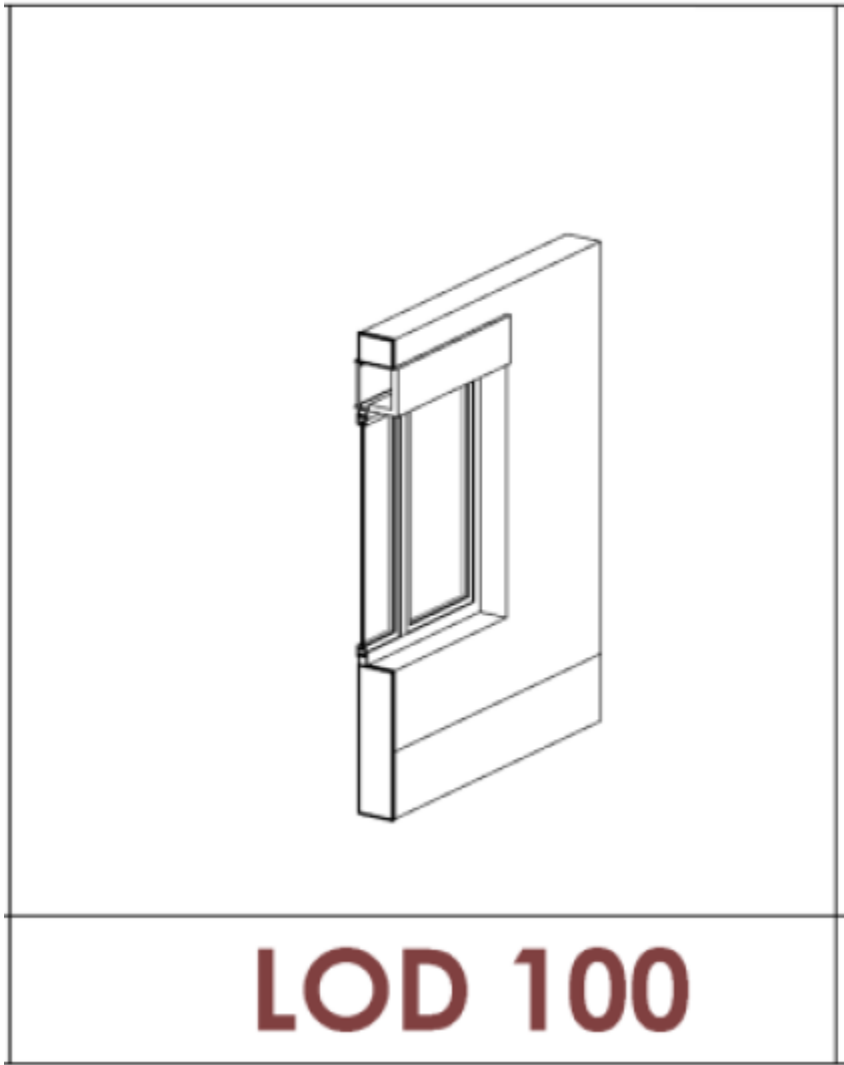
The Definition Level corresponds to the linear evolution of quantity and richness of information of a construction process; **it always increases over time and refers to the project model**, costs/budgets and time planning.



3. LEVELS OF DEVELOPMENT (LOD)

TYPES OF DEVELOPMENT LEVELS

- **LOD 100: Pre-design stage.**
  - Contains basic element information such as area, height, volume, location and orientation. This information should be considered as approximate.
  - The element may be represented graphically in the model with a symbol or other generic representation.
  - For example, in the case of a partition wall, we would have the dimensions of the partition wall.



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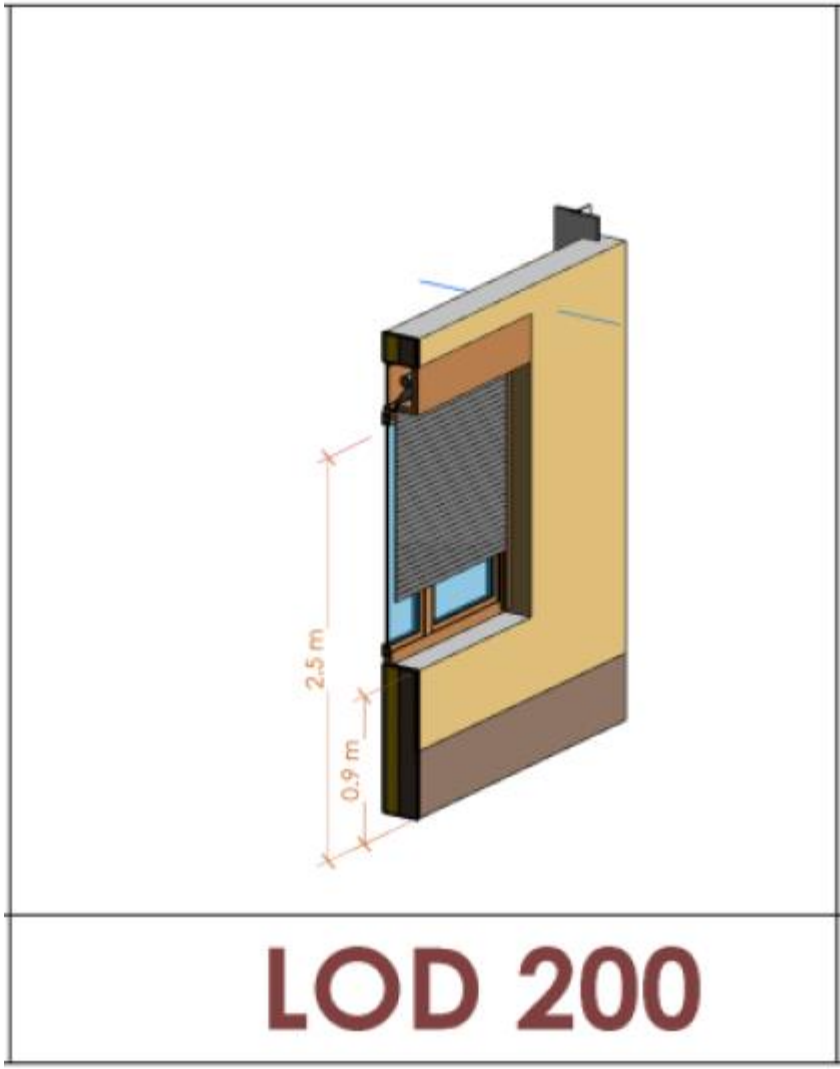
https://www.buildingsmart.es/app/download/11134225126/sjbim1501.pdf?t=1575535509 págs. 40-58
BIM

3. LEVELS OF DEVELOPMENT (LOD)

TYPES OF DEVELOPMENT LEVELS

- **LOD 200: Schematic design.**
  - General model in which elements are modelled with approximate quantities, size, shape, location and orientation.
  - We can also attach non-geometric information to the elements of the model.



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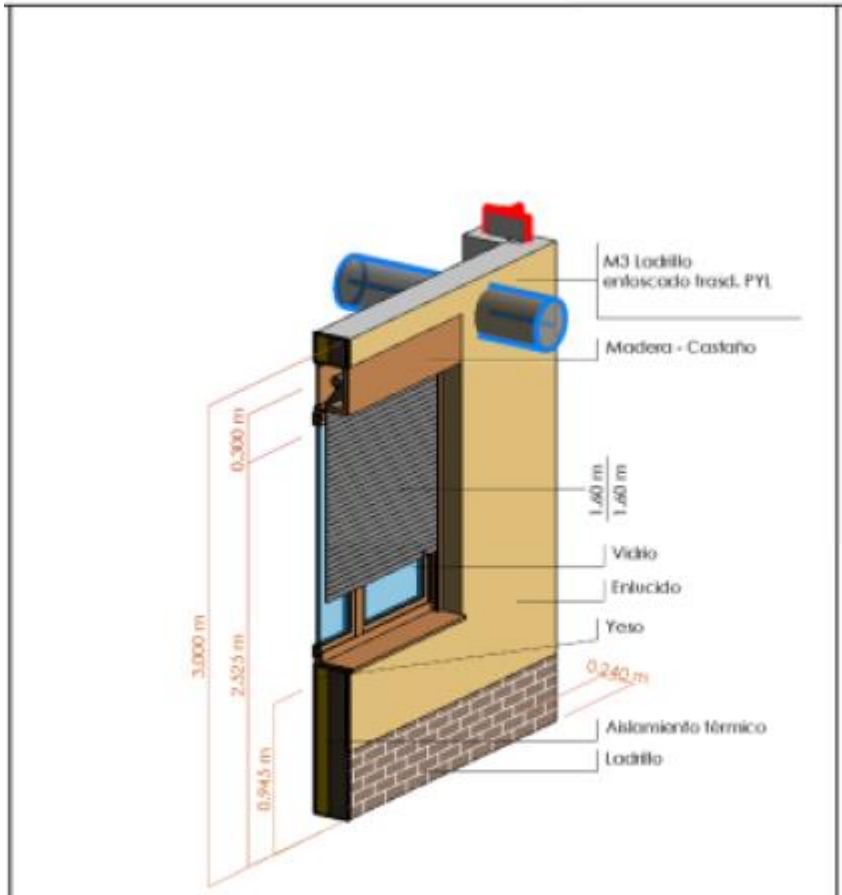
BIM

3. LEVELS OF DEVELOPMENT (LOD)

TYPES OF DEVELOPMENT LEVELS

- **LOD 300: Detailed design.**
  - Precise and geometrically defined modeling in detail, as well as its position, belonging to a specific construction system, use and assembly in terms of quantities, dimensions, shape, location and orientation.
  - Non-graphical information may also be included to the element.



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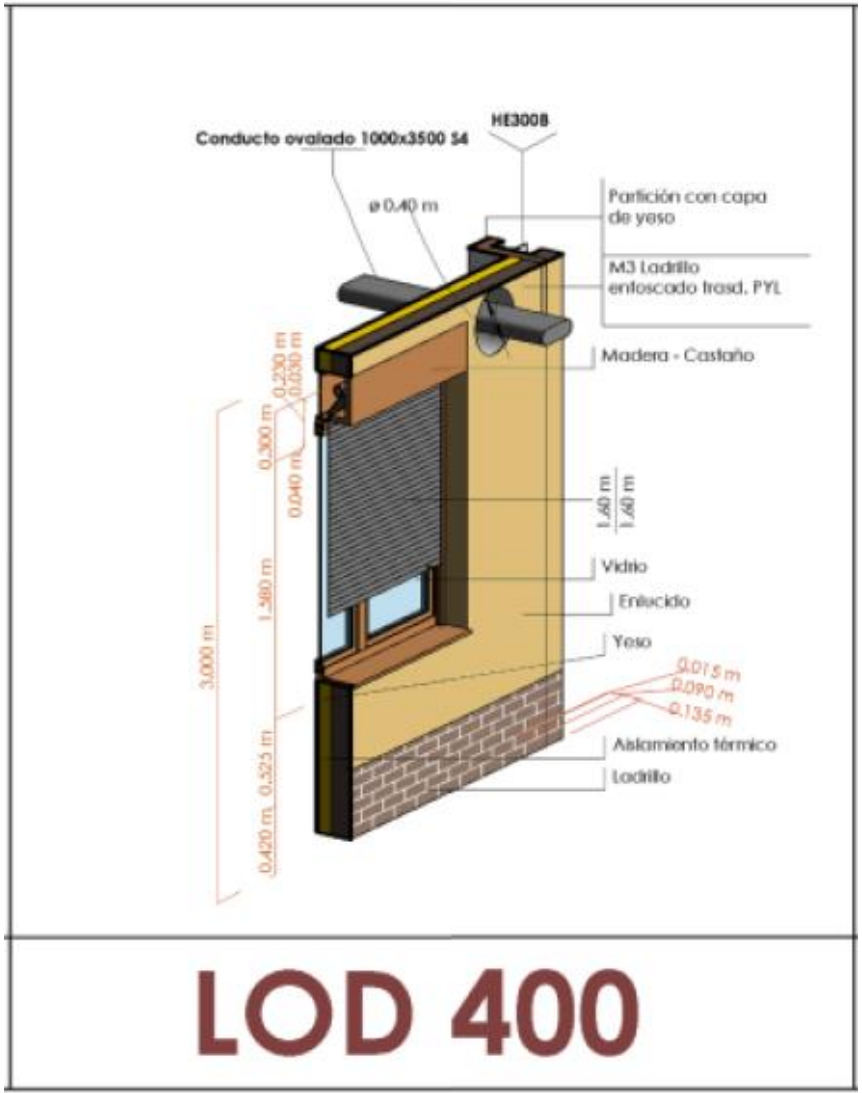
BIM

3. LEVELS OF DEVELOPMENT (LOD)

TYPES OF DEVELOPMENT LEVELS

- **LOD 400: Manufacture and assembly.**
  - The object is defined in detail geometrically, as well as its position, belonging to a specific construction system, use and assembly in terms of quantities, dimensions, shape, location and orientation.
  - It includes specific information for design, commissioning/assembly and installation.
  - Non-graphical information may also be included for the element.



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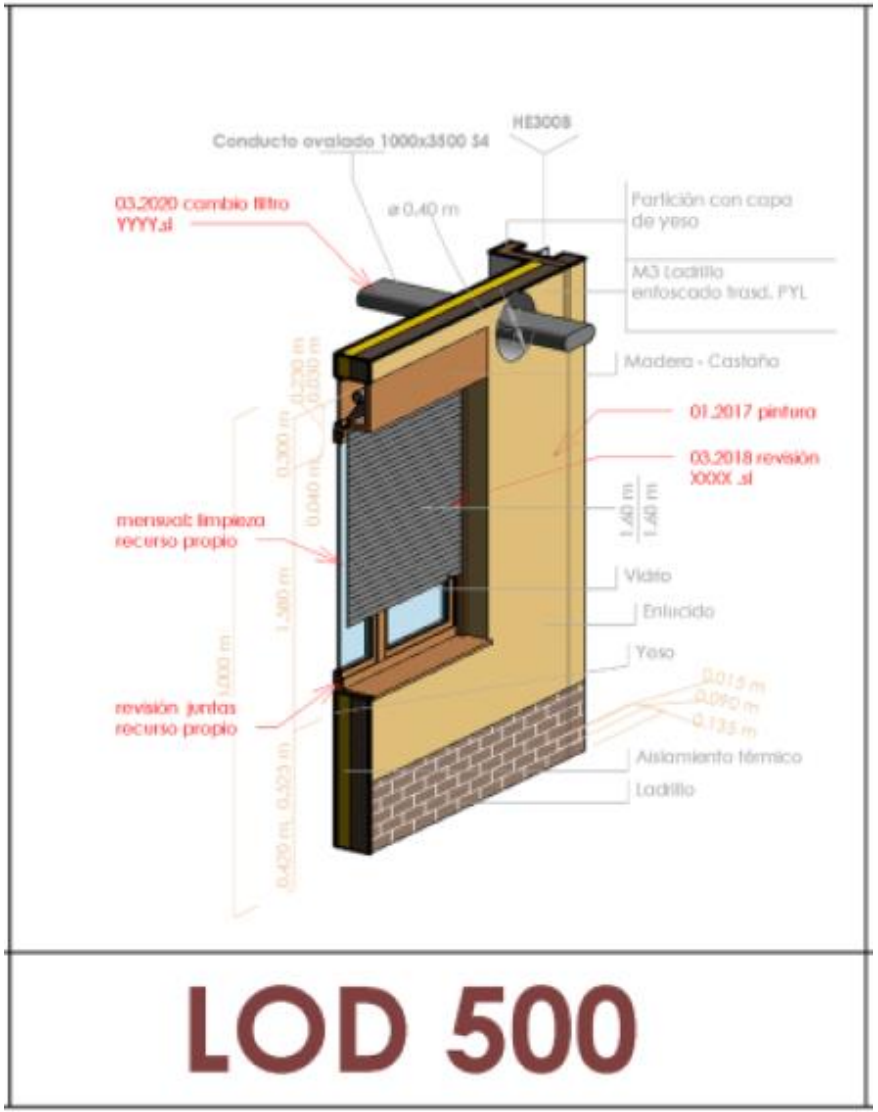
3. LEVELS OF DEVELOPMENT (LOD)

TYPES OF DEVELOPMENT LEVELS

- **LOD 500 (I).**
  - Elements are modelled as assemblies built for maintenance and operations.
  - In addition to the actual and accurate information on size, shape, location, quantity and orientation, non-geometric information is attached to the modelled elements.



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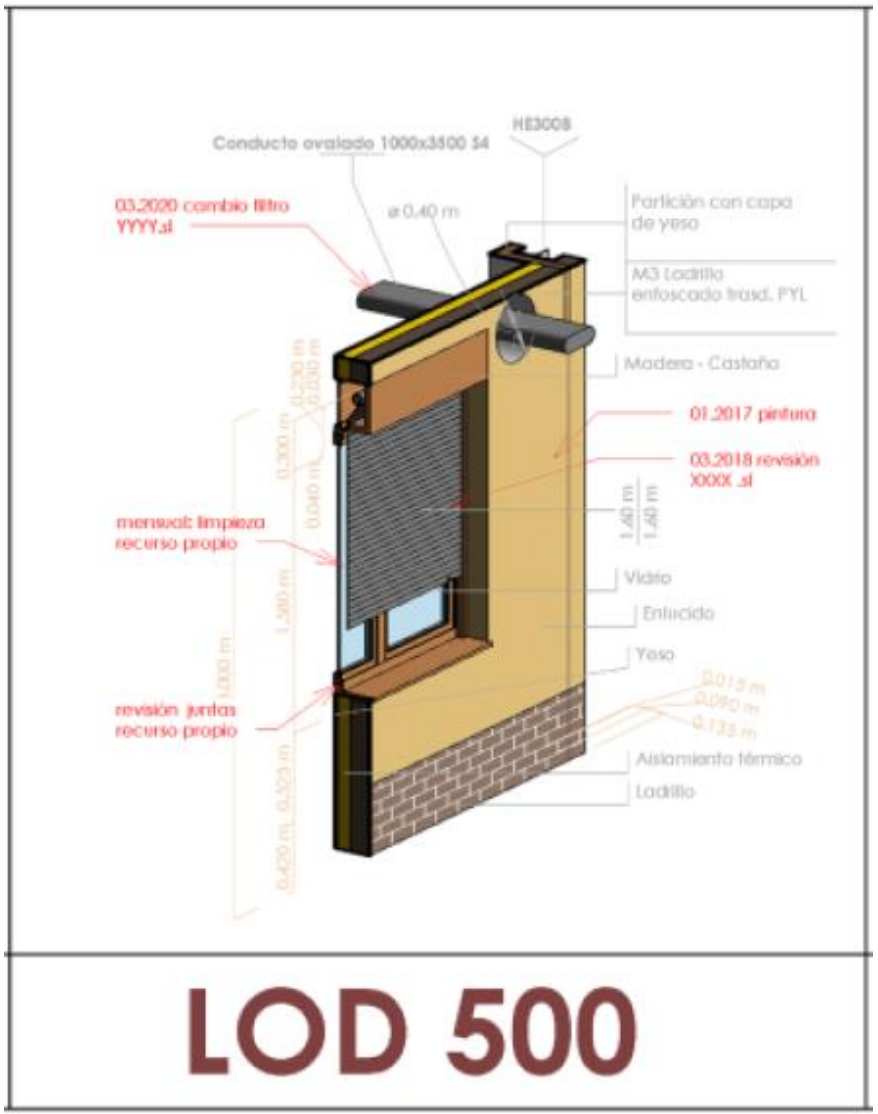
BIM

3. LEVELS OF DEVELOPMENT (LOD)

TYPES OF DEVELOPMENT LEVELS

- **LOD 500 (II).**
  - Information at this level is verified in relation to the "as built" construction process and is not applicable to all elements of the project.
  - Its use is linked to the future and may include determination of current status, product specifications and approvals, direct or indirect use and maintenance, management and operation, as well as renovations and modifications.



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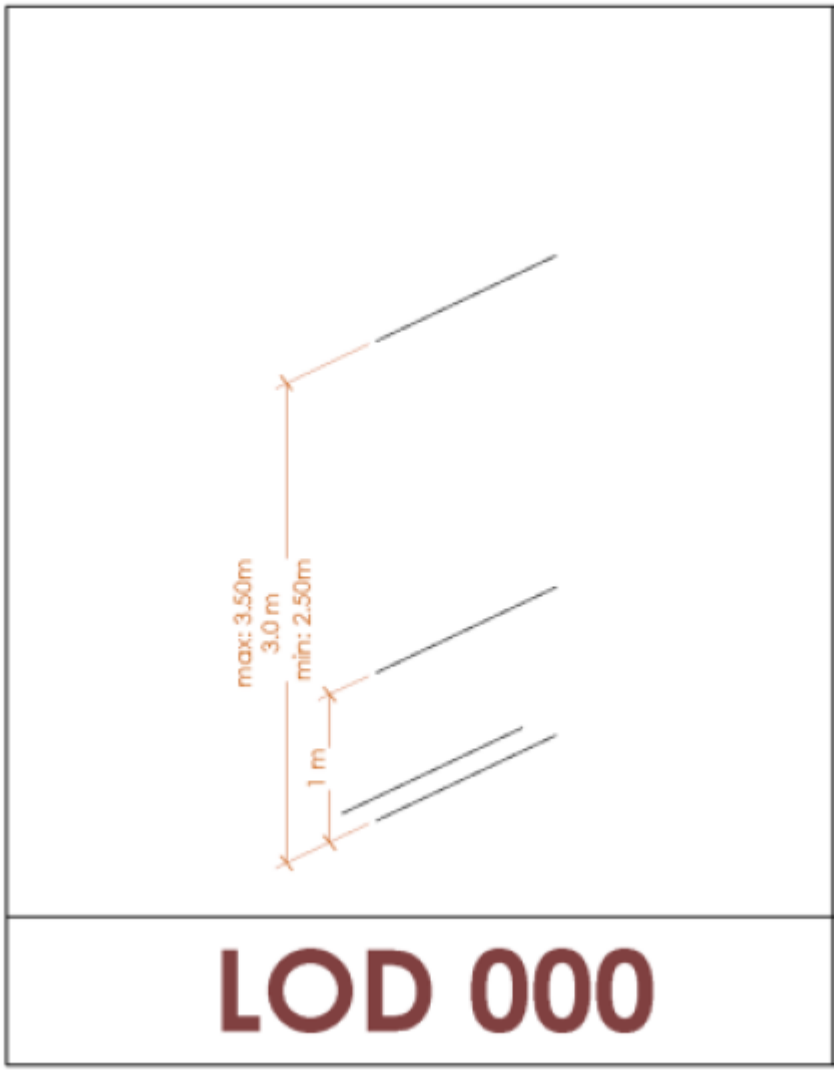
3. LEVELS OF DEVELOPMENT (LOD)

TYPES OF DEVELOPMENT LEVELS

- **LOD 000 *(autor: Alonso Madrid)*.**
  - It includes the characteristics of the land (position, height, topography, geotechnical, state, etc.), those of the surroundings (climate, connections, sunlight, distances to reference points, local needs, etc.) and those of the plot (cadastral reference, surface area, divisions, owner(s), endowments, etc.).

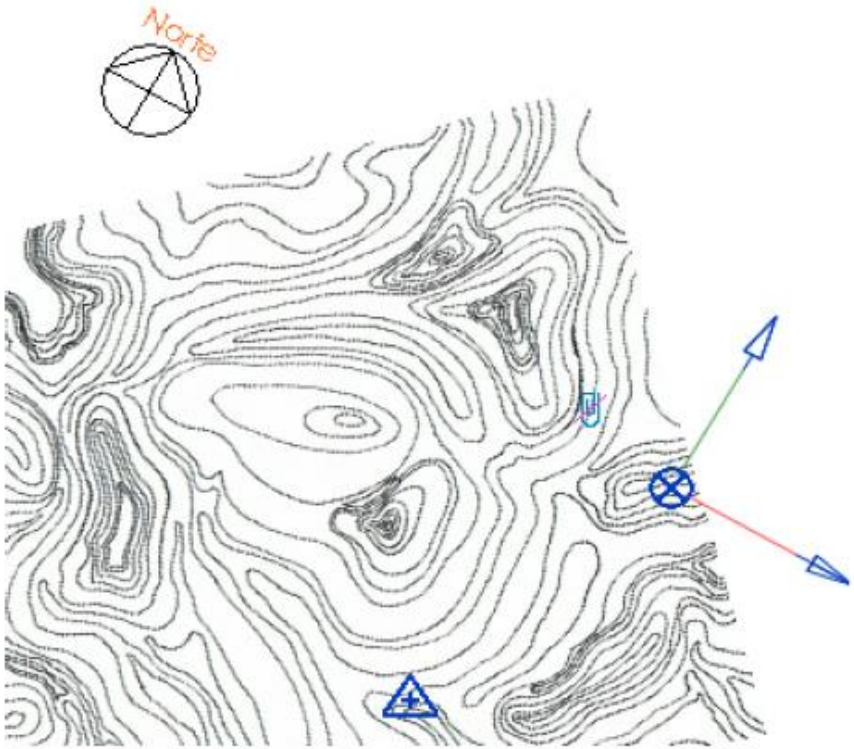


Source:
https://www.buildingsmart.es/app/download/11134225126/sjbim1501.pdf?t=1575535509 págs. 40-58
BIM

3. LEVELS OF DEVELOPMENT (LOD)

TYPES OF DEVELOPMENT LEVELS

- **LOD 000 *(autor: Alonso Madrid)*.**
  - The target element is not geometrically defined, but its basic dimensions, position, location and orientation with respect to the whole site and its surroundings are defined.
  - It is mainly based on non-graphical information linked to the element.



Source:
https://www.buildingsmart.es/app/download/11134225126/sjbim1501.pdf?t=1575535509 págs. 40-58

BIM

3. LEVELS OF DEVELOPMENT (LOD)

TYPES OF DEVELOPMENT LEVELS

- **LOD X00 *(autor: Alonso Madrid)*.**
  - Included in this level of development is an activity that has already begun, such as the 3D scanning of existing buildings that are to be permanently demolished, or moved from their original site, remaining with the corresponding development permanently or temporarily in a virtual world with a specific degree of definition and likely to be the subject of further reproduction or development.

Source:
https://www.buildingsmart.es/app/download/11134225126/sjbim1501.pdf?t=1575535509 págs. 40-58

3. LEVELS OF DEVELOPMENT (LOD)

TYPES OF DEVELOPMENT LEVELS

- **LOD X00 (author: Alonso Madrid).**
  - The object element will be fully geometrically defined and will add new concepts such as distance from which it is visible and different degrees of geometric definition according to distances, for example.
  - The texture shall be derived from the characteristics of its surface materials. It is possible to add other non-graphical information linked to the element.

Source:
https://www.buildingsmart.es/app/download/11134225126/sjbim1501.pdf?t=1575535509 págs. 40-58

BIM

4. ENVIRONMENTAL IMPACT CATEGORIES

DEFINITION

➢The environmental impact categories represent the environmental impacts of interest to which the Life Cycle Impact Assessment (LCIA) results will be assigned. In other words, they are the environmental impacts for which results are desired.

➢There are a multitude of environmental impact categories and the selection of one or the other will depend on the objective of the study, the target audience and the level of accuracy of the results required.

➢In some cases, a substance contributes to several impact categories and should therefore be considered in all impact categories.

4. ENVIRONMENTAL IMPACT CATEGORIES

FUNCTIONAL UNIT

➢**FUNCTIONAL UNIT**: Quantified performance of a product system for use as a unit of reference *(Definition according to EN ISO 14040:2006).*

The functional unit defines how the identified functions or performance characteristics of the product are quantified. The main purpose of the functional unit is to obtain a reference that allows the standardisation of LCA results related to material flows (input and output data) of the construction product and any other information, in order to produce data expressed on a common basis *(UNE-EN 15804, article 6.3.1).*

In principle, the comparison of products based on their EPBD is defined by the contribution they make to the environmental performance of the building. Therefore, the comparison of the environmental performance of construction products using EPBD information should be based on the use of the product and its impacts on the building and should consider the whole life cycle (all information modules) *(UNE-EN 15804, article 5.3).*

4. ENVIRONMENTAL IMPACT CATEGORIES

DECLARED UNIT

➢**DECLARED UNIT**: Quantity of a construction product to be used as a reference unit in a EPD for an environmental declaration based on one or more reporting modules *(Definition according to UNE-EN 15804).*

The declared unit is used instead of the functional unit when the exact function of the product or the scenarios at building level are not established or unknown. The declared unit is to be applied when a EPD covers one or more life cycle stages by means of information modules, i.e. in the case of a 'cradle to door' EPD and a 'cradle to door with options' EPD, and when the EPD is not based on a full 'cradle to grave' LCA.

It provides the reference allowing to combine the material flows attributed to the construction product and to combine the environmental impacts for selected stages of an incomplete life cycle of the construction product, referring to typical product applications.

EXAMPLE (*UNE-EN 15804*):
An element or set of elements, for example a brick, a window, etc. Therefore, defined as a unit of product where the dimensions must be specified:

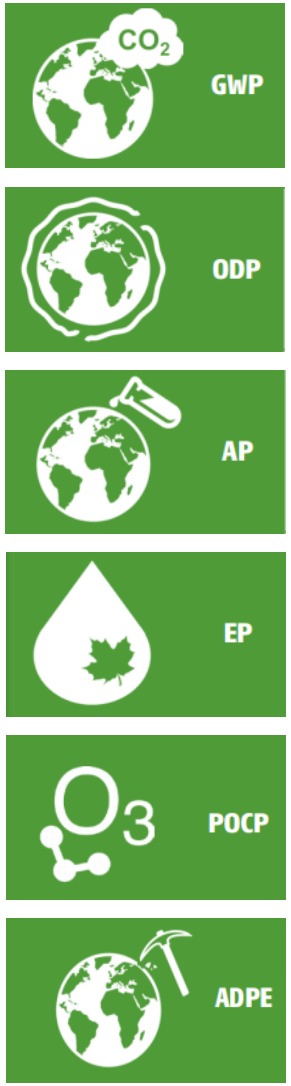
- ➢Mass (kg), e.g., 1 kg of cement.
- ➢Length (m), e.g., 1 m of pipe, 1 m of beam (where dimensions are to be specified).
- ➢Area (m^2), e.g., 1 m^2 of wall element, 1 m^2 of roof element (dimensions to be specified).
- ➢Volume (m^3), e.g., 1 m^3 of timber, 1 m^3 of ready-mixed concrete.

4. ENVIRONMENTAL IMPACT CATEGORIES

ENVIRONMENTAL IMPACT INDICATORS

Environmental impact indicators:

- GLOBAL WARMING POTENTIAL (GWP)
- STRATOSPHERIC OZONE DEPLETION POTENTIAL (ODP)
- ACIDIFICATION POTENTIAL (AP)
- EUTROPHICATION POTENTIAL (EP)
- TROPOSPHERIC OZONE FORMATION POTENTIAL (POCP)
- ABIOTIC RESOURCE DEPLETION POTENTIAL FOR NON-FOSSIL RESOURCES (ADPE)
- ABIOTIC RESOURCE DEPLETION POTENTIAL FOR FOSSIL RESOURCES (ADPF)
- FRESHWATER ECOTOXICITY (SW-ECOTOX)
- HUMAN TOXICITY (H-TOX)
- MARINE ECOTOXICITY (M-ECOTOX)
- TERRESTRIAL ECOTOXICITY (T-ECOTOX)



5. LOD600

BIM OBJECT PLATFORMS

Nowadays it is possible to find several websites where you can download free resources for BIM software: libraries of BIM objects of different LOD levels, families or components, materials, plug-ins, manuals, etc.

bimtool

BIM&CO

bimobject

SYNCRONIA ARCHITECTURE VICTIMS

Bimetica BIM a tu lado

ARCAT

BIM Community

bimstore

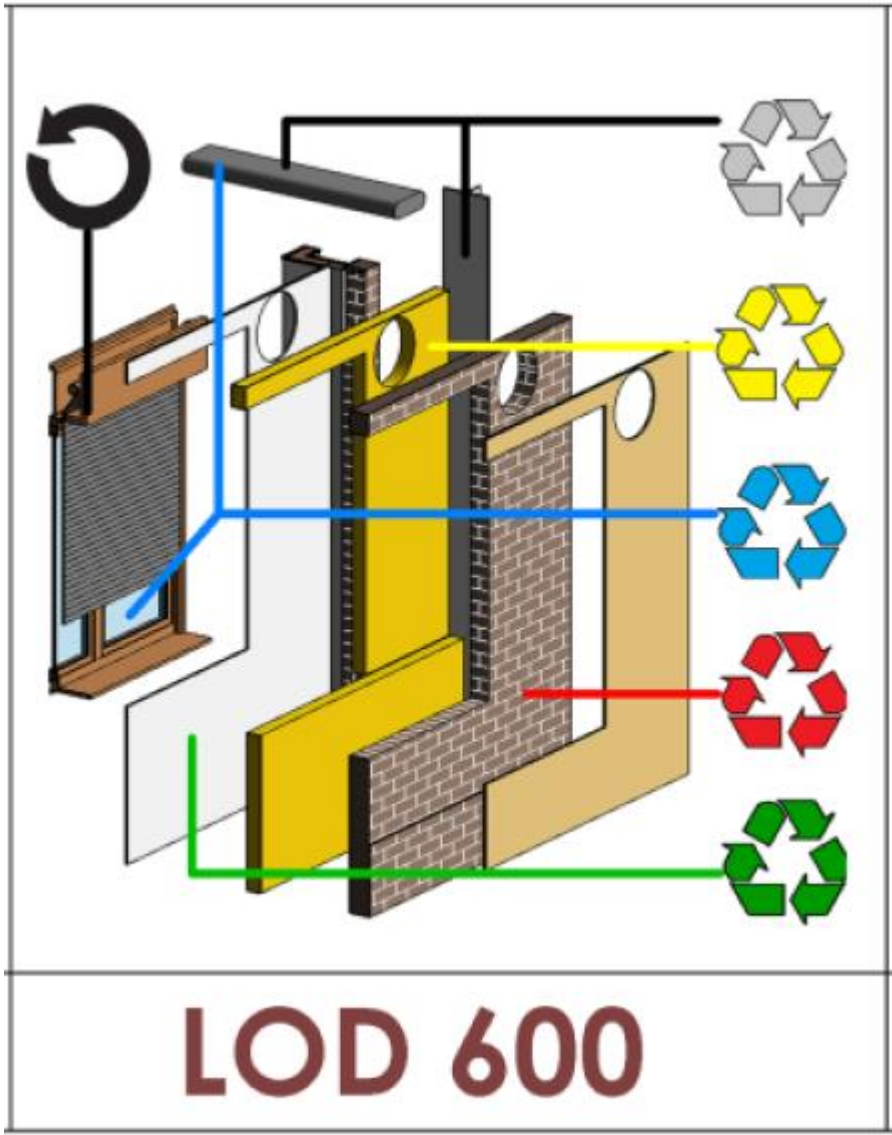
Source: https://www.espaciobim.com/recursos-bim-revit-gratis

5. LOD600

LOD600 LEVEL DEFINITION

Regarding the above-mentioned platforms, many of them BIM objects for the users.

- **LOD 600 *(autor: Alonso Madrid)*.**
  - The object is not geometrically defined in detail, but its recycling conditions, such as own materials, toxicity, lifetime, distance to recycling points, weight and volume, ways of transport and dismantling, etc. are defined.
  - It is mainly based on non-graphical information linked to the item.



Source:
https://www.buildingsmart.es/app/download/11134225126/sjbim1501.pdf?t=1575535509 págs. 40-58

5. LOD600

LOD600 LEVEL DEFINITION

➢**USES OF LOD 600:**

- **Analysis**: The element should include its dismantling, demolition and recycling details. Composed mainly of non-graphical information.

- **Cost**: Estimation of costs/expenses according to the recycling needs of the element, linked to issues such as useful life, depreciation, renewal value, etc. specific to the site and the distance to other environments (recycling points, factories, urban centres, protected areas, etc.).

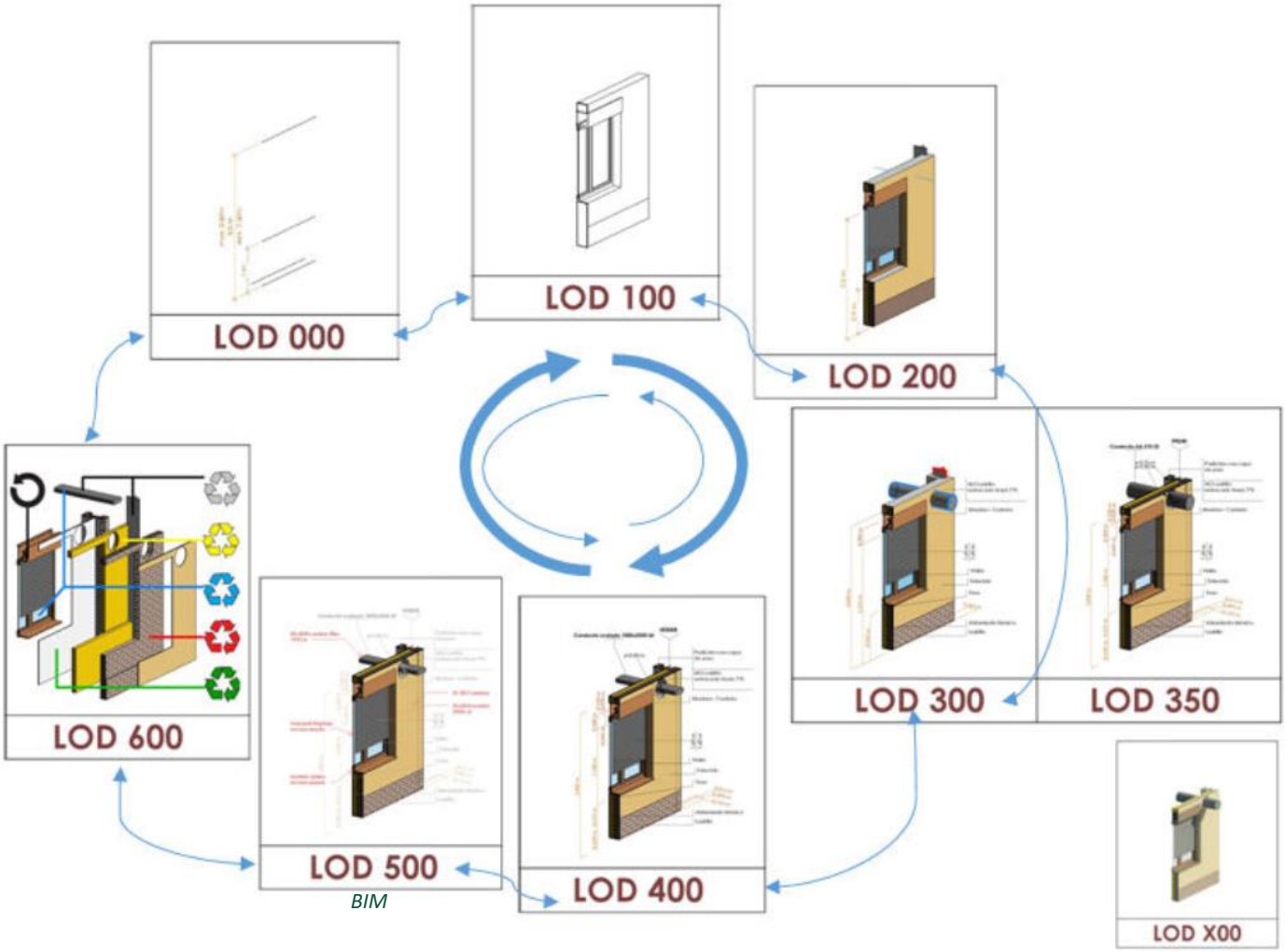
- **Programming**: The item shall consider its useful life, reliability in use and costs arising from recycling, as well as related fees or penalties.

- **Coordination**: The element can be used to coordinate with other elements of the project based on recycling schedules, as well as its effect on the other elements of the project during its modification (removal, decrease in efficiency, toxicity, etc.).

Source:
https://www.buildingsmart.es/app/download/11134225126/sjbim1501.pdf?t=1575535509 págs. 40-58 *BIM*

5.3. LOD600 LEVEL DEFINITION

➢**BIM OBJECT DEVELOPMENT DIAGRAM:**

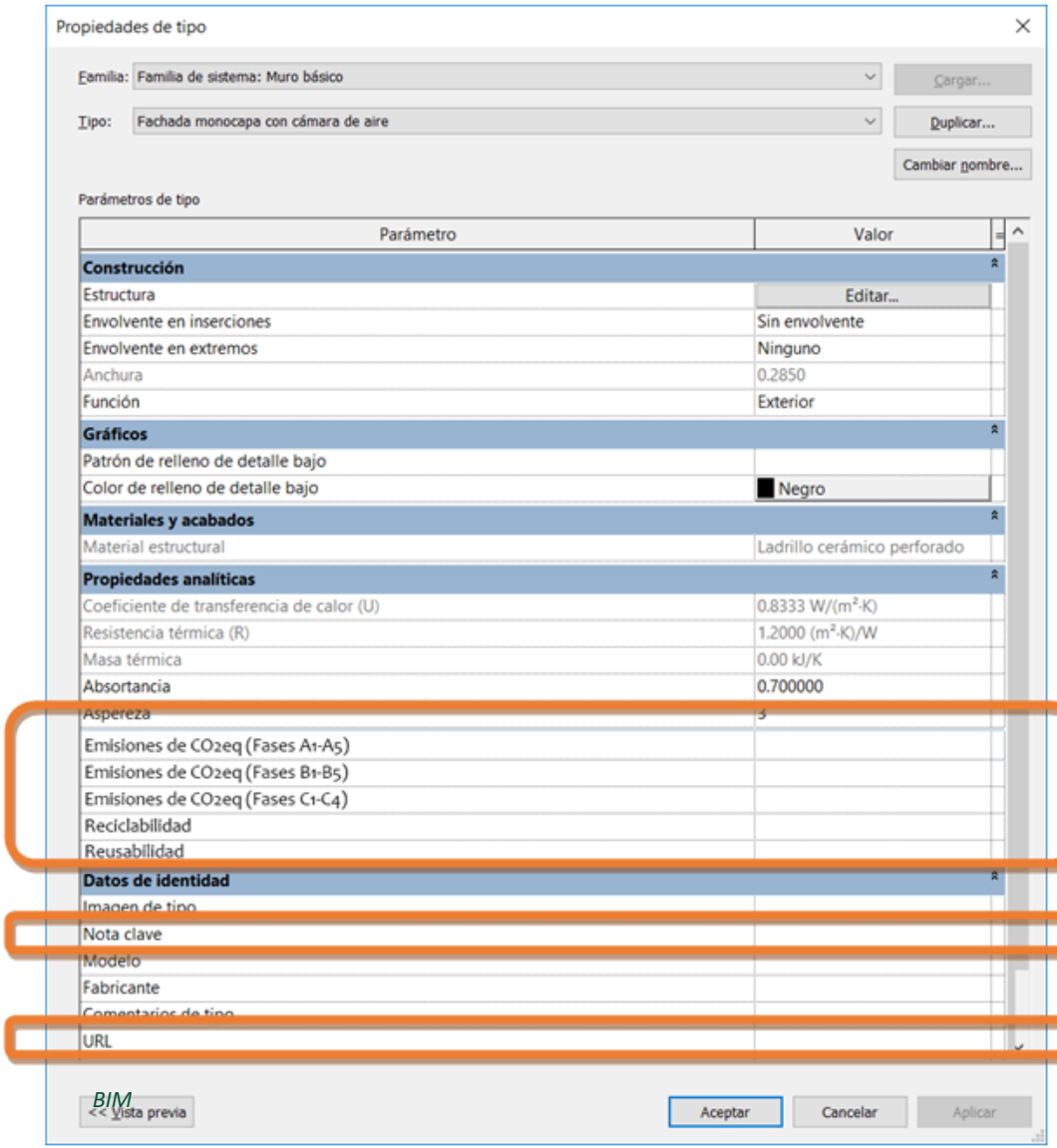


Source: *https://www.buildingsmart.es/app/download/11134225126/sjbim1501.pdf?t=1575535509 págs. 40-58*

5.3. LOD600 LEVEL DEFINITION

Consequently, under the same criteria and based on current standards, it is possible to insert environmental impact data into BIM objects, as will be developed in the following modules of this course.

Example of integration of environmental impact data into a BIM material from Autodesk Revit. Source: http://repositorio.ucam.edu/bitstream/handle/10952/2436/Tesis.pdf?sequence=1&isAllowed=y



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