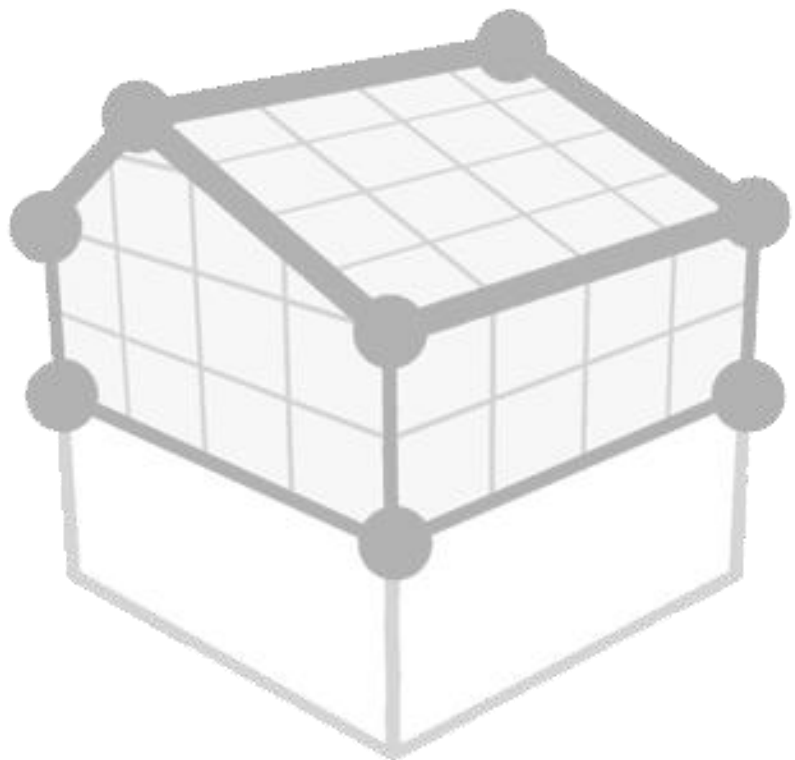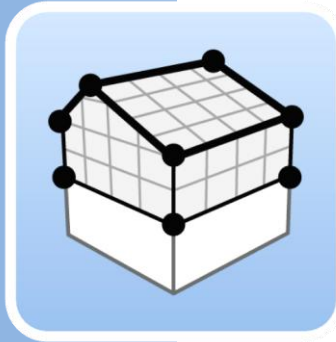# Open BIM
Analytical Model

User's Manual

Guide for using the Open BIM tool to generate analytical geometric models, orientated towards their thermal and acoustic analysis, from architectural models.

Contents

1   **Basic concepts**

1.1   Introduction

The simulation of the thermal and acoustic behaviour of BIM models can be a complex and difficult task because the majority of computer applications oriented to architectural design do not fully generate the information needed to carry out this type of analysis. In other cases, the difficulty resides in the fact that the exchange files used do not cover all the data required.

Open BIM Analytical Model was created with the purpose of avoiding these limitations and to define a calculation model suitable for the analysis of thermal and acoustic transmissions of a building. To do this, it is based on the geometry of the project and, using solid and surface analysis algorithms, it is capable of generating all the elements that make up the analytical model, such as spaces, surfaces, edges, junctions etc. Likewise, it determines the existing relationships between these entities (which spaces they belong to, adjacencies between surfaces, edges that form a junction, etc.).

This guide will explain the steps to follow when generating an analytical model as well as the different tools that Open BIM Analytical Model offers for this end.

1.2   Starting a project

This section of the manual will show how to start a project and begin using Open BIM Analytical Model.

Start by downloading the latest version of Open BIM Analytical Model from BIMserver.center (https://bimserver.center/en/store/259/open_bim_analytical_model); to download it all you need is a BIMserver.center account.

The first step is to open Open BIM Analytical Model. Next, connect to BIMserver.center in the top right and login, if necessary, following the indicated steps. Once you have logged in you can begin using Open BIM Analytical Model.

To continue working on a previous job, select **File Manager** and locate the desired project. Otherwise, to start a new project, select **New...**, choose where the file will be saved, and give it a name and a description. Then a BIMserver.center screen will appear – this is where you can create a new project associated with an active BIMserver.center user by selecting

Create new project or connect this new job to an existing project in BIMserver.center by clicking **Select project,** and a list of all your projects will appear. Select the correct one and click **Accept**.

The program will load the selected project and any associated files into the project. You can select the files that you wish to import. Special care must be taken at this point to import the file corresponding to the architectural model since it is the one that contains the information that will serve as a basis for the creation of the analytical model. On clicking **Accept,** the selected configuration will load and the main program interface will open with your model loaded.
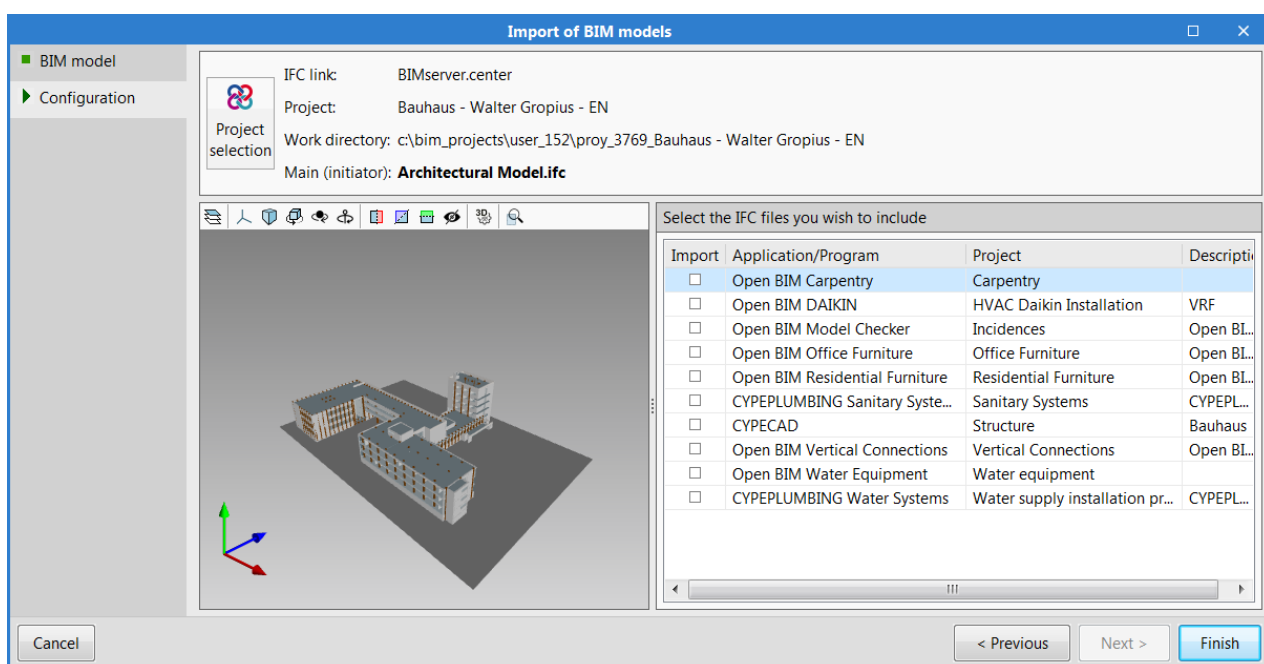
Fig. 1. Import panel of BIM models.

1.3 Application interface

The application interface can be divided into the following groups:

🟥	*Top toolbar*
🟦	*Configuration toolbar*
🟩	*Application toolbar*
🟦	*Views of the project*
🟫	*Tree of the BIM model*
🟨	*Work area*

Fig. 2. Application interface.

1.3.1 Top toolbar

The top toolbar, as in other CYPE applications, has the following options (in order from left to right):

Fig. 3. Top toolbar.

- **Program file button.** Clicking this button opens a tab offering the user to create a new file, open an existing one, save, save as, change the description of the job, print the drawings, select recent files and exit.
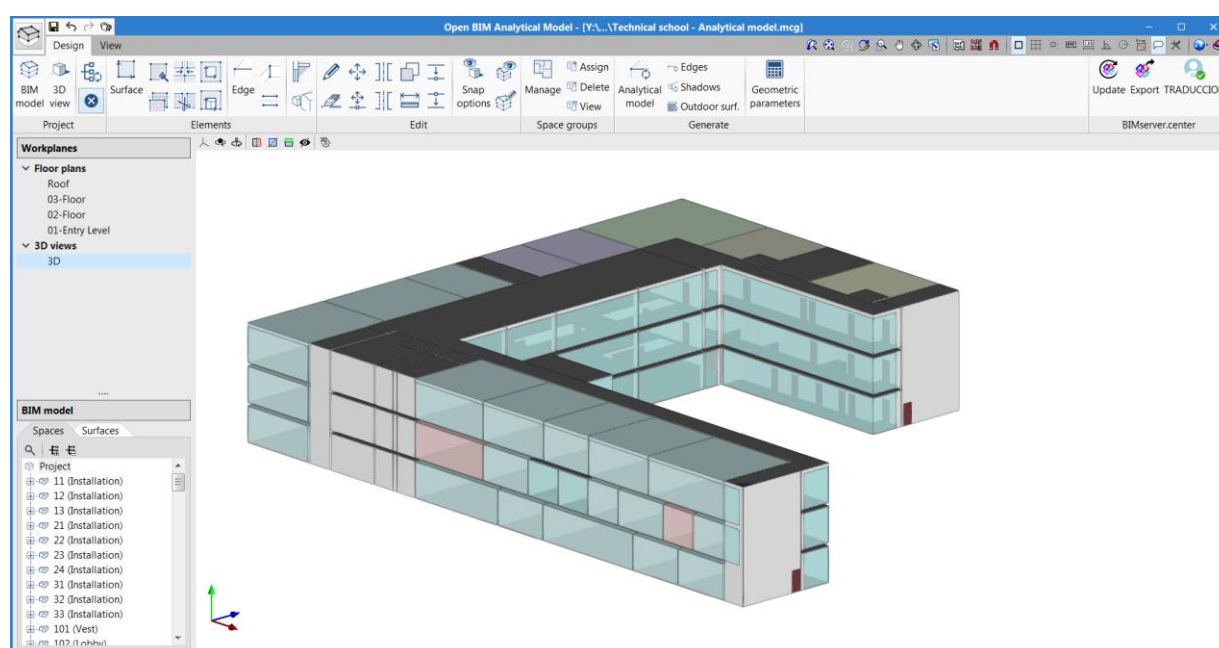
- **Save**

- **Undo.**

- **Redo.**

- **Drawings.**

1.3.2 Configuration toolbar

The configuration toolbar, as with other CYPE applications, has the following options (in order from left to right):
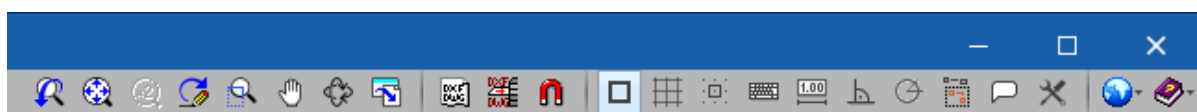

Fig. 4. Configuration toolbar.

- **Previous window.** Restores the previous view as the current view.

- **Full window.** View the whole drawing. You can also do this by double clicking on the mouse wheel.

- **Zoom out x2.** Zoom out twice the size of the "Full screen" view.

- **Redraw.** Redraw the current view without modifying its size.

- **Highlight zoom.** Carry out a zoom action by clicking on the drawing. You can also use the mouse wheel, in which case you can zoom in or zoom out.

- **Window panning.** Window panning. To do so, click on the screen and drag the hand icon while pressing the mouse button. Once done, click again on the hand icon to disable this option and continue working with the last command. You can also pan by clicking on the mouse wheel and dragging the window while pressing it.

- **3D orbit.** Rotate the scene around the rotation pivot. To do so, press on the screen and move the cursor without releasing it. If the option "Rotation around a point" is marked, the point located under the cursor will be used as the rotation pivot. Otherwise, the pivot will be calculated by considering the visible elements of the scene.

Once this turn has been carried out, press this option again to deactivate it and continue with the option with which you were working.

- **Print.** Print the current view. Allows you to print the current view of the work area or generate a file with the drawing in a graphic format ('DXF', 'DWG', etc). If the current view contains a template ('DXF', 'DWG', etc) it will also be included in the drawing.

- **DXF-DWG Template.** Allows you to import and configure templates ('DXF', 'DWG', etc.).

- **DXF-DWG Template (F4).** Allows you to configure the visibility of the templates ('DXF', 'DWG', etc.).

- **Template object snaps (F3).** Captures entities or elements from the 'DXF' or 'DWG' file that was imported previously.

- **Object references (F2).**

- **Draw grid.** Activate or disactivate the grid visibility in the work area.

- **Snap to grid.**

- **Coordinate introduction.**

- **Allows for dimensions to be defined upon introducing each element.**

- **Orthogonality (Ctrl + O).**

- **Polar tracking.**

- **Repeat the last selection.**

- **Show information texts.** Activates or deactivates the visibility of the information texts that appear when moving the cursor over a component of the model in the work area.

- **Configuration of the work area.** Allows you to change some of the parameters related to the visibility of the cursor and the grid in the work area.

- **Configuration.** Allows you to change some of the program's default parameters. Clicking on the button displays a list of different options.

- **Help.** Shows the application help.

1.3.3 Application toolbar

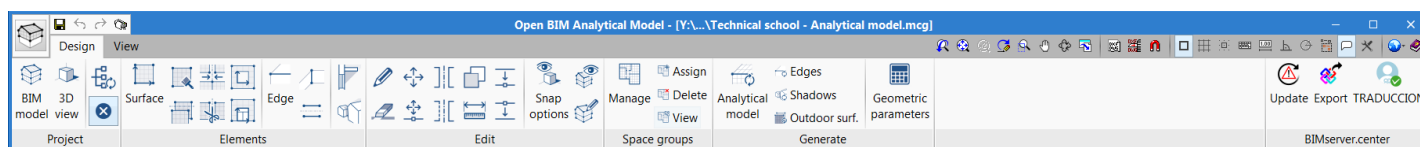The application toolbar is divided into two tabs: *Design* and *View*.

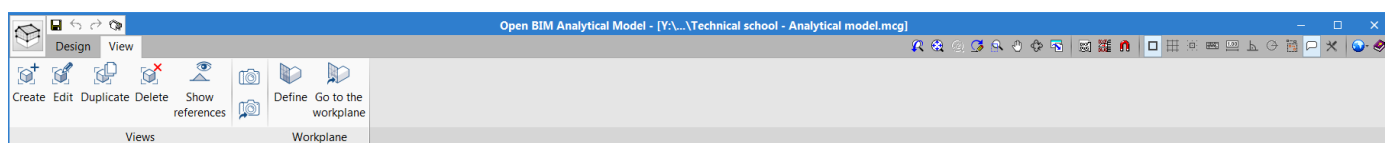Fig. 5. Application toolbar (Design).

Fig. 6. Application toolbar (View).

The *Design* tab contains options that allow the user to introduce and modify the elements that make up the analytical model. The *View* tab contains the tools necessary to configure the different project view modes.

To the left of the work area there is a list with the different views of the project and a panel with two tabs that allows to show the space and surface trees of the analytical model. When selecting a space or a surface it will be lit up in the work area.

2 Design

2.1 Project

This section includes the toolbar options that act in general on the project.

- **BIM model.** Shows a list of all the elements that make up the analytical model of the project. This data is divided into 5 lists: spaces, surfaces, edges, own shadows and remote shadows. From this panel users can create, edit or delete any component of the model.
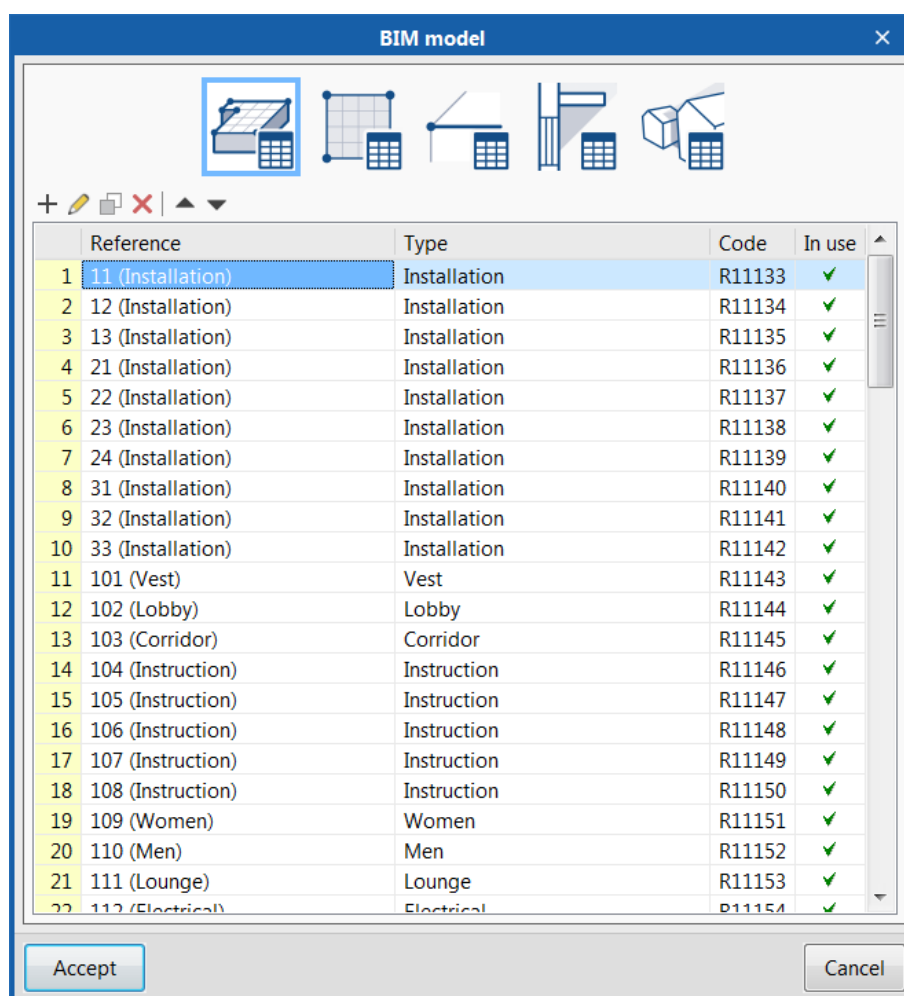

Fig. 7. Panel of the BIM model components.

- **3D view.** Shows the 3D view of the active job in Open BIM Analytical Model together with the rest of the files contained in the BIMserver.center project.
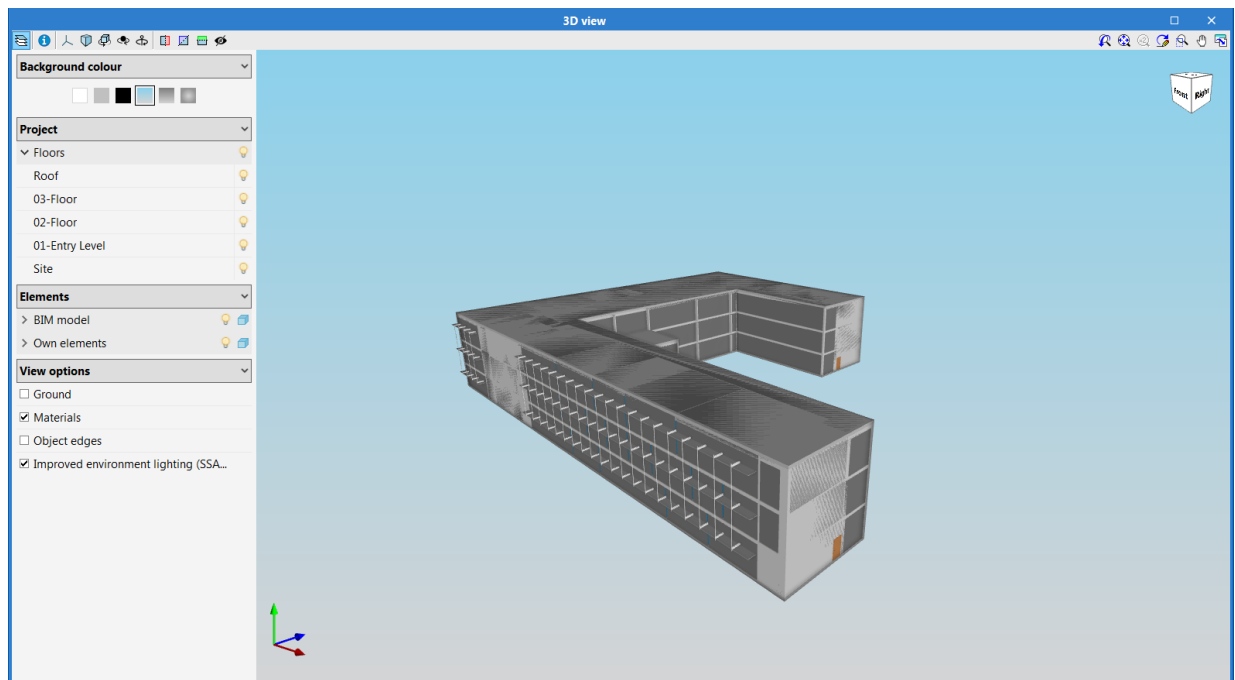

Fig. 8. 3D view of the project

- **Update the view tree of the analytical model.** This option regenerates the space and surface trees of the analytical model.

- **Show/Hide issues.** With this option it is possible to control the visibility of the warnings that appear in the work area related to the components of the model.

2.2 Elements

This section outlines the tools needed to introduce different components of the analytical model into the project.

2.2.1 Spaces

The spaces can be considered as the calculation volumes into which the model is divided. Usually the spaces of the analytical model coincide with the spaces of the architectural model. However, this may not be the case if the user tries to perform a simplification of the calculation or, on the other hand, a higher level of detail is required.

The properties of a model space are:

Fig. 9. Definition of a space.

- **Reference.** Represents a text that identifies the space in the project.

- **Type reference.** Represents a text that identifies the type of space in the project. Several spaces can share common features and, consequently, share this reference.

- **Location.** Indicates whether it is an *internal space* or an *external space*. The *external environment* option allows all the space outside of the building to be represented.

- **Surface.**

- **Volume.**

2.2.2 *Surfaces*

The surfaces form the main vector of thermal and acoustic direct transmission from spaces, either to each other or the external environment.
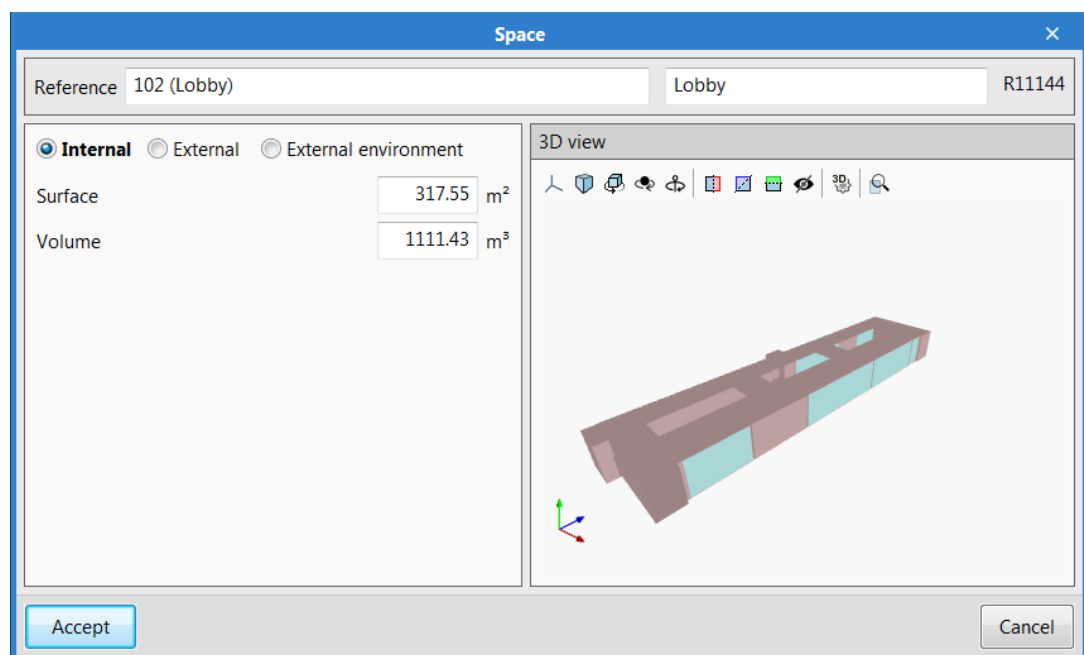
The properties of a model surface are:
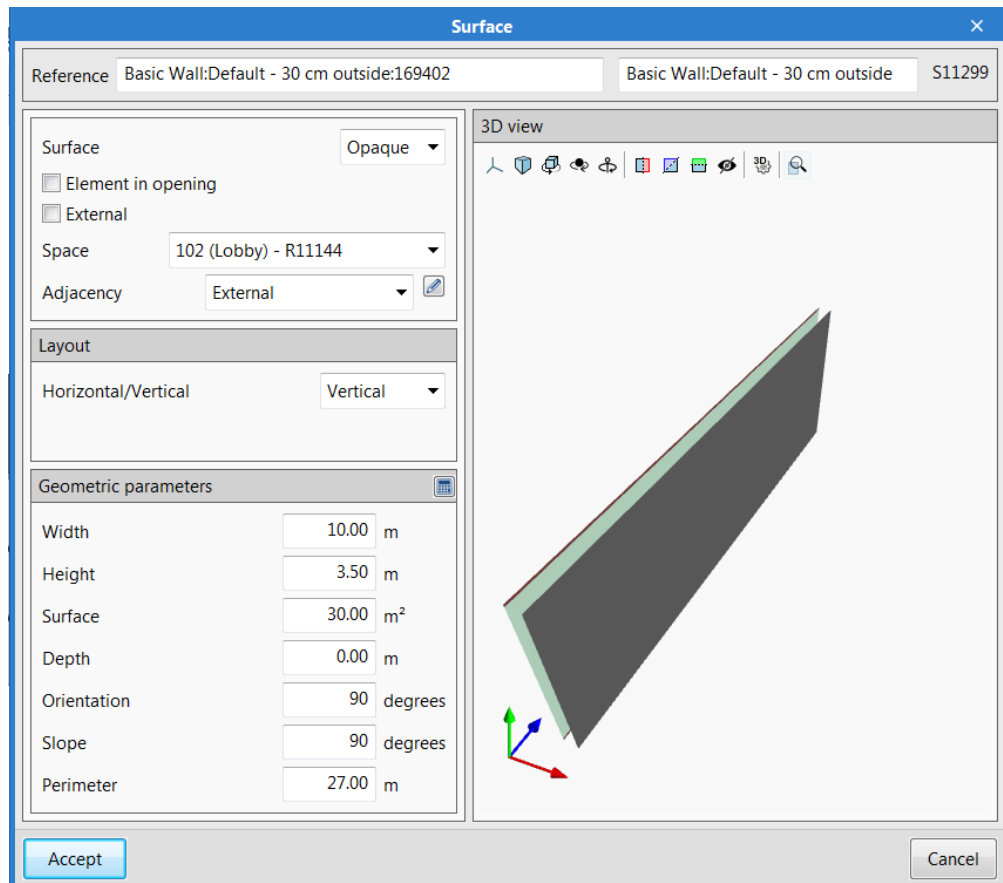
Fig. 10. Definition of a surface.

- **Reference.** Represents a text that identifies the surface in the project.

- **Type reference.** Represents a text that identifies the type of surface in the project. Several surfaces can share common features and, consequently, share this reference.

- **Type of surface.** Indicates if it is an *opaque* or *glazed* surface.

- **Element in opening.** Indicates if it is a surface located in an opening, like a door or a window.

- **External.** Indicates that the surface is in contact with the exterior, like the external face of a façade.

- **Space.** Indicates the space to which the surface belongs.

- **Adjacency.** Indicates the surface of the analytical model that is adjacent to the selected surface. This data is fundamental when establishing the relationships between spaces in the analysis of thermal and acoustic transmissions.

- **Layout.** Indicates whether the surface is *horizontal* or *vertical*. If it is horizontal, it is also necessary to indicate whether it is the *ground* or the *roof*.

- **Geometric parameters.** The geometric parameters make it possible to provide thermal and acoustic calculation models with information about the surfaces independently of their representation.

  o Width

  o Height

  o Surface

  o Depth

  o Orientation

  o Slope

  o Perimeter

The following toolbar options allow users to work with the surfaces of the model:

- **Surface.** Add a new surface to the model.

- **Assign.** Allows specific user-defined properties to be assigned to one or more surfaces in the model. To do this, first users must configure which properties to change and then select the surfaces on the work area.

- **Mark surfaces as adjacent.** Allows surfaces on the work area to be selected and to establish adjacency between them.

- **Join surfaces.** Allows several surfaces to be joined. To do this, first select on the work area the surfaces to join joined, and then enter the vertices that make up the new surface.

- **Divide surfaces.** Allows a surface to be divided into several different surfaces. To do this, first select on the work area the surface to be separated and then enter a polyline to divide it.

- **Hollow.** Allows an opening to be created in a surface. To do this, first indicate the reference of the new opening and then enter the vertices of the opening on a surface in the work area.

- **Assign a surface to an opening.** Allows a surface to be associated with an opening previously entered in the model. To do this, first select the opening on the work area and then the surface to be assigned.

2.2.3 *Edges*

The definition of the edges of the analytical model make is possible to calculate the lateral transmissions in thermal and acoustic analysis applications. If this information is correctly specified in the model it is possible to determine the construction element junctions and thermal bridges that are fundamental for this purpose.

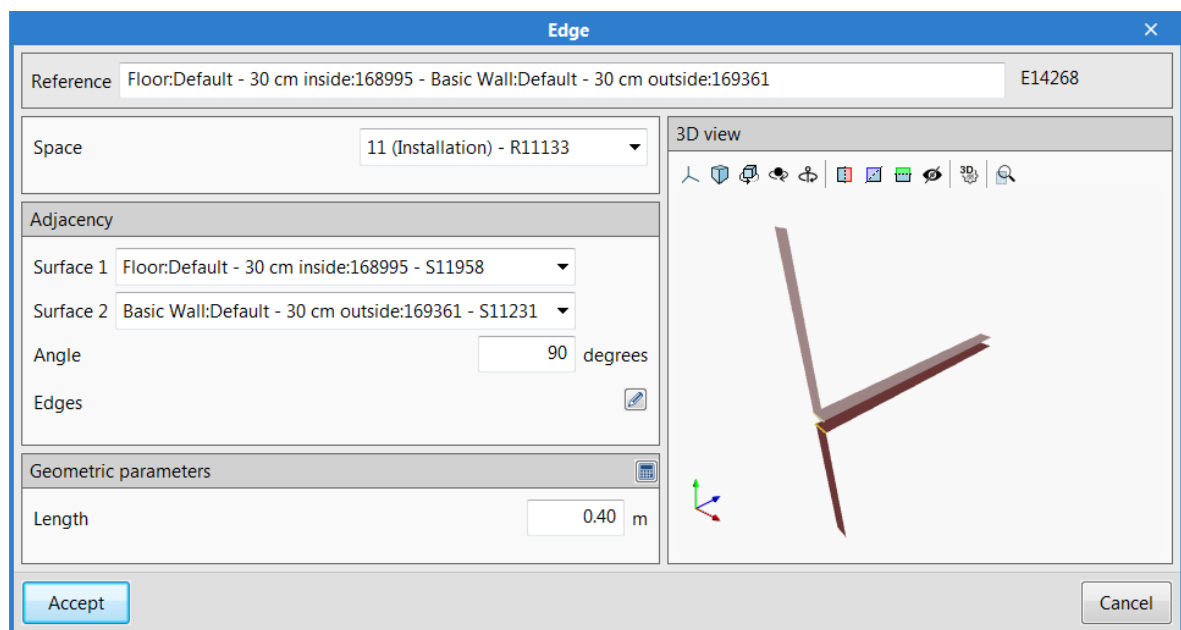The properties of a model edge are:

Fig. 11. Definition of an edge

- **Reference.** Represents a text that identifies the edge in the project.

- **Space.** Indicates the space to which the edge belongs.

- **Surface 1.** Indicates the surface that converges with surface 2 at the edge.

- **Surface 2.** Indicates the surface that converges with surface 1 at the edge.

- **Angle.** Indicates the angle that surfaces 1 and 2 form between them.

- **Edges.** Indicates the edges of the model that, together with the selected edge, form the joint of the construction elements involved.

- **Geometric parameters**. The geometric parameters make it possible to provide the thermal and acoustic calculation models with information about the edges, irrespective of their representation.

  o Length

The following toolbar options allow users to work with the edges of the model:

- **Edge.** Add a new edge to the model.

- **Mark surfaces that converge at an edge.** Allows users to select on the work area an edge of the model and then the two surfaces that converge on it.

- **Mark edges as adjacent.** Allows users to select on the work area the several edges of the model to form a joint.

2.2.4 *Shadows*

The shadows in Open BIM Analytical Model represent elements that are not involved in energy transmission but do generate shadows that must be considered in the thermal analysis.

1. **Own shadows.** The surfaces of the building's own shadow elements, such as overhangs or wings.

2. **Remote shadows.** The surfaces of the shadow elements outside the building, such as adjacent buildings.
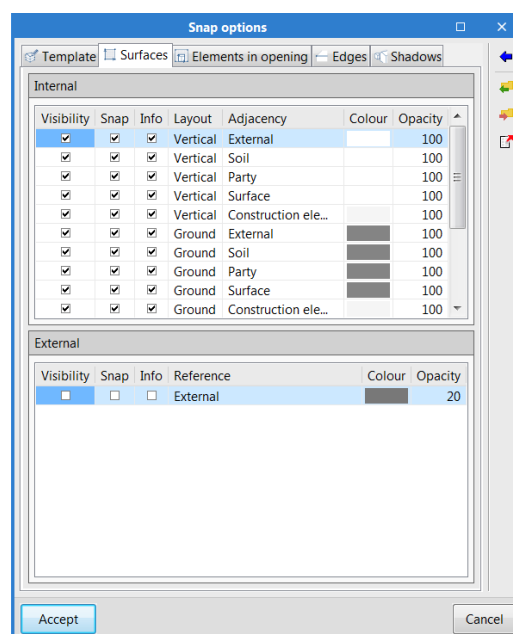
Fig. 12. Snap options panel.

2.3 Editing

The editing tools allow the components of the analytical model to be modified on the work area.

- **Edit.**

- **Delete.**

- **Move a group of elements.**

- **Move.**

- **Symmetry (copy).**

- **Symmetry (move).**

- **Copy.**

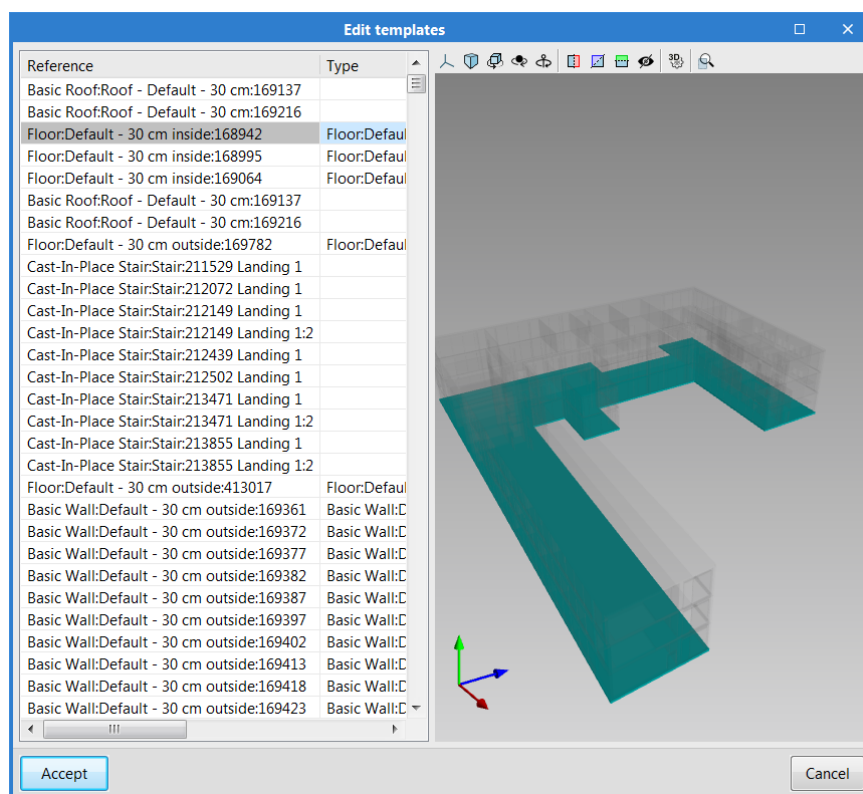- **Measure lengths on plan.**

- **Insert node.**

Fig. 13. Edit panel of the templates.

- **Join elements.**

- **Snap options.** Allows the visibility and the snaps of the different components of the analytical and architectural model to be modified.

- **Show / Hide template.** Allows users to activate or deactivate the display of the architectural model, in IFC format, of the project.

- **Edit templates.** Allows users to edit the properties of the construction elements that have been read from the architectural model of the project in IFC format. These modifications will affect the automatic generation of the analytical model.

2.4 Groups of spaces

In order to take into account the different thermal and acoustic requirements, Open BIM Analytical Model allows different groupings of spaces to be defined. This way it is possible, for example, to establish a grouping by use units and a grouping according to thermal zone criteria on the same analytical model.
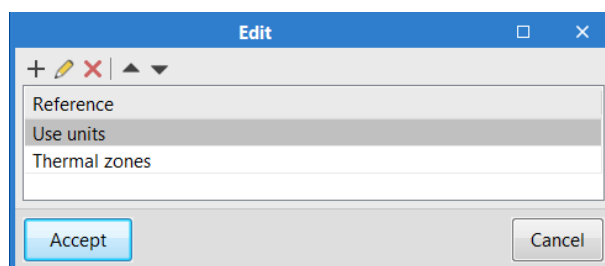

Fig. 13. Definition of the groups of spaces.

The following toolbar options allow users to work with the groups of spaces in the model:

- **Manage.** Allows new groupings to be made and the existing ones to be edited.
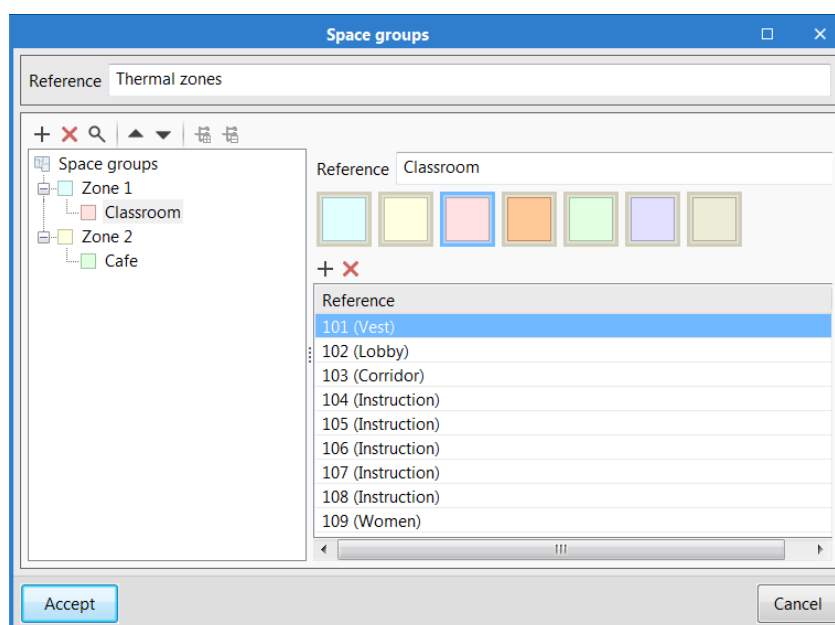

Fig. 14. Management of a group of spaces.

- **Assign.** Allows users to select several spaces on the work area and assign them to a previously chosen group.

- **Delete.** Allows users to select a space on the work area and remove its link to a group.

- **View.** Allows users to view the spaces with the colour defined for their group in the work area.

2.5 Generate

If there is a BIM project stored on the BIMserver.center platform that has an architectural model defined using the IFC standard, the user can make use of the automatic generation process. The algorithm in charge of this task is based on the definition of spaces and architectural elements of the IFC to create surfaces and edges, as well as the determination of the adjacencies and junctions. It should be noted that the user has complete control over the final result of the generation and can modify the elements they consider necessary to adapt them to their needs.
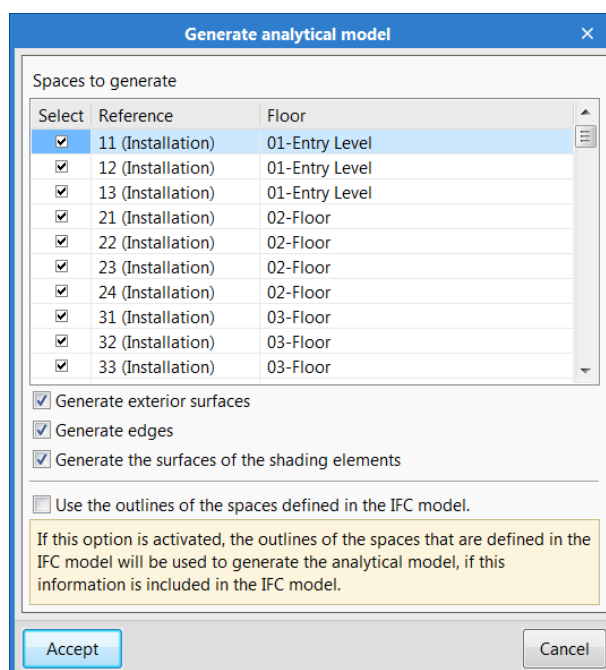

Fig. 16. Configuration of the analytical model generation.

- **Analytical model.** Carries out the generation of the complete analytical model from the information of the architectural model in IFC format. The user must select the spaces of the architectural model that they wish to include in the process. In addition, the user can activate or deactivate the generation of the *external surfaces*, the *edges* and the *surfaces of the shadow elements*. Finally, it is possible to *use the outlines of the spaces defined in the IFC model* if they are already correctly defined.

- **Edges.** Generates the edges of the model from the existing surfaces.

- **Shadows.** Generates the surfaces of the shadow elements (own shadow and remote shadows).

- **External surfaces.** Generates the surfaces in contact with the exterior that do not form part of the group of shadows, such as the exterior face of the façade.

- **Geometric parameters.** Calculates the geometric parameters of all the surfaces and edges of the model.

3 View

3.1 Views

The views are full or partial representations of the application's design model. It is important to note that the components of the model are not linked to the views, so that they can be created, modified or deleted without affecting the underlying data structure.
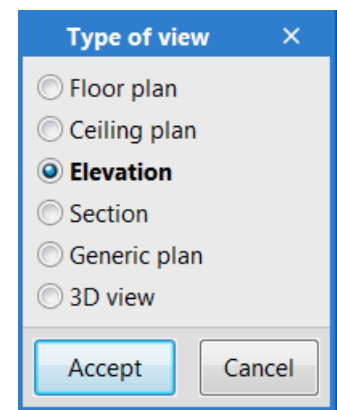
Fig. 15. View type selection panel.

The *Views* group located in the toolbar of the applications contains the following options:

- **Create.** Create a new 2D or 3D view of the model.

- **Edit.** Modifies the properties of the current view.

- **Duplicate.** Copies the current view.

- **Delete.** Deletes the current view

- **Save the start scene.** Establishes the current position of the view as the start scene. This scene will be used to generate the graphical documents of the project.

- **Go to start scene.** Position the current view in the position of the start scene.

- **Show references.** Upon choosing this option, references to other views will be shown in the active view.

3.1.1 *Types of views*

It is possible to generate different types of 2D and 3D views of the project. Each one is oriented to facilitate user interaction with the model in a different way.

3.1.2 *Range of vision*

All the view types, except the 3D view, are associated with an area delimited by two planes, a top and a bottom plane, which determines the elements that will be represented in the view. In the view configuration panel, it is possible to specify the distance to the top and bottom plane from the origin of the view.

In elevation, section and general plan views, the top plane is perpendicular to the direction of vision in a positive direction. The bottom plane is the same, but in a negative direction.
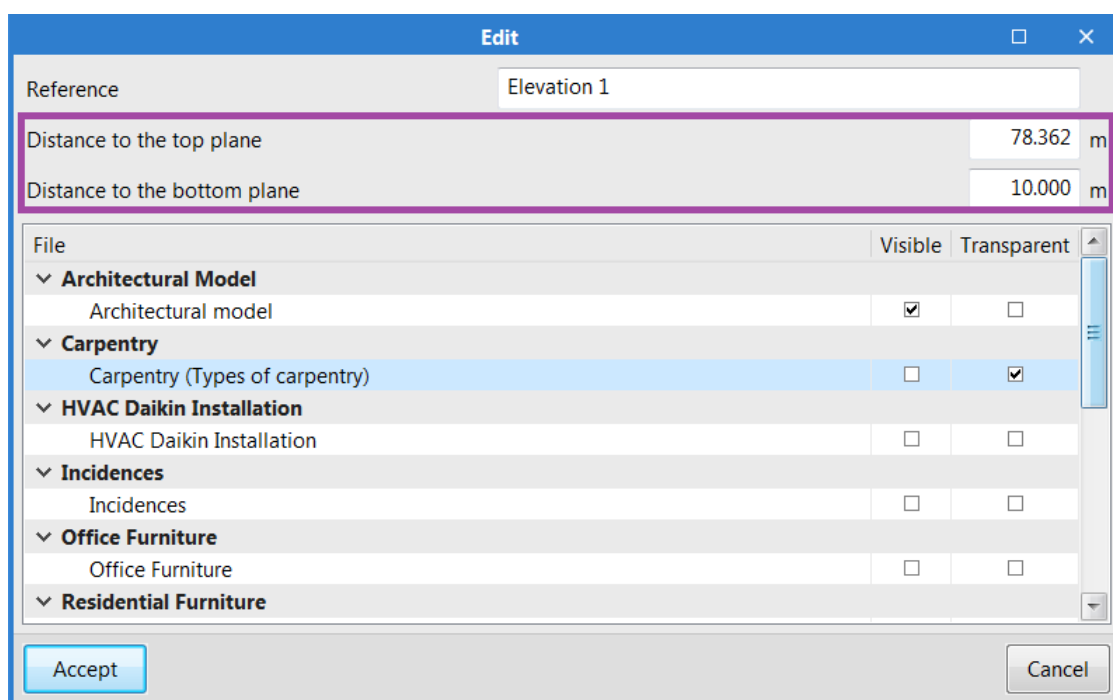

Fig. 16. Configuration of the range of vision in the edit panel of a view.

3.1.3 *Visibility of model layers*

In the configuration panel of a view it is possible to indicate the layers of the digital model of the building that come from an associated BIMserver.center project, which will be drawn in the work area.
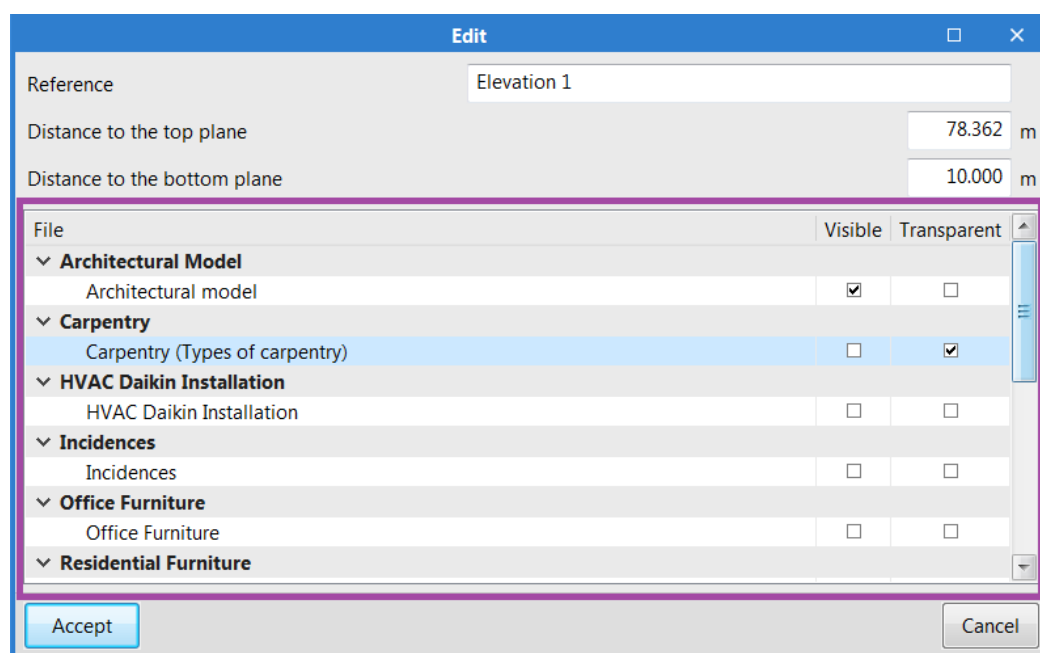

Fig. 17. Configuration of the visibility of the layers of a BIM Project in the edit panel of a view.

3.2 Workplane

The "workplane" group in the toolbar contains the following options:

- **Define.** Specifies the workplane associated with the current view. The workplane is used as a base to introduce the components of the model.

- **Go to the workplane.** Places the current view in the position of the workplane.

Each view of the model has an associated workplane. The workplane is automatically generated in all view types except in the 3D view. Consequently, the options for the "Workplane" group are only active when the selected view is of that type.

It is possible to define the workplane of a 3D view using one of the following options:

- **Existing view.** The workplane of the selected view will be used.

- **Define a plane.** The workplane will be generated by entering a plane on the model.

- **Select a point and generate a horizontal workplane.** A workplane will be generated horizontal to the selected elevation point.
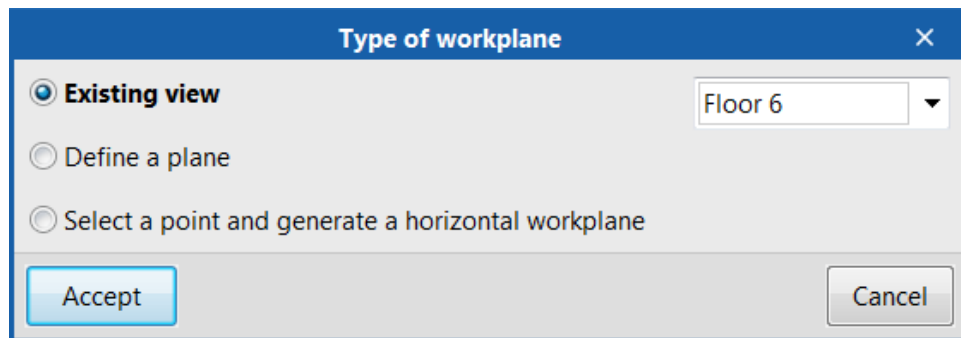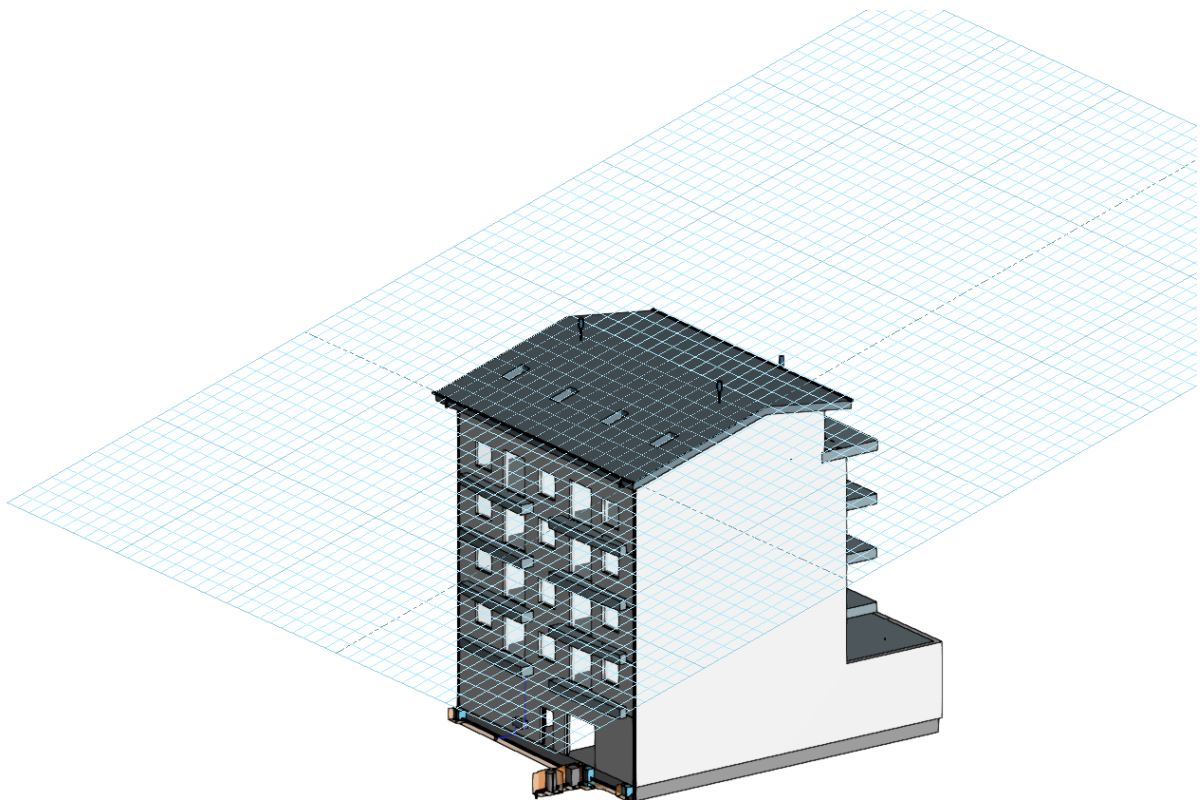

Fig. 18. Definition of a new workplane.

Fig. 19. Workplane generated from a generic plan

3.3   Inserting components

When entering a new component of the model or editing the position of an existing one, the applications provide a series of tools to facilitate the user's interaction with the work environment.

Fig. 20. Toolbar to insert components in the work area.

Selection of the input mode:

- **2D mode.** When capturing a component of the model its position will be projected on the workplane, where the new element will be introduced.

- **3D mode.** When capturing a component of the model the new element will be inserted in the exact position of that component, even if it is outside the workplane.

Selection of the workplane:

- **Workplane.** Indicates the view whose workplane will be used as the basis for entering the new component. This option is only available in 3D views – in the rest, the workplane associated with the active view will be used.

- **Displacement.** Indicates a displacement on the workplane.

4 Export and interoperability

Once a job in Open BIM Analytical Model has been associated with a BIMserver.center project, a link is created between the two that allows the data that makes up the application's calculation model to be updated if modifications are made to the BIM model.
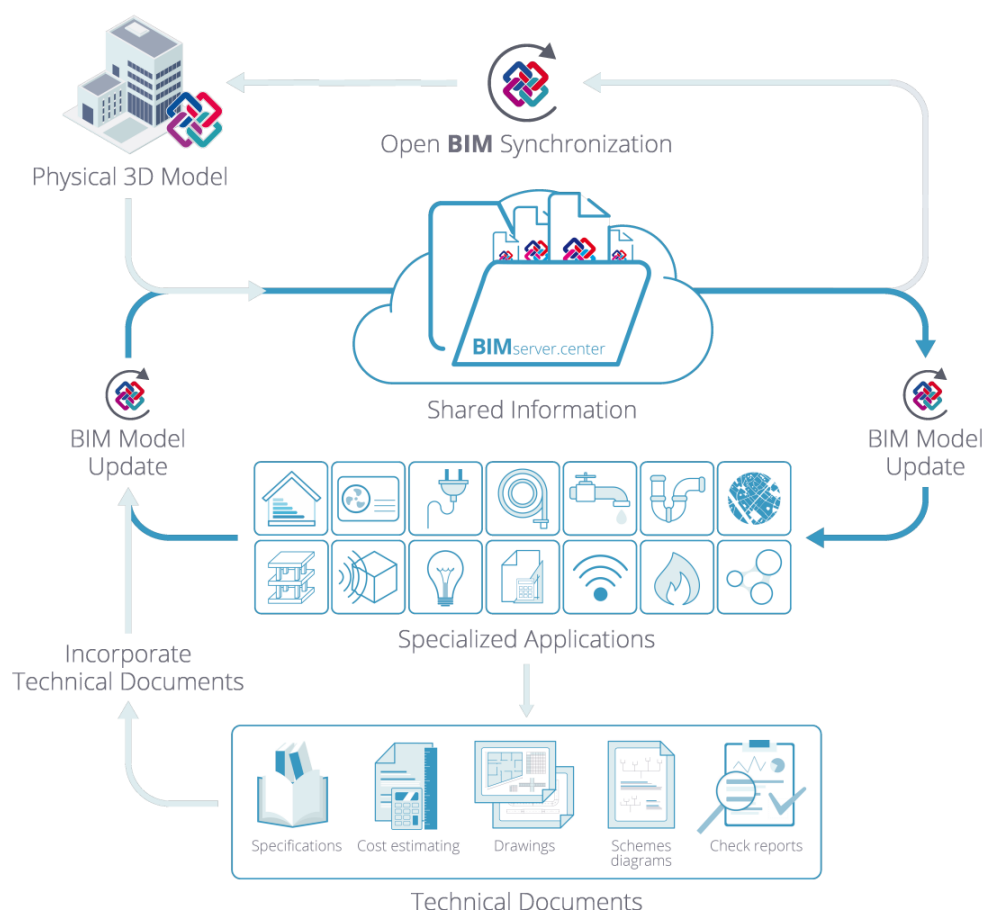

Fig. 21. Open BIM workflow using the BIMserver.center platform.

Otherwise, the information from the analytical model can be exported to the BIMserver.center project to be later interpreted by CYPE's Open BIM tools dedicated to the thermal and acoustic analysis of buildings. Some of these applications are listed below:

- **Acoustic analysis:**

    o AcoubatBIM by CYPE

    o CYPESOUND CTE

    o CYPESOUND RRAE

- **Thermal analysis:**

  o CYPETHERM HE Plus

  o CYPETHERM EPlus

  o CYPETHERM LOADS

  o CYPETHERM RT 2012

  o CYPETHERM RT 2012 CNOA

  o CYPETHERM RTExistant

  o CYPETHERM COMETH

  o CYPETHERM REH

  o CYPETHERM RECS Plus

  o CYPETHERM C.E.

Contact

The configuration of a project, navigating through the user interface, the design inside the software and achieving results based on the design will become evident after completing this Open BIM Analytical Model user guide. If you still have questions or need more information, please visit our website or contact CYPE's technical support.

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