Ferrovia

by CGS Labs

BIM Modeling in Ferrovia

Tutorial

CGSLABS

A Transoft Solutions company

CGS Labs d.o.o.

Brnčičeva ulica 13

1000 Ljubljana

BIM Modeling in Ferrovia

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Printing: CGS Labs d.o.o.

T: +386 1 235 06 00

E: info@cgs-labs.com

Internet: www.cgs-labs.com

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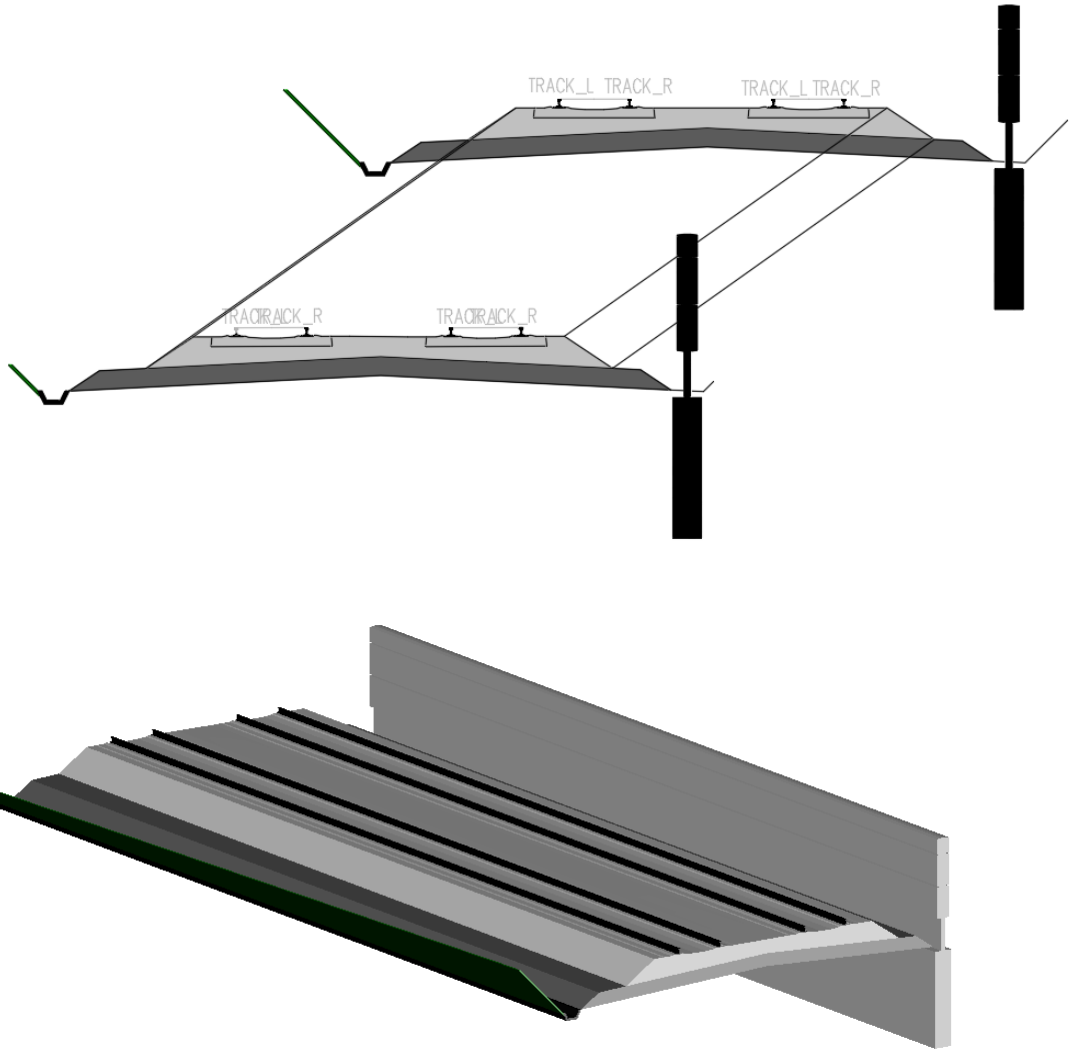
INTRODUCTION

In this tutorial, we will show the complete process of BIM modeling railway infrastructure using Ferrovia – from creating a 3D model, adding attributes to each element, and finally exporting the model to IFC format.

The 3D model in Ferrovia starts with cross-sections, which define the geometry and planimetry quantity of each railway element. For example, ballast, substructure, slopes, or other layers must first be drawn in the cross-section, where we define their planimetric quantities – these are areas or shapes that the software uses to build the 3D model. When we have several cross-sections with these shapes, Ferrovia automatically connects the matching points between them to create a solid 3D model.



Because cross-section axes define the location of each section along the alignment, it's important to create a new cross-section wherever there is a change – for example, in structure, width, slope, a road crossing, or any other geometry. This way, the 3D model correctly follows all design changes and builds an accurate model along the entire route.

One of the main advantages of Ferrovia's cross-sections is flexibility – you are not limited to predefined library parts. Instead, you can create custom and complex shapes that fit your project needs. We also developed additional tools like "Convert hatches to planimetry" and "Convert hatches inside blocks", which make the process even faster and easier. And with the Macro tool, you can save any cross-section to a library and reuse it in another project – saving time and ensuring consistency across similar designs.

In the following parts of the tutorial, we will demonstrate:

- how to create cross-sections,
- how to define planimetric quantities and use them to generate 3D models,
- how to assign BIM attributes (such as material, construction phase, ID, etc.),
- and finally, how to export the model to IFC and view it in various BIM viewers.

1. CROSS – SECTION VIEW

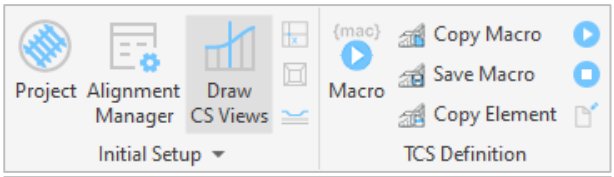
1. Click on Draw CS Views icon.

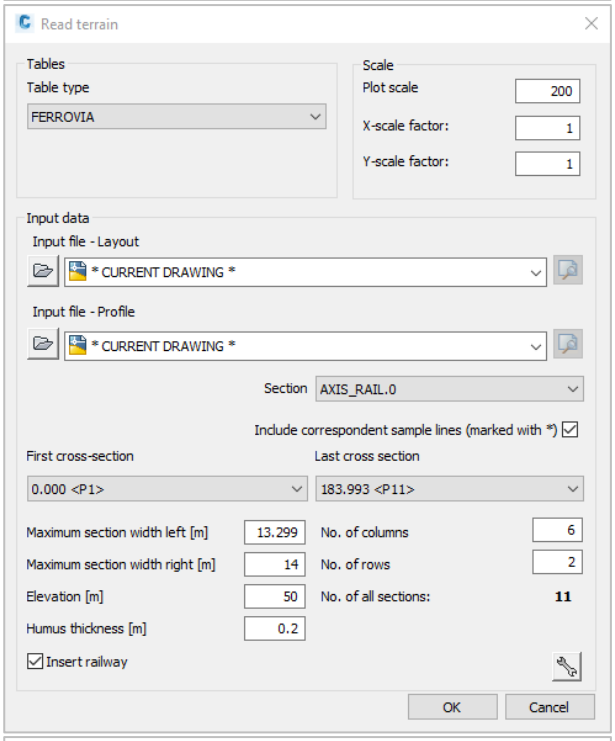
2. Choose Ferrovia table type, for source data use *Current drawing*, or select another drawing if you started to draw cross section views in a new drawing.

3. Define horizontal and vertical scale of tables inserted.

4. Select the first and the last cross-section in selected sections/segments.

5. If the button Insert railway is checked, the railway will be inserted automatically in the cross sections.

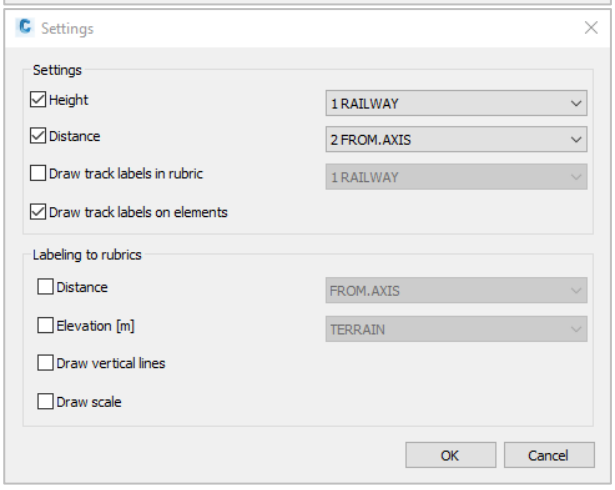




6. Click on the Setting button.

7. Uncheck the boxes at distance, elevation and draw vertical lines. When finished, press the OK.

8. Confirm all the parameters by pressing OK.



2. DRAW TCS ELEMENTS

Ferrovia provides tools for designing and editing railway cross-sections in a detailed and flexible way, with almost no limits to the geometry of the final design.

The Typical Cross Section elements (TCS) group contains commands for adding standard railway elements like embankments, substructure layers, ditches, fillets, etc. You can also insert basic elements such as blocks, lines, and points.

⚠ **Important:**

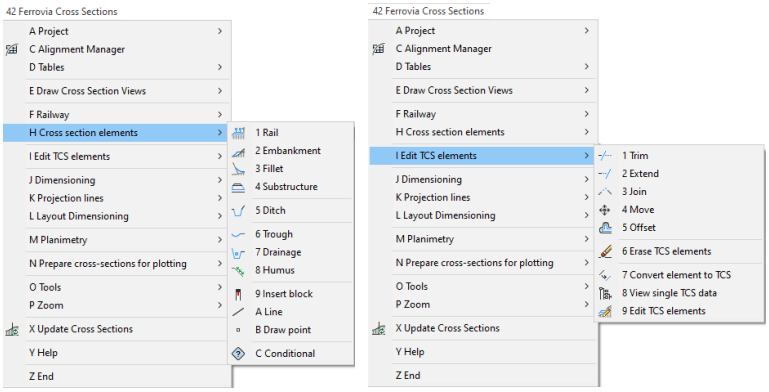
To ensure everything works correctly – including 3D model creation and calculation of planimetric quantities – **you must use these dedicated TCS commands**. Do **not** draw cross-section elements using standard CAD tools (like basic polylines or copy/paste). If CAD polylines or hatches are used, they must be converted into TCS elements using the **Convert element to TCS** command available in Ferrovia. This ensures that all elements are correctly recognized by the system.

Ferrovia also includes special commands for copying, offsetting, trimming, or extending TCS elements (as shown in the *"Edit TCS elements"* menu). These commands keep the data connected and functional.

Why is this important?
When you use the proper TCS tools:

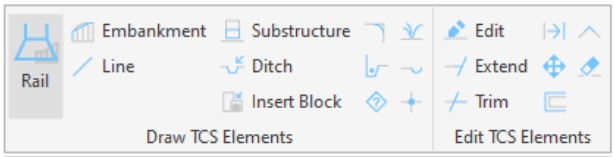
- The software recognizes each element as a **TCS object**, not just a line.
- You can later use the **Edit** command to change the element.
- All related geometry and connected elements **automatically update**, which saves time and reduces errors.
- Your cross-sections remain fully compatible with 3D modeling tools and quantity calculations.

Using the correct workflow ensures smooth editing, accurate modeling, and reliable BIM data all the way to your final IFC export.



2.1 Draw rail

1. Click on the Cross Sections tab and click on the Rail icon.



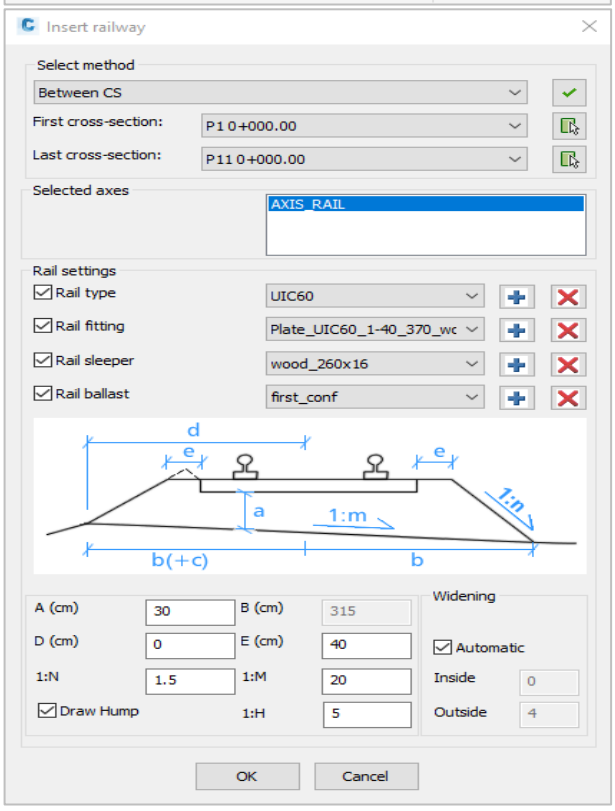
It opens a new dialog box, named Insert railway.

2. At the top of the dialog press tick button to select all cross sections.

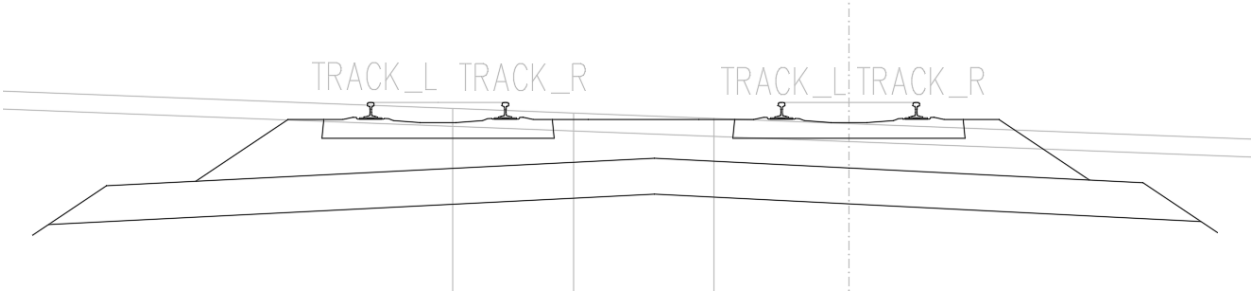
Then define following parameters:

- rail type.
- rail fitting,
- rail sleeper,
- rail ballast

3. Check the box at Automatic Widening and Draw Hump and then click on the OK icon.



Example of a basic cross-section of a double-track railway line:



2.2 Draw embankment

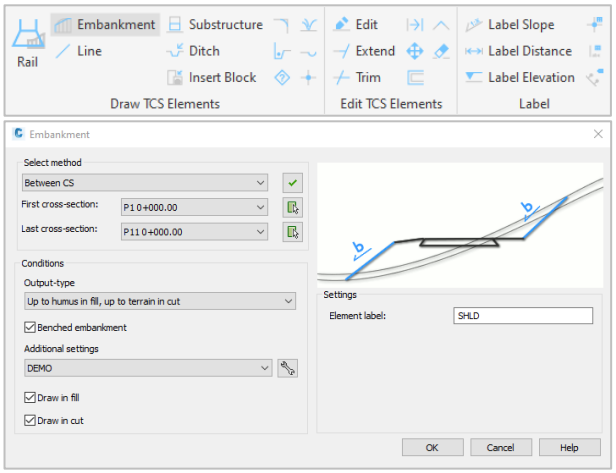
1. Click on the Cross Sections tab and select the Embankment icon.

2. Press the tick button to select all cross sections.

3. From the drop-down menu select Up to hummus in fill, up to terrain in cut, check Draw in fill and Draw in cut and confirm by clicking OK.

4. Click on the left edge of the rail.

Then repeat the same procedure on the right side. Once again click on the embankment icon. Since the parameters remain the same just press OK and click on the right edge of the rail.



3. EDIT TCS ELEMENTS

With this command group it is possible to edit designed cross sections. Only Ferrovia commands should be used, not standard AutoCAD/BricsCAD editing commands.

3.1 Edit TCS elements

Assume that thickness of the substructure should be changed from 40 cm to 60 cm.

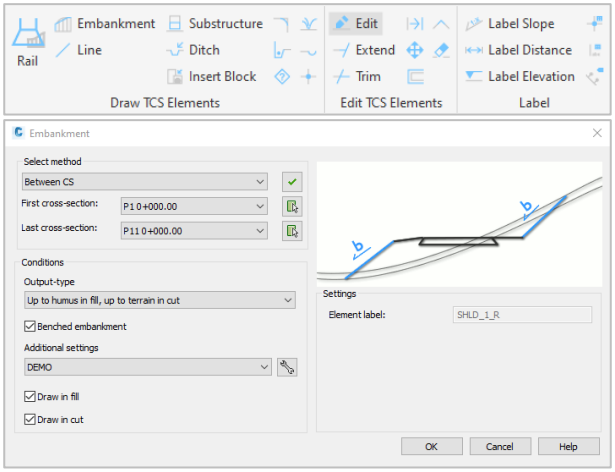
1. Click on the Cross sections tab and select the Edit command.

2. Select the embankment in the drawing.

3. Press the tick button to select all cross sections.

4. Define new name.

5. Confirm by pressing OK.



3.2 Other commands

There are also bunch of commands, available for editing TCS elements:

- **Trim**: to trim selected TCS elements
- **Extend**: to extend selected TCS elements
- **Erase**: to erase selected TCS elements
- **Move**: to move selected TCS elements
- **Offset**: to parallel copy selected TCS elements
- **Join**: to join selected TCS elements

4. LABEL TCS ELEMENTS

4.1 Label slope

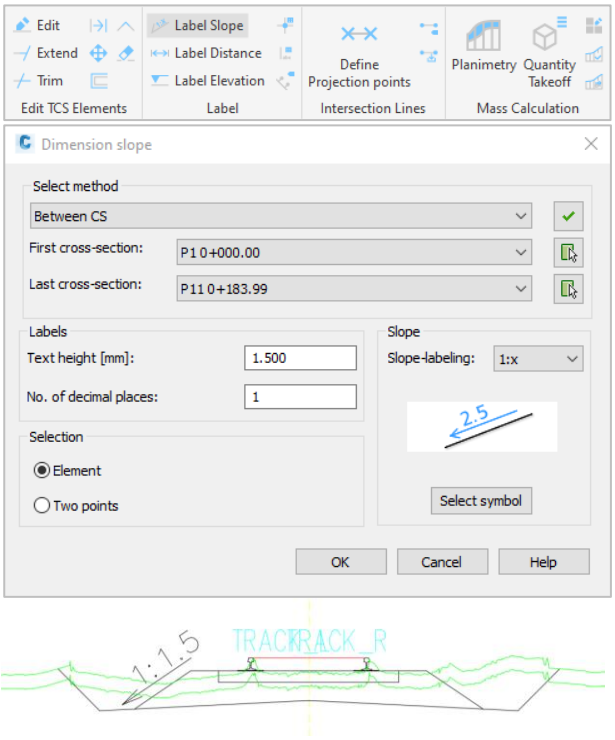
1. Click on the Cross Sections tab and select the Label Slope icon.

2. Press the tick button to select all cross sections.

3. Define the following parameters:
   Text height [mm]
   No. of decimal places:
   Selection: check *Element.*
   Slope labelling: %.

3. Confirm by pressing OK.

4. In the drawing select the element, the slope of which you want to label.



4.2 4.2 Label distance

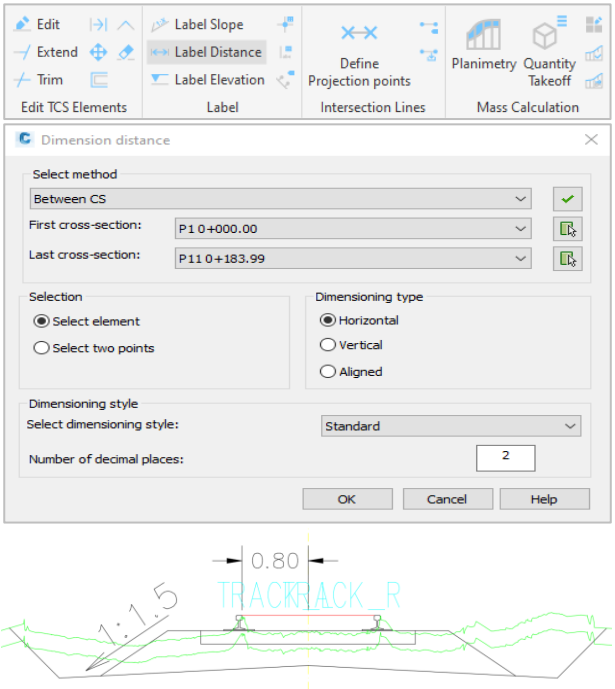
1. Select the Cross Sections tab and click on the Label Distance icon.

2. Press the tick button to select all cross sections.

Define the following parameters:
   Dimensioning type: check *Horizontal.*
   Dimensioning style: Standard
   Number of decimal places: 2

3. Confirm by pressing OK.

4. In the drawing select the element, the dimension of which you want to label.

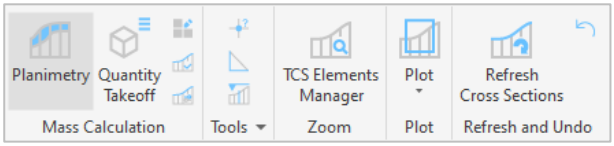


5. PLANIMETRY

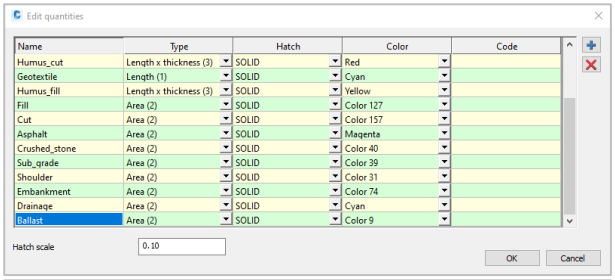
Based on constructed cross-sections, it is possible to precisely calculate the cut, the fill and other volumes. The calculation is based on the so-called planimetry polygon lines that represent borders of planimetry quantities. **Each element that we want to generate as a 3D model in the next step must be defined as a planimetry quantity in the cross-sections.**

1.1 Ballast

1. Click on the Cross Sections tab and select the Planimetry icon.



2. In the dialog box press the tick button to select all cross sections and define the type of the planimetry quantity.

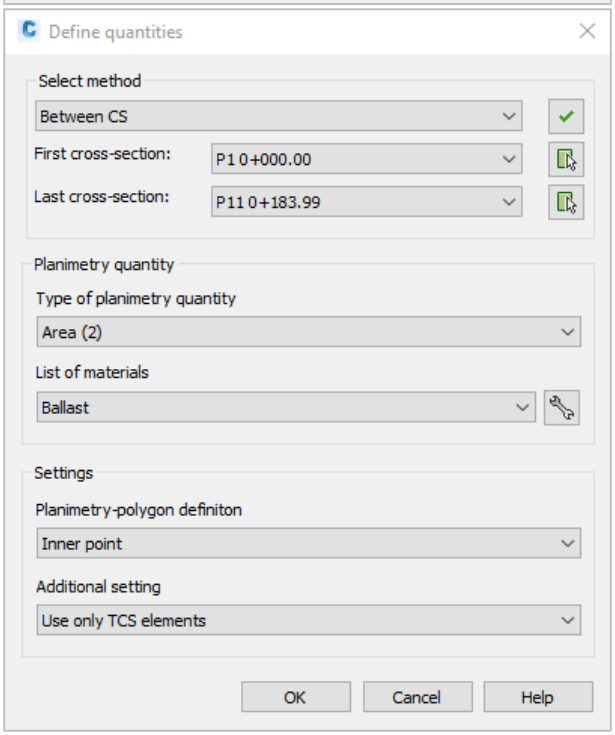


3. Click on the button next to the list of materials. It opens a new dialog, where you add and edit quantities.

4. Press the plus button and define new quantity. Enter the name Ballast and select the colour from the drop-down menu.

5. When finished, press OK.

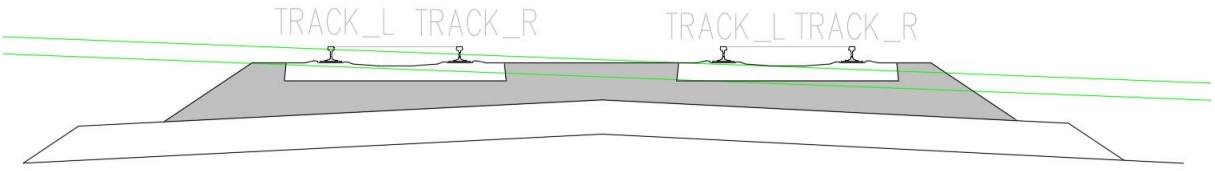
6. Select a new defined material from the list.



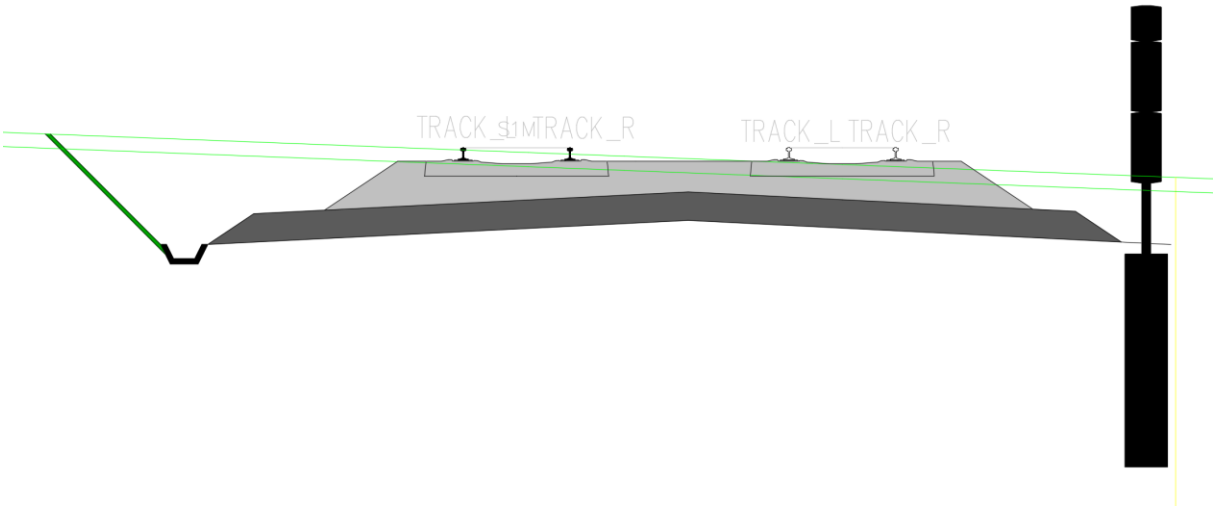
7. Select Inner point for the Planimetry-polygon definition and then define the additional settings.

8. Confirm by pressing OK.

9. Click on the line, which represents the upper edge of the Ballast and then select any point in the planimetry-polygon area.

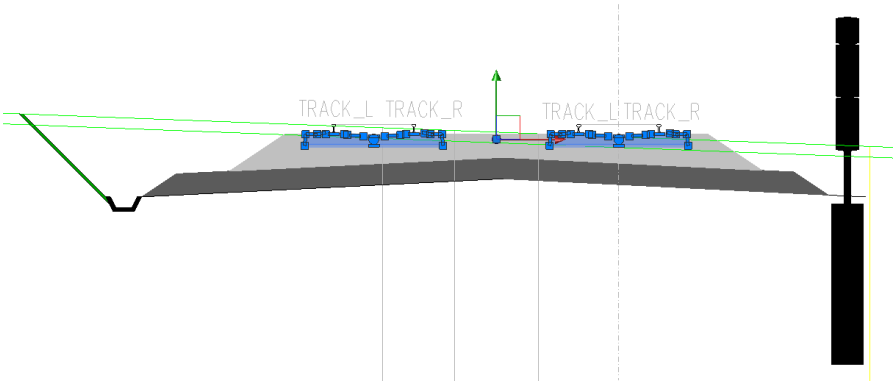


Example of a basic cross-section of a double-track railway line with noise barrier on the right:

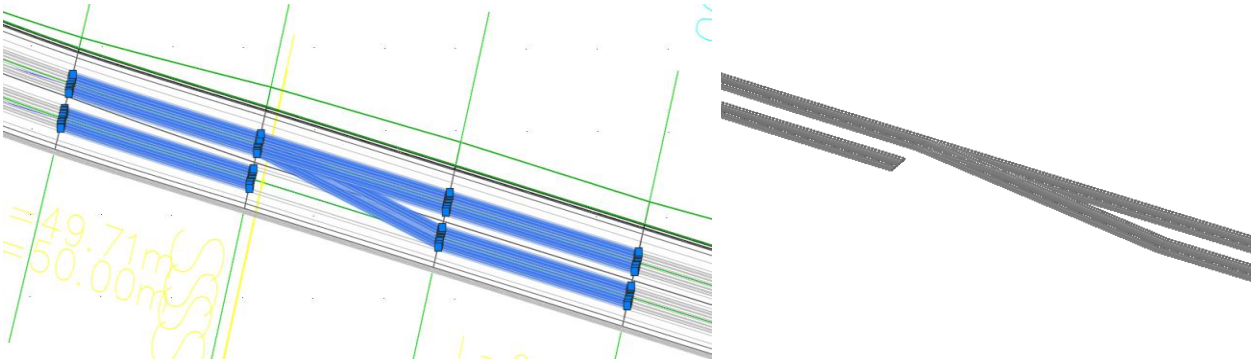


⚠ **Important:** Sometimes, when we have multiple elements with the same name for planimetric quantities, Ferrovia may incorrectly link these quantities during 3D model generation. This can result in issues like the one shown in the example below.

Both sleepers are created using the same material/quantity:

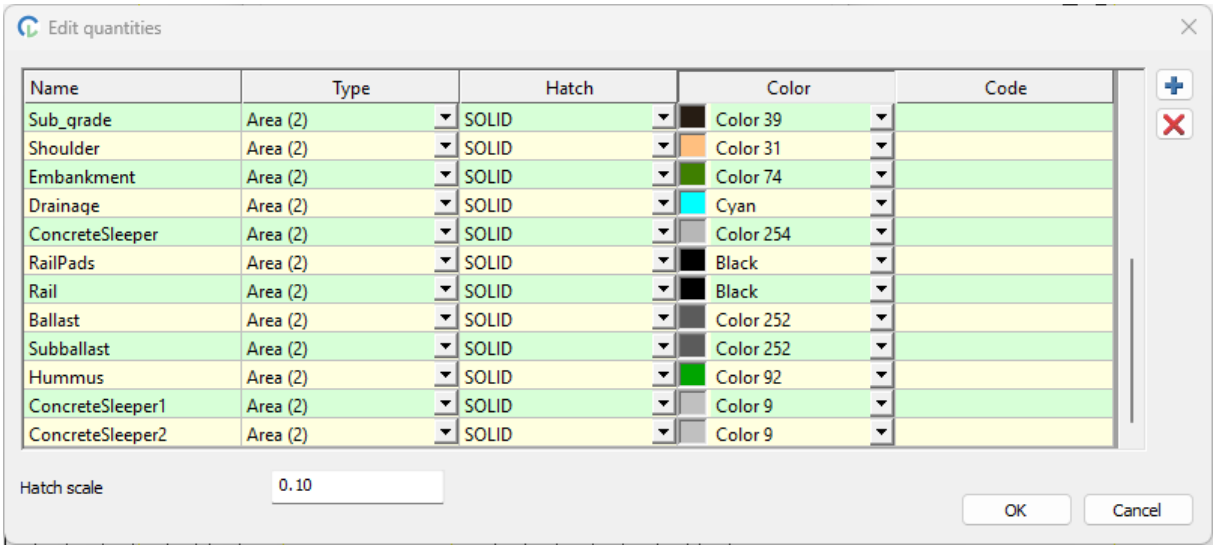


When the model is generated, the following issue occurs:



In this specific case, the same material was used for both the left and right sleeper, which caused Ferrovia to incorrectly associate the elements in one of the cross-sections.

If this happens, we recommend assigning two different materials to these elements — for example, instead of using the same material for both (e.g. Sleeper), use ConcreteSleeper1 and ConcreteSleeper2. This will ensure the issue does not occur.



6. QUANTITY TAKE - OFF

The command calculates the quantities by sections as well as for the whole area. The results can be saved to a file and/or displayed in the drawing.

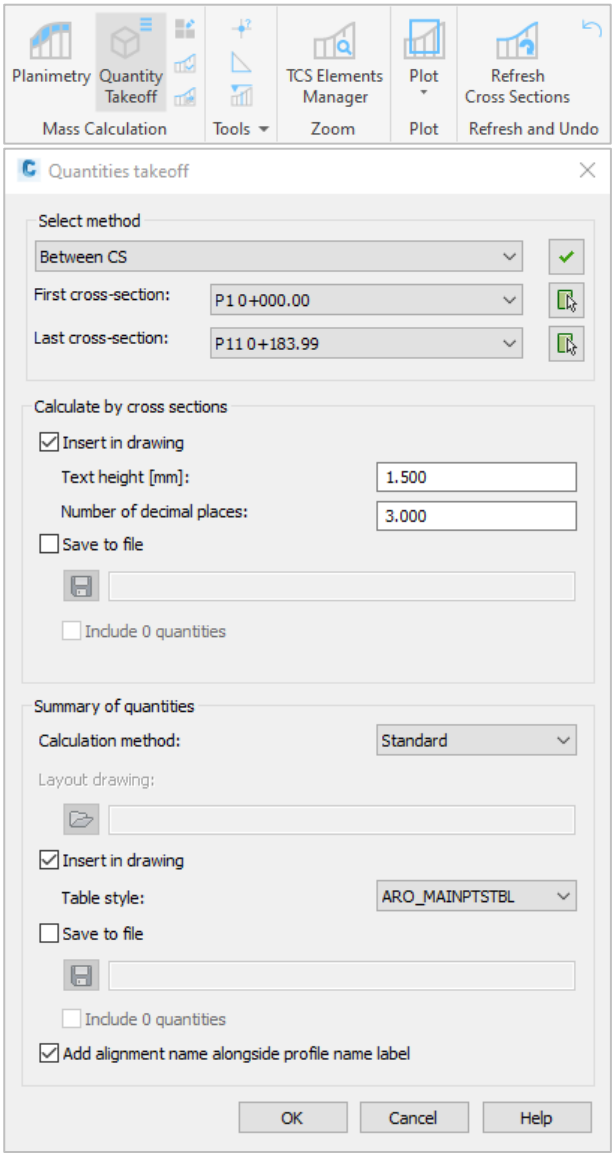
1. Click on the Cross Sections tab and select the Quantity take-off icon.

2. Press the tick button to select all cross sections.

3. Check insert and select the location for planimetry labels in the drawing.

4. For summary of quantities calculation, check insert in drawing option and define an insertion point of quantity table in the drawing.

5. Confirm by pressing OK.



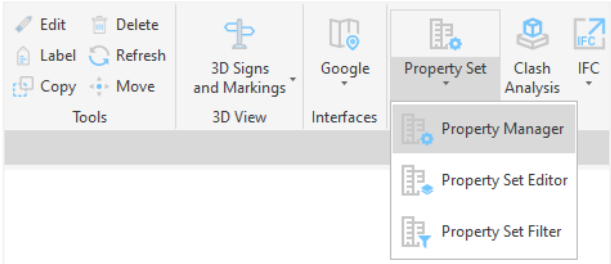
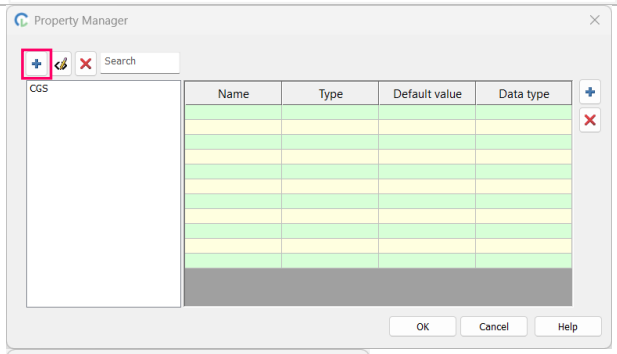
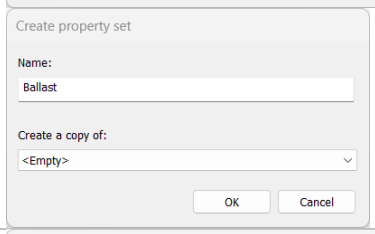
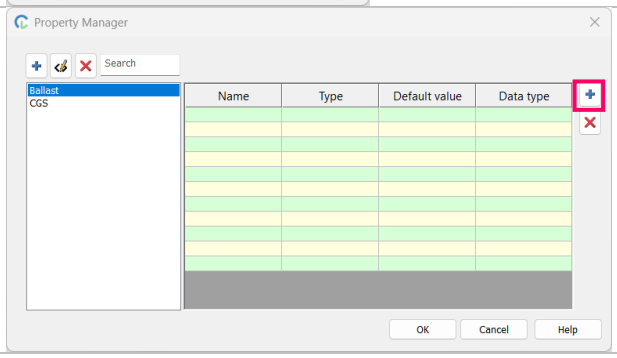
7. BIM MODEL

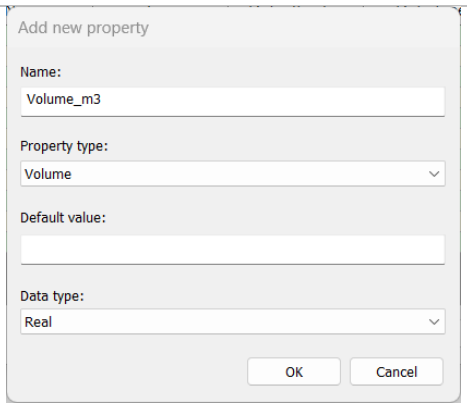
11.1 Defining Attributes

Before we generate BIM model (3D Models with Attributes), we need to define property sets. There are two types of attributes available: automatic attributes, which are calculated and inserted automatically after creating the model with the "Draw 3D Model" command, and manual attributes.

Automatic Property Type: Axis, Start station, End station, Material, Code, Volume, GUID

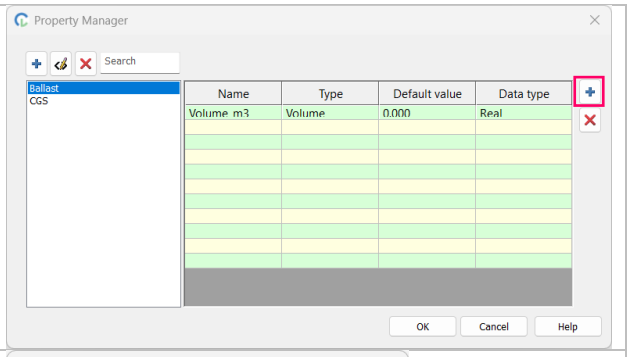
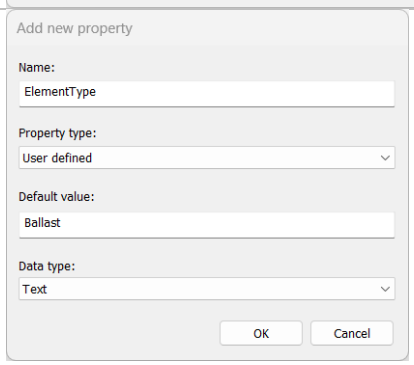
Utility

1. Run the "Property Manager" command: This command is used to define property sets.	
2. Click the plus icon on the left section of the dialog box to add a new property set. 3. After that, the "Create Property Set" dialog appears, where the user enters the name of the property set and, if desired, selects an existing property set (e.g., CGS) as a template for the new property set or leaves the option as "empty."	 
4. Next, the user clicks the Plus button on the right to add attributes. (The list of property sets and their attributes is typically included in the BIM Execution Plan.)	

- First, define the name of the attribute. - If you select "User-defined," you will need to enter the value manually. If you select "Volume" or any other option, the value will be calculated automatically after you run the "Draw 3D Model" command. **In this case, "Volume" is selected, which means the volume will be automatically inserted as the value.** - Then select data type from drop-down menu and click OK.	

Property Type: User defined

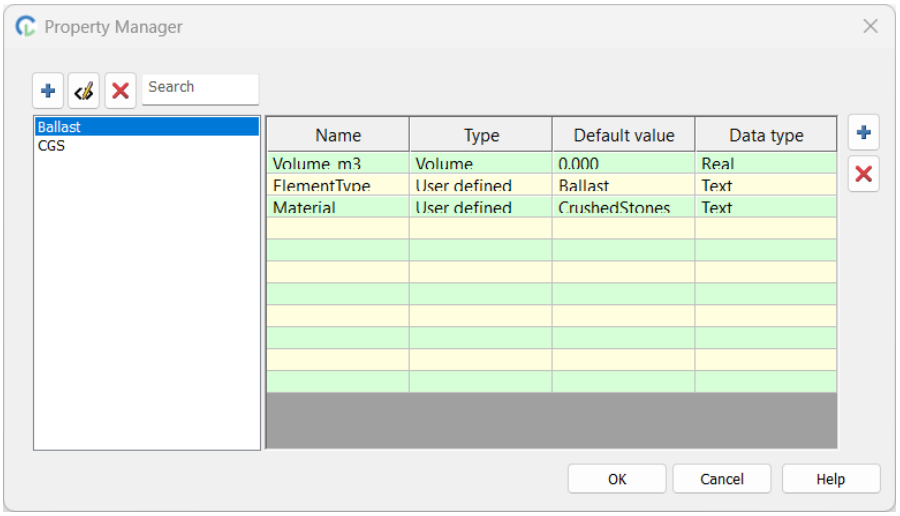
This property type is used for all custom attributes where the values must be entered manually. It provides flexibility for defining attributes that do not have predetermined or automatically calculated values. Below is an example where the attribute is constant, meaning it will always have the same value for this property set. Therefore, we'll enter its value as the default. However, if the value varies, we can leave this cell empty and manually enter the value later using the "Property Set Editor."

5. To add another attribute, we click the plus button on the right again.	
- First, define the name of the attribute. - After that, define the type. If you select "user-defined," it means you will manually enter the value. - Then define the default value. If you know that this value will always be the same, you can enter it now. In our example, we are attaching this property set to an element type called Ballast, so you can enter "Ballast" as the default value. However, if the value is expected to vary between instances, leave	

this field blank and enter the value manually later using the "Property Set Editor." - Then select data type from drop-down menu and click OK.	

⚠ **Note:** The property types Axis, Start Station, End Station, Material, and Code are automatically calculated only when they are defined during the “Draw 3D Model” command. If you attach them manually after the model has already been created, they will not be calculated automatically, and the cells will remain empty.

5. In this way, you then add other attributes that apply to this property set:



7.1 Create 3D Solid model

1. Create 3D Solid model with Draw 3D Model command.

2. In Layout/alignment enter the alignment drawing, in Profile enter the drawing of the profile and in Cross sections enter the drawing of the cross-sections of the railway. Data sources can be either in one group or in separate DWG-drawings.

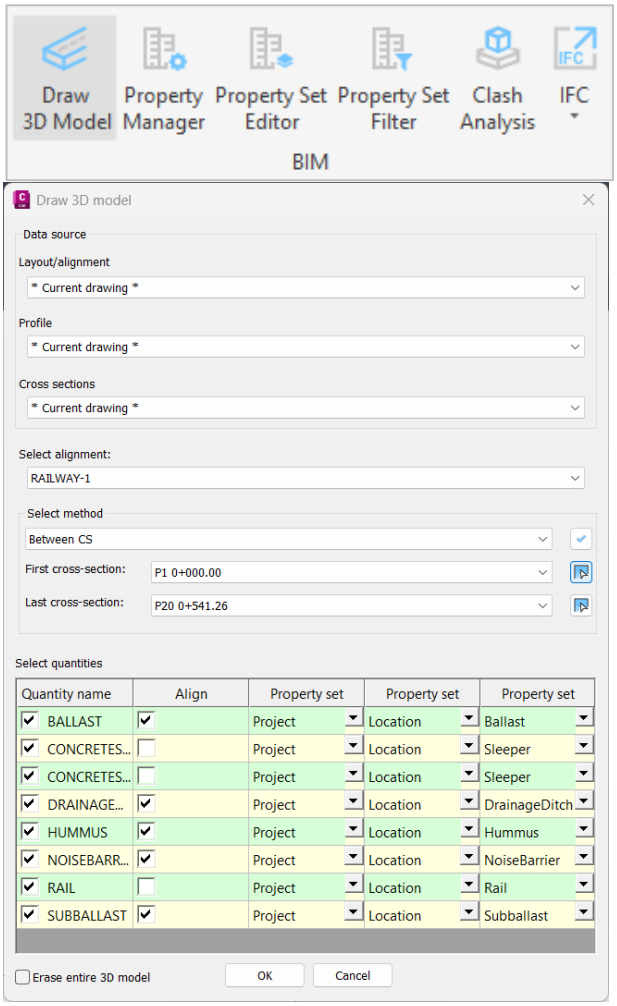
3. In the Select alignment select the main alignment and define the starting and ending cross section.

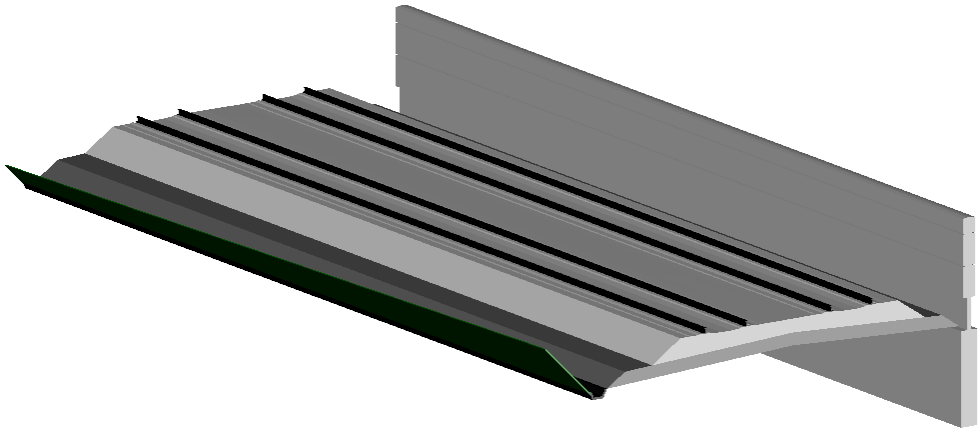
4. Check planimetry quantities you want to create a 3D solid model from.

5. Check Align to connect the consecutive planimetry polygons along the alignment. Otherwise it connects the adjacent planimetry polygons with sectional straight lines.

6. Select Property Sets from the drop-down menu.

7. Confirm by pressing OK.



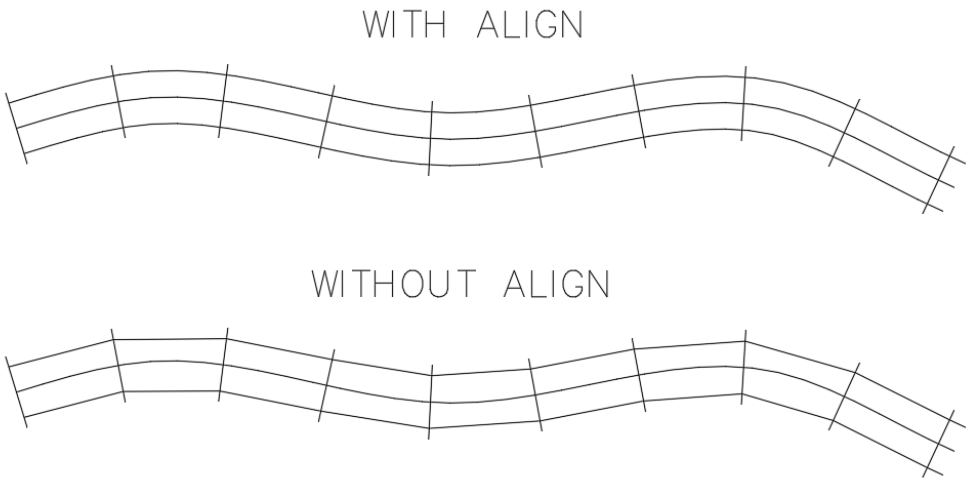


Difference in 3D Model Drawing When Using the Align Option

The image below shows how the 3D model looks different depending on whether the **Align** option is checked or not:

☑ **With Align**
When the **Align** option is checked, the planimetry polygons are connected along the alignment. As shown in the top part of the image, the cross sections are curved and follow the path of the alignment. The result is a smooth and natural-looking 3D model, which is ideal for roads, railways, or other linear structures.

❌ **Without Align**
When the **Align** option is not checked, the polygons are simply connected with straight cross lines. As you can see in the bottom part of the image, the model becomes more rigid and does not follow the alignment properly.

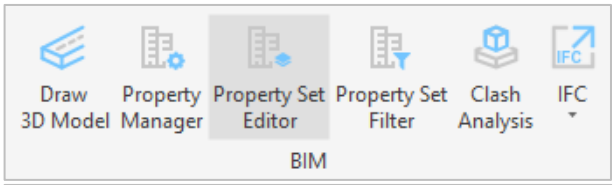


⚠ **Note:** The Align functionality currently works only when Ferrovia is installed on the AutoCAD and Civil 3D platform. It does not work with BricsCAD.

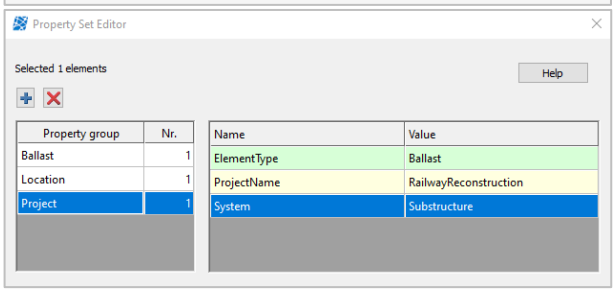
7.2 Property Set Editor

Property Set Editor user interface enables users to assign, add, change or remove property set data to a single or multiple 3D solid elements, selected in the drawing.

1. Run the Property Set Editor command.



2. Select an element in the drawing and its property sets and attributes will be displayed in the dialog box.



3. Press plus button to add new property sets (3 property sets can be attached to one element).

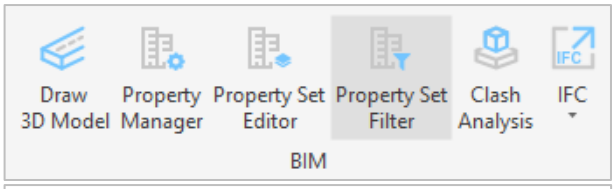
4. Change the value of the attributes in the right table, by simply clicking in the cells.

7.3 Property Set Filter

Property Set Filter enables users to quickly find 3D solid objects with the drawing by listing material definitions assigned to 3D solid objects and manipulate these objects as:

- select 3D solid in drawing,
- isolate 3D solids with selected material definition and
- hide 3D solids with selected material definition.

1. Run the Property Set Filter command.

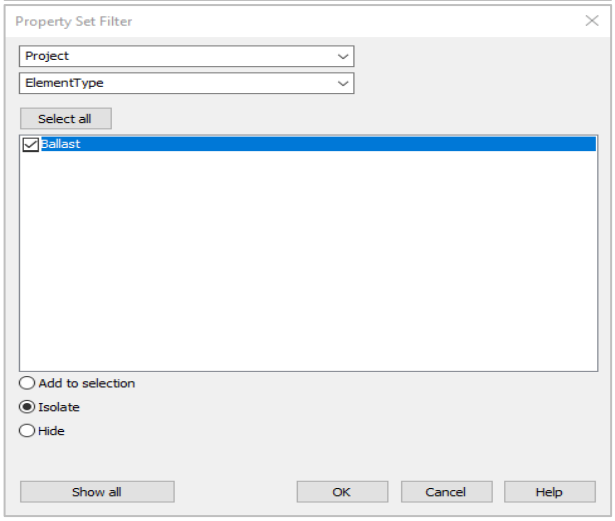


2. Define a search set.

3. Select if you want to add those elements to existing selection or if you want to isolate or hide them.

4. Confirm by pressing OK.

According to the parameters shown in the figure on the right, all elements of the Ballast type are isolated in the drawing.



8. IFC EXPORT

1. Run the IFC export command.

IFC export dialog box opens.

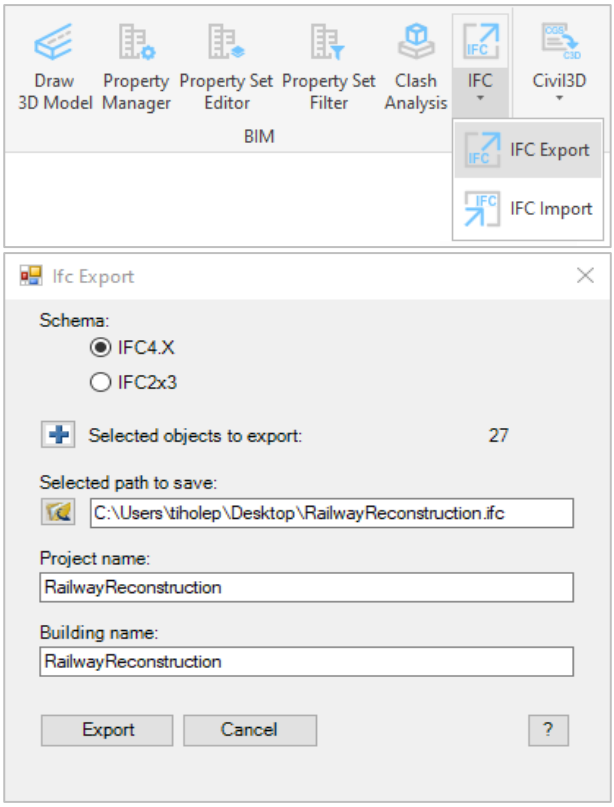
2. Select the IFC schema. You can choose between IFC4.1 and IFC2x3.

3. Select path to save the IFC.

4. Define project and building name.

5. Click on the Plus button and select the objects to export.

6. Confirm by pressing OK.



9. OPENING IFC IN BIM VIEWERS

When working with Building Information Modeling (BIM), it is often necessary to open and review IFC (Industry Foundation Classes) files in different software programs. These files contain 3D models and important building data that can be shared between different stakeholders, such as architects, engineers, and project managers.

To help with this, there are several BIM viewers available that allow users to open and inspect IFC files without needing the original modeling software. In this tutorial, we will show you how to open IFC files using two different viewers.

The first viewer we will look at is **BIMvision**, a lightweight and easy-to-use IFC viewer. One great advantage of BIM Vision is that its basic version is completely free, making it a popular choice for quick viewing and collaboration.

The second viewer we will introduce is **Autodesk Navisworks**, a powerful tool used in professional environments for advanced model coordination, clash detection, and 4D simulation. Although Navisworks is a paid software, it offers many features that are useful in large or complex projects.

In the next sections, we will guide you step-by-step through the process of opening IFC files in both BIM Vision and Navisworks.

9.1 BIMvision

You can download BIMvision for free from their official website:

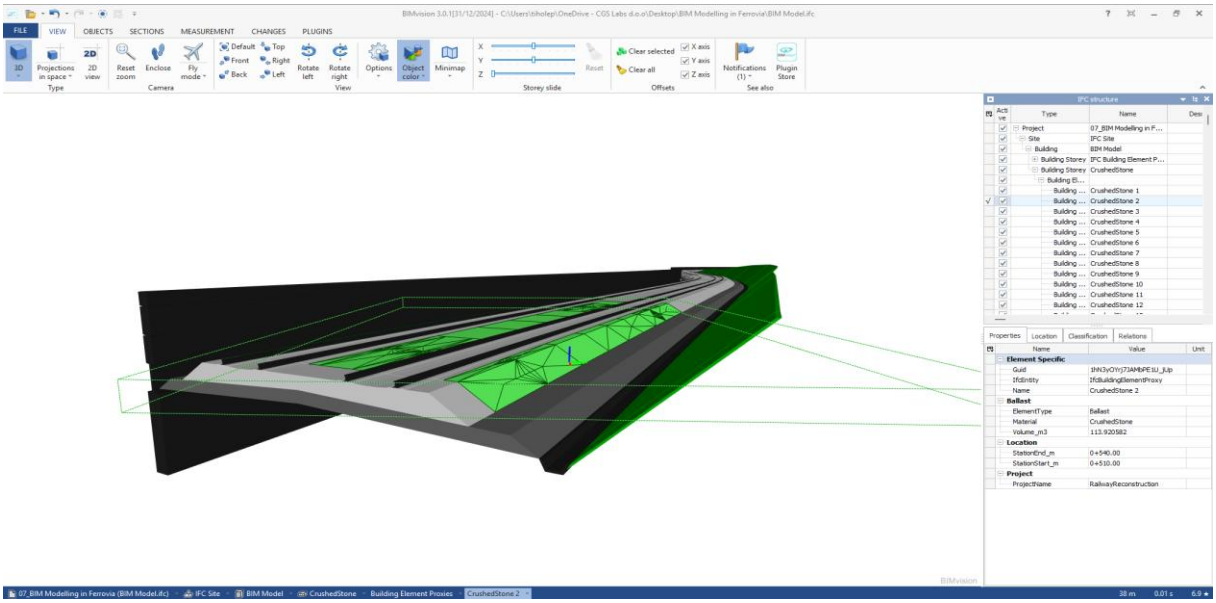
https://bimvision.eu/download/

Once you have installed BIM Vision on your computer, follow these steps to open an IFC file:

1. Open the BIM Vision application.
2. In the top-left corner, click on File and then select Open.
3. Choose the IFC file you want to open from your computer.

BIM Vision will load the model, and you can start viewing and exploring the building data right away. This viewer is ideal for quick inspection and simple navigation through the BIM model.

When you click on the element, you can also see which property sets are attached and the values of the attributes on the right side:



9.2 Navisworks

Navisworks is a software tool commonly used in construction and architecture projects that involve Building Information Modelling (BIM). It helps teams plan, visualize, coordinate, and analyze complex building models by bringing together data from different disciplines and software tools into one shared environment.

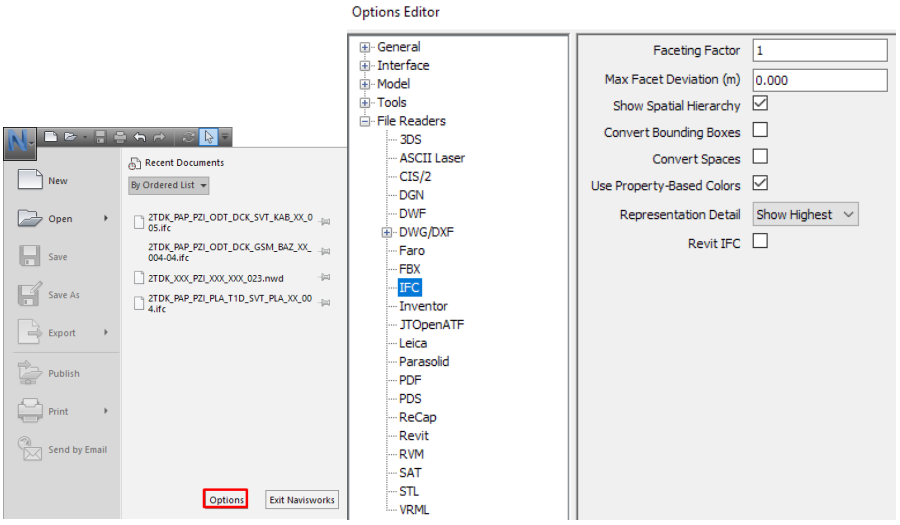
Besides helping detect clashes and coordinate models, Navisworks also supports 4D and 5D BIM workflows.

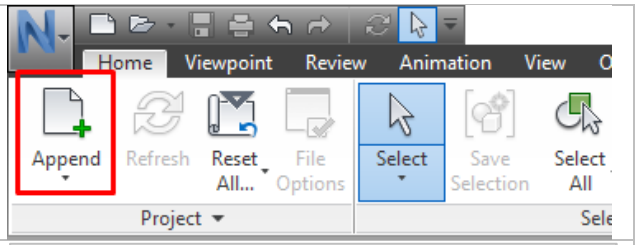
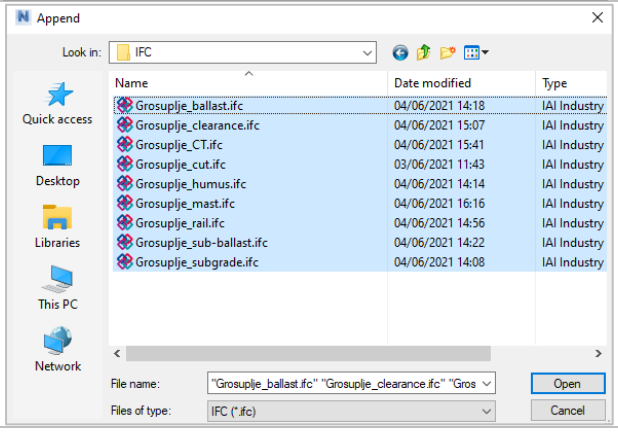
- 4D BIM adds the time aspect by connecting the model to the project schedule. This lets teams simulate construction stages and visually track progress.
- 5D BIM adds cost information, which helps with accurate budgeting and financial planning throughout the project.

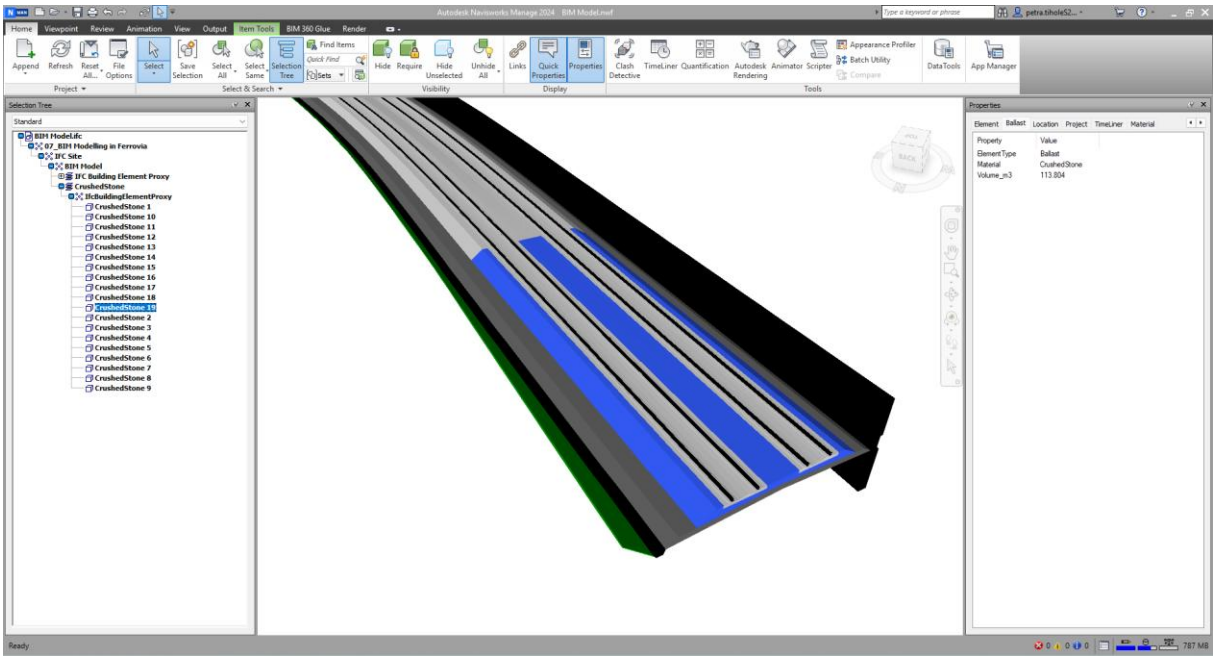
9.2.1 Opening Files in Navisworks

When the user opens the program for the first time, they must first configure the IFC settings, as shown in the image below.

NW -> Options -> File Readers -> IFC

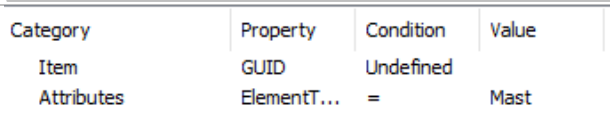


1. Under the Home tab, click the Append command.	
2. Select the IFC file. You can also add multiple files at once.	



9.3 Attribute Values

You can obtain attribute values from the Navisworks software.

1. Start the **"Find Items"** command.	
2. A dialog window will open, where you can create a **Search Set**. 3. Click the **"Find All"** button, located at the bottom left of the dialog window.	

In this case, the result is the number of all masts of the overhead line system.