AMBERG TUNNEL - Tutorial

Project creation - Design

Amberg Tunnel version: 2.25

In this tutorial you will learn

This tutorial will walk you through the process of defining and verifying the tunnel design for a tube and shaft. We will explore options how you can import the full design from the file or create it manually. This tutorial is a follow-up tutorial to "Project creation - Axis".

Tutorial takes approximately 20 minutes.

For more detailed information see manual → Amberg Tunnel → Help → Base module

Contents

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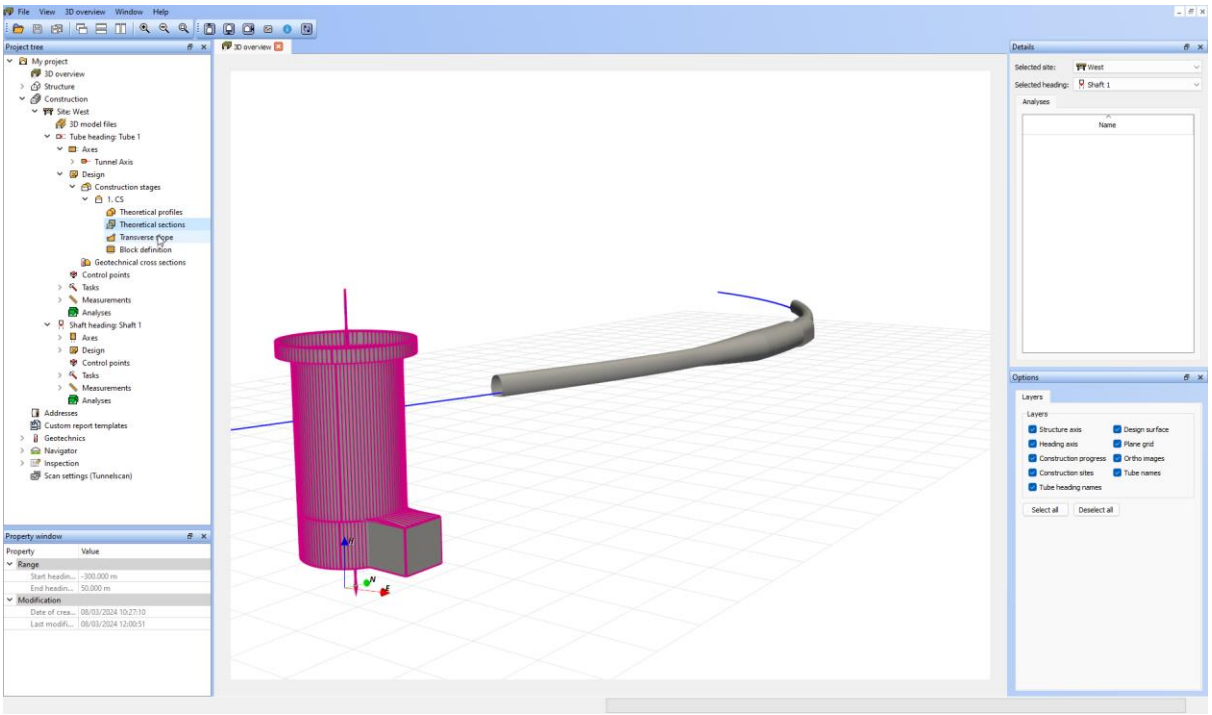
Demo data

Download the project from our home page and unzip it:

https://ambergtechnologies.com/fileadmin/fileadmin/user_upload/amberg-technologies/downloads/AmbergTunnel2/Tutorials/Tutorial_Design_definition.zip

The folder contains a final project created by this tutorial and data for import.



Project Overview

The individual steps are also described in video tutorial at this link.

https://www.youtube.com/playlist?list=PLdAutjItdJ9BjCkcUMDesV4mQu6-mgYHB

Download & Install

Please download the software from the following link. You will be asked just for contact information, so we can reach out to you later if you have any following questions.
https://ambergtechnologies.com/private-area/amberg-tunnel/software-manuals

Demo license

You can contact support.tunnel@amberg.ch to get 1 week demo license.

How to create project in Amberg Tunnel

In the previous tutorial we have created a new project and axis. You can use the project that you crated in the tutorial "Project Creation – Axis" and continue to build it in this tutorial. Optionally you can go to the folder with the data that you downloaded and open project in the folder "Starting project".

- In Amberg Tunnel go to **File** → **Open project** → browse for your old project or the project in downloaded data in "starting projec" folder → select *Project name.at2prj* file and **Open**.

1. Step: Design creation

In Amberg Tunnel there are Construction stages that describe the shape of the individual tunnel layers. For example, in TBM tunnels there is generally one construction stage e.g. “Final lining” but for Drill & Blast tunnels there is an excavation layer first followed by a shotcrete layer and so on.

We have two approaches for defining the design of a construction stage:

1. The traditional approach: creating 2D profiles and defining sections along the axis.
2. Or using IFC or OBJ file with 3D representation of the individual tunnel layers (see a separate tutorial for this workflow).

- In the **Project tree** go to **Construction** → **Site: Site West** → **Tube heading: Tube 1** → **Design** → Right-click on **Construction stages** → **Add Construction stage**
- Set the **Name** to “1.CS” and press “**OK**”
- Open the newly created construction stage (double-click)

The construction stage definition consists of 2 mandatory steps that will define the shape of the construction stage

- Theoretical profiles
- Theoretical sections

And two optional steps, that you must enter if they are defined in your project

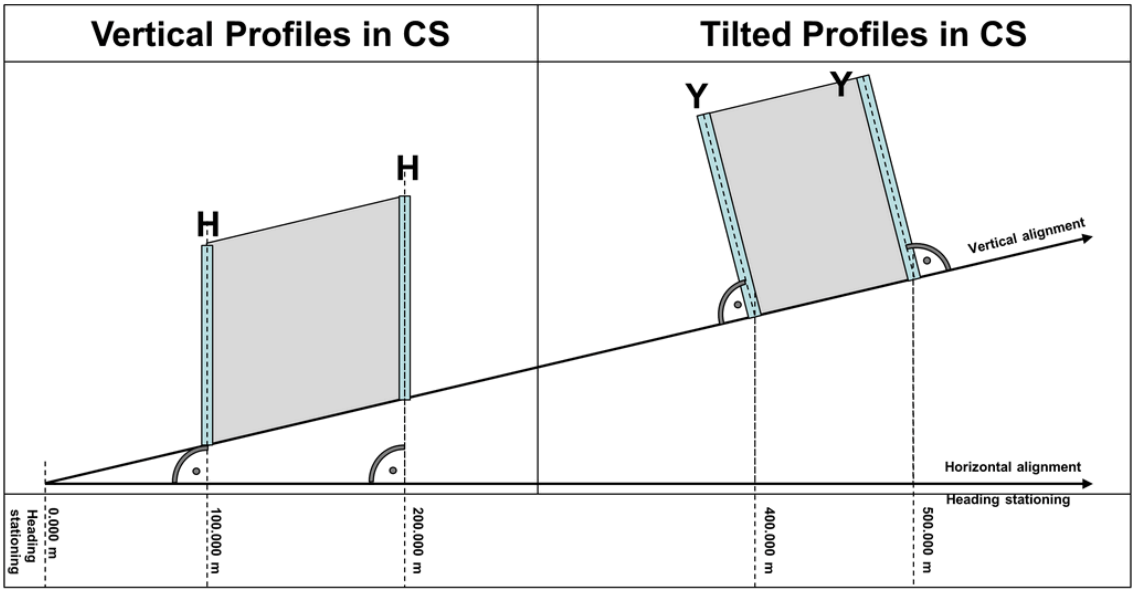
- Transverse slope
- Block definition

Theoretical profiles

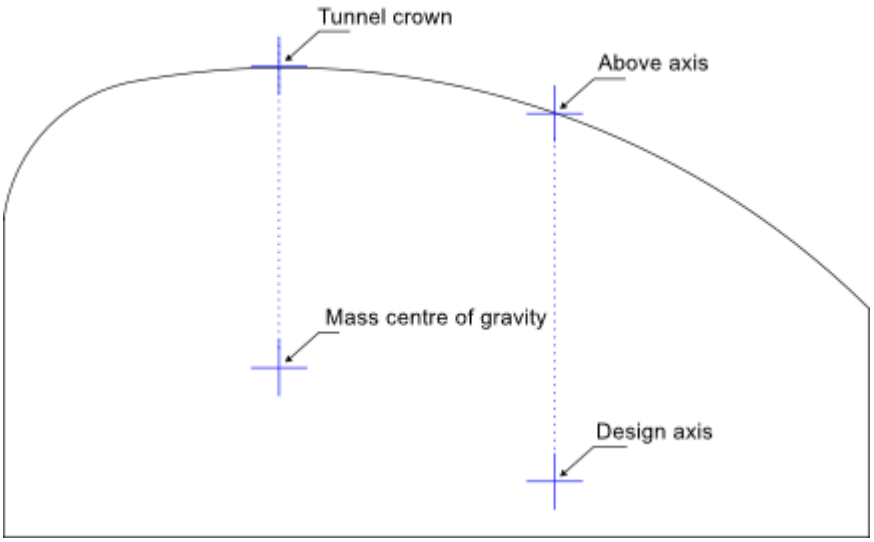
- Open the **Theoretical profiles** node in the newly created construction stage (double-click)

In this editor, we need to define one or more theoretical 2D profiles. We can define them manually or import them from a file.
Also, you can specify whether the profiles will be:

- Always vertical
- Tiling with the longitudinal slope



There is also a setting for the derolment centreline. This is important for the visualisation of derolment pictures in the point cloud analysis.

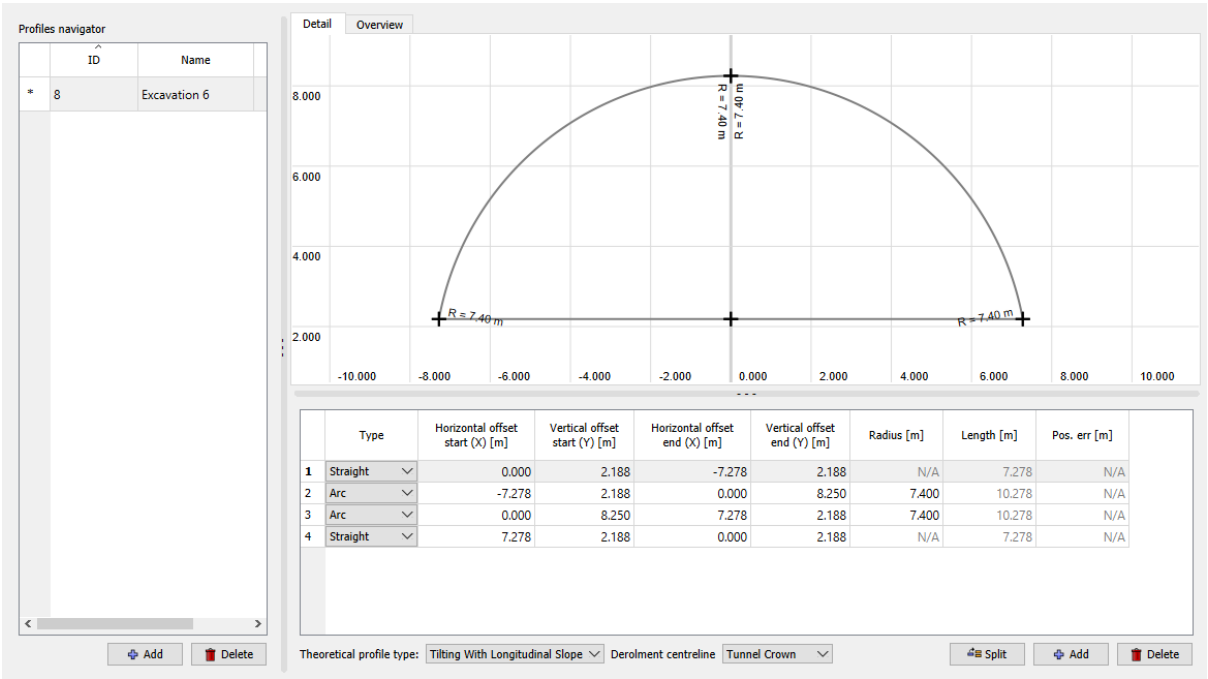


Manual creation of profiles

- Press the **Add** button in the **Profile Navigator** area
- **Double-click** on the **Name** field in the created profile line and call it "*Excavation 6*"
    - There is a warning sign because we don't have a closed profile yet. This will be fixed in the next steps
- Use the **Add** button on the right-bottom corner of the screen to add 4 elements with the following parameters:

Type	Horizontal offset start (X)	Vertical offset start (Y)	Horizontal offset end (X)	Vertical offset end (Y)	Radius
Straight	0	2.188	-7.278	2.188	N/A
Arc	-7.278	2.188	0	8.25	7.4
Arc	0	8.25	7.278	2.188	7.4
Straight	7.278	2.188	0	2.188	N/A

    - Create 4 elements and then **copy & paste** the values from the table above



Profile import

Profiles can be imported from multiple source files (DXF, LandXML, SBG Geo).

- In the theoretical profile editor
- Select **Import** from the toolbar or right-click in the 2D graphic view and find **Import**
- Select either:

DXF

- Import all DXF profiles located in …\2. Design\Rail Tunnel\Theoretical profiles***.dxf**

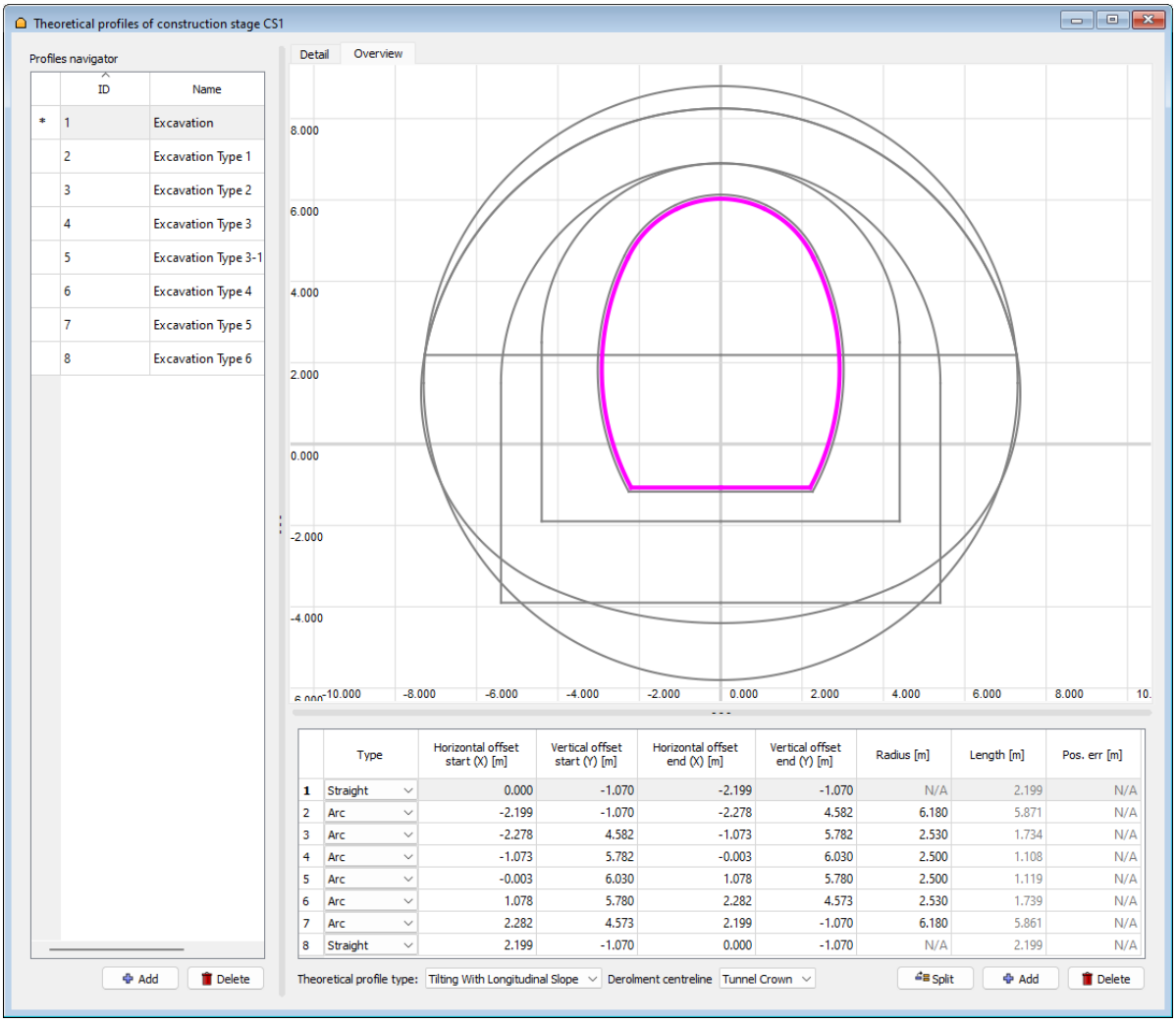
Rules for a profile in a DXF file

- *The DXF must contain only a single theoretical profile and no other data*
- *The DXF sheet origin (0,0) must correspond to the axis position*
- *Circle segments must not be larger than quarter circles*
- *The whole profile must be one closed polyline*

- Or select:

LandXML

- The LandXML file is located in …\2. Design\Rail Tunnel**Rail Tunnel.xml**
- Check **All Stations** check-box
- **Save** the editor



The results of the import should be the same in both formats (DXF and LandXML).

Tips & tricks for theoretical profiles

- *All profiles should have the same orientation (clockwise or anticlockwise)*
- *All profiles should have approximately the same amount of elements*
- *All profiles should have the first element at approximately the same position (e.g. always start from 0,0)*

In order to save time, you can also:

- ***Copy & paste** profiles either within or between construction stages*
- *Change the dimension of a profile with the **Inflate/Deflate** function*
- ***Shift** the entire profile horizontally or vertically.*
  - ⇨ *All these functions can be found in the **context menu***

Theoretical sections

After the creation of theoretical profiles, the next step is to create theoretical sections. In this step we will create a 3D model out of the 2D profiles (extrude them along the axis).

- Open **Theoretical sections** (double-click)

Manual creation of theoretical sections

- Create the first element by pressing the **Add** button in the right- bottom corner

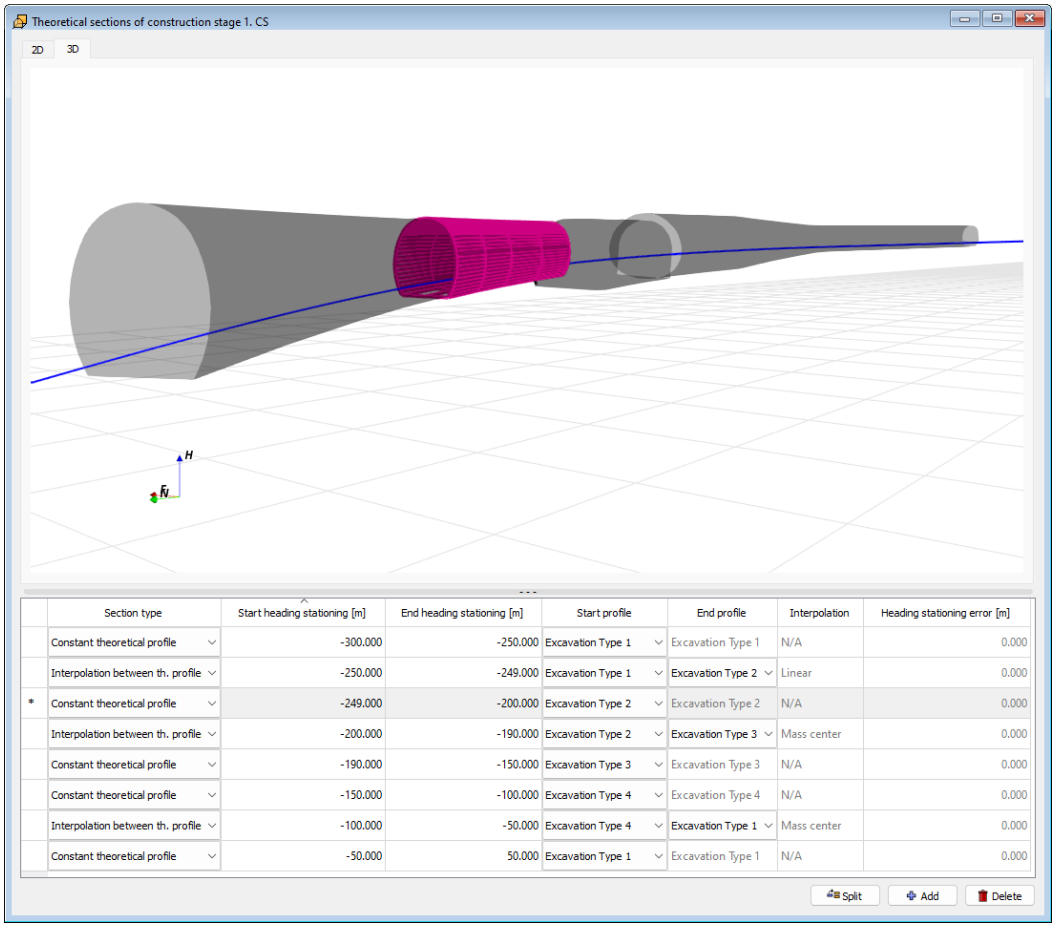
Section type	***Start HS***	***End HS***	***Start profile***	***End profile***
Constant	*-300*	*-250*	*Excavation type 1*	*-*

- Now the creation of the first element is complete, press the **Add** button again to define the second section.

Section type	***Start HS***	***End HS***	***Start profile***	***End profile***
Interpolation	*-250*	*-249*	Excavation type 1	Excavation type 2

Now we can explore our created design in the **2D** plan view or switch the tab to **3D** view (top-left corner).

- At this point the sections can be finished manually, or you can jump to the next chapter



Theoretical section import

- In the theoretical section editor, **right-click** in the 2D graphic view and press **Import**
- Confirm choices in warning dialogue
- Import the LandXML file located in … \2. Design\Rail Tunnel**Rail Tunnel.xml**
- **Save** the editor

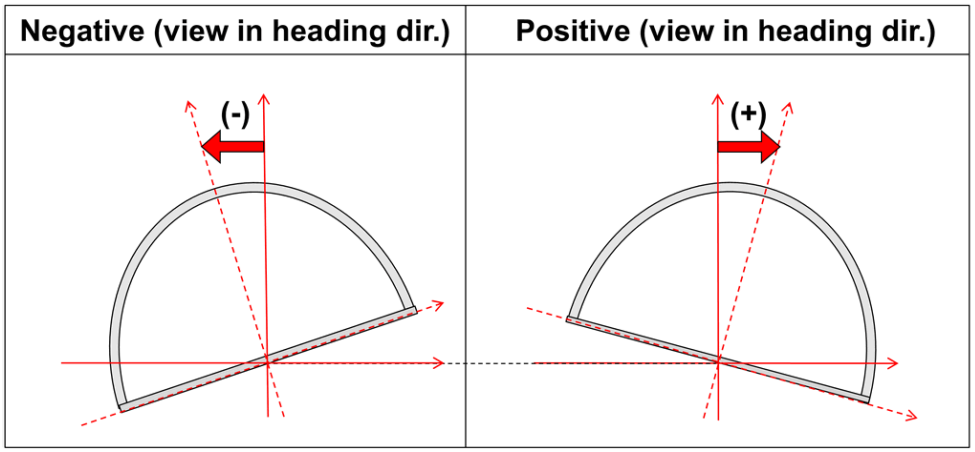
*In the **Settings** of the editor (and many following editors) you can choose if you want to see Heading stationing or 3D Tunnelmeter.*

- ***Heading stationing** is the stationing value in 2D (identical to horizontal alignment).*
- ***3D Tunnelmeter** is the stationing along the axis in 3D space*

The difference between these 2 values can be quite significant in steep tunnels (for example hydropower projects)

Transverse slope

In the **Transverse slope** editor, you can add or edit the tilt of the tunnel design Defining the Transverse slope in Amberg Tunnel is optional.



Note: the rotation point of the profile is the heading axis

- Open **Transverse slope** editor (double-click)

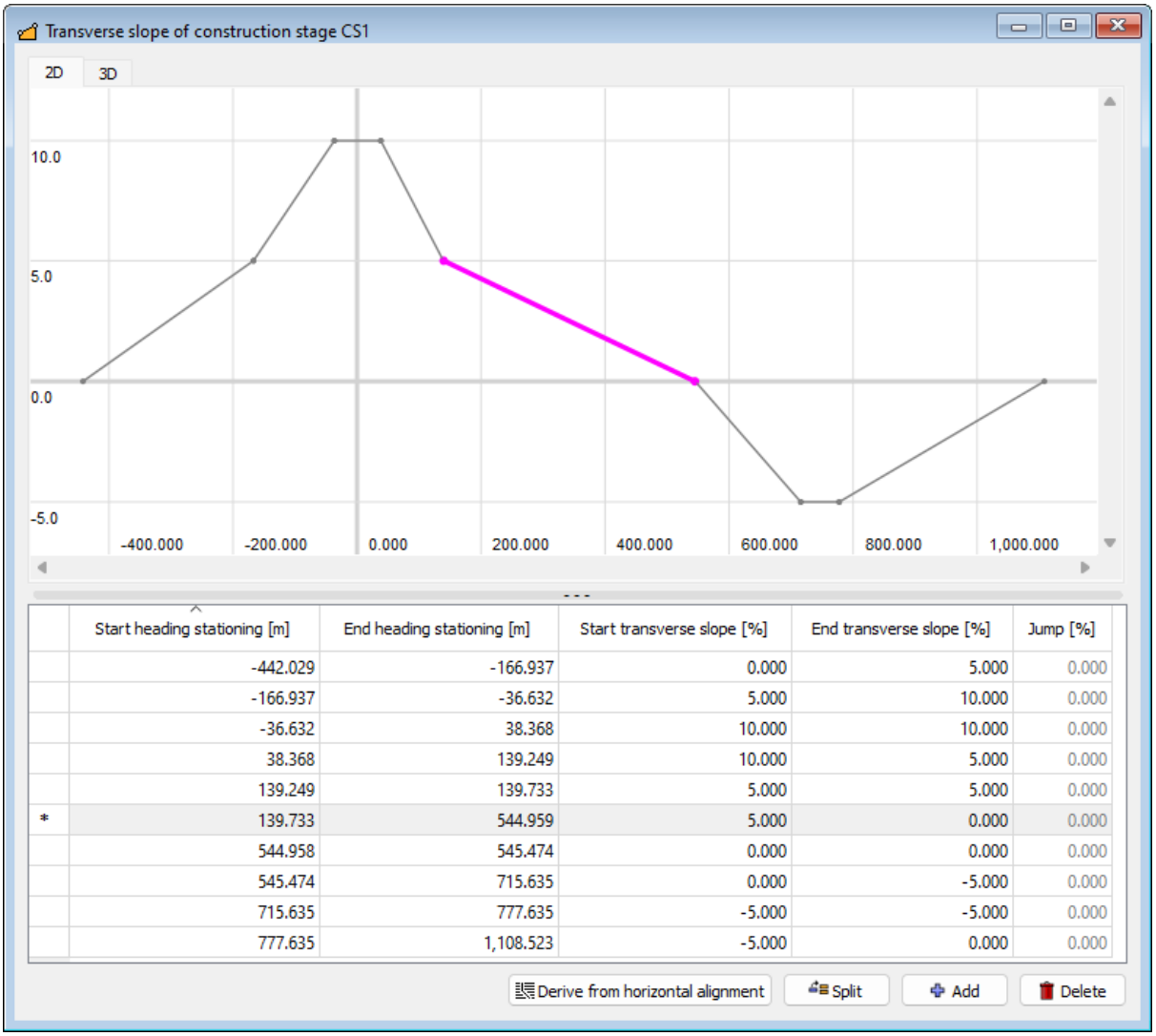
Manual creation of transverse slope

We can create transverse slope elements one by one by pressing the **Add** button in the bottom-right corner or we can derive the elements from the horizontal alignment.

- Find and press the **Derive from horizontal alignment** button in the bottom-right corner.
  - The number of created elements is the same as the number of elements in the **Horizontal alignment** editor
- Fill in the information from the picture in the following chapter or import a **Transverse slope** from a file

Transverse slope import

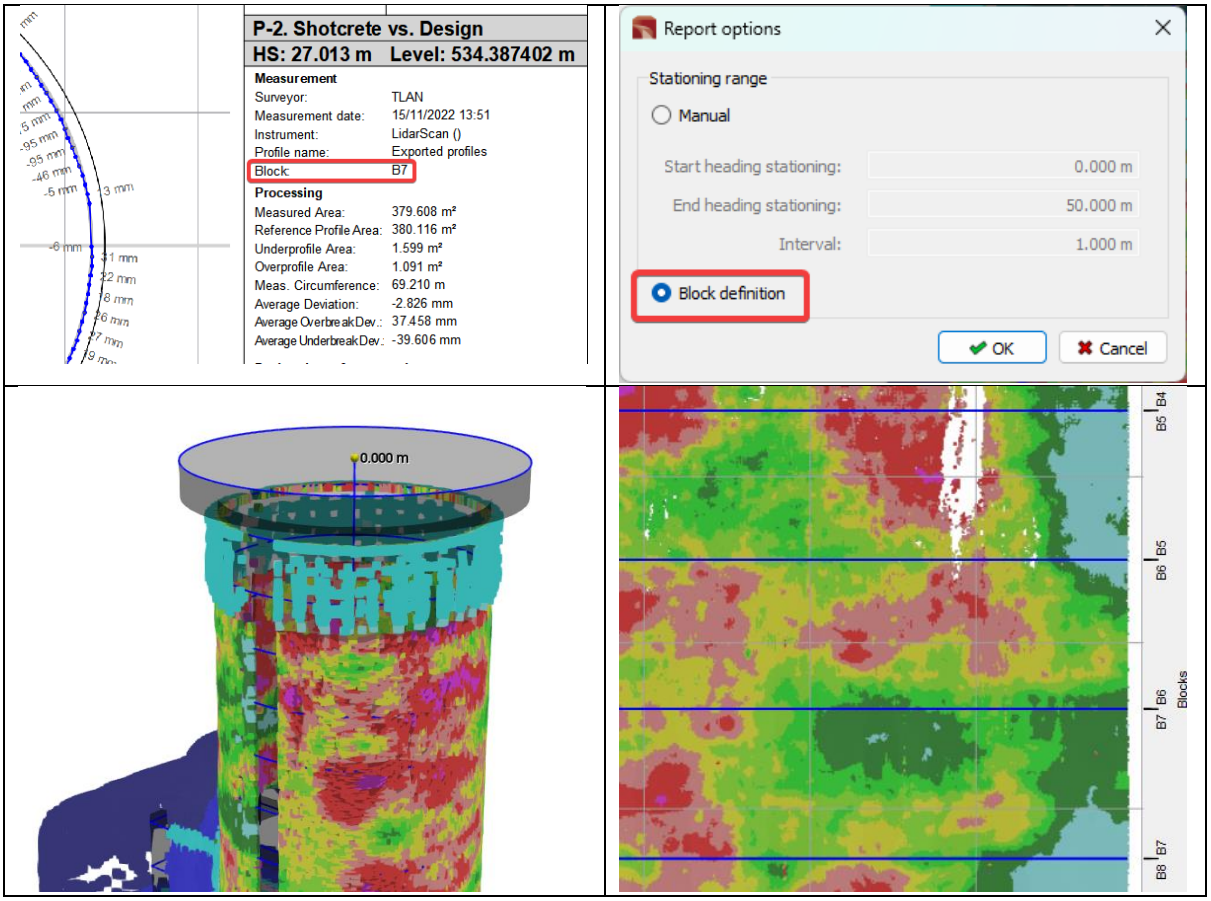
- In the transverse slope editor, **right-click** in the 2D graphic view and press **Import**
- Confirm choices
- Import the LandXML file located in …\2. Design\Rail Tunnel**Rail Tunnel.xml**
- **Save** the editor



	Start heading stationing [m]	End heading stationing [m]	Start transverse slope [%]	End transverse slope [%]	Jump [%]
	-442.029	-166.937	0.000	5.000	0.000
	-166.937	-36.632	5.000	10.000	0.000
	-36.632	38.368	10.000	10.000	0.000
	38.368	139.249	10.000	5.000	0.000
	139.249	139.733	5.000	5.000	0.000
*	139.733	544.959	5.000	0.000	0.000
	544.958	545.474	0.000	0.000	0.000
	545.474	715.635	0.000	-5.000	0.000
	715.635	777.635	-5.000	-5.000	0.000
	777.635	1,108.523	-5.000	0.000	0.000

Block definition

Defining blocks along the alignment is an optional step. An individual block is created by start and end **Heading stationing** or **Tunnelmeter** and a block name.
Blocks can be used for visual and reporting purposes, e.g. for better navigation in the data or it can help with consistent export from point cloud analysis.



- Open the **Block definition** editor (double-click)
- Use the **Add** button in the bottom-right corner to add a block with the following parameters:
    - *End Heading stationing: 10*
    - *Start heading stationing: 0*
- Press the **Add** button again
- A block with the same length is created
- Explore the blocks in the 3D tab view

2. *Step: Design validation*

When the design of an individual layer is finished, you might want to verify it. You can export a triangle mesh or a point cloud from Amberg Tunnel and compare it with the same design in other trusted 3D software.

Export design points

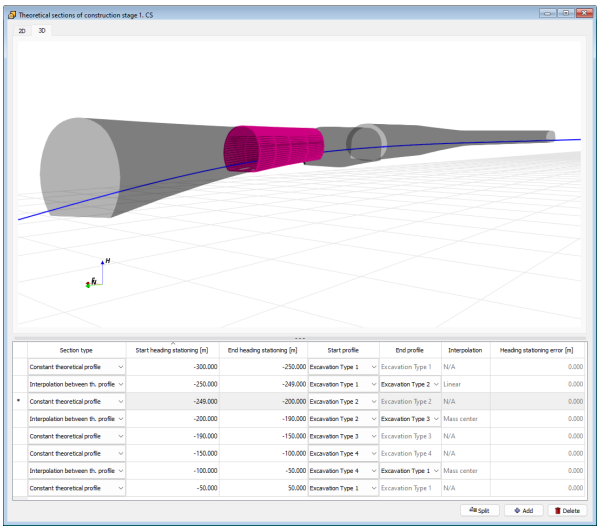
This option will derive an artificial point cloud from the design.

- Open the **Theoretical sections** editor (double-click)
- **Right-click** somewhere in the graphic view and choose **Export design points**
- For exporting just one meter of the tunnel design use these parameters
    - Start HS: -300.00
    - End HS: -299.00
    - Resolution: 0.01
- Press export and save the file
- It will save the file with **Easting[m] Northing[m] Height[m]** coordinates

Export design mesh

In the second option you can export a created 3D design in ***.obj** format

- Open **Theoretical sections** editor (double-click)
- **Right-click** somewhere in the graphic view and choose **Export design mesh**
- Save as ***.OBJ** file
- It will create the **same** amount of files as the number of elements in the **Theoretical section** editor



Shaft definition

A shaft is a vertical structure defined by a straight element with the same easting and northing values at both the start and end points. The design of the shaft is very similar to the tube, with only slight differences:

1. Different axis definition
2. Missing transverse slope editor
3. Limitation of Navigator tasks available for shaft

In the following steps we will focus just on creating the Shaft axis alignment. The rest of the design creation is the same as in previous chapters (manual creation or import)

1. Step: Creation of shaft

Use the already created shaft heading or create a new one with these steps

- In the **Project tree** go to **Construction** → **Site: Site West** → Right-click → Add **Shaft heading** → Set the **name** → press **OK**

2. Step: Axis definition

- In the **Project tree** go to **Construction** → **Site: Site West** → **Shaft heading:Shaft 1** → **Axes** → Right-click → **Add heading axis**
- Set name of the Axis to “Shaft Axis” and press **OK**
- Expand the created **Axis node**
- Double-click on **Alignment** node

The definition of the Shaft axis can only be done manually

Easting	Northing	Start point height	End point height	Start point Heading stationing
677752.300 m	244649.640 m	244649.640 m	500.000 m	0.000 m

3. Step: Design definition

The rest of the workflow for creating the shaft design is the same as for Tube heading. Please see previous chapters.

You can import Theoretical profiles and Theoretical sections from …\2. Design\Shaft**Shaft Design.xml**