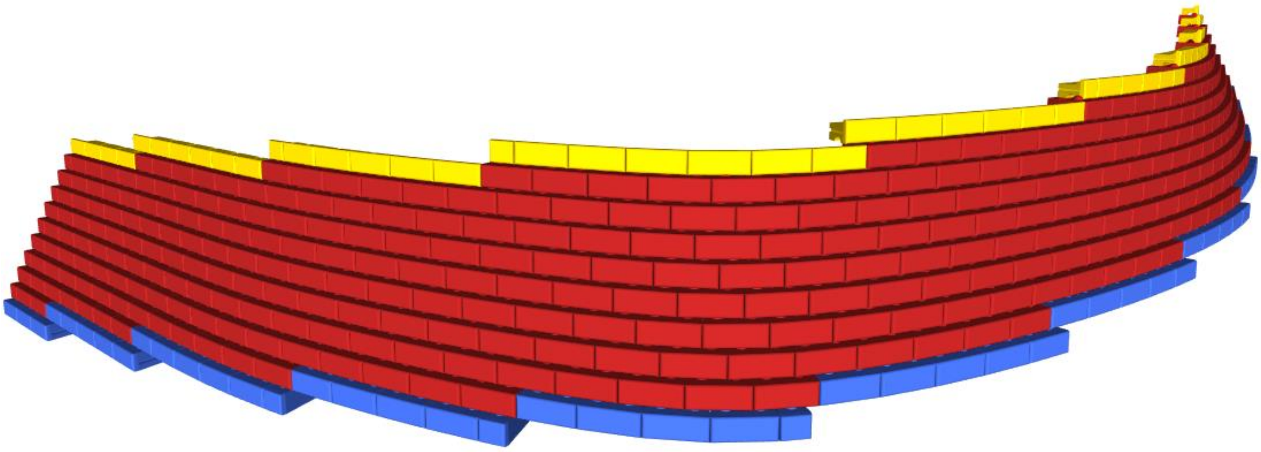
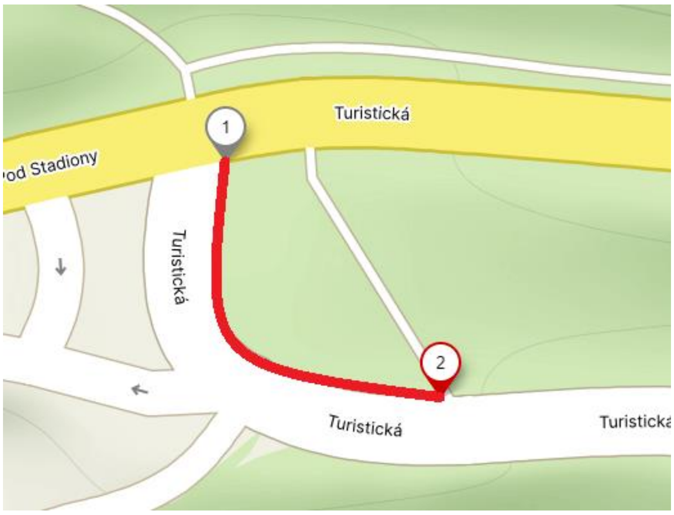
Complex Design of the Entire Wall Made of Prefabricated Blocks

Program: Prefab Wall
File: Demo_manual_39.gpz

The aim of this manual is to show the complete design of an entire wall made of prefabricated blocks. The final wall will look as follows.



The wall is proposed along the part of the street "Turistická" between points 1 and 2. The contour of the wall is approximately marked on the map below with a red line.



The coordinates of points 1 and 2 in the S-JTSK coordinate system are as follows:

- Point 1: x = -745546,50 [m] y = -1043687,03 [m]
- Point 2: x = -745519,55 [m] y = -1043726,24 [m]

Note: The coordinates of the points can be normally obtained from the geodetic engineer, for preliminary design the coordinates can be obtained from most map applications (Google Maps, Mapy.cz). However, these applications provide points mostly in GPS, for conversion to X,Y coordinates you can use e.g. Stratigraphy program, which allows this conversion.

The terrain at the base of the wall in the lower part is 300 m above sea level, and the terrain in the upper part is 305 m above sea level. The wall retains 4 m of soil at the bottom and 3 m at the top. The wall will be placed 0.5 m in the soil.

Behind the wall, there is a sandy silt. For drainage reasons, a gravel-sand backfill will be made behind the wall at an angle of 45°.

The parameters of both soils are as follows:

Sandy silt

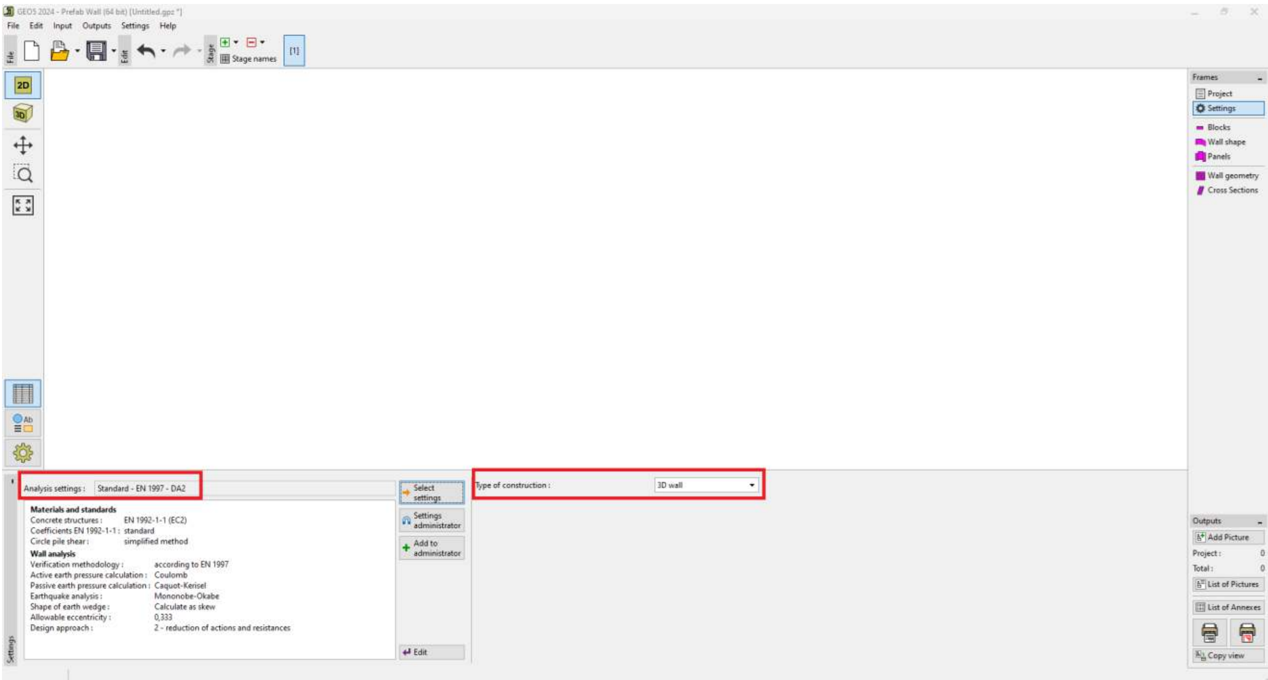
Unit weight :	γ =	18,00 kN/m³
Stress-state :	effective	
Angle of internal friction :	φ_{ef} =	28,00 °
Cohesion of soil :	c_{ef} =	15,00 kPa
Angle of friction struc.-soil :	δ =	15,00 °
Soil :	cohesionless	
Saturated unit weight :	γ_{sat} =	18,00 kN/m³

Backfill

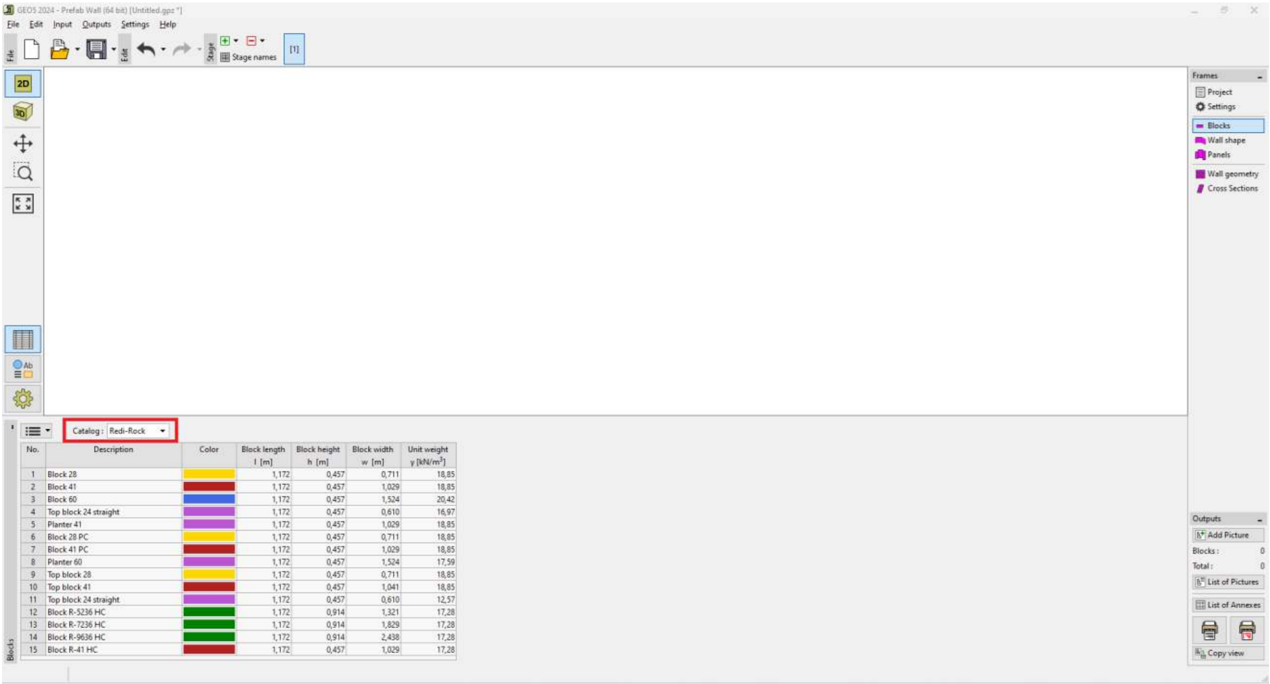
Unit weight :	γ =	20,00 kN/m³
Stress-state :	effective	
Angle of internal friction :	φ_{ef} =	35,00 °
Cohesion of soil :	c_{ef} =	0,00 kPa
Angle of friction struc.-soil :	δ =	20,00 °
Soil :	cohesionless	
Saturated unit weight :	γ_{sat} =	21,00 kN/m³

The wall must meet all the verifications we will perform according to EN1997, Design Approach 2.

Launch the "GEO5 Prefab Wall" program and in the "Settings" frame, select the Analysis settings as “Standard - EN1997 - DA2” and the Type of construction as "3D wall".

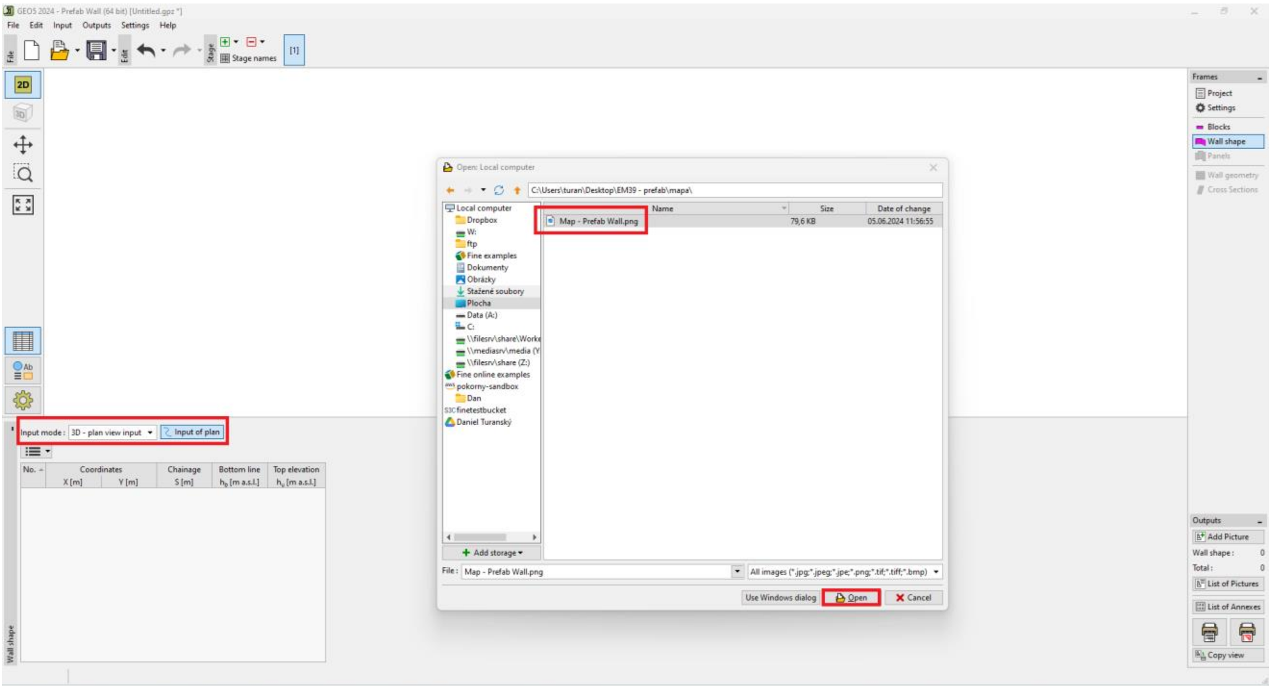


In the "Blocks" frame, select the type of blocks you want to build the wall from. We can either define the blocks manually (specify their dimensions and parameters) or use the built-in catalogs of manufacturers. In our case, we will choose the catalog from the American company Redi-Rock.

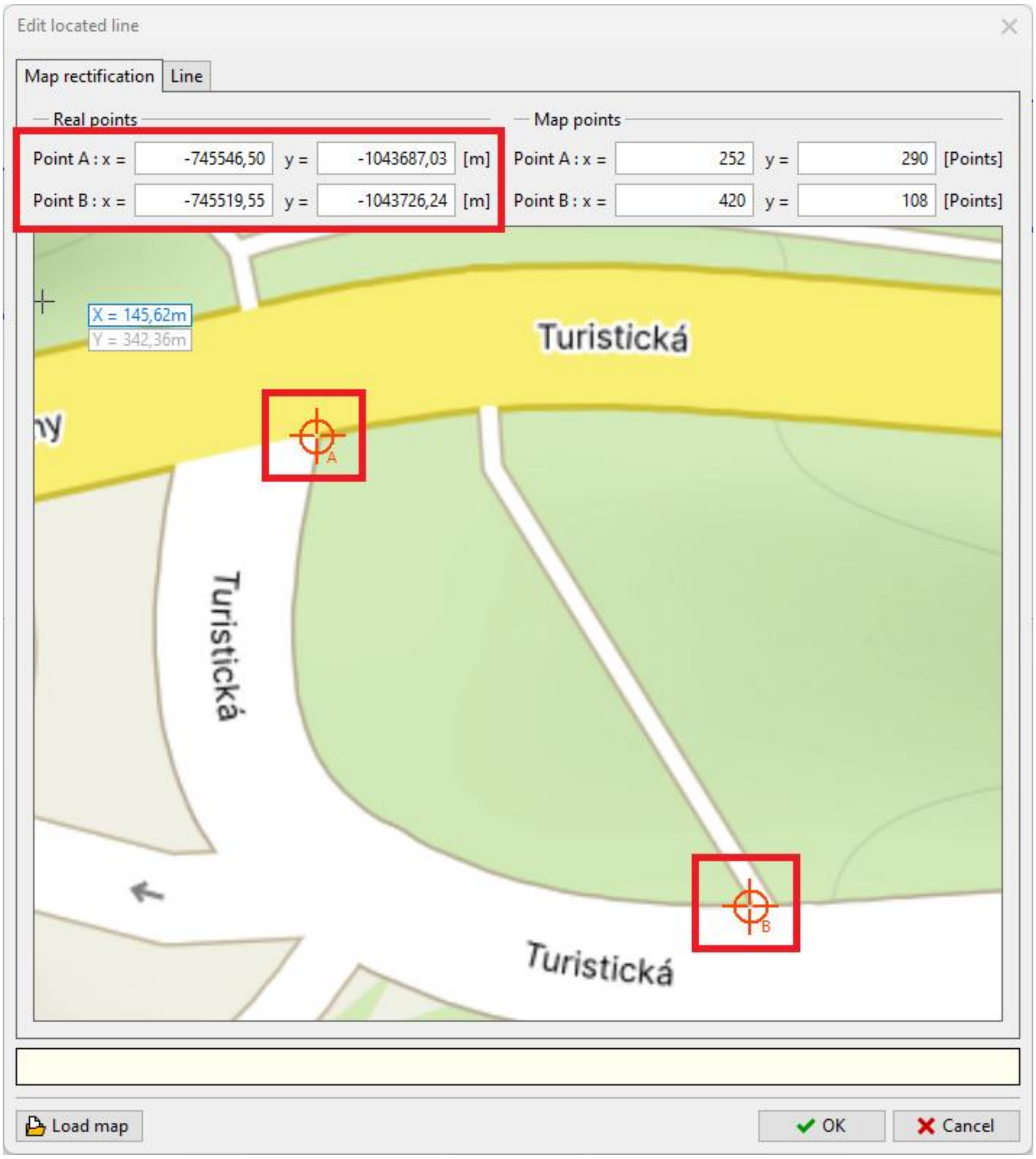


In the "Wall shape" frame, enter the floor plan and heights of the wall. For simpler types of input, the 2D input method can be used. In this mode, we define only the height of the wall, and the plan layout of the wall parts is defined in the "Panels" frame. For more complex assignments, 3D input including [loading of the wall plan]() is more suitable. We choose this method.

We start by loading a map of the area - it can be downloaded [here]().

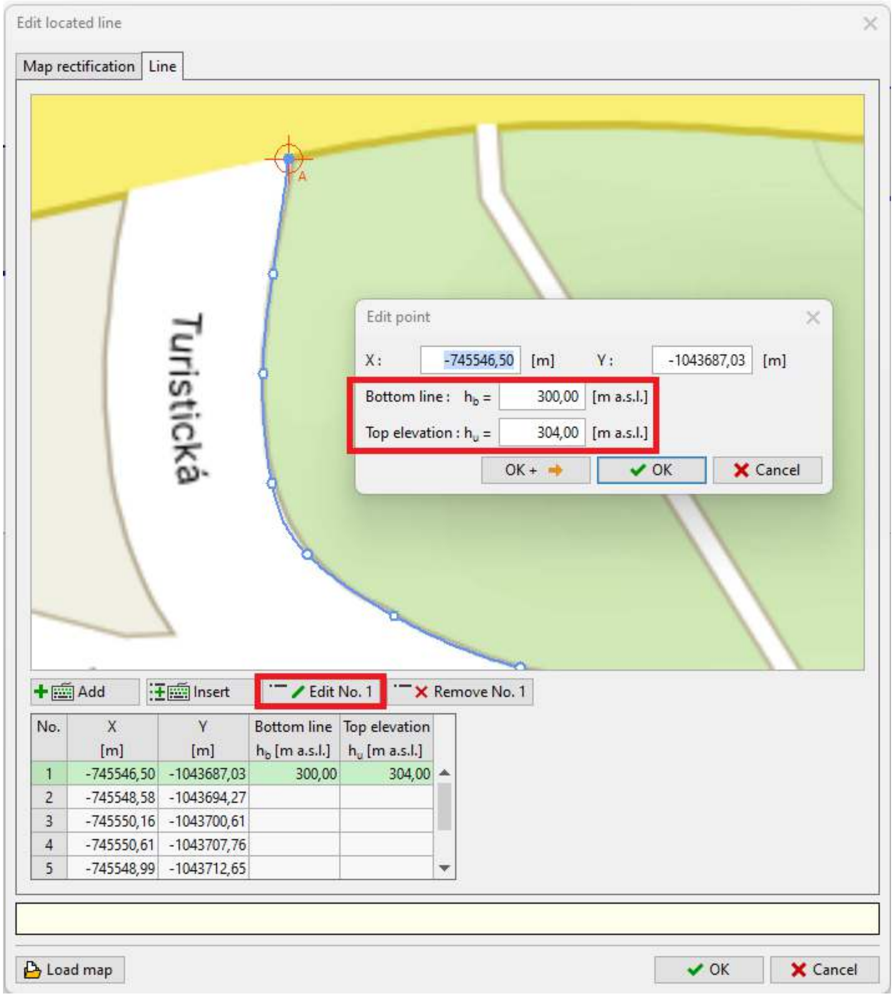


Then, in the "Map Rectification" tab, place map points A and B by dragging the mouse and insert the real coordinates of points 1 and 2 (see above in the assignment). Map point A corresponds to point 1 (start of the wall), and point B corresponds to point 2 (end of the wall).

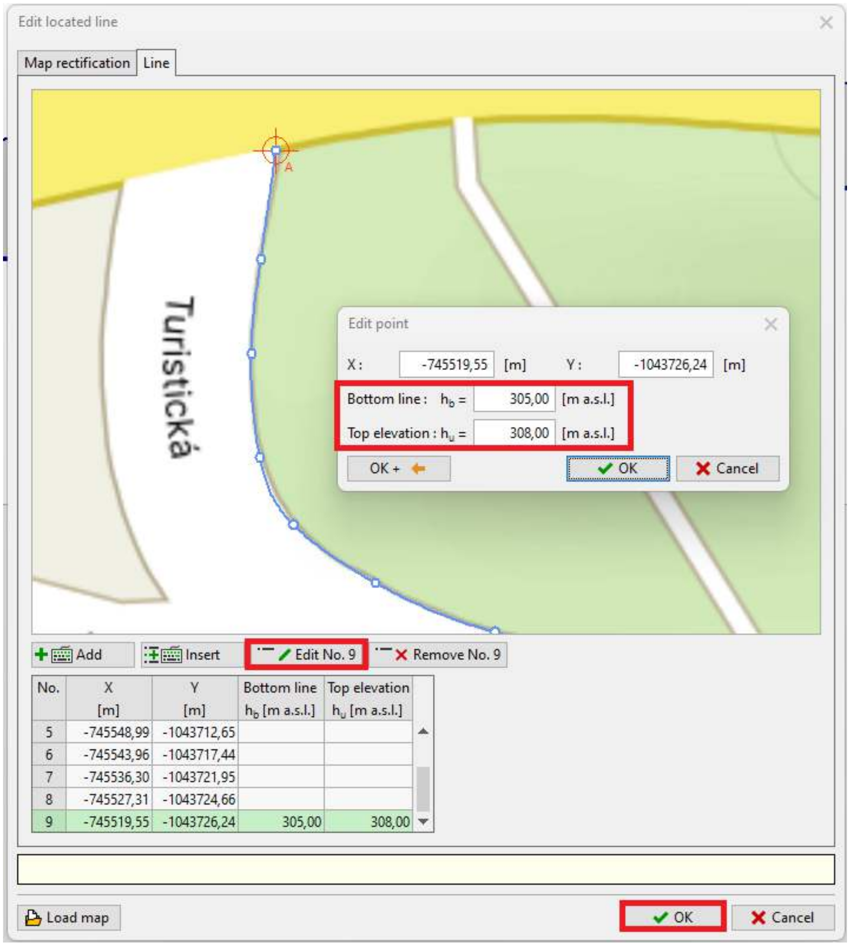


In the next step, switch to the "Enter line" tab and insert the wall points with the mouse. Start at point A and end at point B. The program will automatically insert a spline-type curve through the wall line. We have inserted 7 intermediate points to follow the street line as closely as possible. A sample of the point input is also included in the tutorial video for this program.

The point coordinates are displayed in the table at the bottom of the window. It is also possible to define the height coordinates of the bottom and top of the wall for each point. We define heights only for the start and end points – this is sufficient for designing the wall shape.

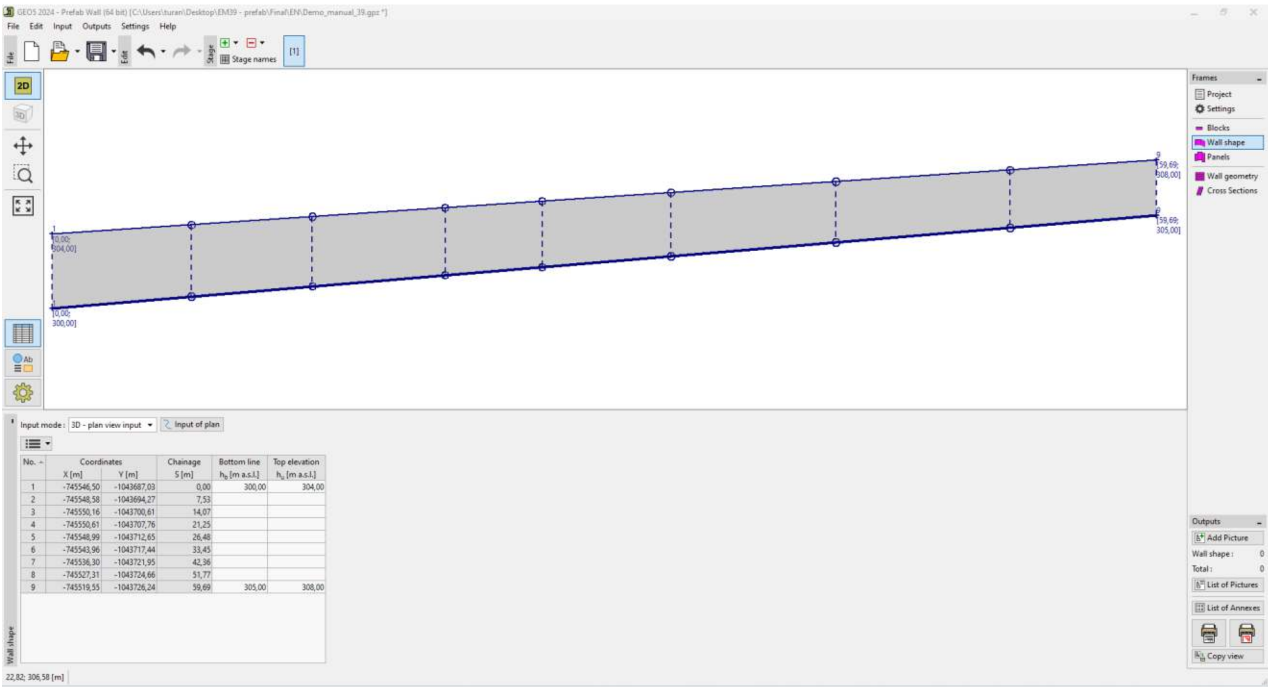


Defining heights at the beginning of the wall

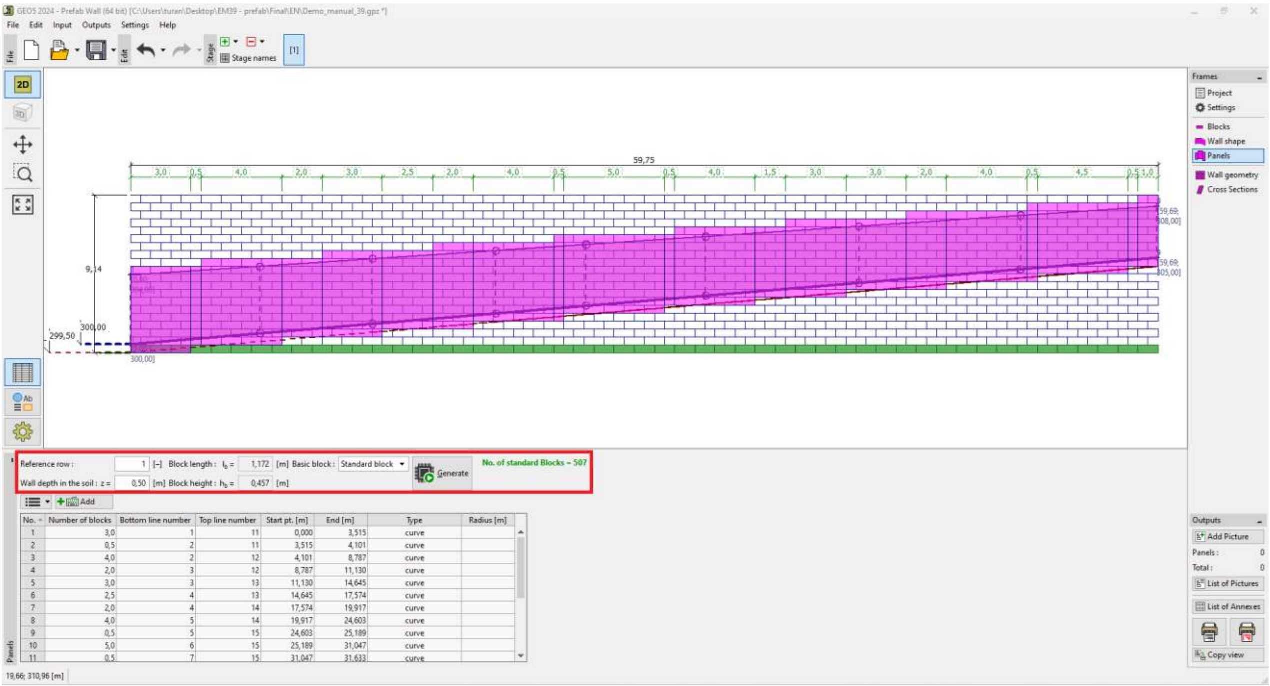


Defining heights at the end of the wall

Confirm the 3D input with the "OK" button after defining the heights and the wall shape expanded into 2D will be drawn on the desktop.

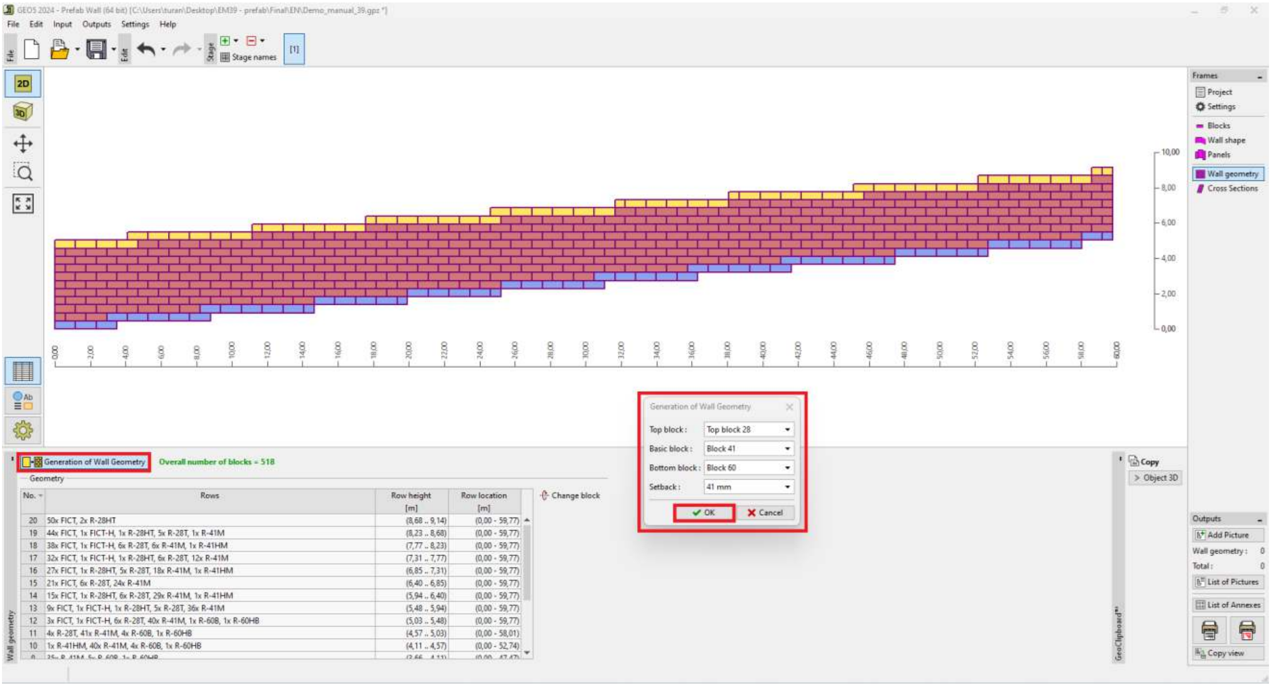


Now we switch to the "Panels" frame, where we select the basic block that will be used to fill the panels. The Redi-Rock system offers two block sizes - standard and XL. We will choose the standard.
Next, we specify the depth of the wall in the soil as 0.5 m (see the input above) and generate the panels using the "Generate" button.

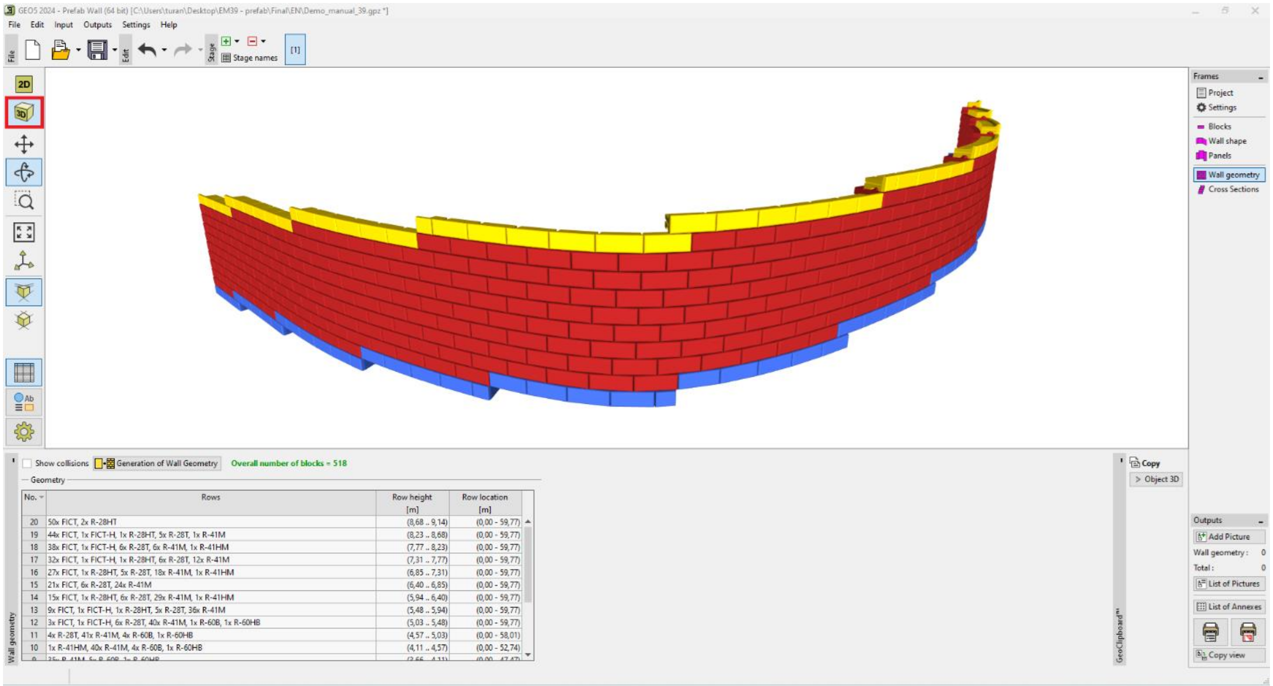


In the case of walls with row setbacks, the so-called "Reference row" is an important input. This determines which row of blocks follows the exact floor plan of the wall. The other rows are shifted to the reference plan by the specified offsets. We chose the first row of blocks, it is underlined in green in the picture.

Switch to the "Wall geometry" frame and press the "Generation of Wall Geometry" button. Select the required type for the top, base, and bottom block, and the setbacks between the rows, and use the "OK" button to generate the wall.



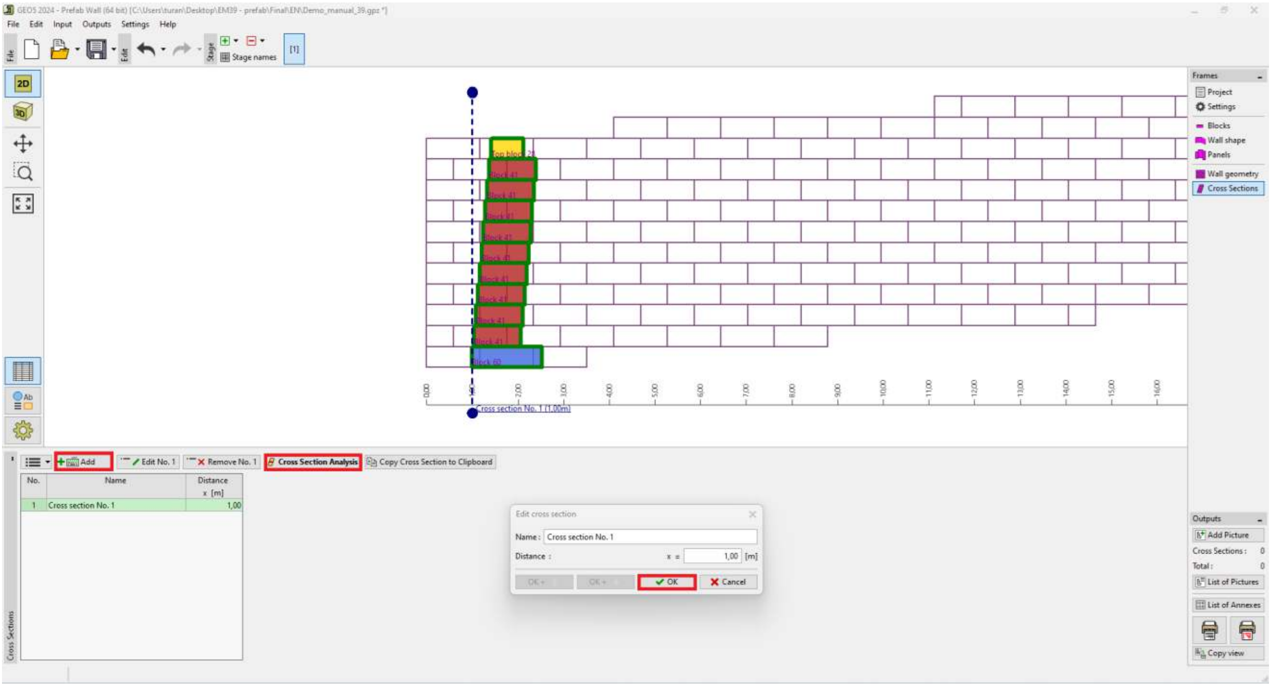
Now we can also look at the wall in 3D – it switches on the left bar:



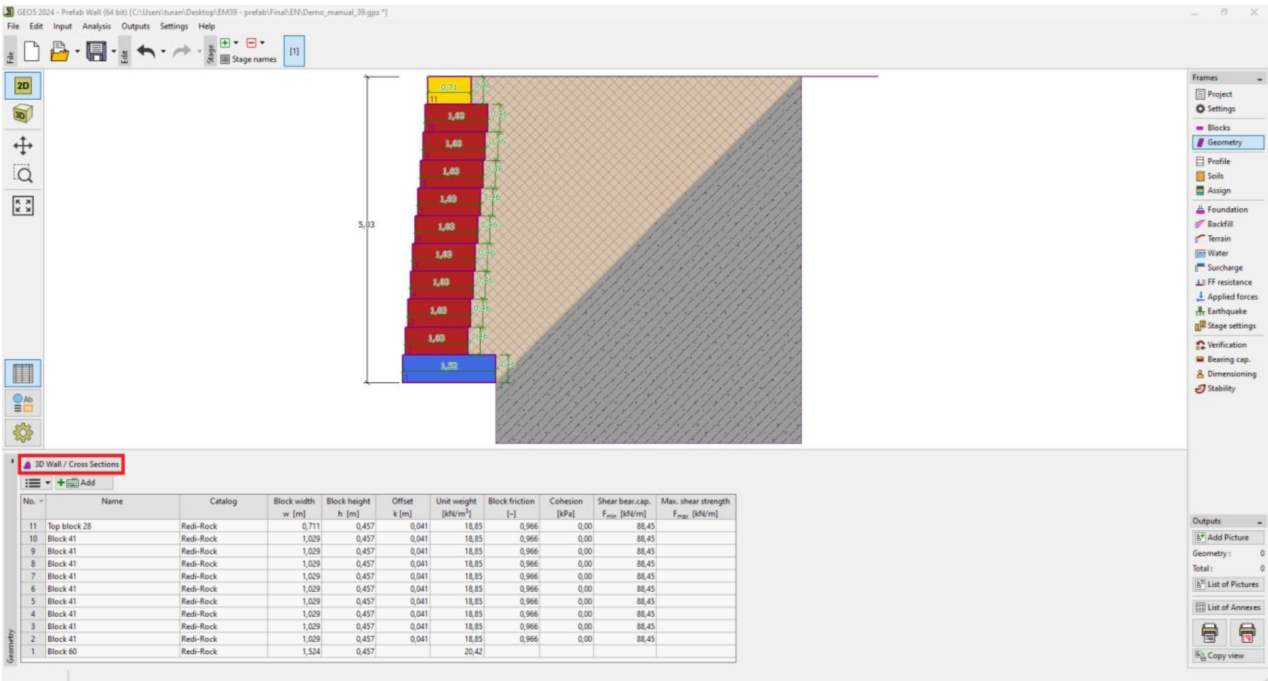
The wall was preliminarily designed with 41-type blocks, the top block is made of Top block 28-type and the base block was chosen as 60-type. The rows were set with a spacing of 41 mm. All the rows are described in detail in the table, and the meaning of the abbreviations is explained in the program help.

We will now proceed to the verification to check whether our design is OK.

We start in the "Cross Sections" frame, where we define the cross-section we want to check. We specify the sections using the chainage, in this case, we are interested in the section at the beginning of the wall, where the wall is highest. So we add a section at the distance of 1 m, which is drawn on the desktop.



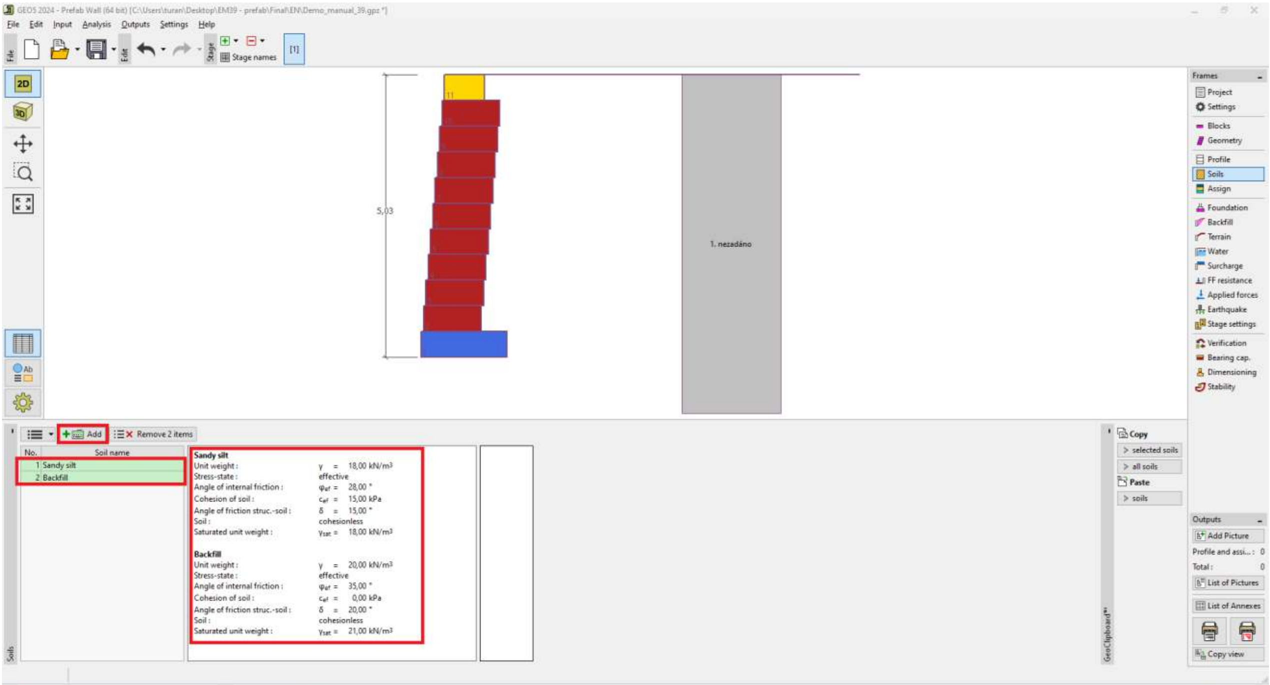
After selecting a cross-section in the table and pressing the "Cross Section Analysis" button, the program switches to the standard 2D mode where the wall can be checked.



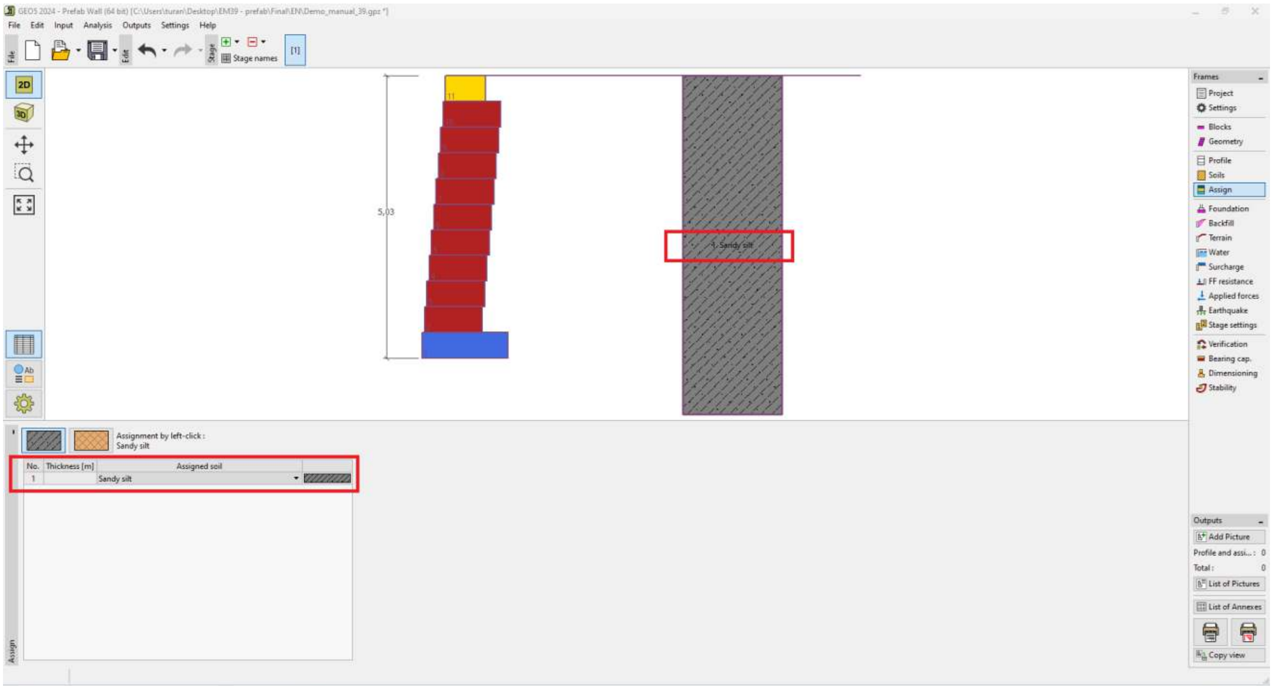
No.	Name	Catalog	Block width w [m]	Block height h [m]	Offset k [m]	Unit weight [kN/m³]	Block friction [–]	Cohesion [kPa]	Shear bear.cap. F_{min} [kN/m]	Max. shear strength F_{max} [kN/m]
11	Top block 28	Redi-Rock	0,711	0,457	0,041	18,85	0,966	0,00	88,45	
10	Block 41	Redi-Rock	1,029	0,457	0,041	18,85	0,966	0,00	88,45	
9	Block 41	Redi-Rock	1,029	0,457	0,041	18,85	0,966	0,00	88,45	
8	Block 41	Redi-Rock	1,029	0,457	0,041	18,85	0,966	0,00	88,45	
7	Block 41	Redi-Rock	1,029	0,457	0,041	18,85	0,966	0,00	88,45	
6	Block 41	Redi-Rock	1,029	0,457	0,041	18,85	0,966	0,00	88,45	
5	Block 41	Redi-Rock	1,029	0,457	0,041	18,85	0,966	0,00	88,45	
4	Block 41	Redi-Rock	1,029	0,457	0,041	18,85	0,966	0,00	88,45	
3	Block 41	Redi-Rock	1,029	0,457	0,041	18,85	0,966	0,00	88,45	
2	Block 41	Redi-Rock	1,029	0,457	0,041	18,85	0,966	0,00	88,45	
1	Block 60	Redi-Rock	1,524	0,457		20,42				

Note: If we want to go back to 3D mode, we can use the "3D Wall / Cross Sections" button.

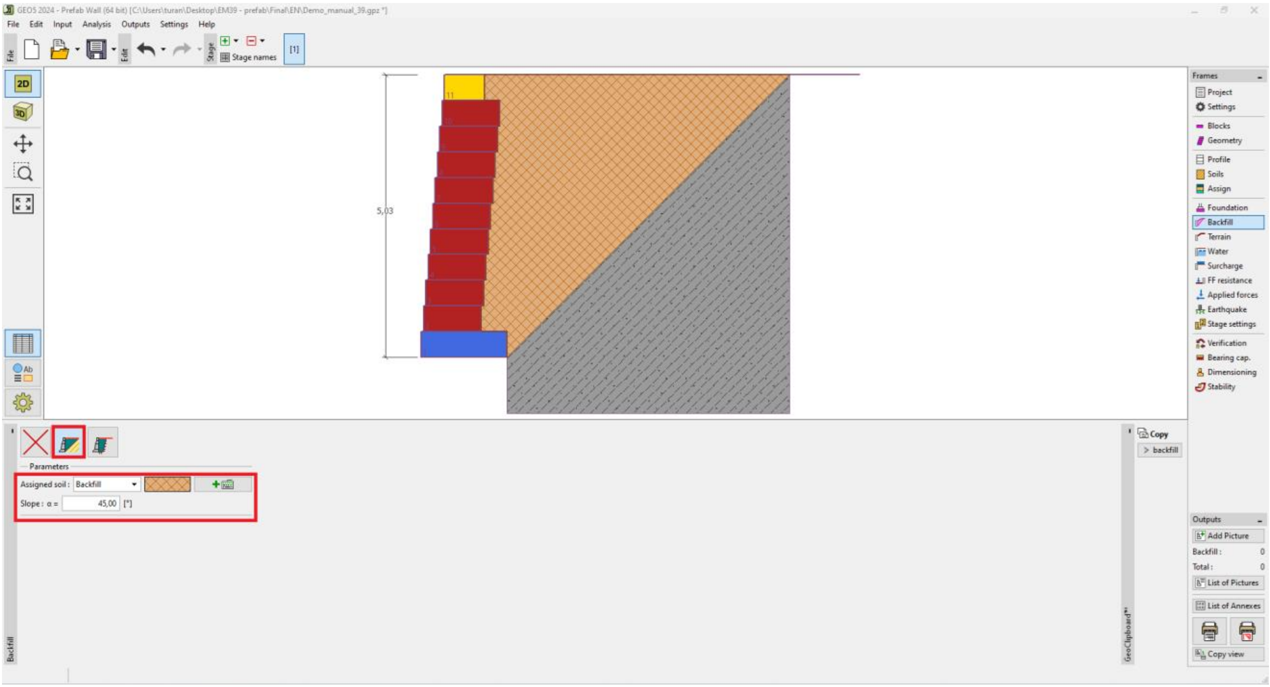
In the "Soils" frame, enter the soil F3, which is behind the wall, as well as the backfill material (see the parameters in the assignment).



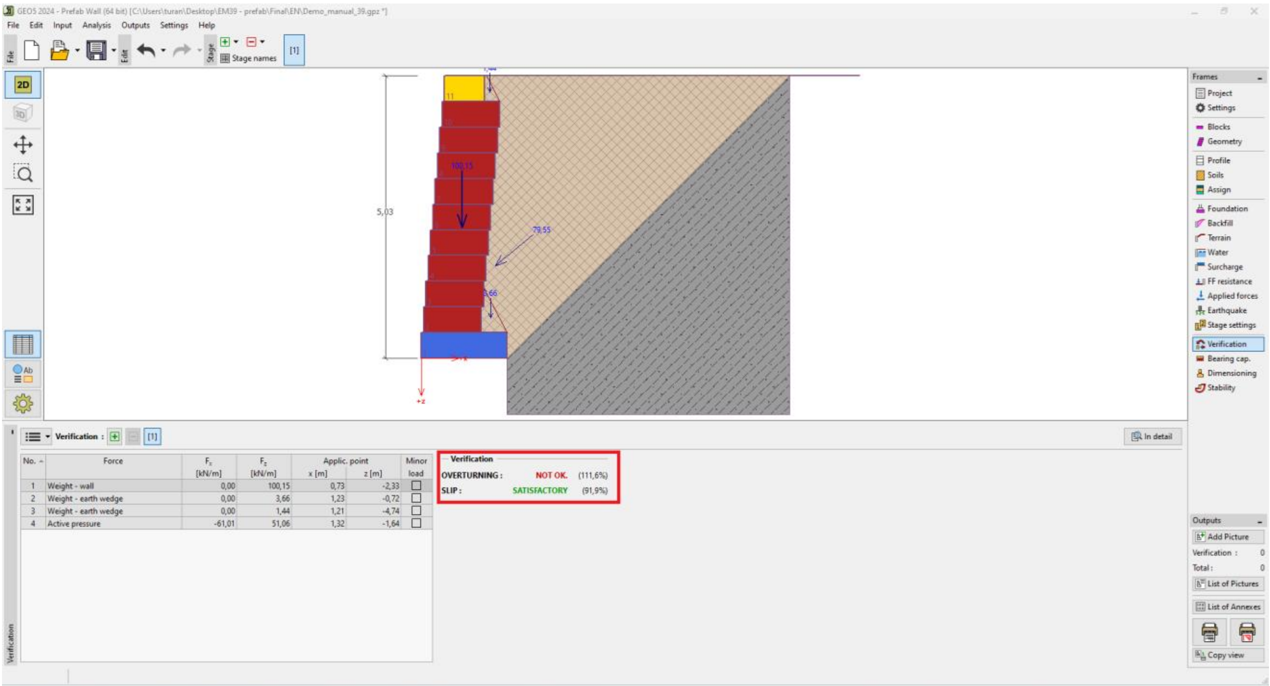
Assign the soil behind the wall to the geological profile in the "Assign" frame.



And input the backfill in the "Backfill" frame at an angle of 45°.



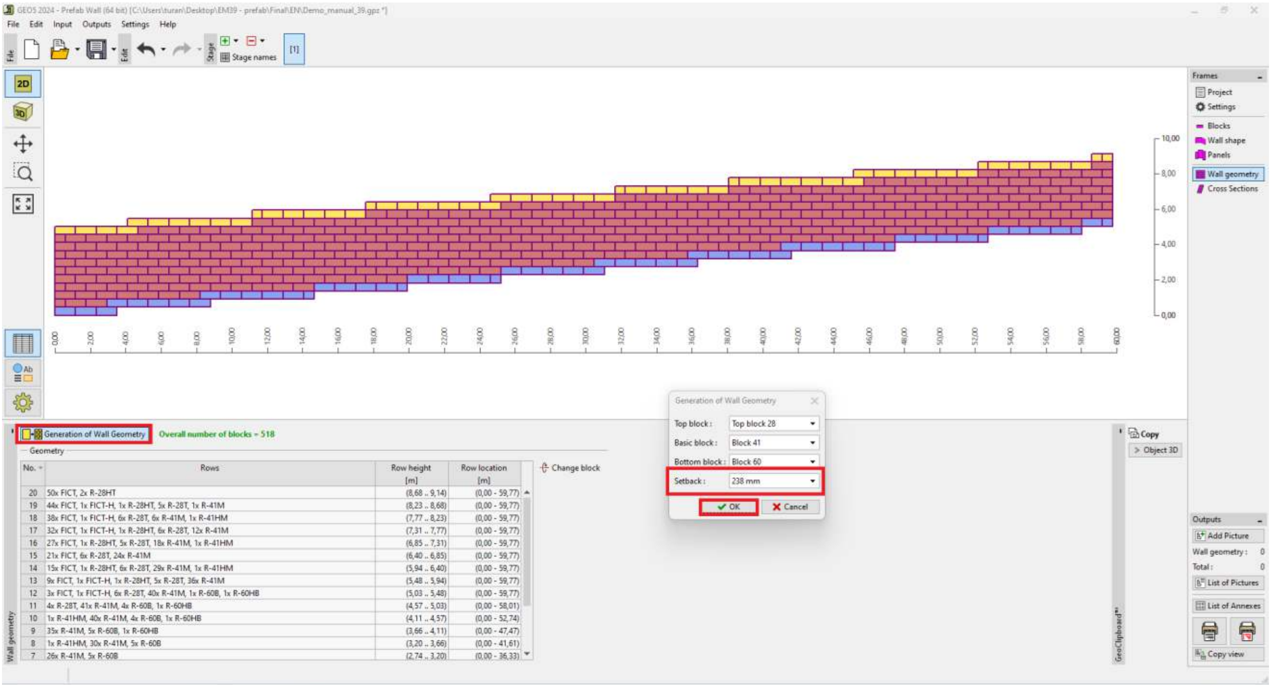
Now let's move on to the wall calculation itself - starting in the "Verification" frame.



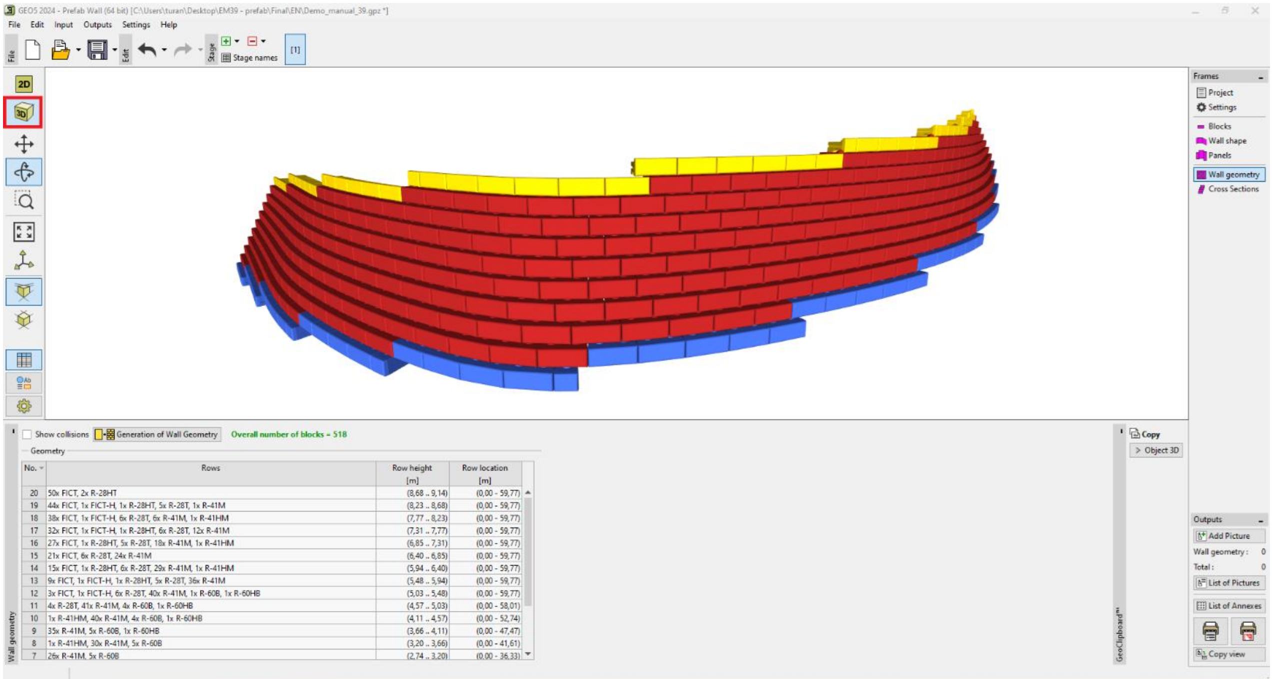
We can see that on the first verification (overturning) the wall is not satisfactory - the utilization is over 111 %.

Now, of course, we have several options that we could use to improve the design – change the type of blocks, reinforce the space behind the wall with geogrids, etc. As the simplest option, we will try to change only the setback between the blocks – everything else will remain the same, but more shifted rows will have a more favorable effect on the stabilizing moment due to the shift of the center of gravity of the wall.

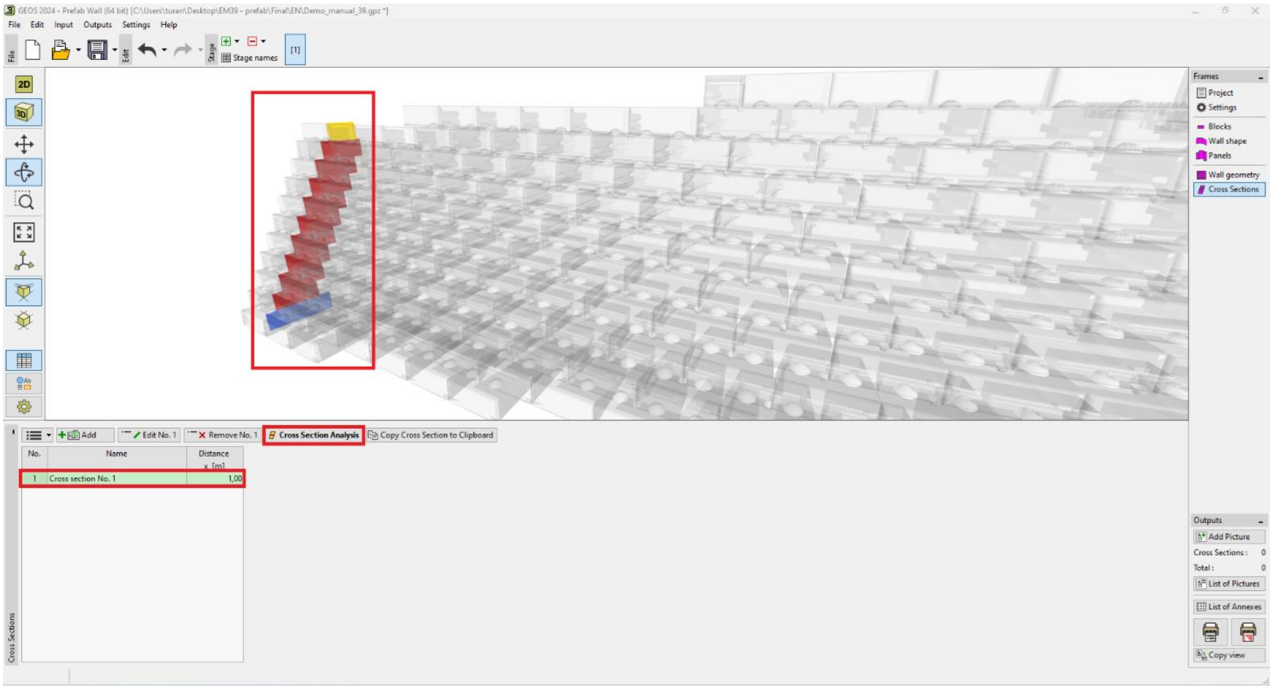
So we return to the 3D design - by switching in the "Geometry" or "Settings" frame.
In 3D mode, we return to the "Wall geometry" frame, where we press the "Generation of Wall Geometry" button and change the row setback to 238 mm. Confirm with the "OK" button and the wall will be re-generated.



In the 2D view, the wall still looks the same, in the 3D view the larger setbacks are obvious.

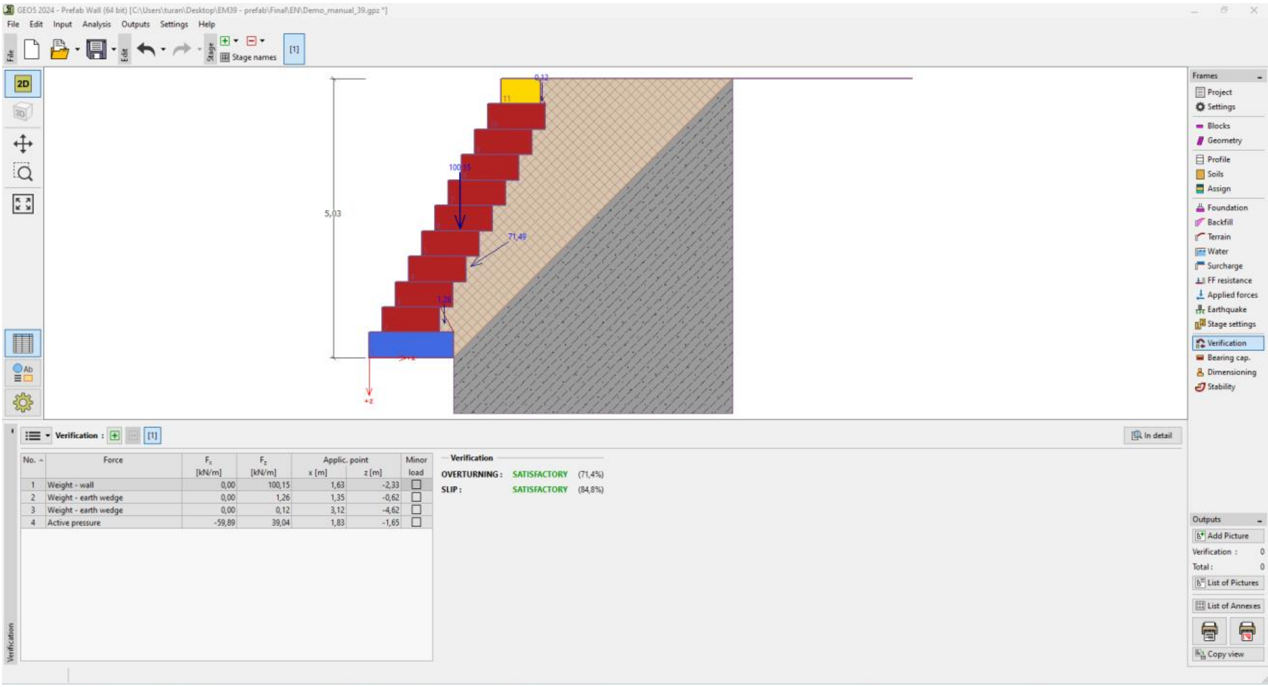


Then go to the “Cross Sections” frame again and run the calculation for the earlier defined section.



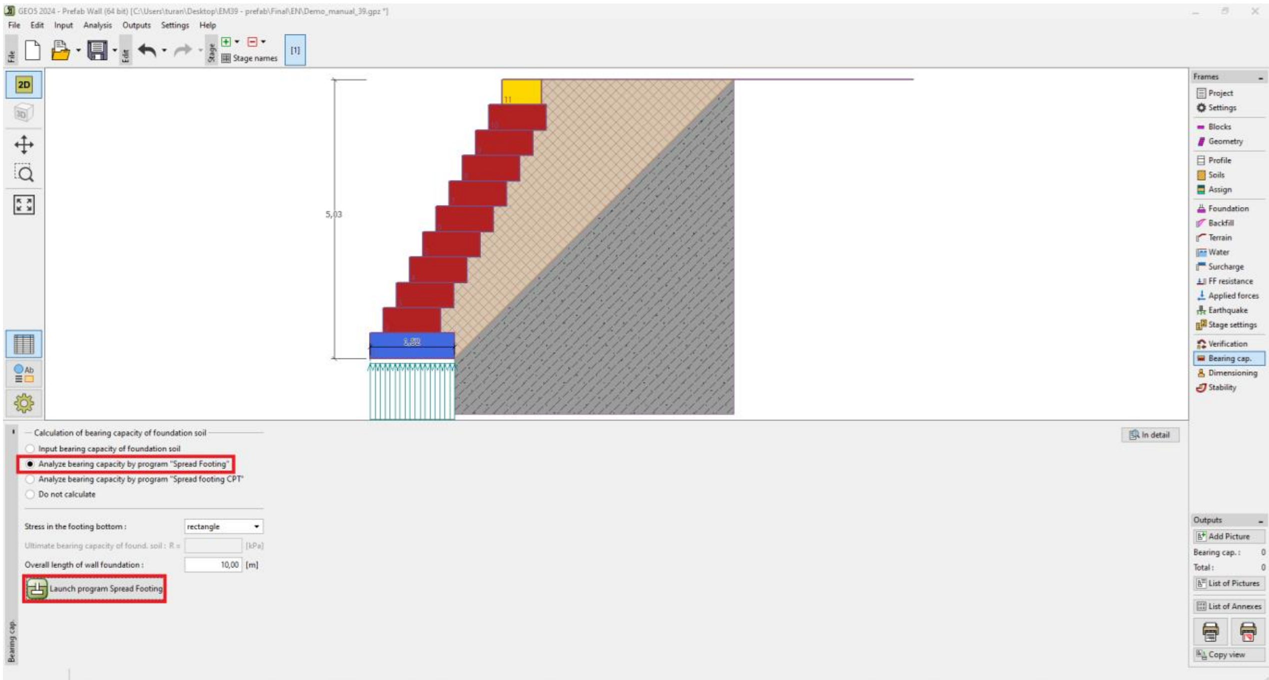
In 2D mode, we go through all available checks.

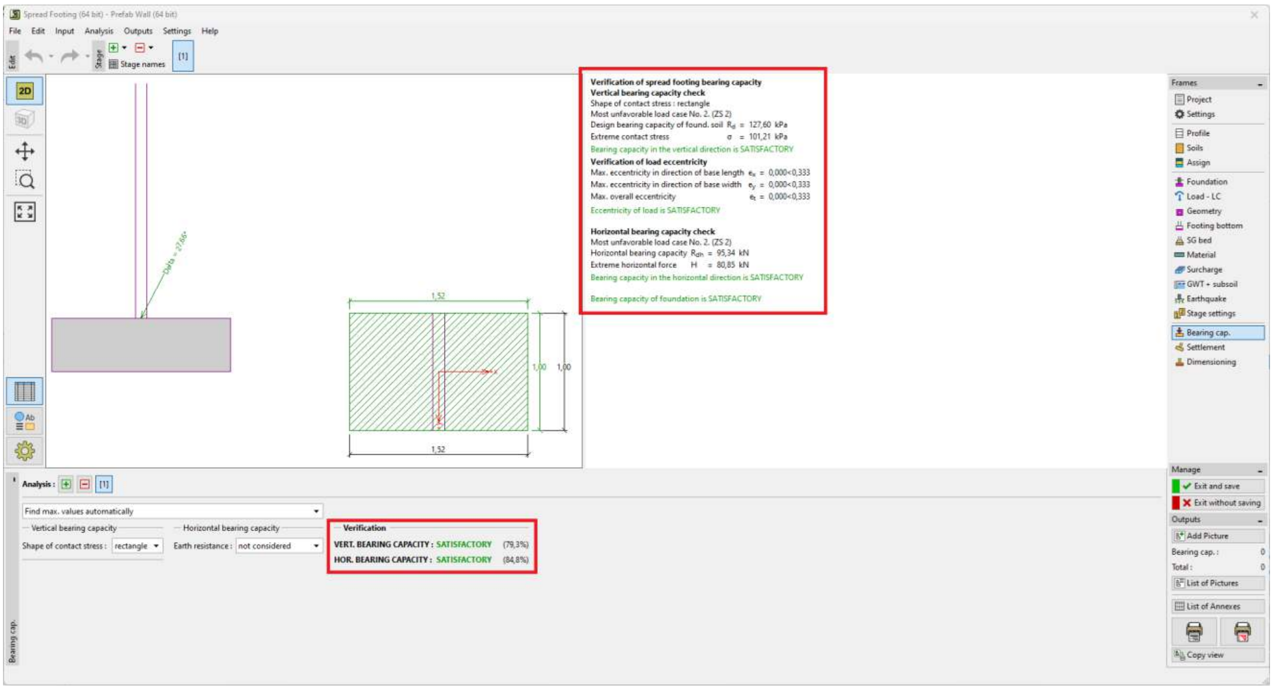
We start in the "Verification" frame, where we check the overturning and slip.



In the "Bearing capacity" frame, we verify that the stress under the wall does not exceed the bearing capacity of the foundation soil.

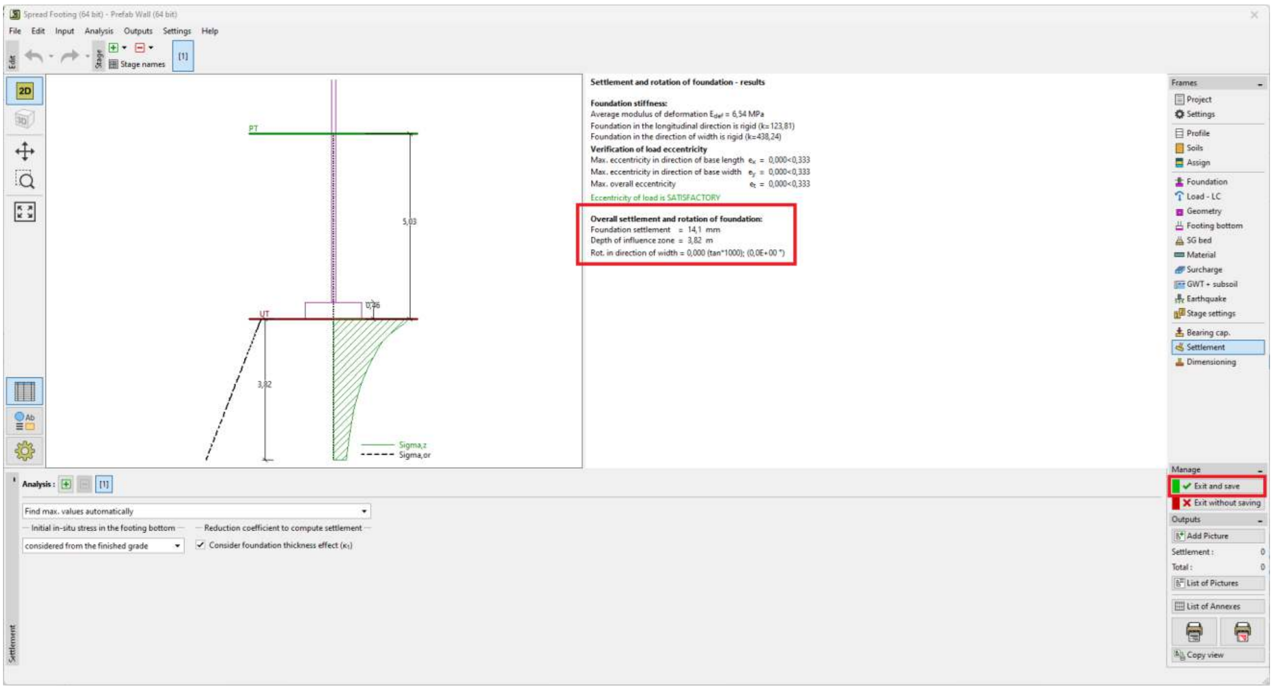
To calculate the bearing capacity of the foundation soil, we use the "Spread Footing" program, where all data is automatically transferred after pressing the " Launch program Spread Footing" button.





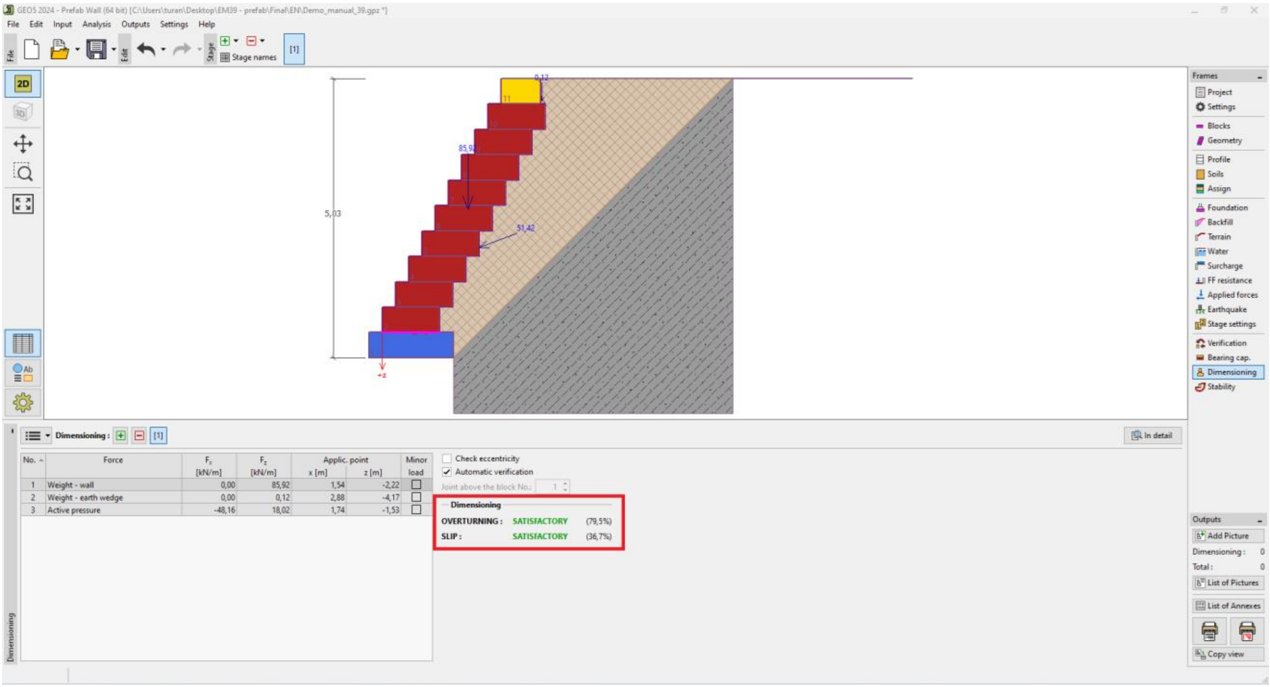
Calculation of foundation soil bearing capacity in the "Spread Footing" program

In this program, we can also get the settlement and rotation of the wall foundation.

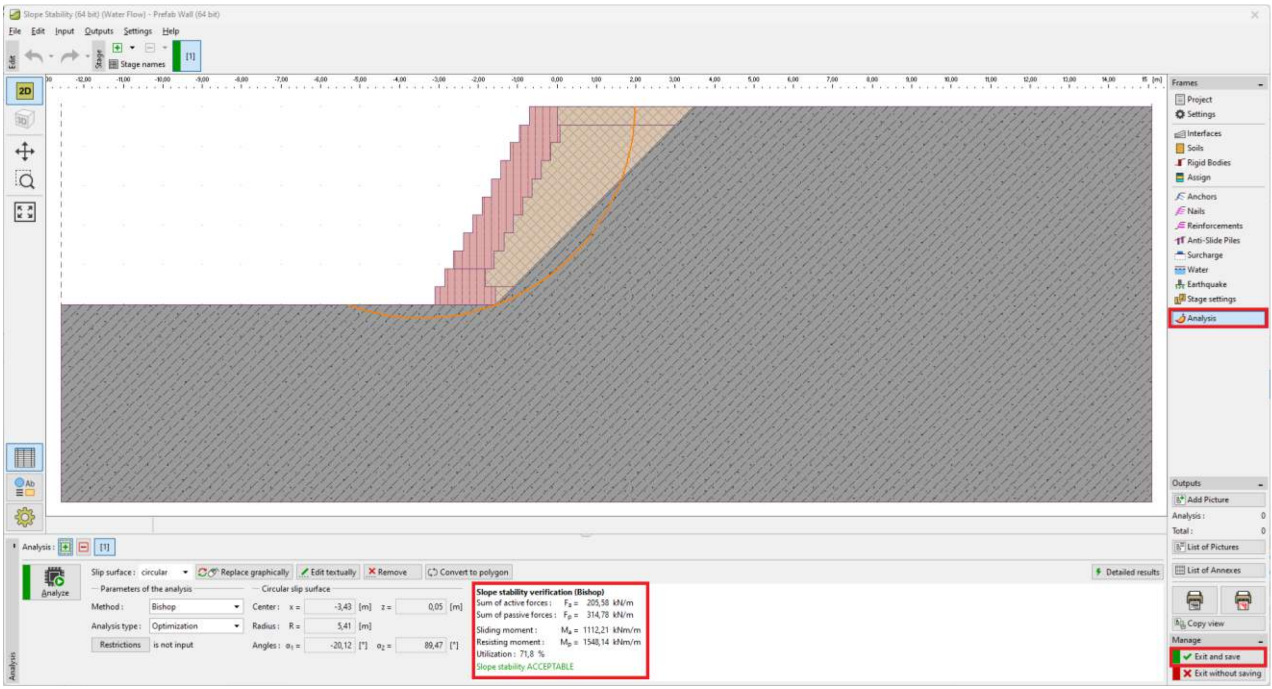


By clicking the "Exit and save" button, we return to the "Prefab Wall" program. All information from this program will be part of the output document of the entire wall.

In the "Dimensioning" frame, check the joints between the individual blocks.



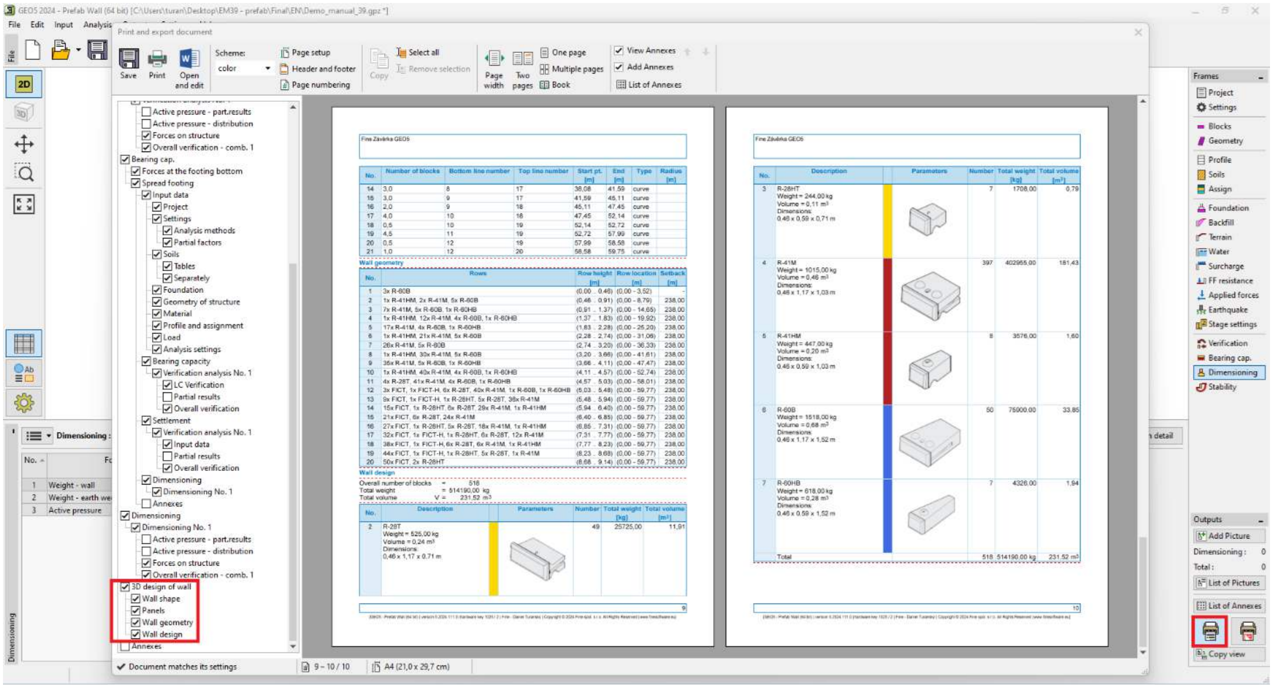
Finally, the overall stability calculation is performed in the "Slope Stability" program – this program is launched automatically when you click on the "Stability" frame.



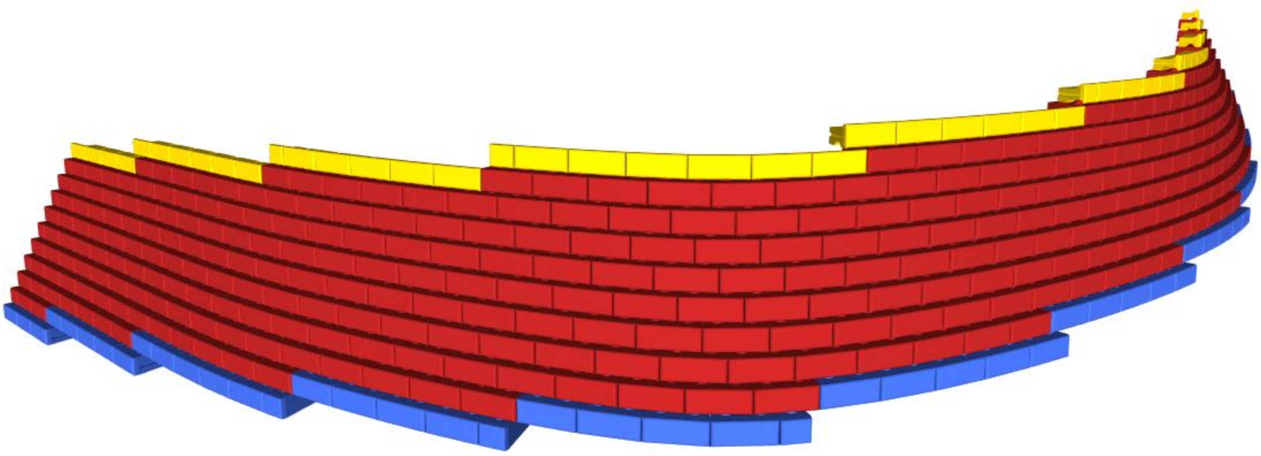
Again, we will save all the results to be part of the documentation of the original task.

The wall has met all verifications.

At the end we print detailed documentation - it includes a clear list of all the blocks used, their weights, and volumes - this is especially important when preparing a quotation, organizing the transport of materials, etc.



With this we have completed the design, the wall with a length of about 60 m will consist of 518 blocks of the Redi-Rock system with a total weight of about 514 tons.



Final view on the wall

Note: An example with this task (demo_manual_39.gpz) can be found in [Online examples](#).