3D Modeling of Walls in the Redi-Rock Program

Program: Redi-Rock Wall

File: Demo_manual_39.grr

Objective:

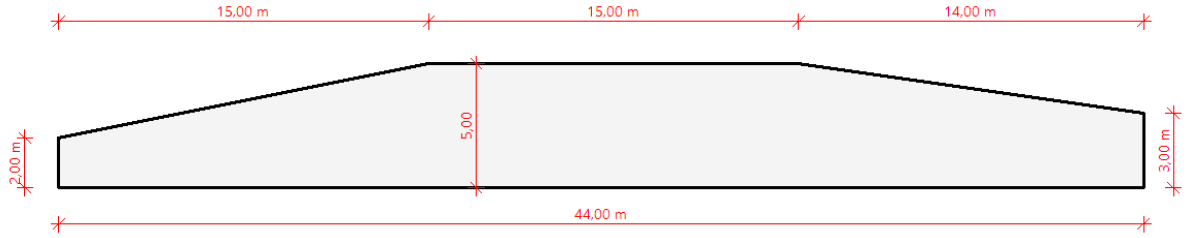
Design a retaining wall using Redi-Rock blocks. Then verify the stability of the wall at the highest point.

The base of the wall is horizontal at an elevation of 320 meters.

The coordinates of the proposed ground level behind the wall are shown in the table below:

Terrain point	Coordinates [m]	
	X	Z
1	0.00	322.00
2	15.00	325.00
3	30.00	325.00
4	44.00	323.00

Due to the shape of the terrain, the wall will have approximately these dimensions:



Assume a standard 41 mm block setback.

Create two wall alternatives:

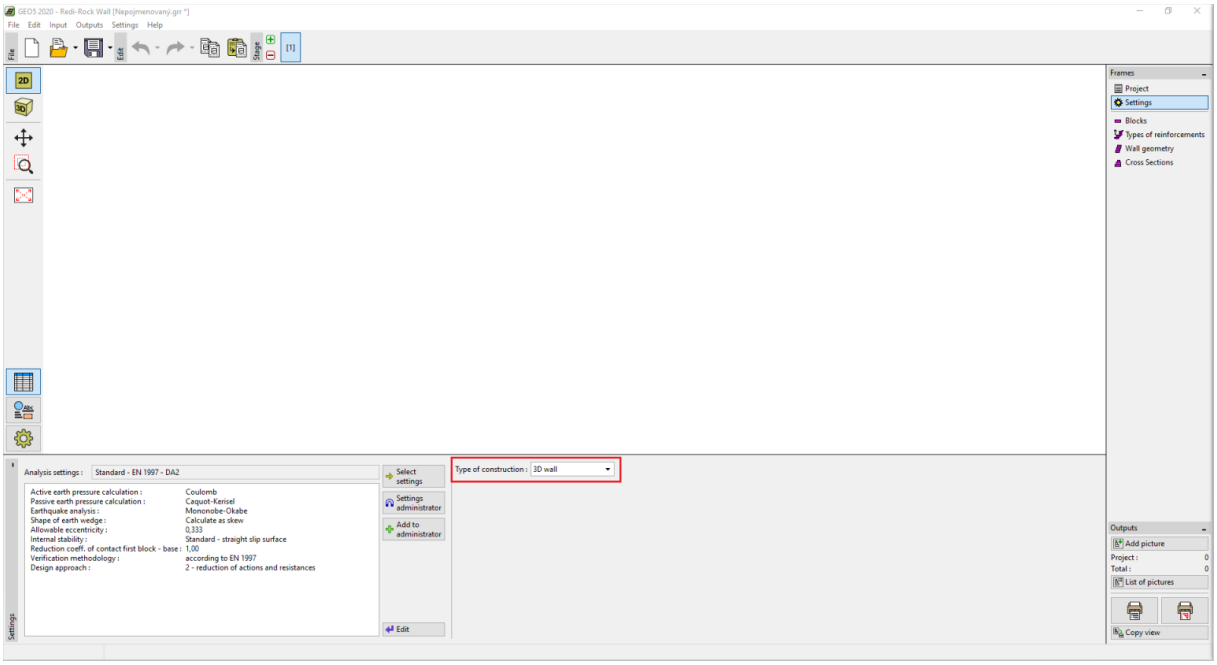
- gravity wall
- MSE wall

Compare the process of laying out both walls.

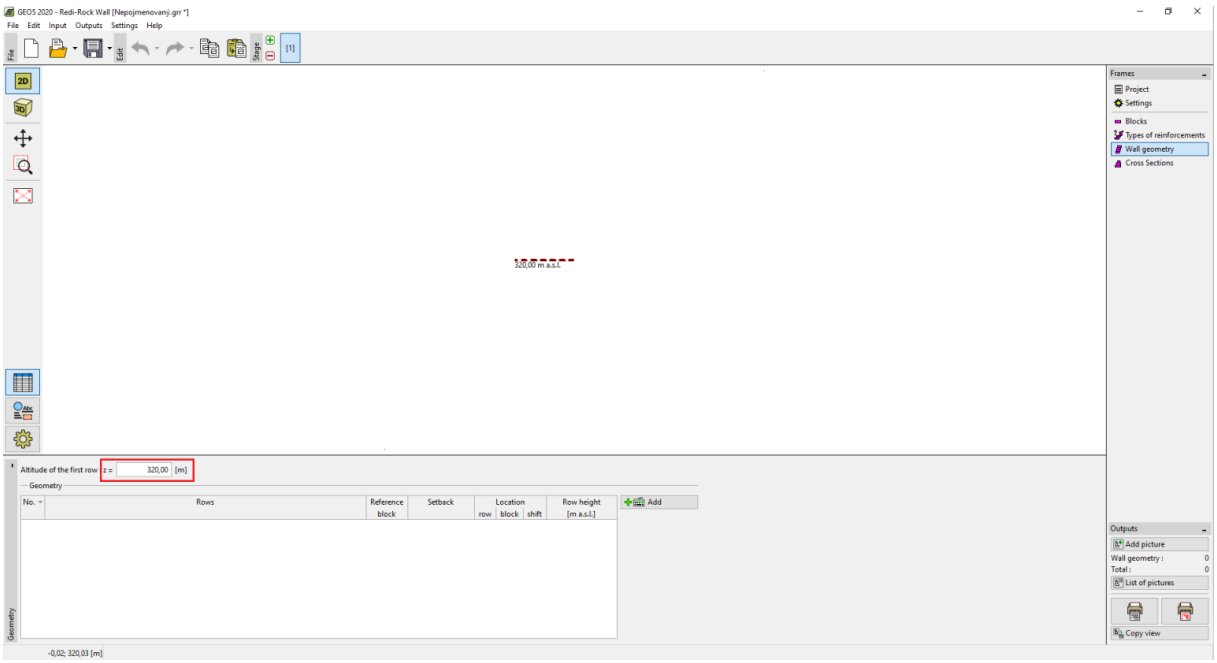
Bonus task: Design the same wall with a curve.

Solution:

In the “Settings” frame, choose the type of construction as “3D wall”

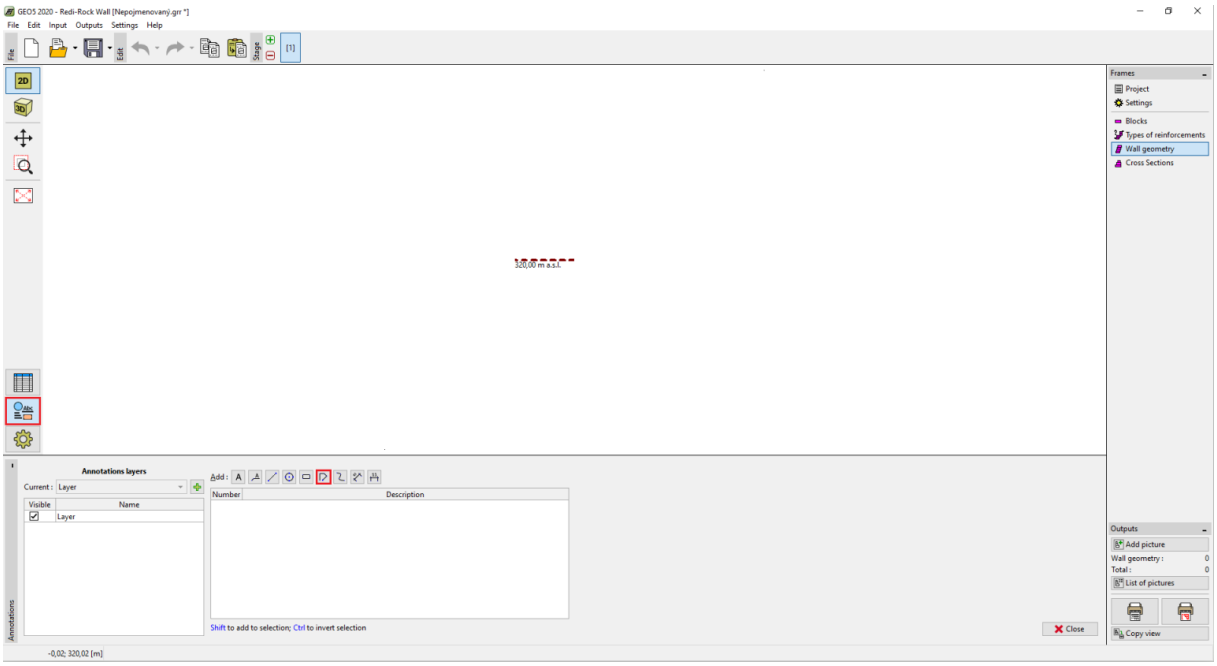


In the “Wall geometry” frame, enter the elevation of the first row (320 m) and then use the button on the left toolbar to switch to the “Annotations” mode.

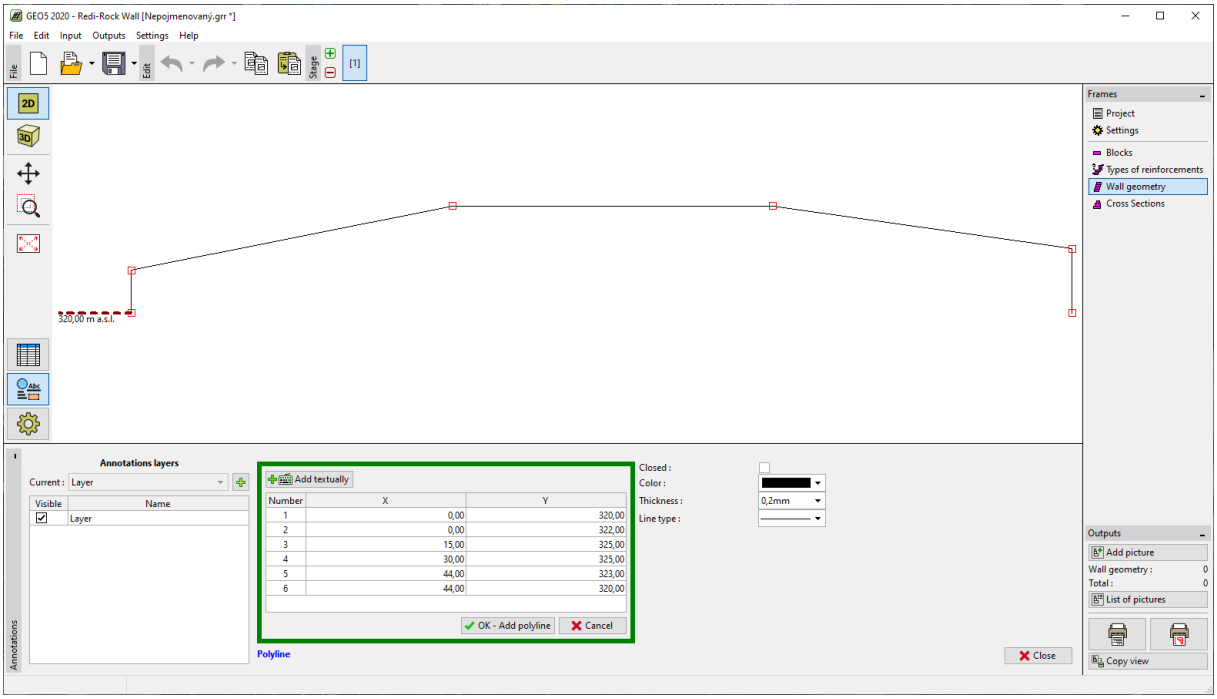


Note: The “Annotations” mode is used to add custom labels and objects to the model on the desktop. The input is similar to CAD-type programs and is explained in detail in EM No. 38 – Annotations.

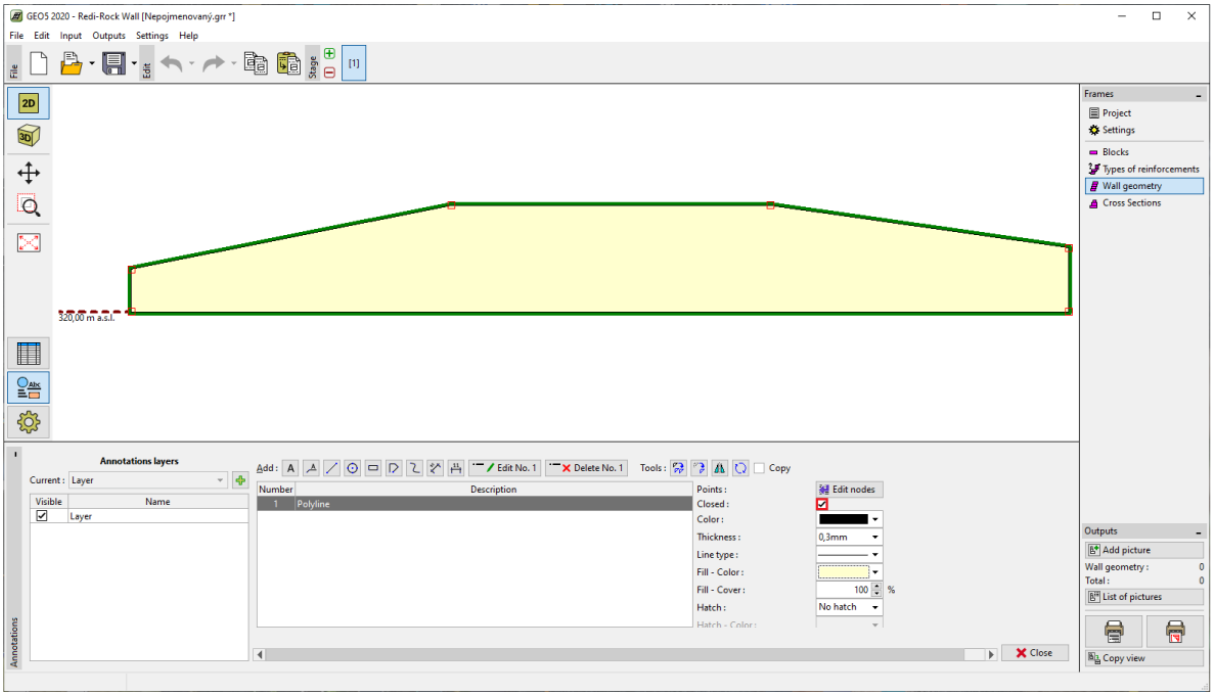
We will use the “Annotations” mode to enter the wall outline. which we will subsequently “cover” with blocks. To create the outline of the wall, use the “Polyline” command.



Then we enter the coordinates of the proposed ground surface and the base of the wall. The coordinates are: [0, 320], [0, 322], [15, 325], [30, 325], [44, 323], [44, 320].

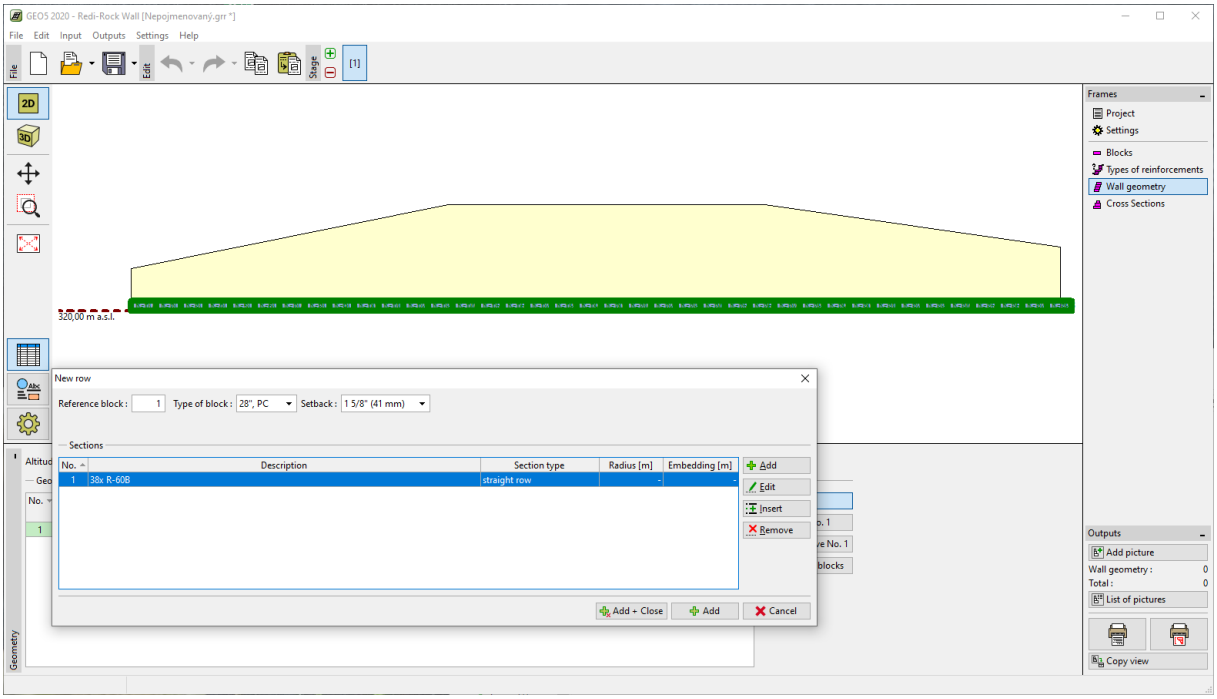


We will close the Polyline and color it for clarity

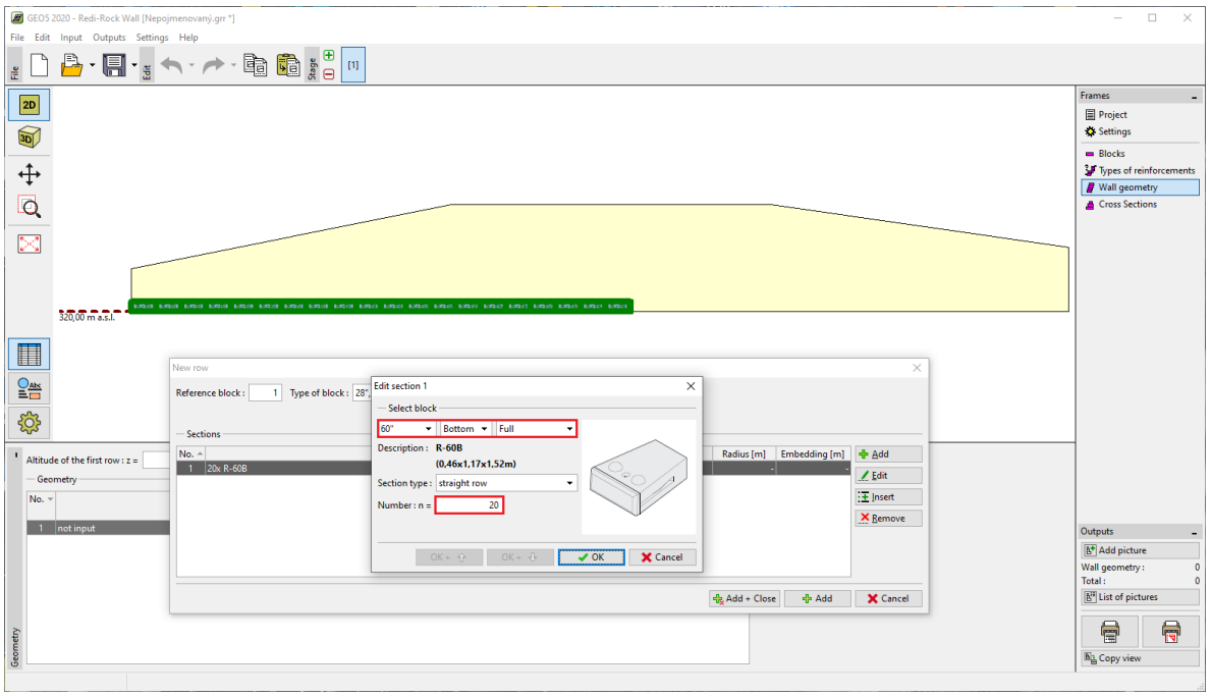


We will switch back to the data edit mode and start to input the first row of the wall. For the first row, we will choose to use the 60-inch bottom (R-60B) block type.

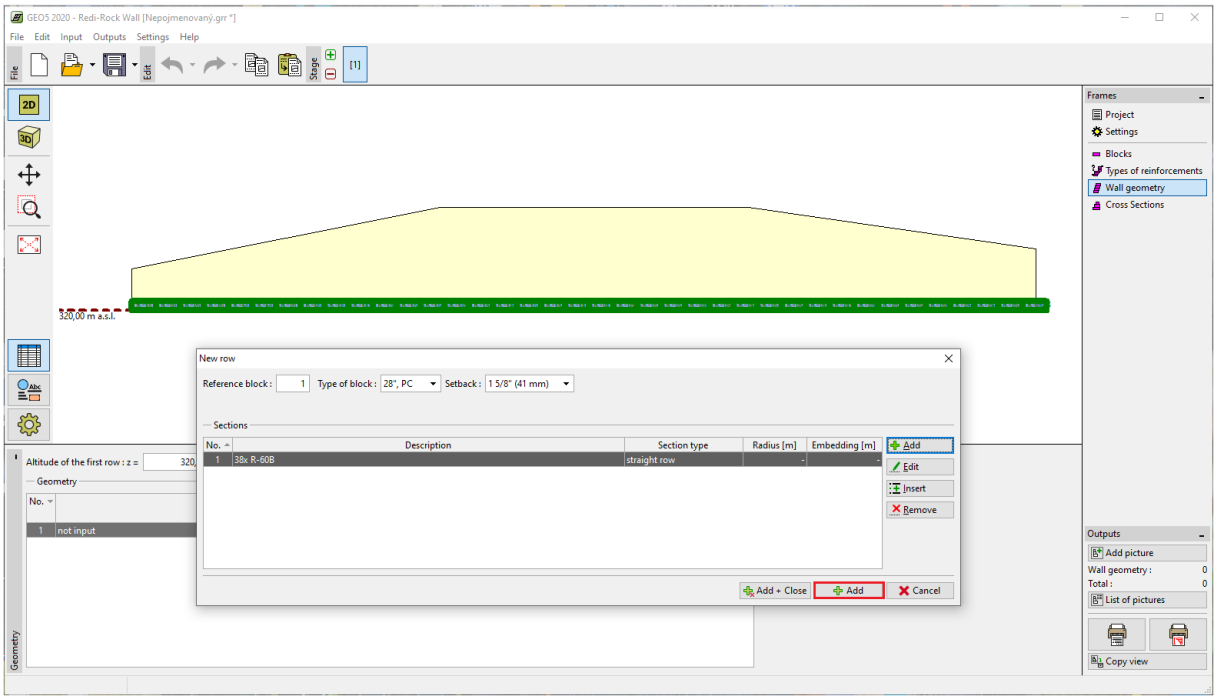
We “Add” the first row and select the desired setback. The default value is 41mm. The setback can be changed in different rows or (in special cases); we can define different setbacks within one row of blocks.



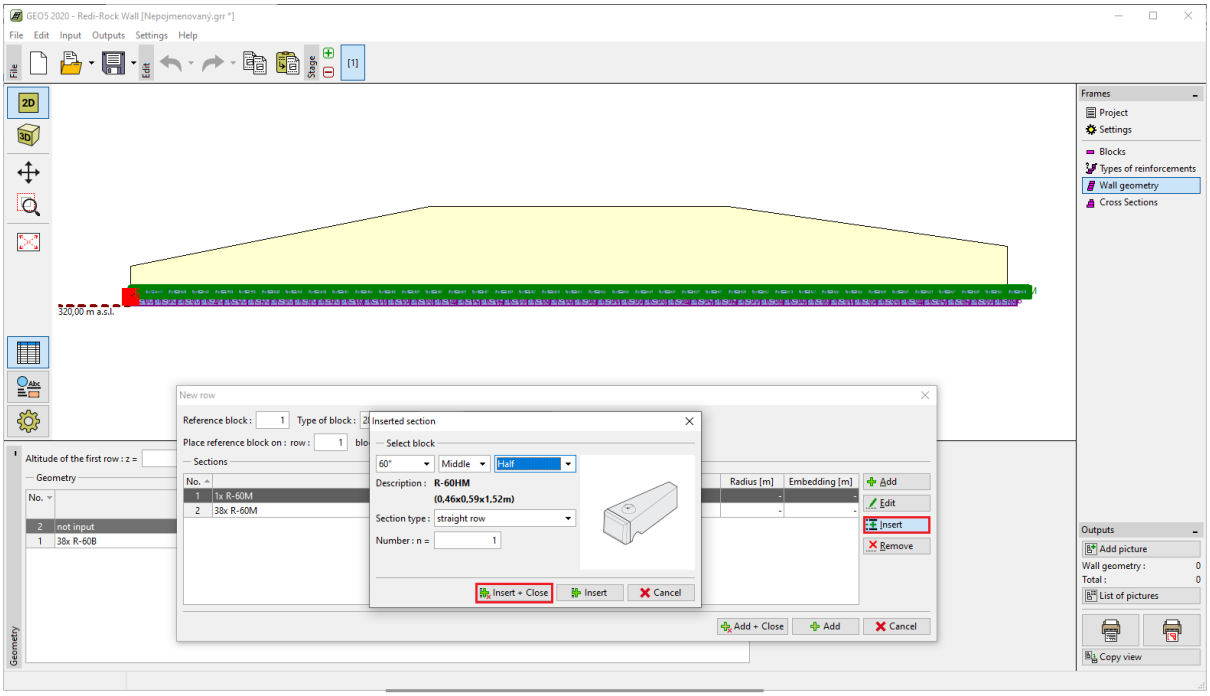
We choose the number of blocks so that we achieve the required length. In our case, it is 38 blocks. After inputting, the desktop image will be redrawn, so choosing the right number of blocks is easy.



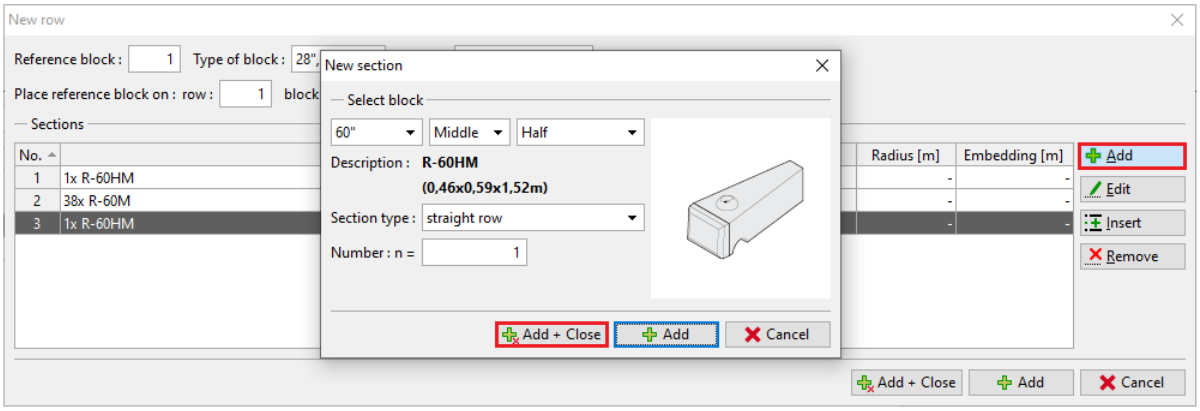
We can see that if we input the number of blocks as 20, it will not cover the desired length, so we change it (in this case to 38), and by clicking the “Add” button, we will be redirected to the inputting of the second row.



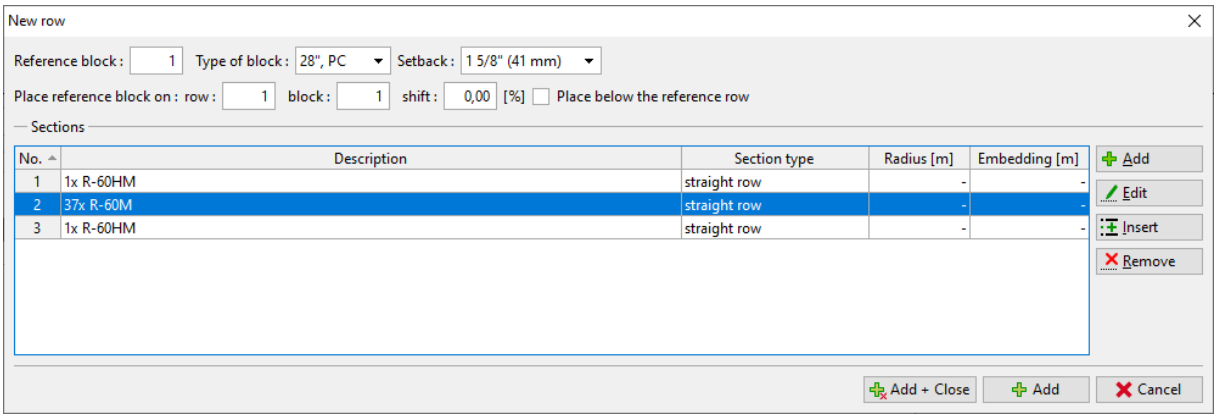
The next row will consist of 60-inch middle (R-60M) blocks. To maintain the staggered running bond pattern, we will first insert one half block (R-60HM). The “Insert” button will insert a block in front of the selected block group.



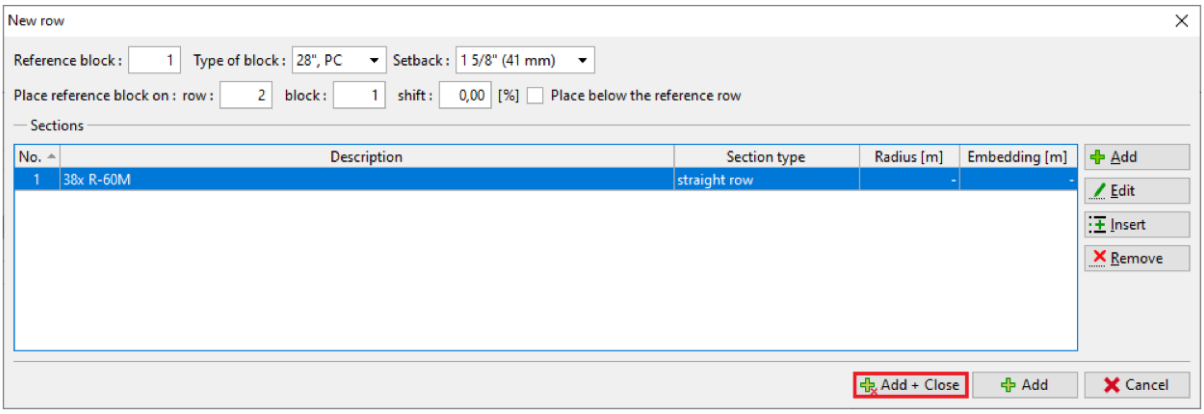
Using the “Add” button, we will add another R-60HM block at the end of the row. The “Add” button always adds blocks at the end.



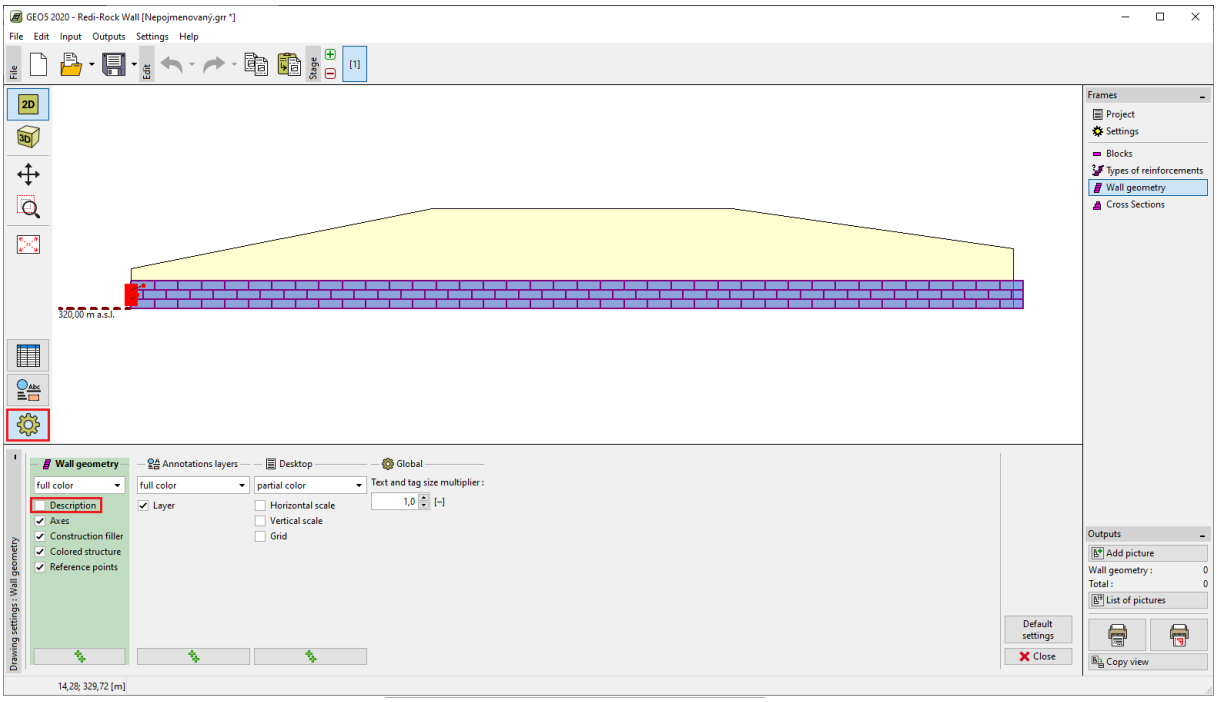
Do not forget to change the number of blocks from 38 to 37 to account for the two half blocks. By doing this, the row is finished. Click on the “Add” button and go on to the next row.



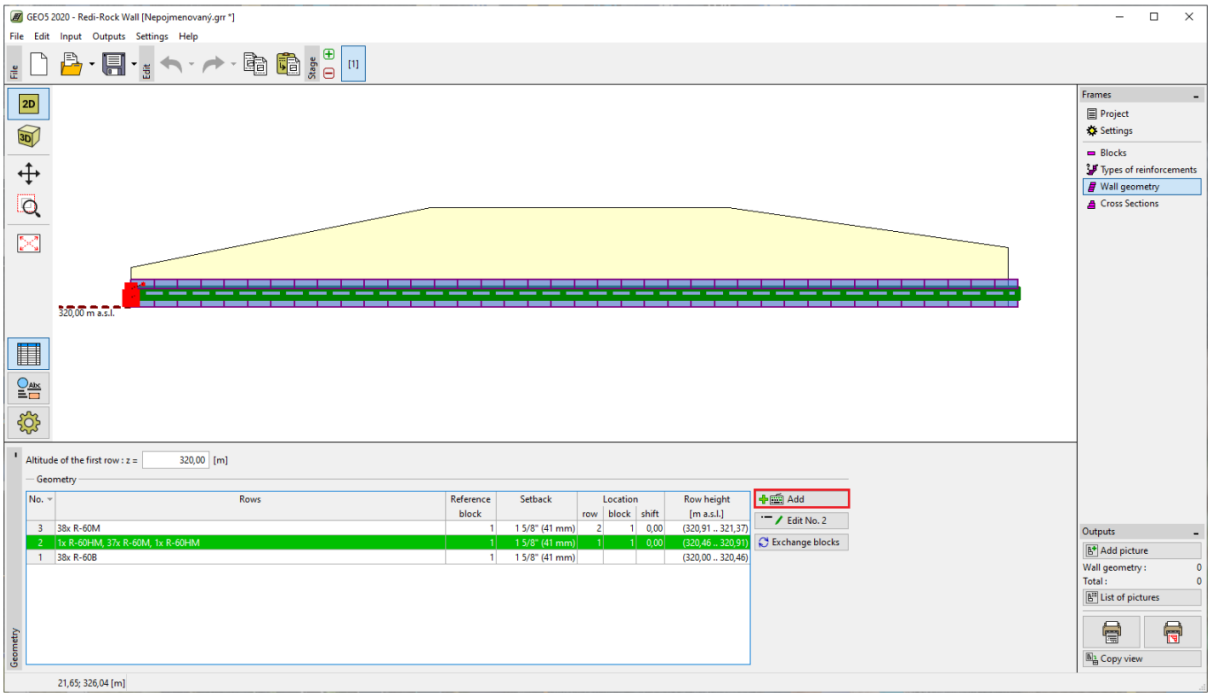
Next row is also composed of R-60M blocks. We could go on the same way with other rows; however, we can create the next rows by copying the previous ones. We will leave this window by clicking the “Add + Close” button.



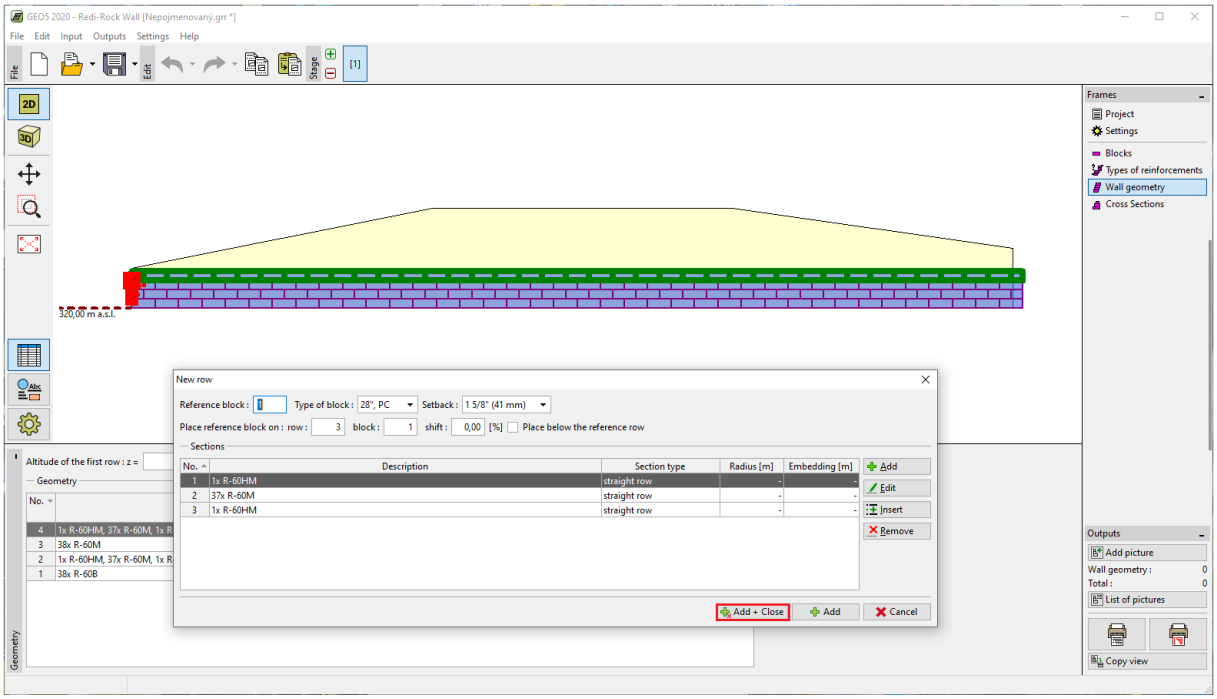
Now we can see 3 rows. For clarity, we will turn off the description.



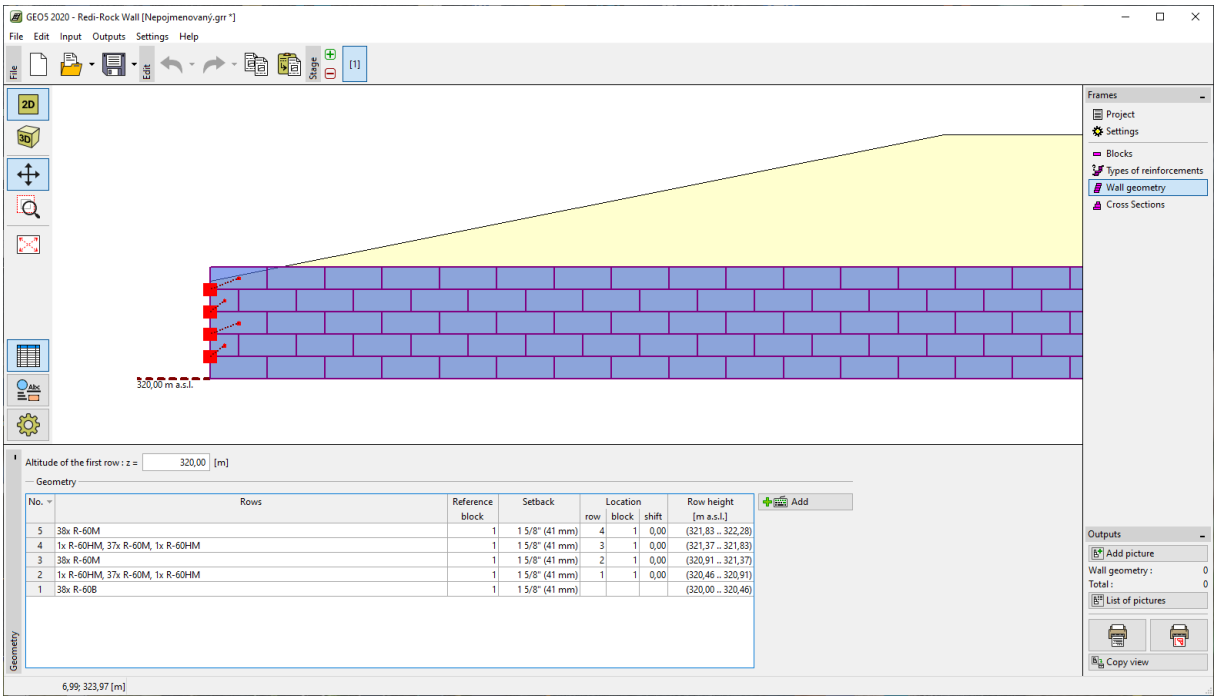
The fourth row will be the same as the second one. We will, therefore, select the second row and click the “Add” button. By that, we will create a copy.



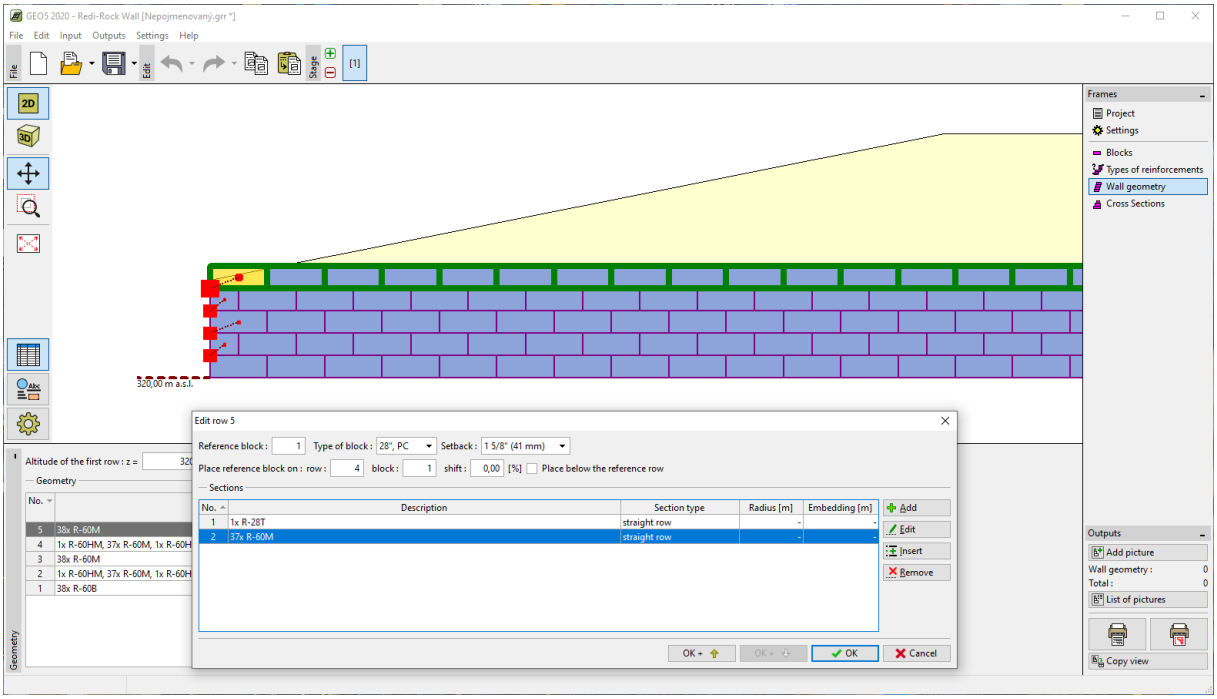
Confirm the entry with the “Add + Close” button.



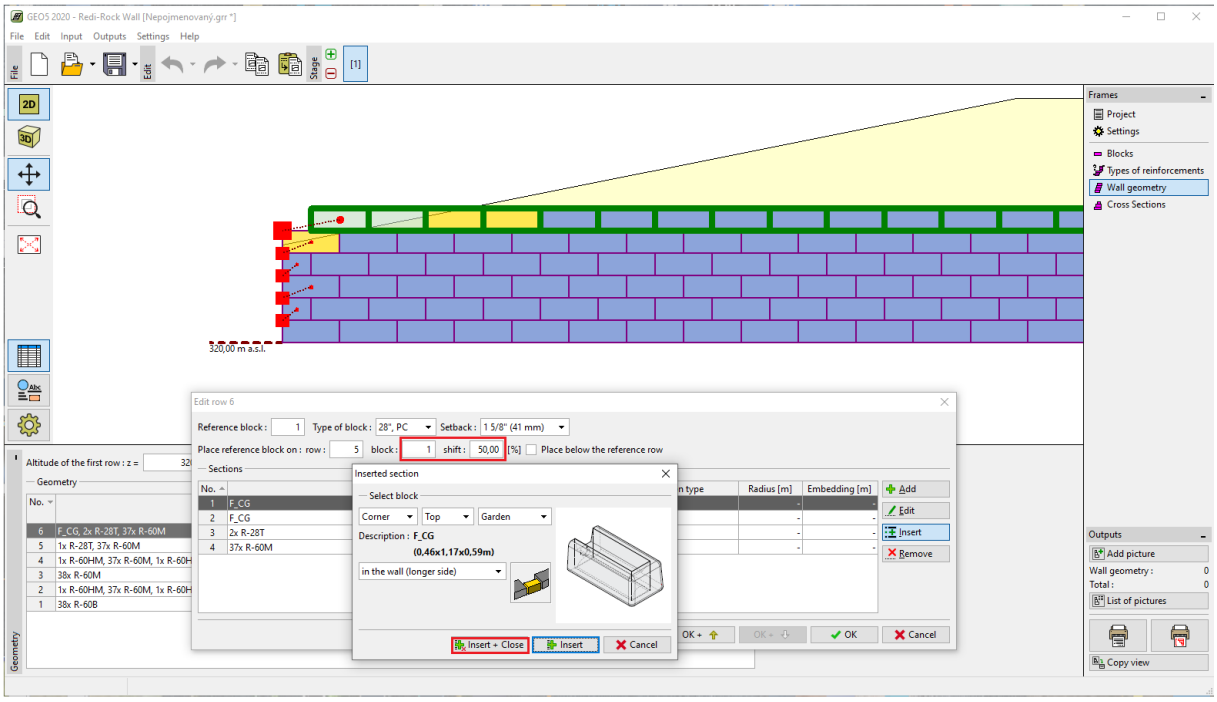
In the same way, we will copy the third row to the fifth. We can now see that the wall has reached the desired height at the edge.



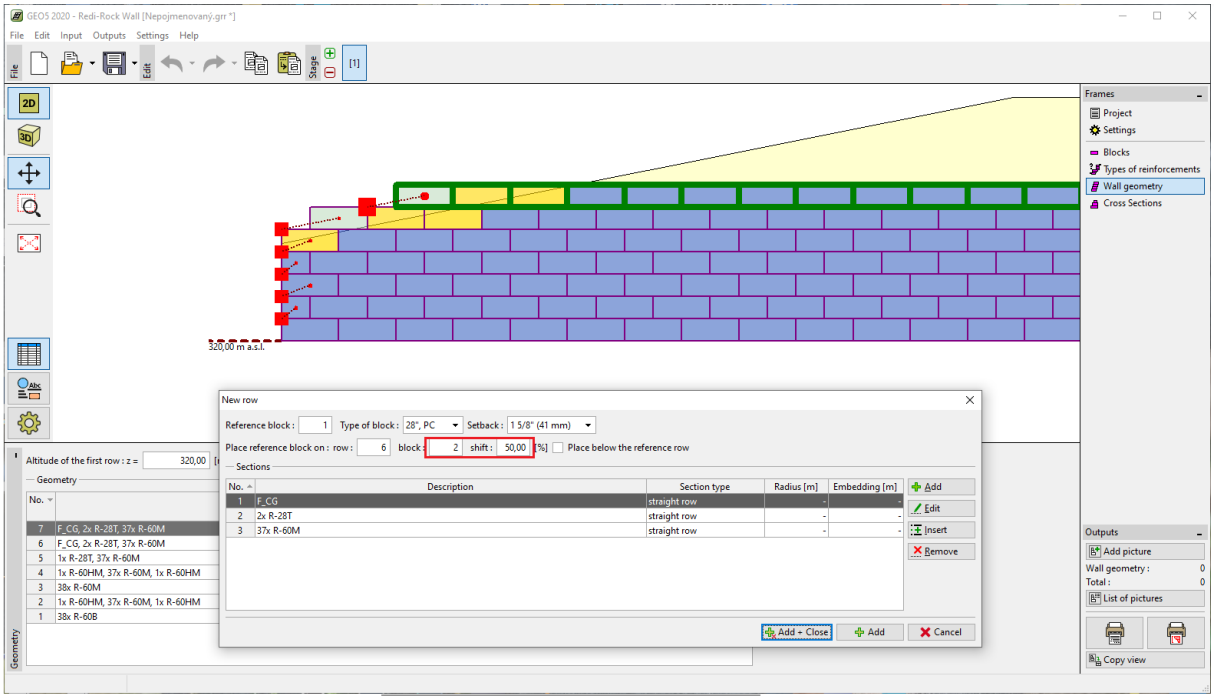
We will use the R-28T as the top block – therefore, we will adjust the input of the row.



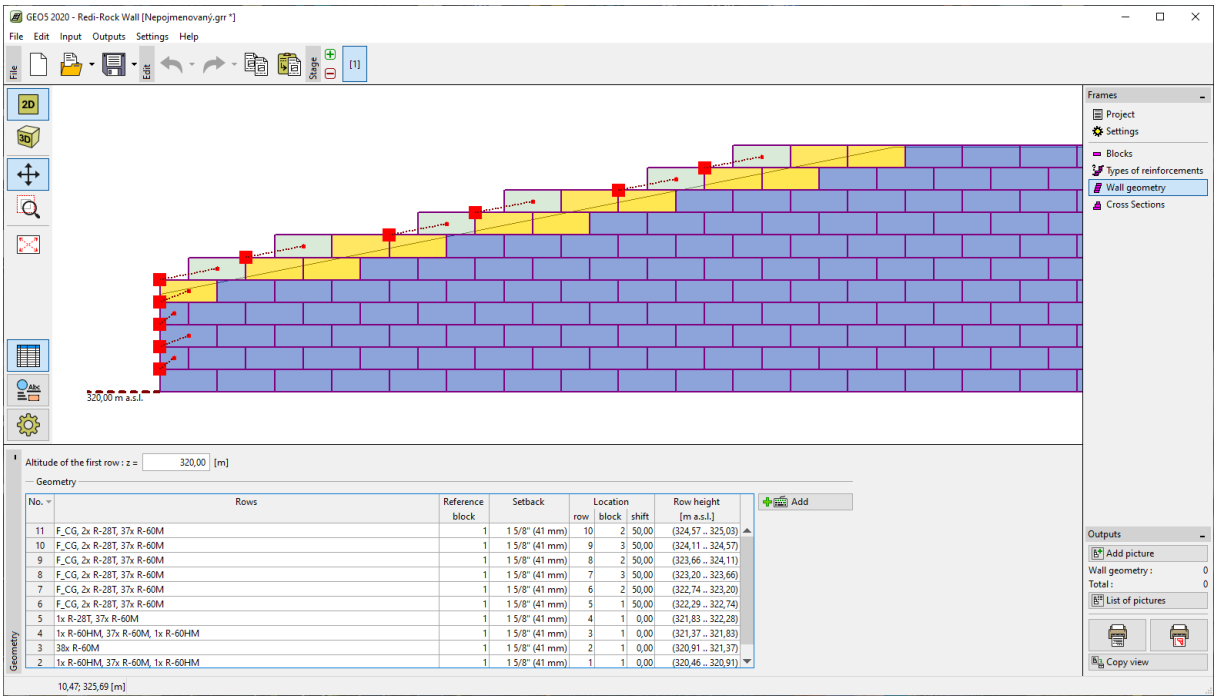
We will add another row. The placement of the row is regulated by the “Reference block”. Here we define the reference block as No.1, but we move the top row by 50 percent of its length to obtain the required stagger. Next, insert two R-28T blocks and end the wall with a corner garden block (F-CG). The corner block garden must be entered as “in the wall” to designate that we are not creating a corner in the wall.



The next row is simply a copy of the previous one, we will only shift the reference block to the desired place.

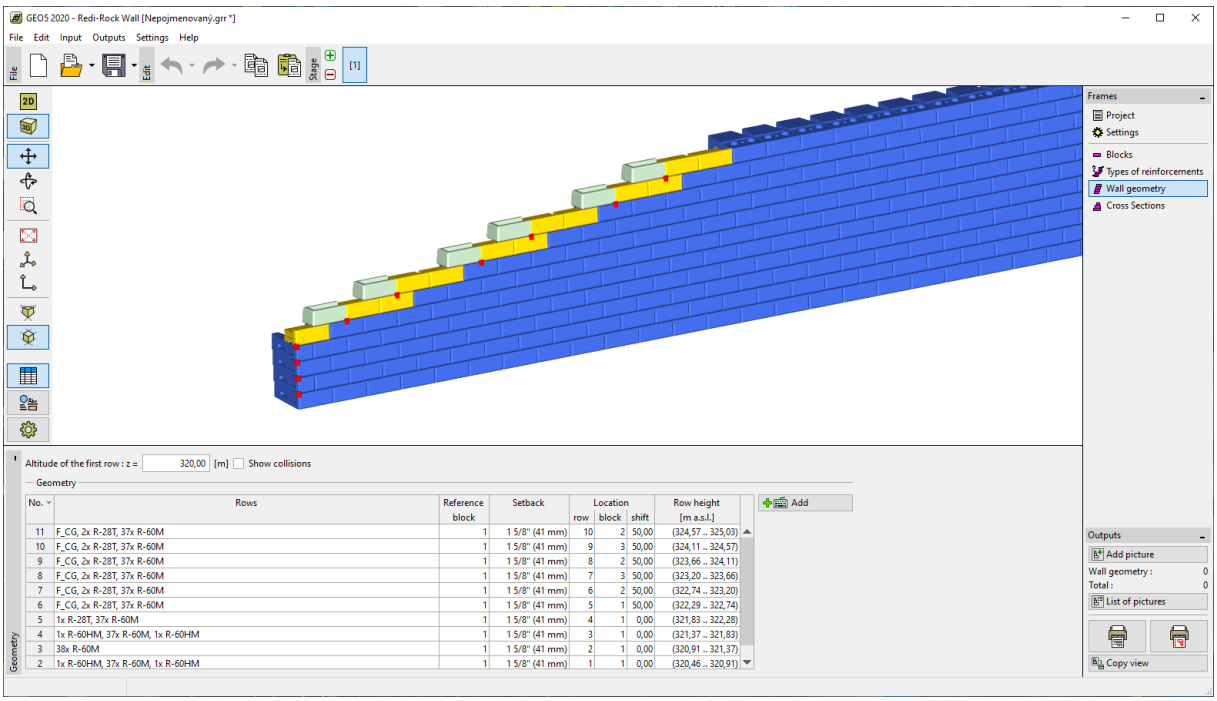


After inputting another four rows, the wall should look like this:



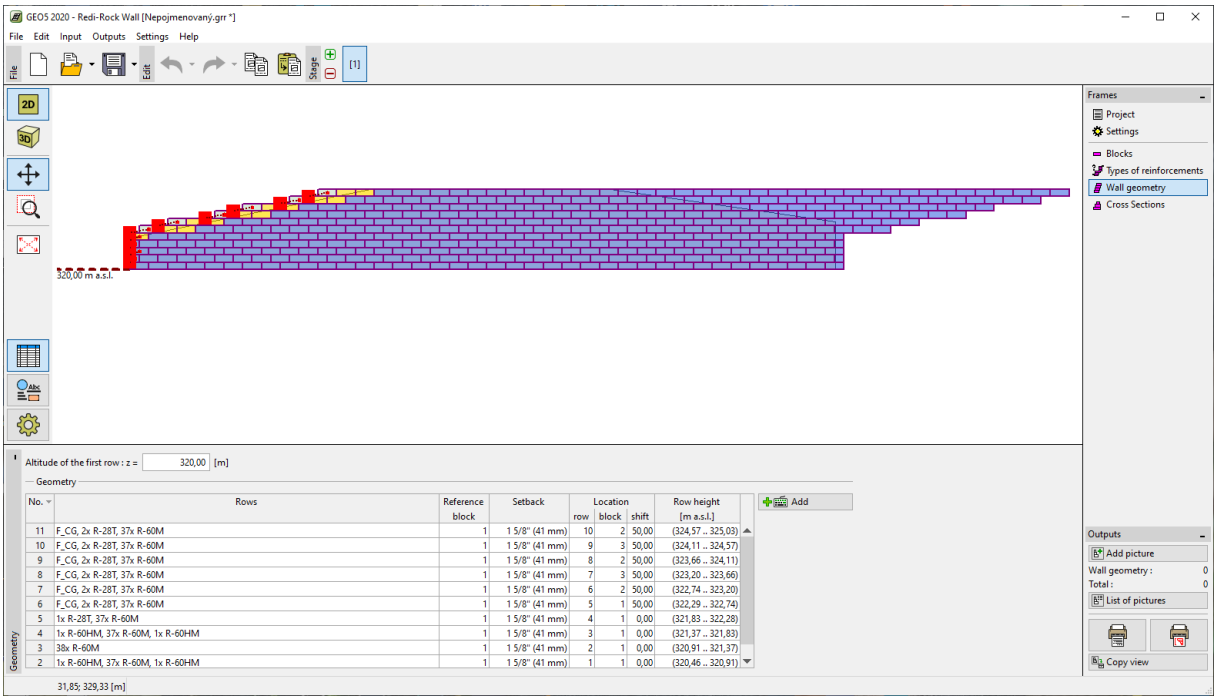
No.	Rows	Reference block	Setback	Location row	Location block	Location shift	Row height [m a.s.l.]
11	F_CG, 2x R-28T, 37x R-60M	1	1 5/8" (41 mm)	10	2	50,00	(324,57 .. 325,03)
10	F_CG, 2x R-28T, 37x R-60M	1	1 5/8" (41 mm)	9	3	50,00	(324,11 .. 324,57)
9	F_CG, 2x R-28T, 37x R-60M	1	1 5/8" (41 mm)	8	2	50,00	(323,66 .. 324,11)
8	F_CG, 2x R-28T, 37x R-60M	1	1 5/8" (41 mm)	7	3	50,00	(323,20 .. 323,66)
7	F_CG, 2x R-28T, 37x R-60M	1	1 5/8" (41 mm)	6	2	50,00	(322,74 .. 323,20)
6	F_CG, 2x R-28T, 37x R-60M	1	1 5/8" (41 mm)	5	1	50,00	(322,29 .. 322,74)
5	1x R-28T, 37x R-60M	1	1 5/8" (41 mm)	4	1	0,00	(321,83 .. 322,28)
4	1x R-60HM, 37x R-60M, 1x R-60HM	1	1 5/8" (41 mm)	3	1	0,00	(321,37 .. 321,83)
3	38x R-60M	1	1 5/8" (41 mm)	2	1	0,00	(320,91 .. 321,37)
2	1x R-60HM, 37x R-60M, 1x R-60HM	1	1 5/8" (41 mm)	1	1	0,00	(320,46 .. 320,91)

We can view the created edge of the wall in 3D by selecting the 3D view button in the upper left portion of the screen.

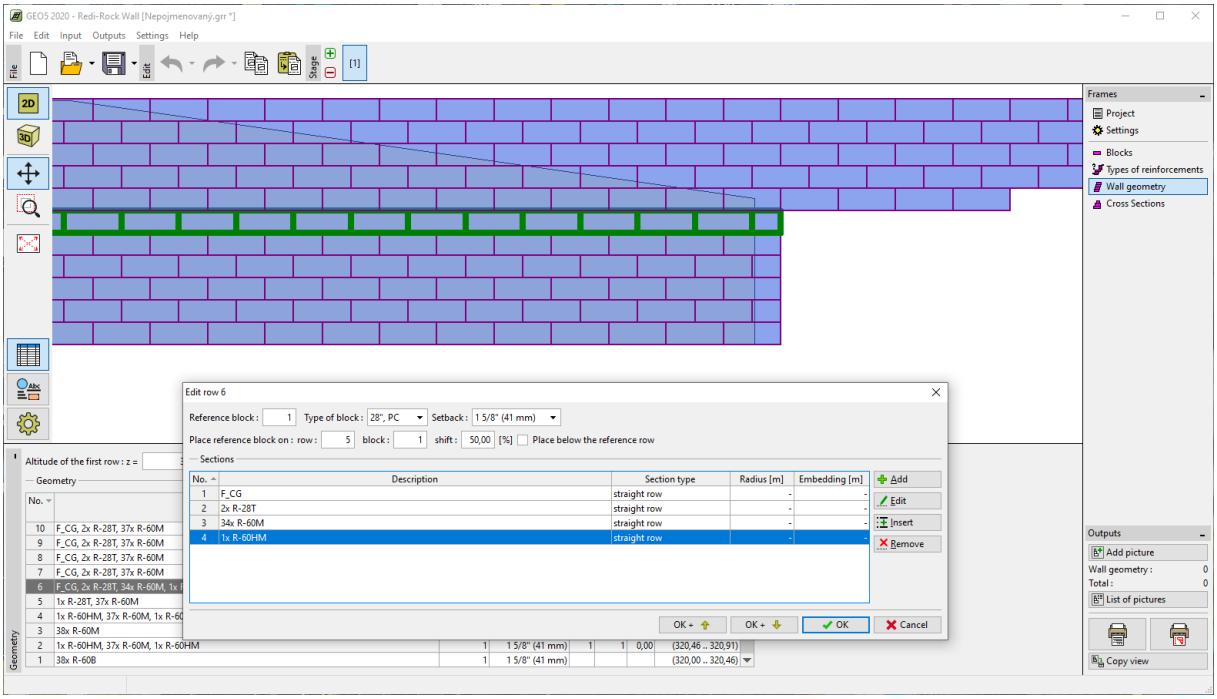


No.	Rows	Reference block	Setback	Location row	Location block	Location shift	Row height [m a.s.l.]
11	F_CG, 2x R-28T, 37x R-60M	1	1 5/8" (41 mm)	10	2	50,00	(324,57 .. 325,03)
10	F_CG, 2x R-28T, 37x R-60M	1	1 5/8" (41 mm)	9	3	50,00	(324,11 .. 324,57)
9	F_CG, 2x R-28T, 37x R-60M	1	1 5/8" (41 mm)	8	2	50,00	(323,66 .. 324,11)
8	F_CG, 2x R-28T, 37x R-60M	1	1 5/8" (41 mm)	7	3	50,00	(323,20 .. 323,66)
7	F_CG, 2x R-28T, 37x R-60M	1	1 5/8" (41 mm)	6	2	50,00	(322,74 .. 323,20)
6	F_CG, 2x R-28T, 37x R-60M	1	1 5/8" (41 mm)	5	1	50,00	(322,29 .. 322,74)
5	1x R-28T, 37x R-60M	1	1 5/8" (41 mm)	4	1	0,00	(321,83 .. 322,28)
4	1x R-60HM, 37x R-60M, 1x R-60HM	1	1 5/8" (41 mm)	3	1	0,00	(321,37 .. 321,83)
3	38x R-60M	1	1 5/8" (41 mm)	2	1	0,00	(320,91 .. 321,37)
2	1x R-60HM, 37x R-60M, 1x R-60HM	1	1 5/8" (41 mm)	1	1	0,00	(320,46 .. 320,91)

The left side of the wall is finished, now we can go to the right side, which we did not edit yet.

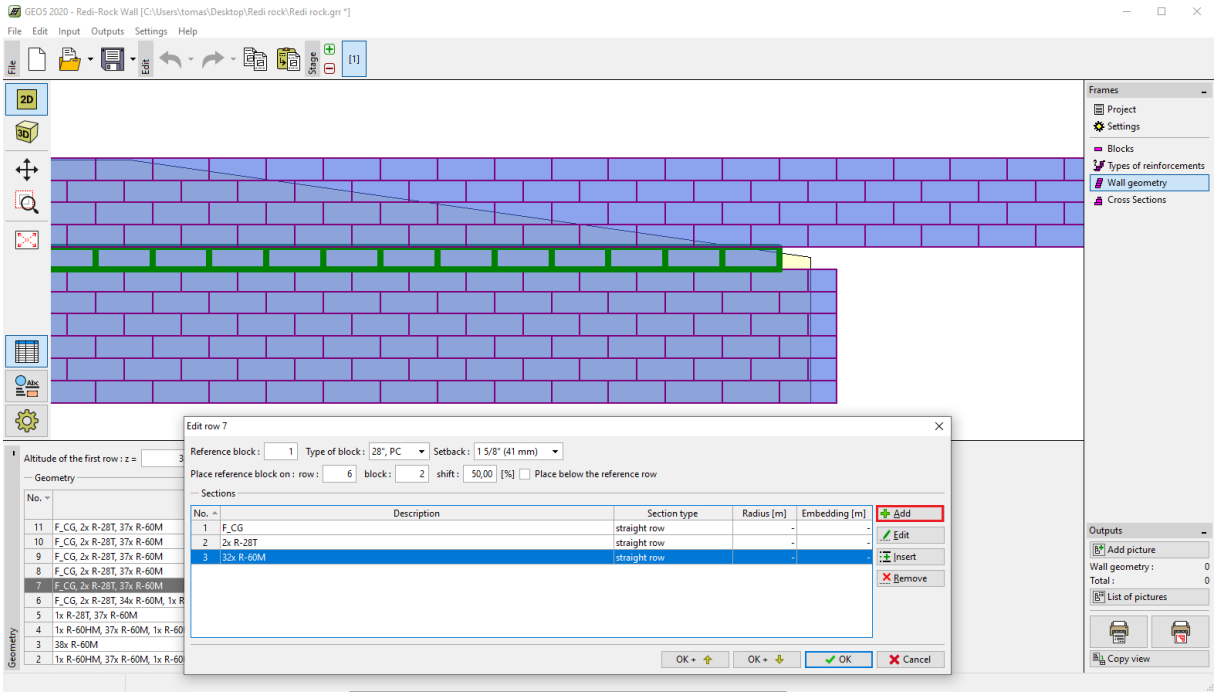


We will begin with the sixth row, where we will reduce the block number and add one half block. When we are satisfied with the result, we can switch to the next row by clicking the arrow.

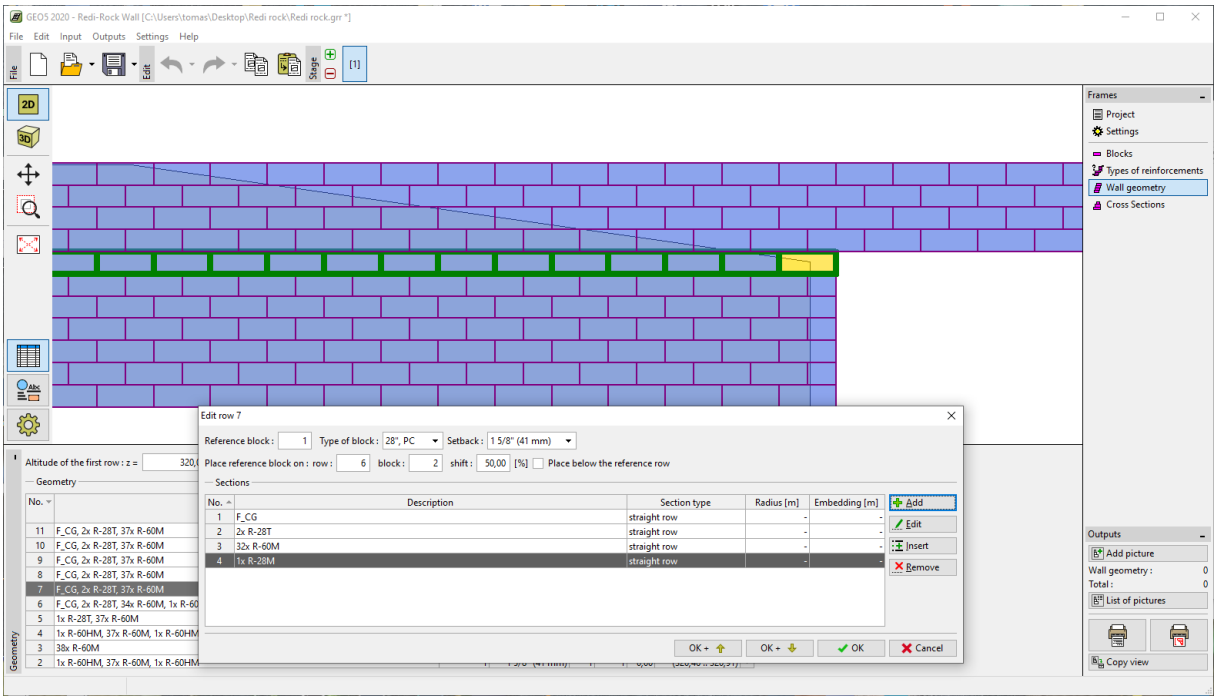


Note: The arrows behave according to how the objects are sorted in the table, so it may sometimes happen that the up arrow selects the bottom row and vice versa. This can be modified by changing the sorting of the table.

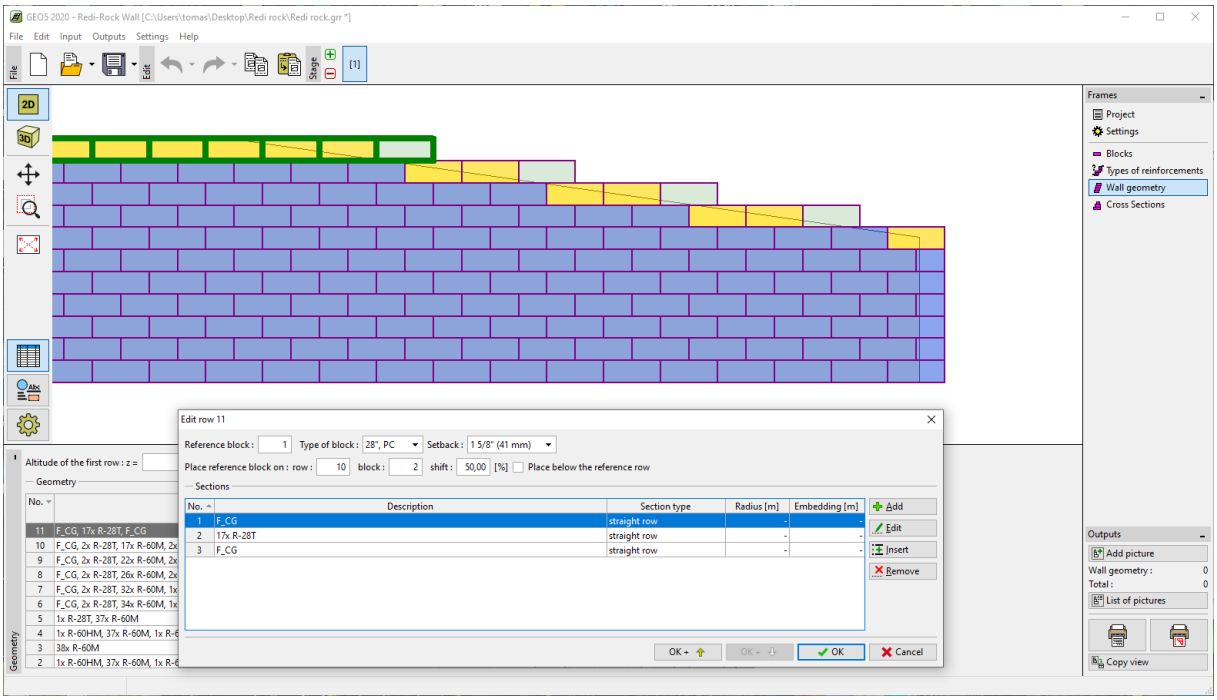
For the next row, we will reduce the number of the R-60M blocks and add an end block R-28T. This can be easily done by selecting the desired block in the window and then clicking the “Add” button.



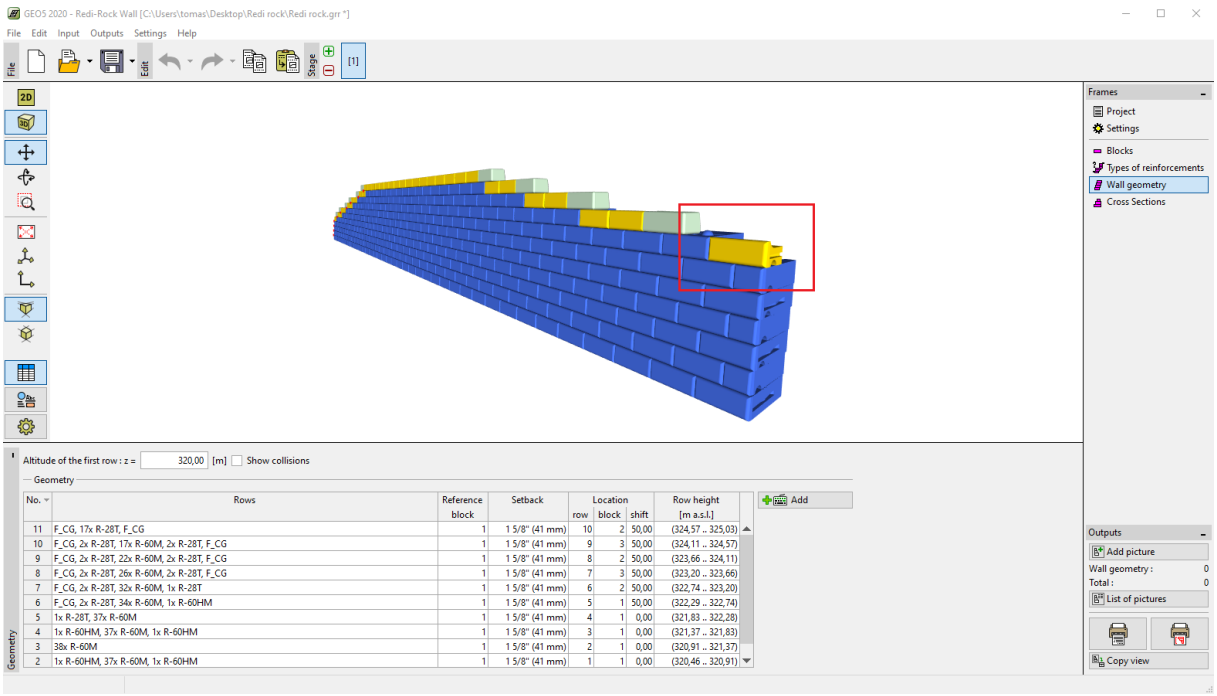
After we edit this row, we can go to the next by clicking the arrows.



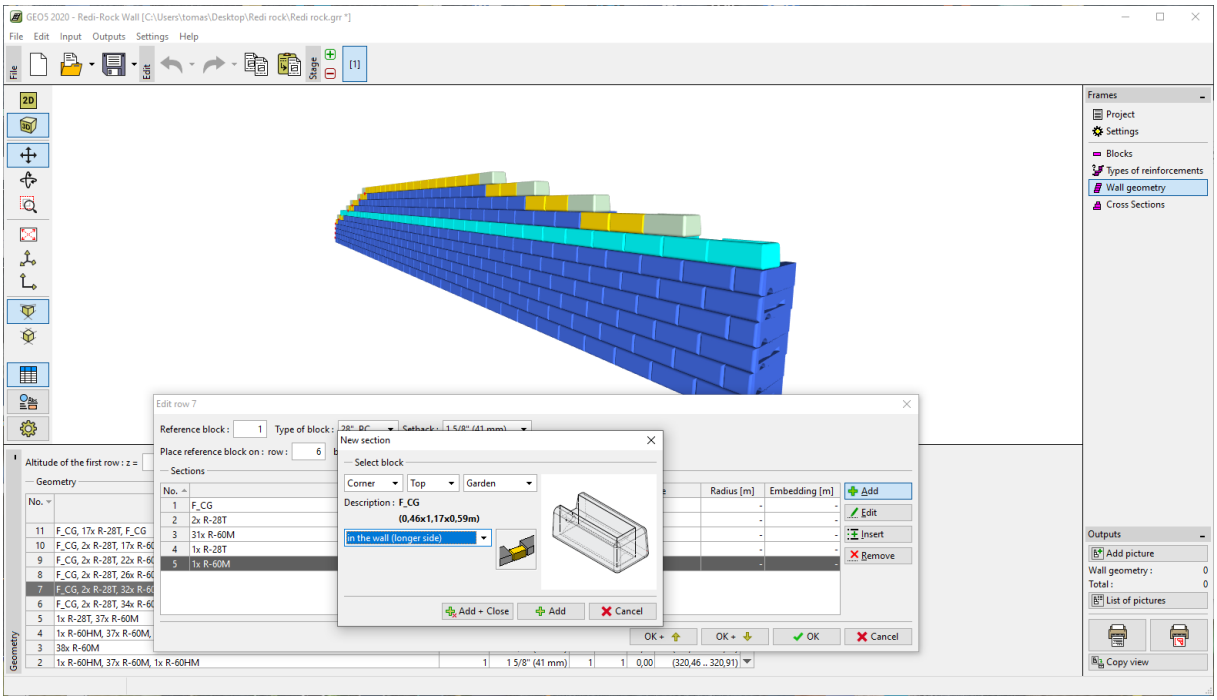
We will adjust all the rows the same way until we are satisfied. The upper row of the wall will consist of R-28T blocks only, with F-CG blocks at the edges



We can view the created wall in 3D. We can see that the end of the wall is not very well designed, at the end of the R-28T bock would be exposed.

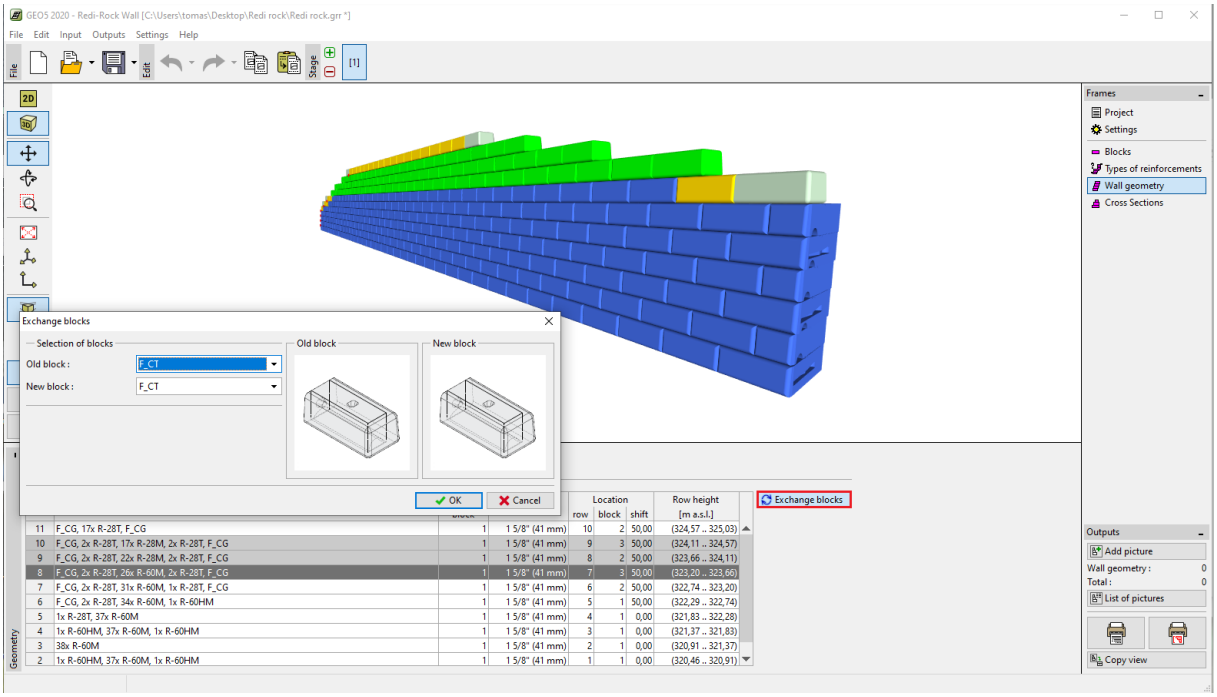


We will correct the row by replacing the top block with a garden block.

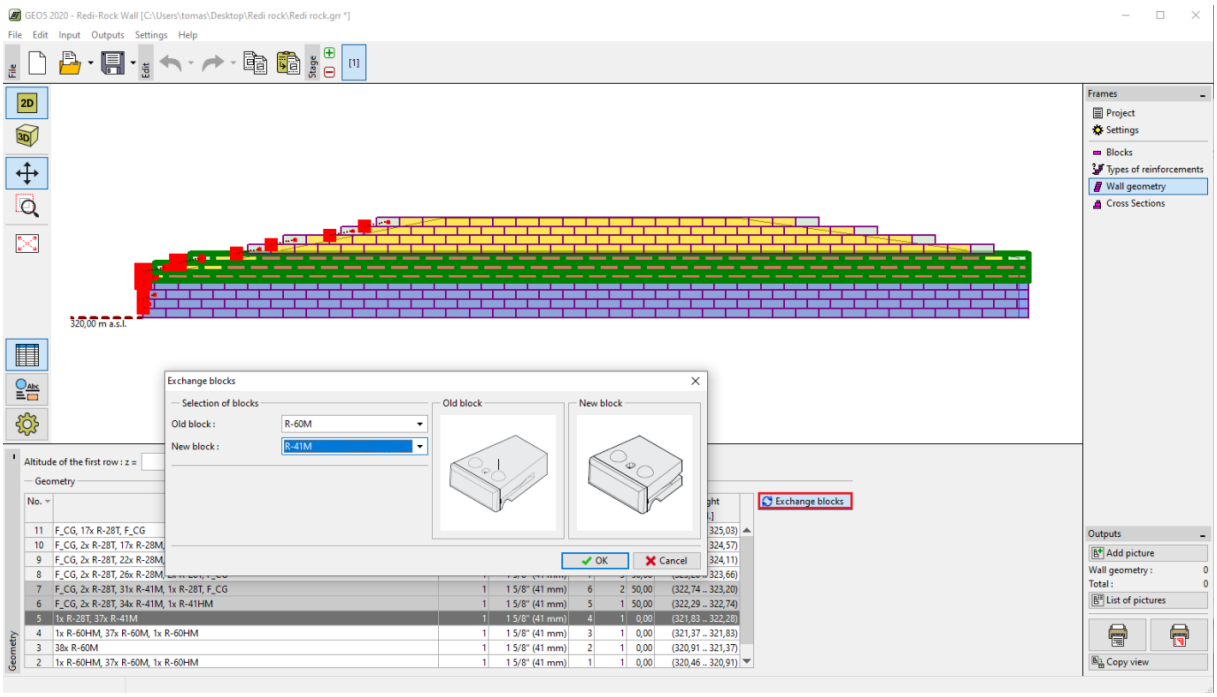


Now we have the entire wall designed from the R-60 blocks, however, this design would not necessarily be very efficient. So we will replace some blocks with smaller-sized blocks. In the upper three rows, we will assume 28-inch blocks, underneath there will be three rows consisting of 41-inch blocks.

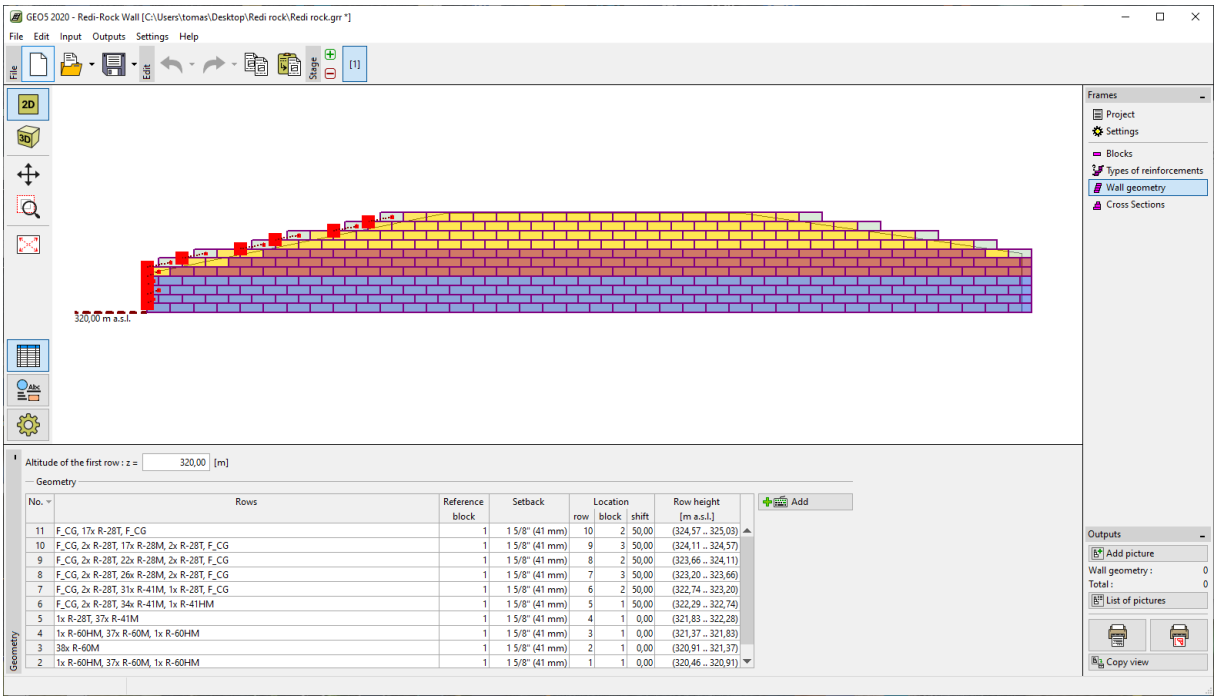
Replacement is simple – We will select the top three rows and use the “Exchange blocks” button to replace the R-60M blocks with R-28M



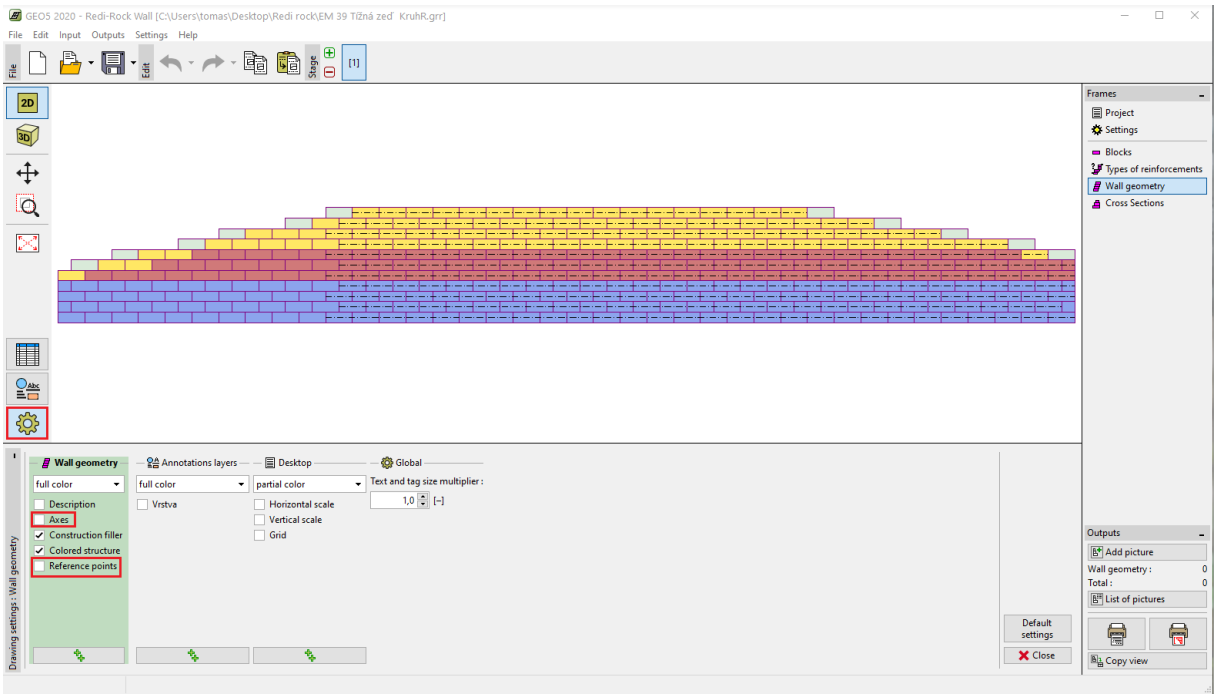
The same way we will replace the three rows underneath with R-41M. Do not forget to change the half blocks as well (R-60HM => R41HM).



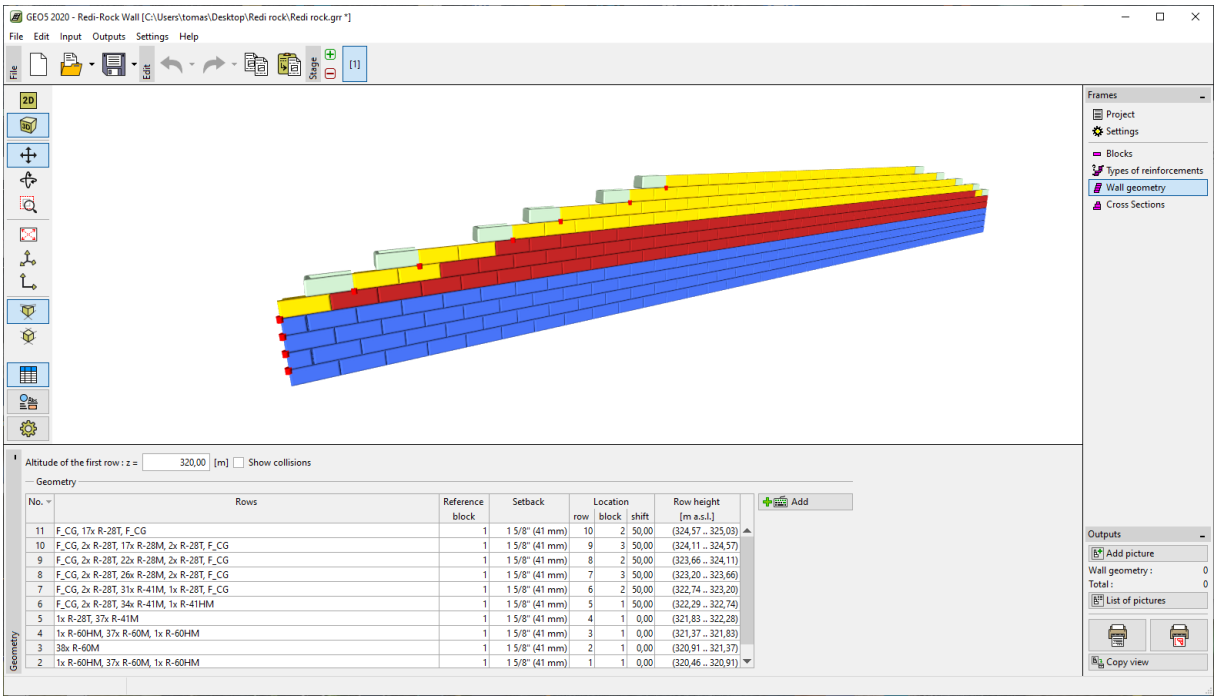
Now the gravity wall is finished.



Some parts of the visualization – such reference points or axes – may not be important now. We can go to visualization settings and switch them off.

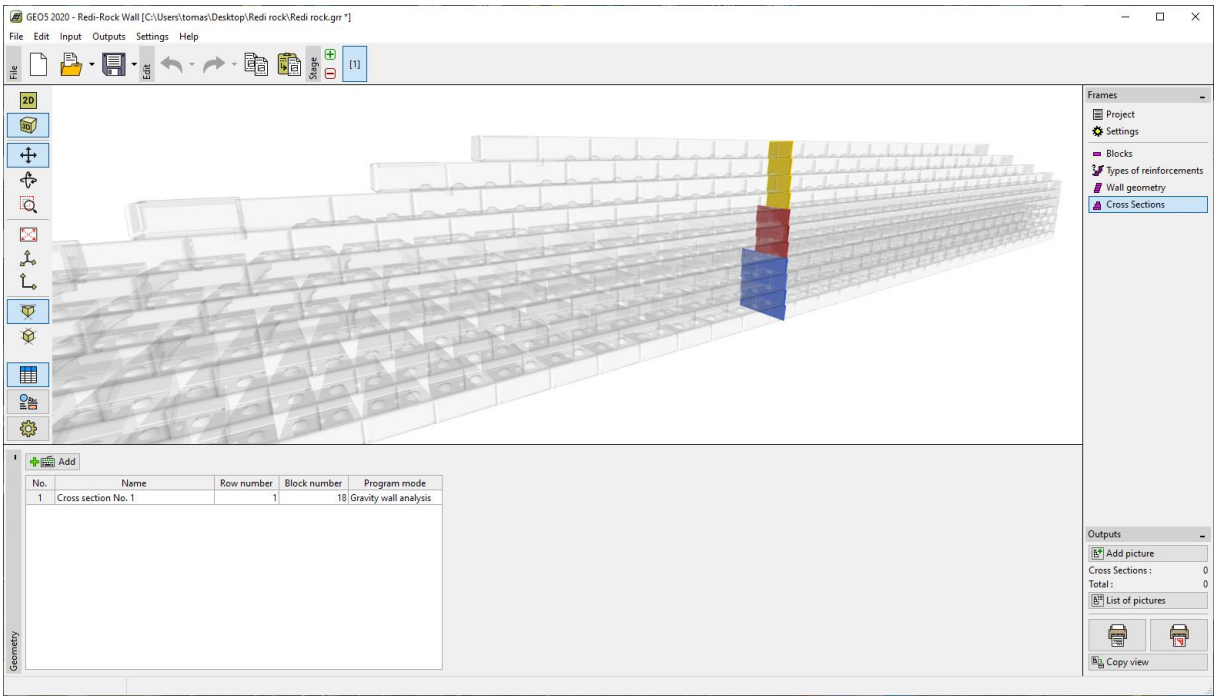


We can check our wall in 3D mode too.

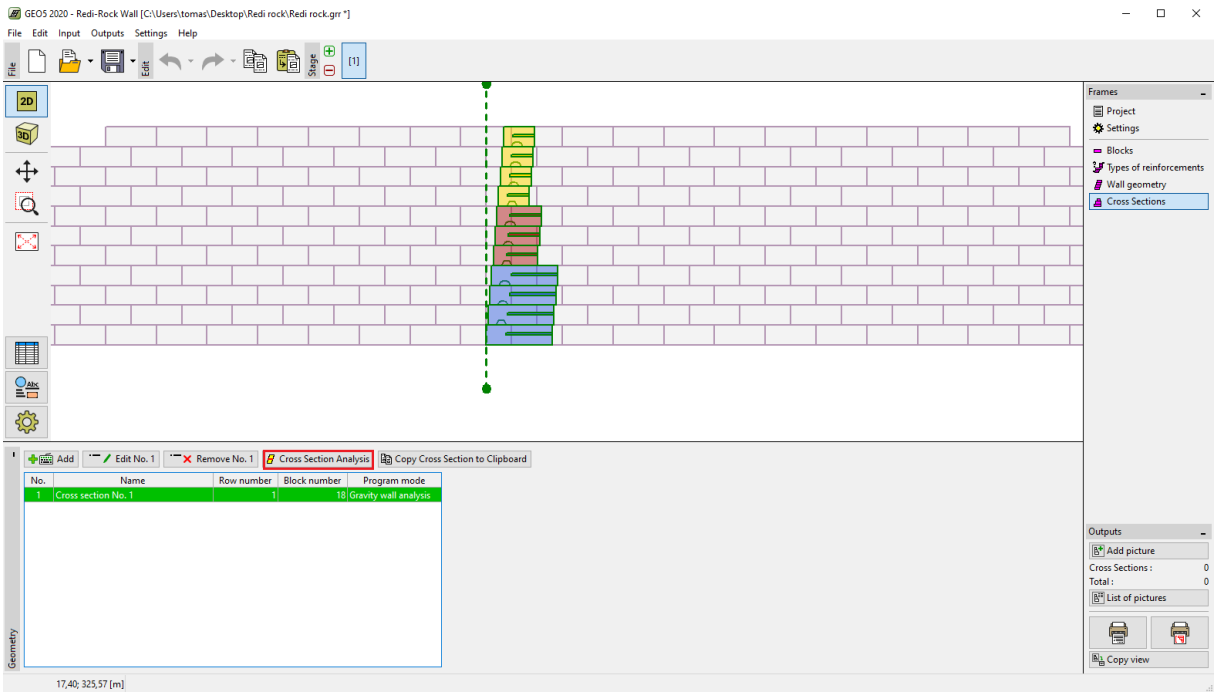


No.	Rows	Reference block	Setback	Location row	Location block	Location shift	Row height [m a.s.l.]
11	F_CG, 17x R-28T, F_CG	1	1 5/8" (41 mm)	10	2	50,00	(324,57 .. 325,03)
10	F_CG, 2x R-28T, 17x R-28M, 2x R-28T, F_CG	1	1 5/8" (41 mm)	9	3	50,00	(324,11 .. 324,57)
9	F_CG, 2x R-28T, 22x R-28M, 2x R-28T, F_CG	1	1 5/8" (41 mm)	8	2	50,00	(323,66 .. 324,11)
8	F_CG, 2x R-28T, 26x R-28M, 2x R-28T, F_CG	1	1 5/8" (41 mm)	7	3	50,00	(323,20 .. 323,66)
7	F_CG, 2x R-28T, 31x R-41M, 1x R-28T, F_CG	1	1 5/8" (41 mm)	6	2	50,00	(322,74 .. 323,20)
6	F_CG, 2x R-28T, 34x R-41M, 1x R-41HM	1	1 5/8" (41 mm)	5	1	50,00	(322,29 .. 322,74)
5	1x R-28T, 37x R-41M	1	1 5/8" (41 mm)	4	1	0,00	(321,83 .. 322,28)
4	1x R-60HM, 37x R-60M, 1x R-60HM	1	1 5/8" (41 mm)	3	1	0,00	(321,37 .. 321,83)
3	38x R-60M	1	1 5/8" (41 mm)	2	1	0,00	(320,91 .. 321,37)
2	1x R-60HM, 37x R-60M, 1x R-60HM	1	1 5/8" (41 mm)	1	1	0,00	(320,46 .. 320,91)

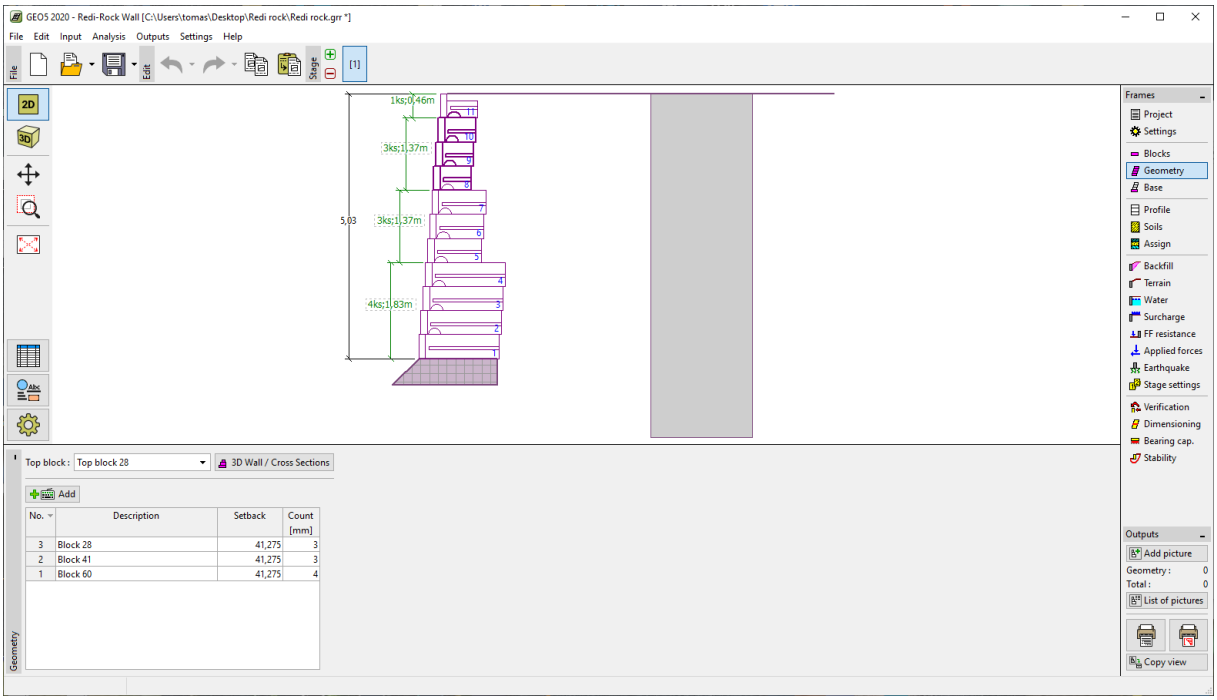
We will go to the “Cross Sections” frame and add a section in the highest point of the wall.



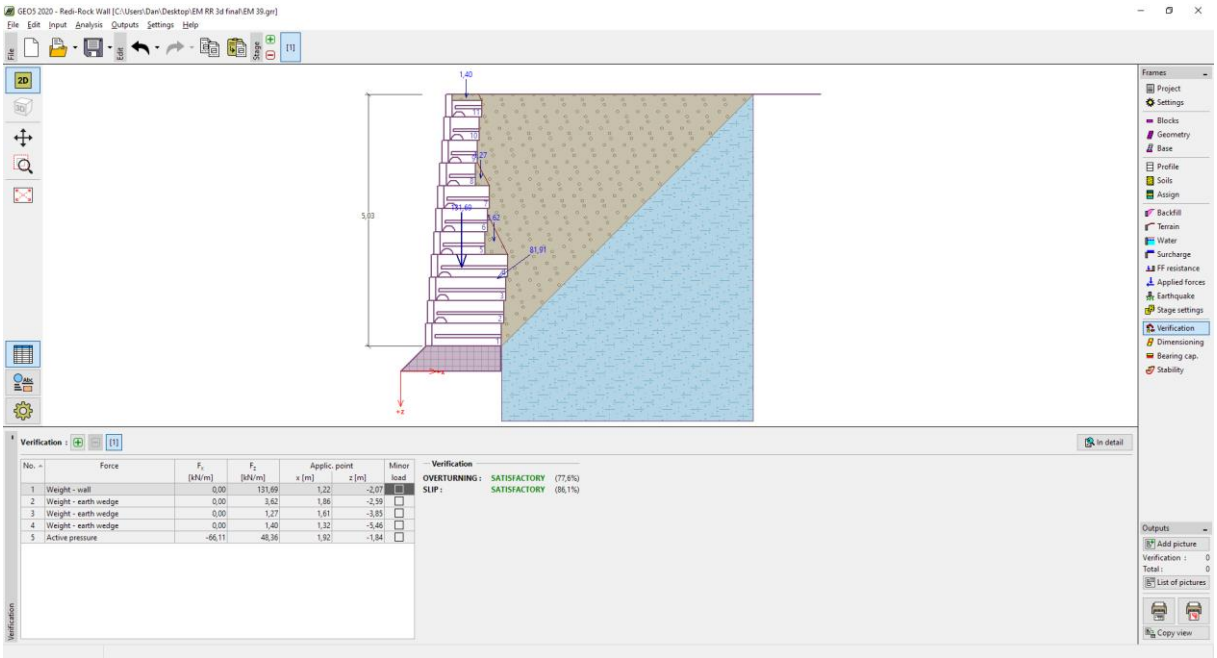
By clicking “Cross Section Analysis” we will switch to calculation mode.



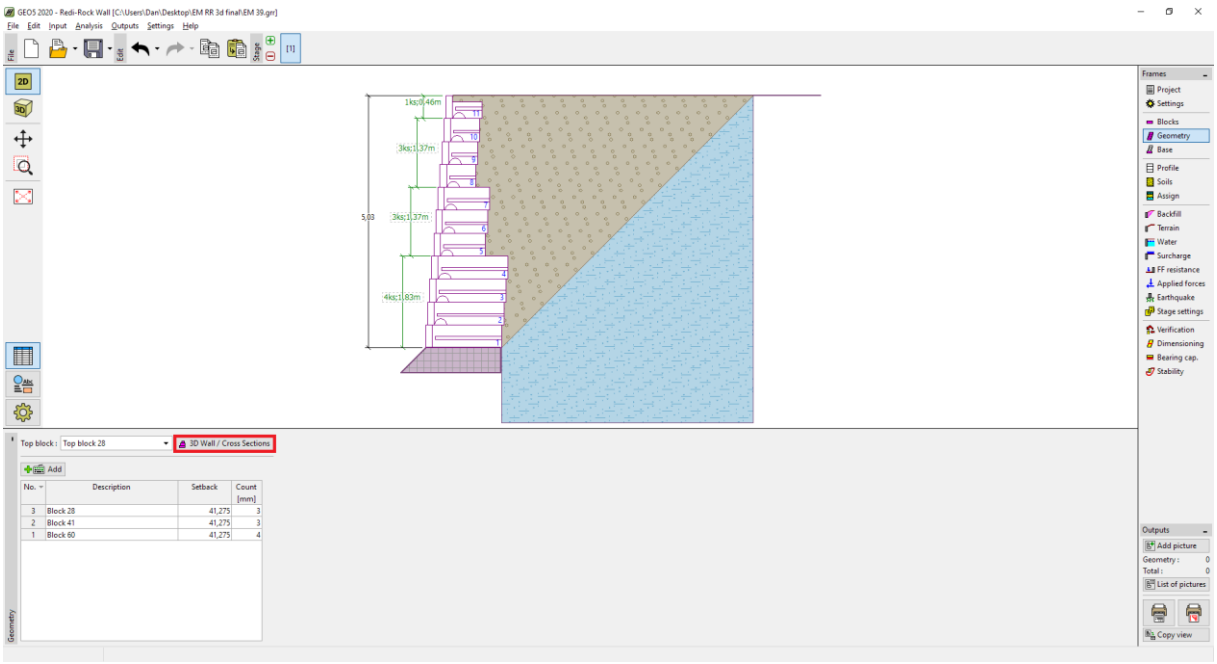
Here we add a soil and perform a standard analysis of the designed wall.



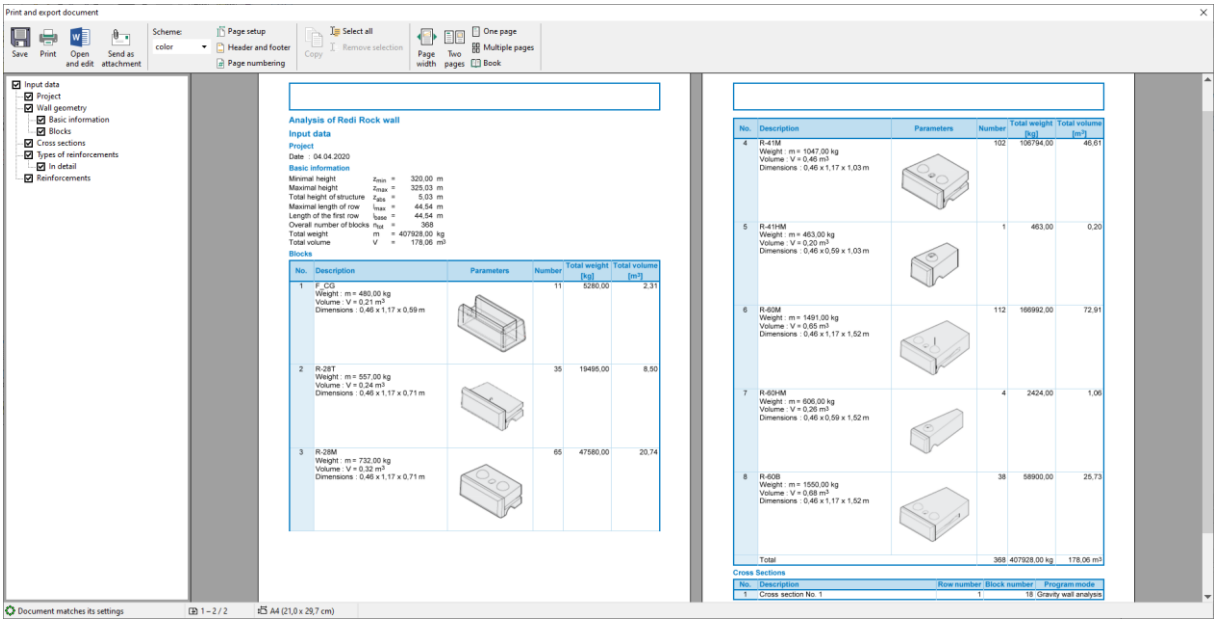
If the wall is not suitable or is not economically designed, we can change it and find the optimized design. After that we return to 3D mode and make modifications, as required, to account for the revisions.



Now we will return to the input of the 3D wall. We can do that in the “Geometry” frame, by clicking the “3D Wall/Cross Sections” button or in the frame “Settings” tab.



In the detailed output documentation, we have information on the total number of blocks and their total weight.



Now we will save our design as “Final Design Gravity Wall”. However, because we want to compare the price of the designed wall with a reinforced wall, we also save the data as “MSE Wall” and convert the model to the design of an MSE wall.

We will go back to 3D construction mode and change all the blocks as follows:

R-60B -> R-41PCB

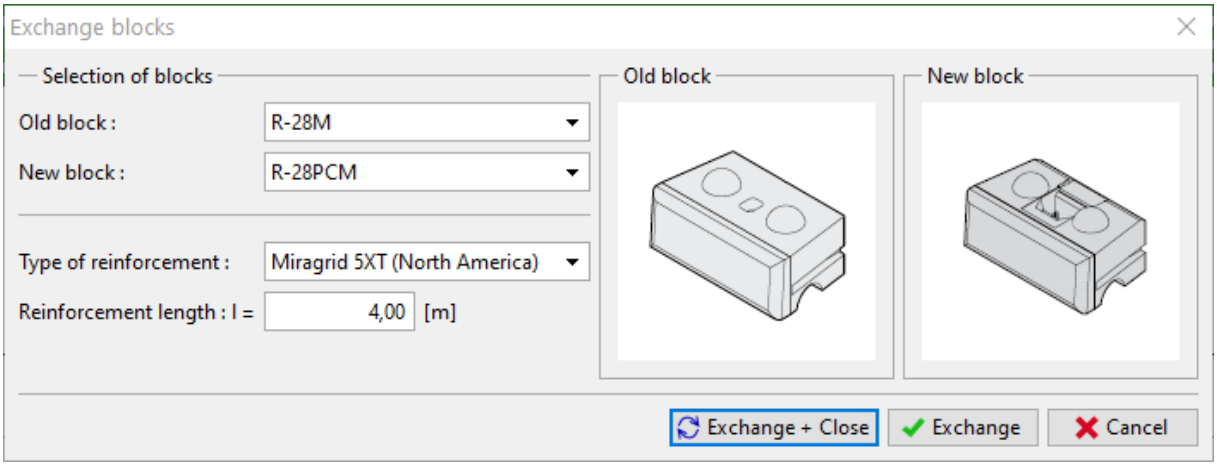
R-60M -> R-41PCM

R-41M -> R-41PCM

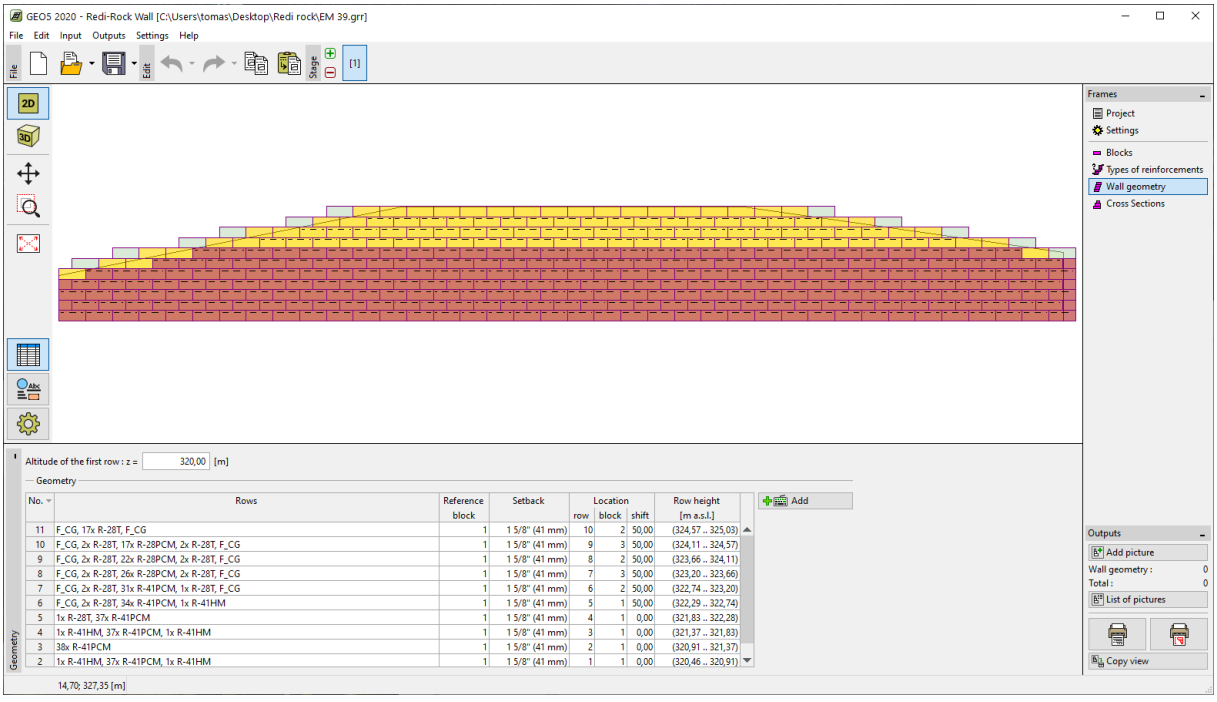
R-28M -> R-28PCM

R-60HM -> R-41HM

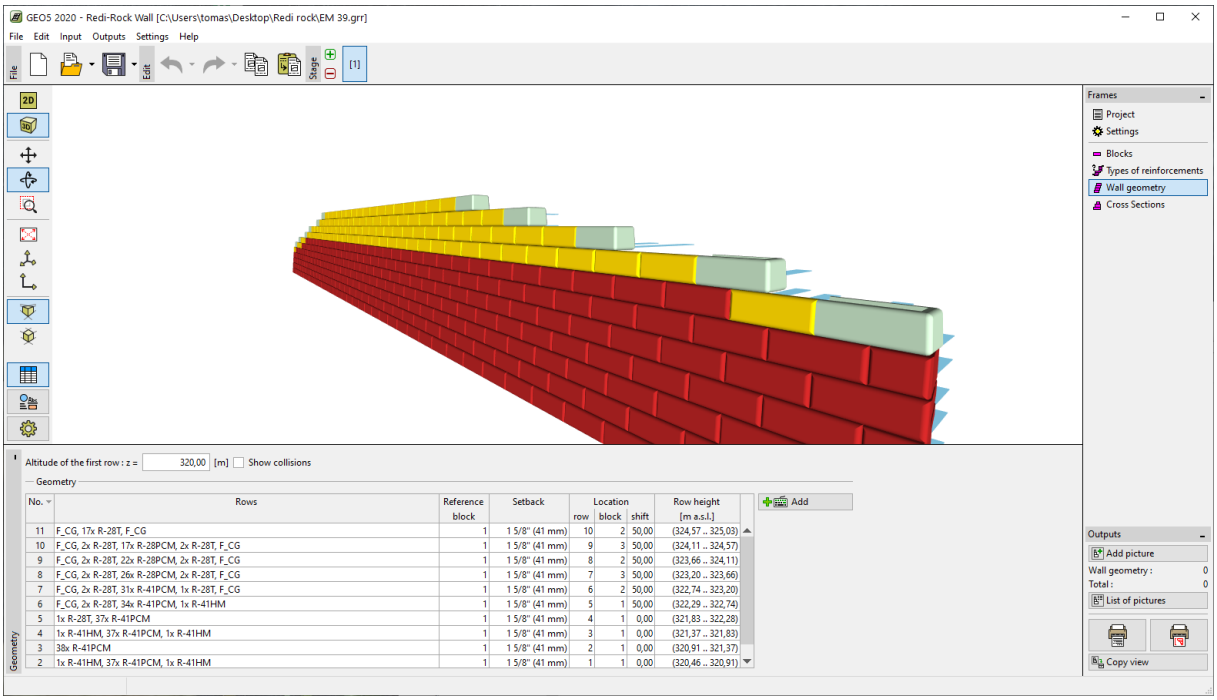
Enter the Miragrid 10XT reinforcement with a length of 4 m for the R-41PCM blocks and Miragrid 5XT for the R-28PCM blocks. This dialog window can be used just for the input of the desired reinforcement and its length.



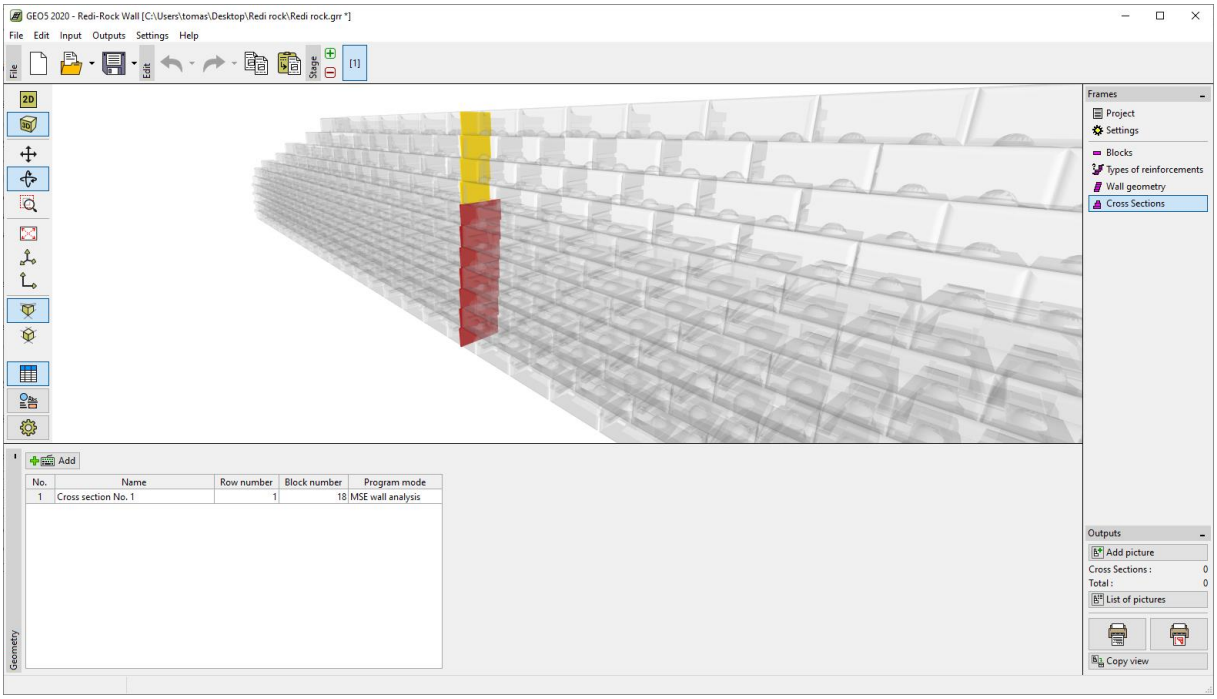
The reinforcement is shown as a dashed line on the upper part of the blocks.



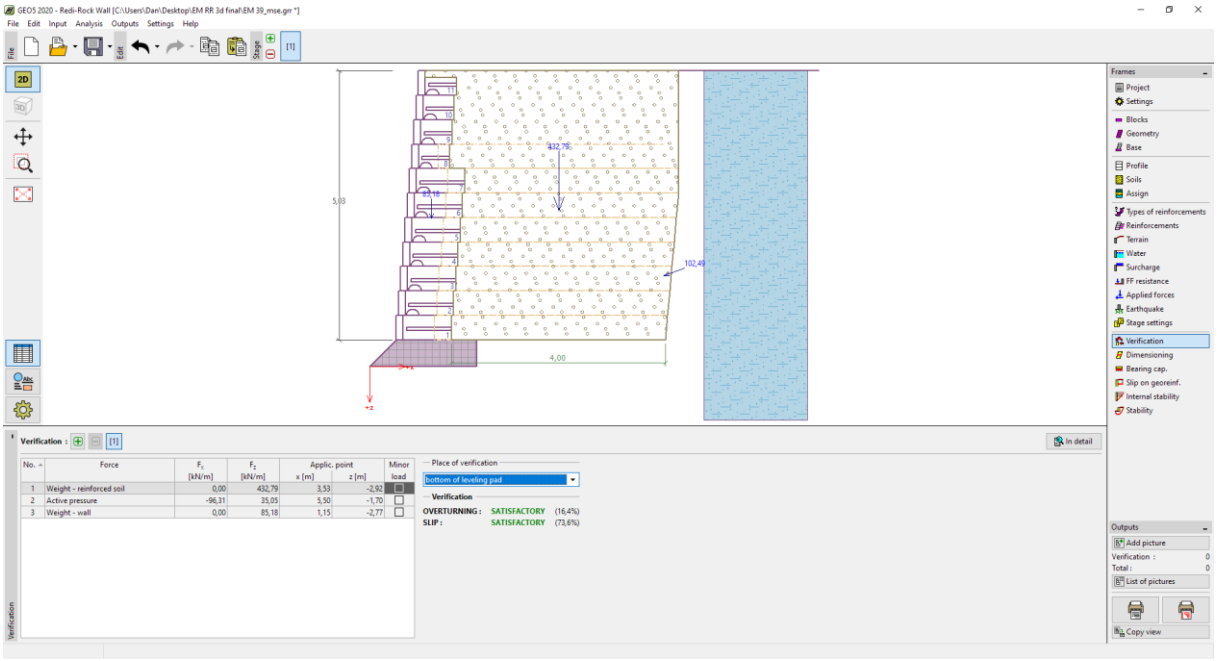
In any case, it is much easier to visualize it in 3D mode.



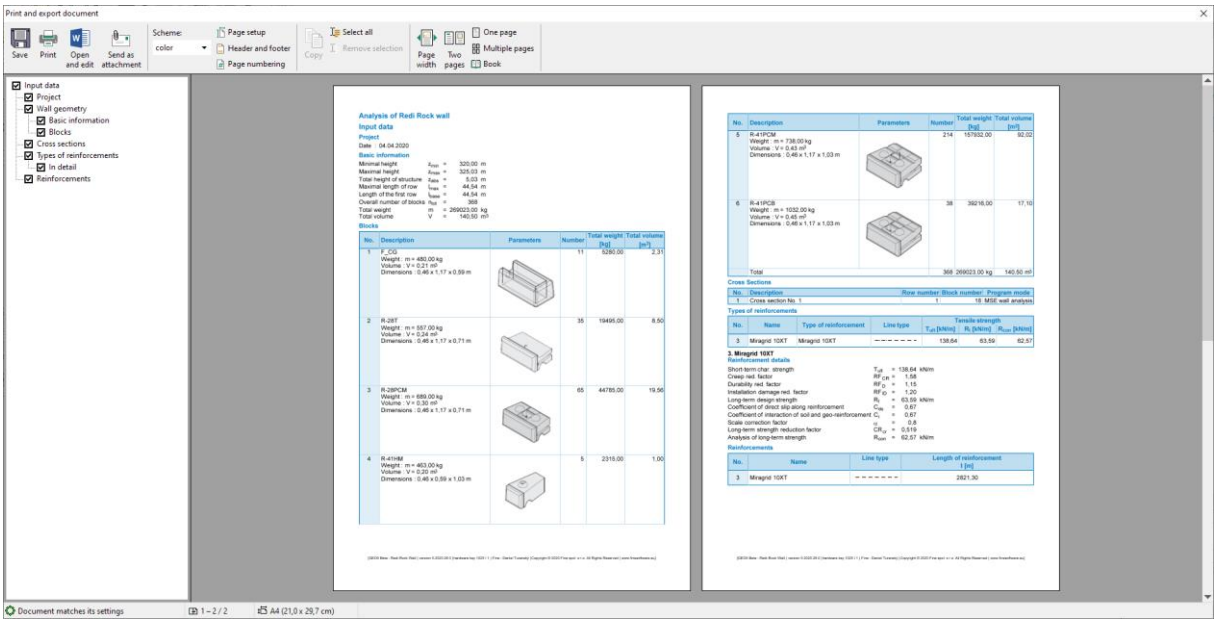
We will go to cross-sections and generate a section for analysis.



If the wall is not suitable or is not economically designed, we can change it and optimize the design. After that, we will return to the 3D mode and make any necessary modifications to block size, geogrid strength, or geogrid length.



In the detailed output documentation, we have information of the total number of blocks, their total weight, and also information about total length of all reinforcements used in the wall.



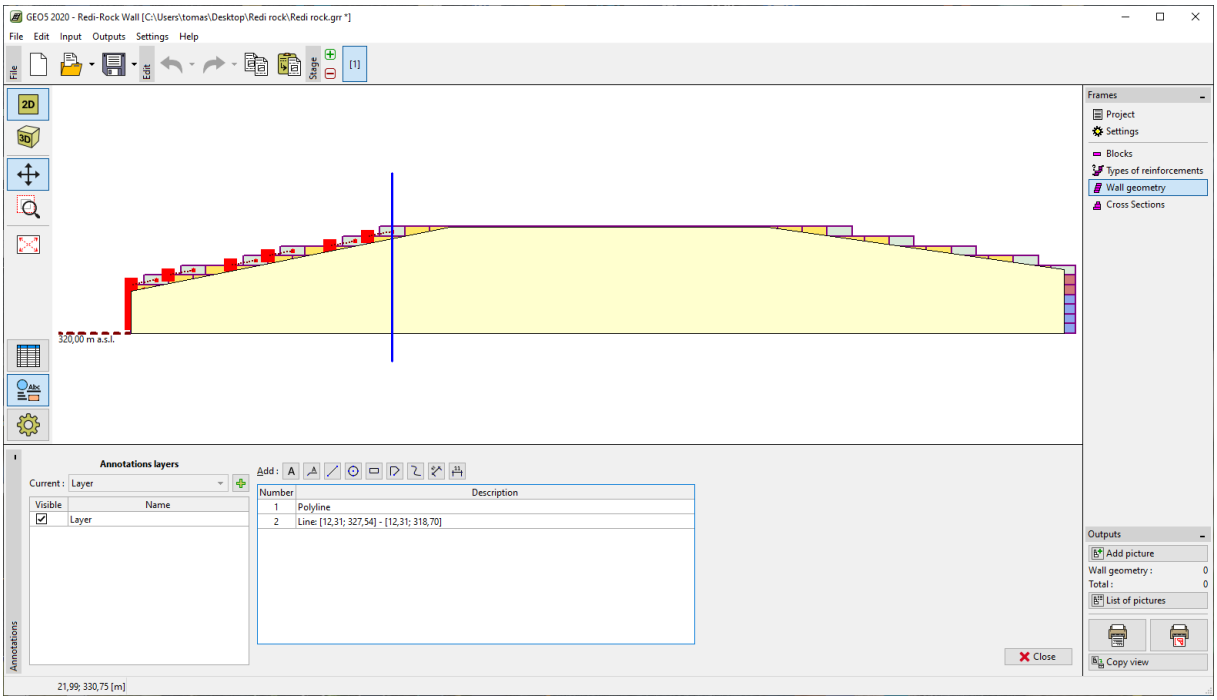
In the end we can compare costs for both options and decide which design is preferred.

Bonus

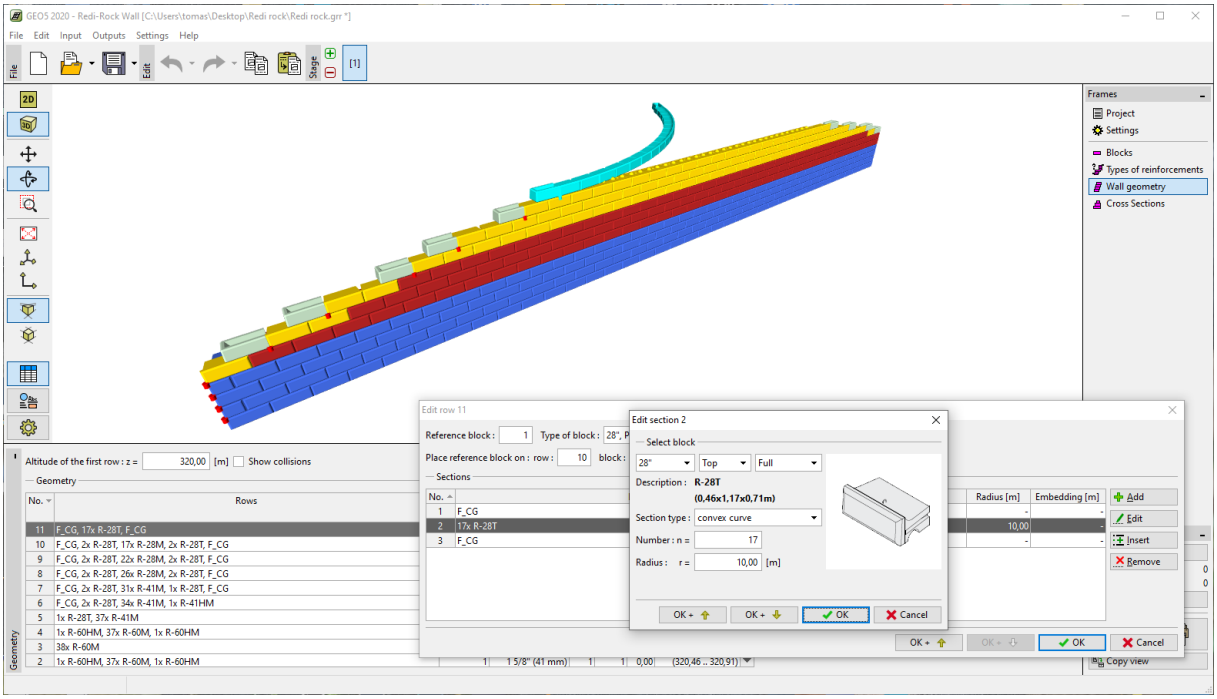
When modeling walls, the most difficult task is to model a curve. In this example, we will change the geometry of the gravity wall, where the top of the wall is in an arc with a 10m radius.

Solution:

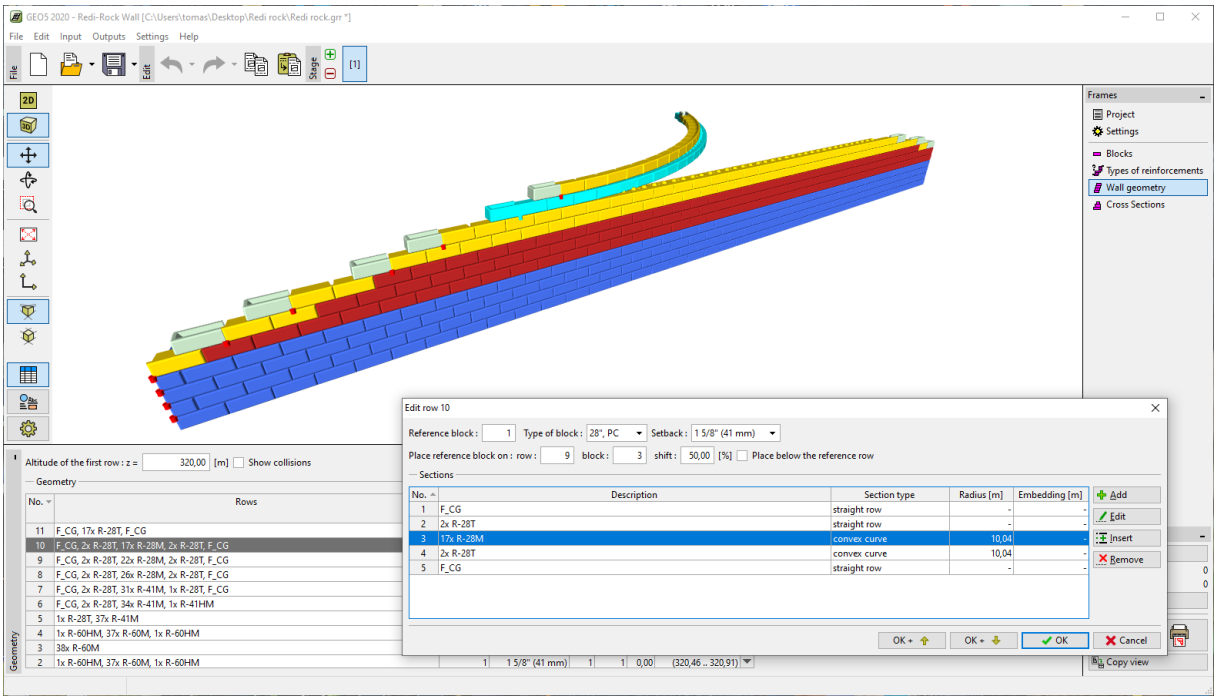
We will switch to the annotations mode and draw a line representing the start of the arc



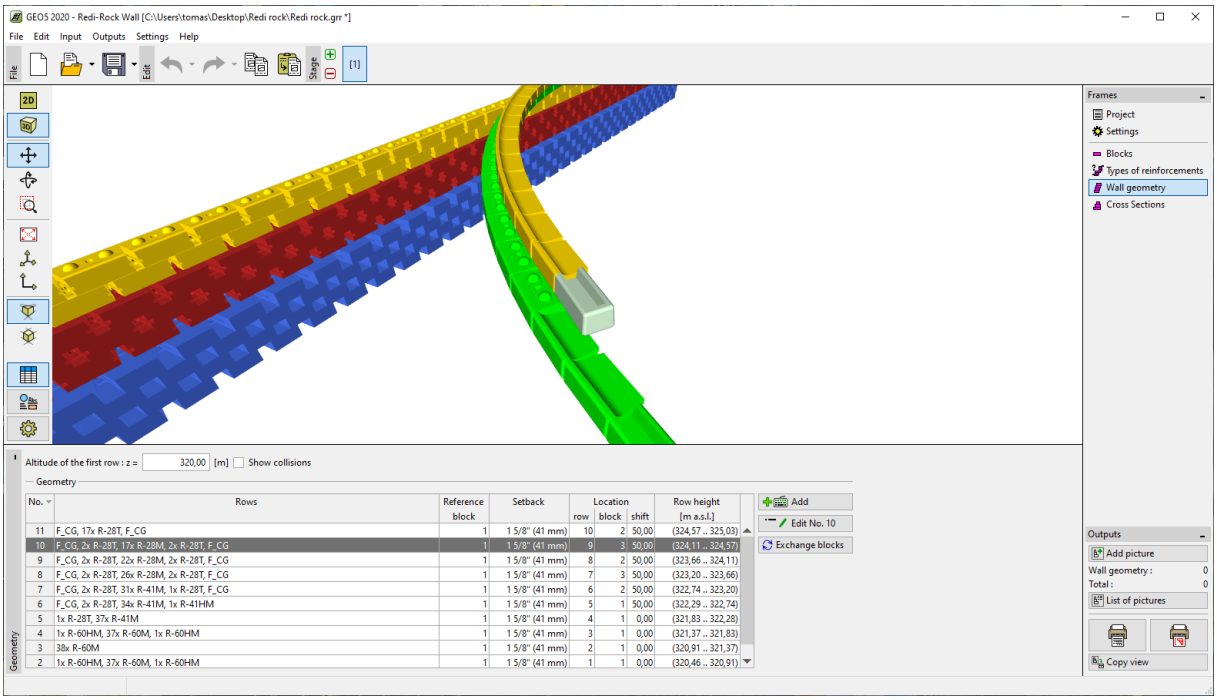
We will edit the most upper part of the wall – we will enter a convex arc with a 10 m radius.



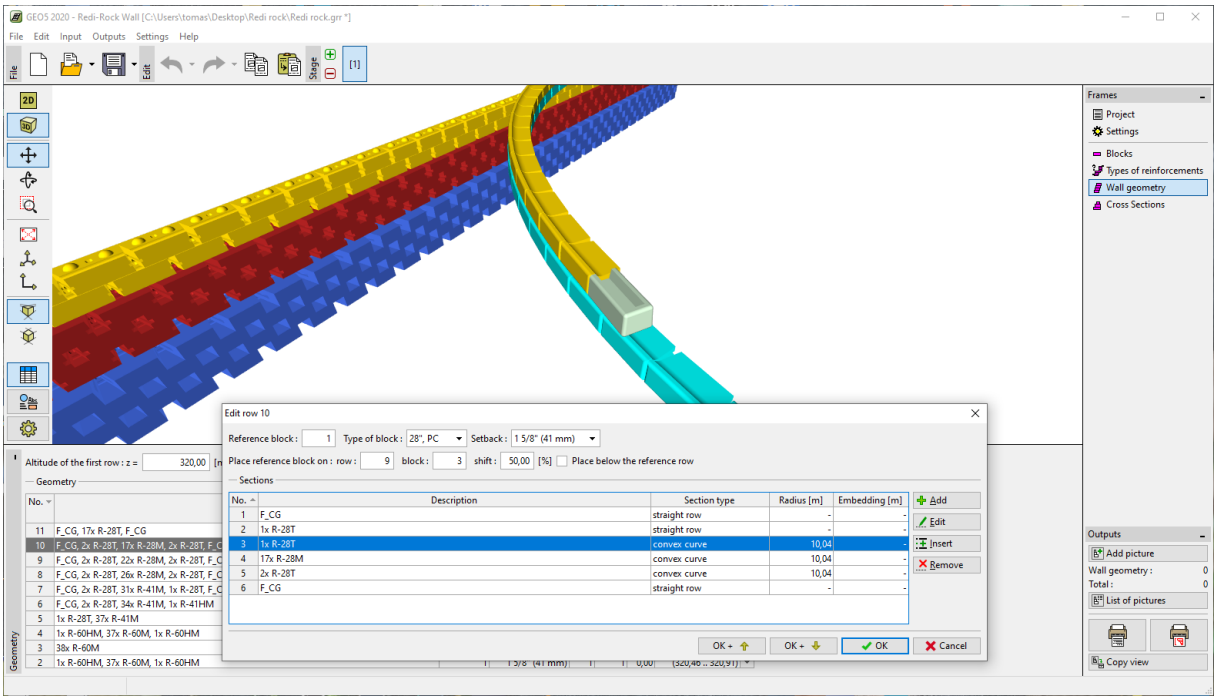
We will go to the second row and enter the arc for the seventeen R-28M blocks and two end R-28T blocks. The radius of the arc will be 10.04 m, as the wall setback is 41mm. The radius has to change by this value in each row to account for the wall batter.



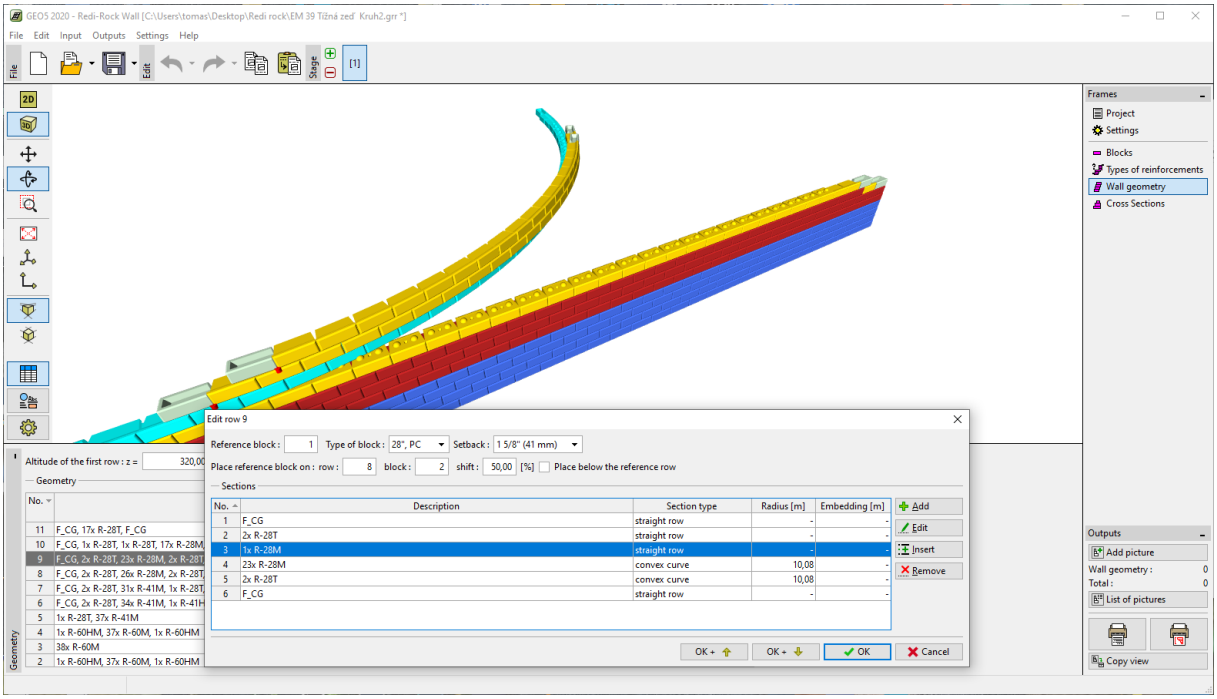
We will view the result - we can see here that the model is not correct. We must begin the curvature one block earlier.



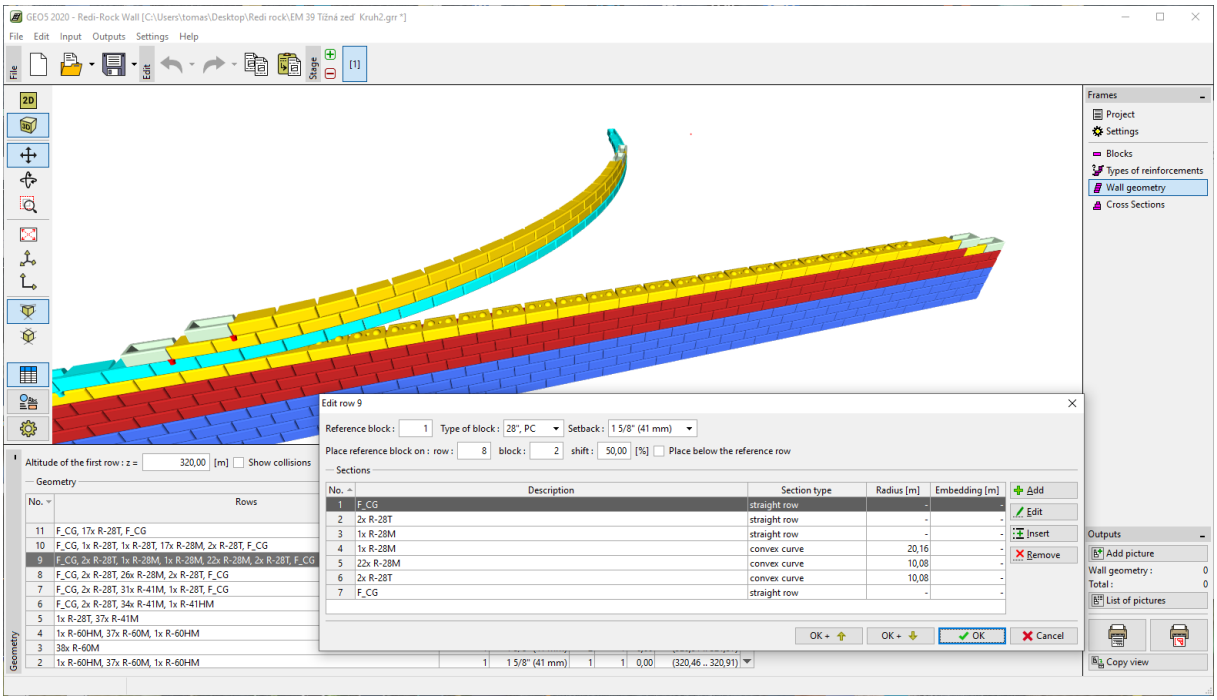
We will divide the two R28-T blocks into two entries and input the arc on the second block. The row is now correctly input.



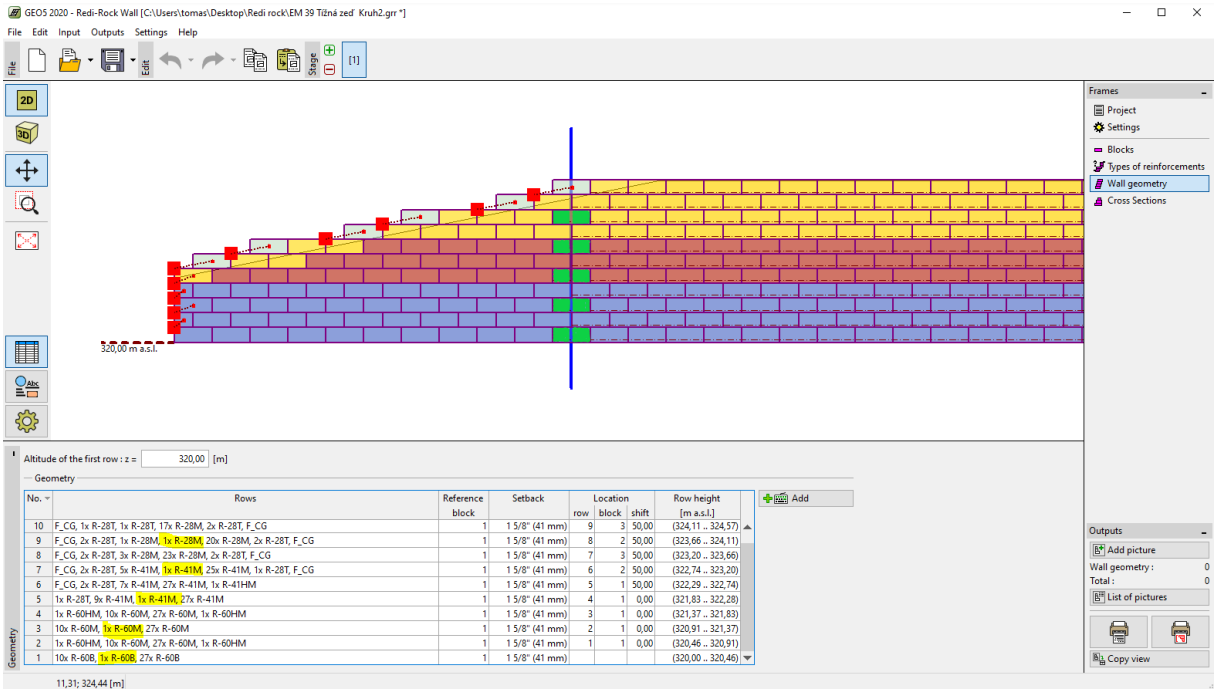
In the next row, one R-28M block is straight, the other 22 blocks are then part of the curve. The arc radius in this row is 10.08 m. The result is not correct since the curve begins halfway along a block.



We will make the necessary correction. The block that starts the curve has to have twice the arc radius (20.16 m).



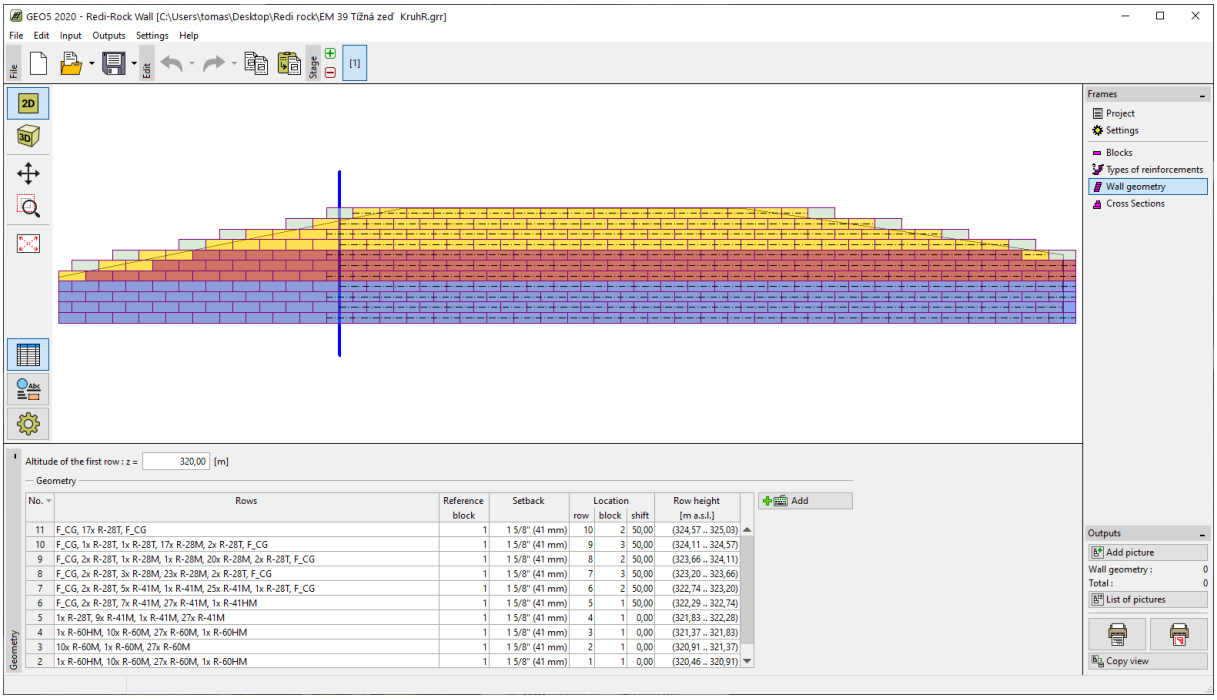
Other rows will be modeled in the same way. Radius **r** of each next row has to be increased by the row-to-row setback (41mm). Blocks in green must be entered separately with an arc diameter of **2*r**. All other blocks beyond the line have the same radius **r**.



Here is the final block division:

No.	Rows	Reference block	Setback	Location row	Location block	Location shift	Row height [m a.s.l.]
10	F_CG, 1x R-28T, 1x R-28T, 17x R-28M, 2x R-28T, F_CG	1	1 5/8" (41 mm)	9	3	50,00	(324,11 .. 324,57)
9	F_CG, 2x R-28T, 1x R-28M, 1x R-28M, 20x R-28M, 2x R-28T, F_CG	1	1 5/8" (41 mm)	8	2	50,00	(323,66 .. 324,11)
8	F_CG, 2x R-28T, 3x R-28M, 23x R-28M, 2x R-28T, F_CG	1	1 5/8" (41 mm)	7	3	50,00	(323,20 .. 323,66)
7	F_CG, 2x R-28T, 5x R-41M, 1x R-41M, 25x R-41M, 1x R-28T, F_CG	1	1 5/8" (41 mm)	6	2	50,00	(322,74 .. 323,20)
6	F_CG, 2x R-28T, 7x R-41M, 27x R-41M, 1x R-41HM	1	1 5/8" (41 mm)	5	1	50,00	(322,29 .. 322,74)
5	1x R-28T, 9x R-41M, 1x R-41M, 27x R-41M	1	1 5/8" (41 mm)	4	1	0,00	(321,83 .. 322,28)
4	1x R-60HM, 10x R-60M, 27x R-60M, 1x R-60HM	1	1 5/8" (41 mm)	3	1	0,00	(321,37 .. 321,83)
3	10x R-60M, 1x R-60M, 27x R-60M	1	1 5/8" (41 mm)	2	1	0,00	(320,91 .. 321,37)
2	1x R-60HM, 10x R-60M, 27x R-60M, 1x R-60HM	1	1 5/8" (41 mm)	1	1	0,00	(320,46 .. 320,91)
1	10x R-60B, 1x R-60B, 27x R-60B	1	1 5/8" (41 mm)				(320,00 .. 320,46)

The curved blocks are marked in 2D view by the line in the middle.



The final result of our effort is this 3D model of our wall: