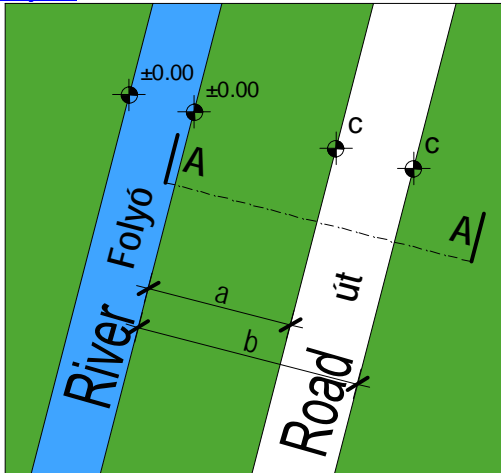


Exercise

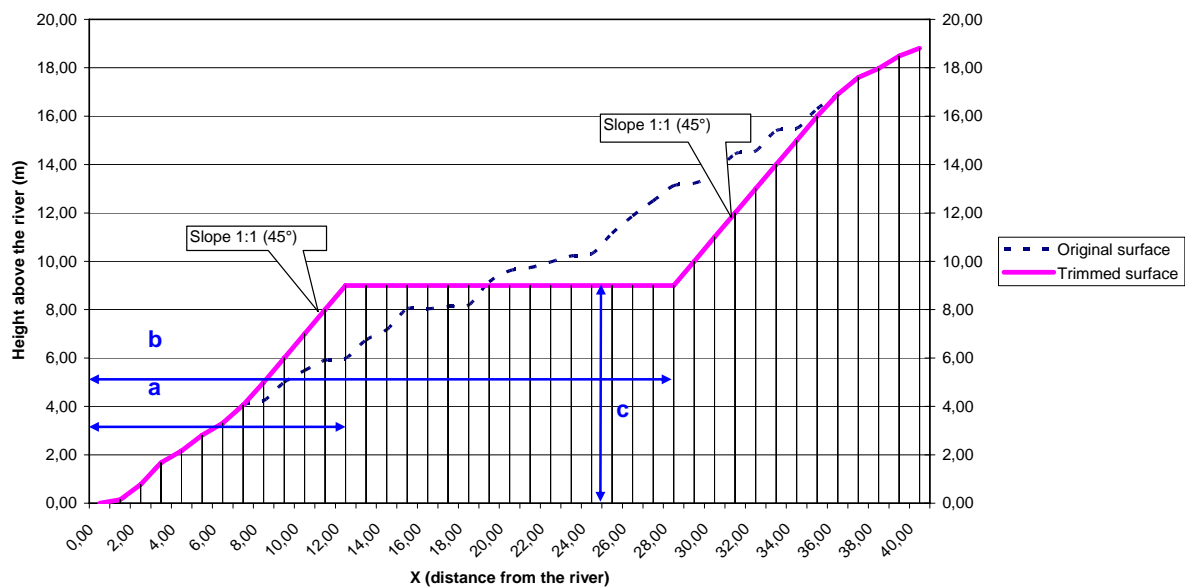
The map shows a river and a parallel road. The area has a slope toward the river, the cross-section shown on A-A section (the cross-section does not change along the leg considered). A geodetic survey is available: the height from the river is measured in each 1 m. The data is in the [Survey.txt](#) file.



To build the road along the river, a horizontal plateau should be formed, which connects to the original surface with a 1:1 (45°) slope. Distances: $a = 12$ m, $b = 28$ m, $c = 9.00$ m.

1. Create the chart of the original and the trimmed surface.
2. Calculate the excavated and the refilled amount of soil per meter.
3. What should be the level of the road (c) so that the landscaping can be solved without soil transport (i.e. the amount of excavated and refilled soil is equal). Other parameters of the road (a , b) is unchanged.

**A-A section
(original and trimmed surface)**

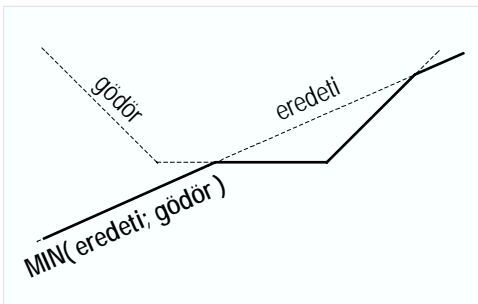
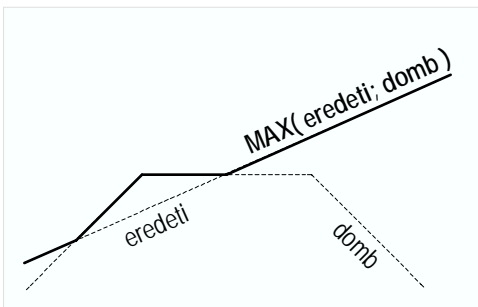


Principles of the solution

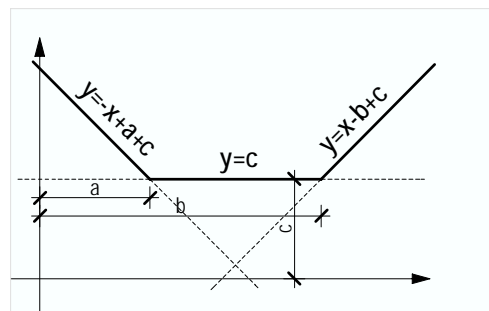
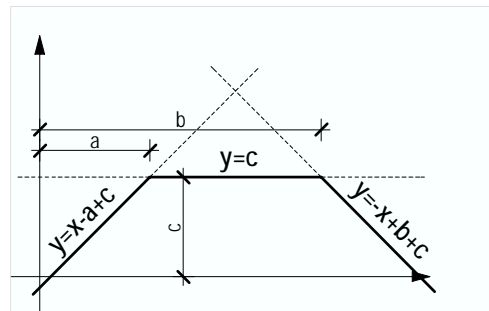
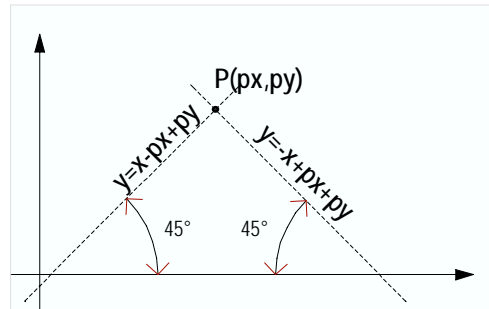
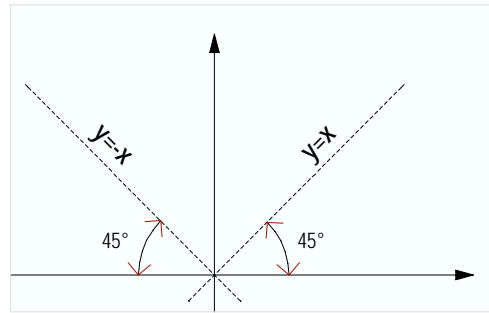
Let's calculate separately the modifications for the excavation and for the refillment.

We can draw the contours of the „hill” independently from the original surface. Comparing the height of the hill and the original surface point-by-point, and selecting always the higher we get the refilled surface. In a similar manner, comparing the contour of the cutting and the previous surface, and selecting always the lower, we get the trimmed surface.

The contour function of the hill makes up of three functions: two for the slopes and one for the plateau, and always the lowest is considered. Similar way, to get the hole, we have to consider the highest of the three functions (see figures).



To get the slope functions see the following figures.



To calculate the amount of soil to move, we can use the trapeze-method: we have to calculate the area between the original and the trimmed surface. We examine only 1 m length of road, so the width and the length of the trapezoid prism is also 1 m.

Solution table

x (distance)	Original surface	Hill			Hole			Trimmed surface
		slope	with surf.	difference	slope	with surf.	difference	
0,00	0,00	-3,00	0,00	0,00	21,00	0,00	0,00	0,00
1,00	0,15	-2,00	0,15	0,00	20,00	0,15	0,00	0,15
2,00	0,77	-1,00	0,77	0,00	19,00	0,77	0,00	0,77
3,00	1,68	0,00	1,68	0,00	18,00	1,68	0,00	1,68
4,00	2,16	1,00	2,16	0,00	17,00	2,16	0,00	2,16
5,00	2,81	2,00	2,81	0,00	16,00	2,81	0,00	2,81
6,00	3,31	3,00	3,31	0,00	15,00	3,31	0,00	3,31
7,00	4,06	4,00	4,06	0,00	14,00	4,06	0,00	4,06
8,00	4,24	4,76	4,24	0,00	13,00	4,24	0,00	5,00
9,00	4,99	6,00	6,00	1,01	12,00	4,99	0,00	6,00
10,00	5,49	7,00	7,00	1,51	11,00	5,49	0,00	7,00
11,00	5,91	8,00	8,00	2,09	10,00	5,91	0,00	8,00
12,00	5,99	9,00	9,00	3,01	9,00	5,99	0,00	9,00
13,00	6,74	9,00	9,00	2,26	9,00	6,74	0,00	9,00
14,00	7,18	9,00	9,00	1,82	9,00	7,18	0,00	9,00
15,00	8,03	9,00	9,00	0,97	9,00	8,03	0,00	9,00
16,00	8,03	9,00	9,00	0,97	9,00	8,03	0,00	9,00
17,00	8,14	9,00	9,00	0,86	9,00	8,14	0,00	9,00
18,00	8,19	9,00	9,00	0,81	9,00	8,19	0,00	9,00
19,00	9,14	9,00	9,14	0,14	9,00	9,14	0,00	9,00
20,00	9,60	9,00	9,60	0,00	9,00	9,60	0,60	9,00
21,00	9,74	9,00	9,74	0,00	9,00	9,00	0,74	9,00
22,00	9,97	9,00	9,97	0,00	9,00	9,00	0,97	9,00
23,00	10,22	9,00	10,22	0,00	9,00	9,00	1,22	9,00
24,00	10,30	9,00	10,30	0,00	9,00	9,00	1,30	9,00
25,00	11,16	9,00	11,16	0,00	9,00	9,00	2,16	9,00
26,00	11,87	9,00	11,87	0,00	9,00	9,00	2,87	9,00
27,00	12,50	9,00	12,50	0,00	9,00	9,00	3,50	9,00
28,00	13,12	9,00	13,12	0,00	9,00	9,00	4,12	9,00
29,00	13,22	8,00	13,22	0,00	10,00	10,00	3,22	10,00
30,00	13,60	7,00	13,60	0,00	11,00	11,00	2,60	11,00
31,00	14,44	6,00	14,44	0,00	12,00	12,00	2,44	12,00
32,00	14,56	5,00	14,56	0,00	13,00	13,00	1,56	13,00
33,00	15,40	4,00	15,40	0,00	14,00	14,00	1,40	14,00
34,00	15,49	3,00	15,49	0,00	15,00	15,00	0,49	15,00
35,00	16,31	2,00	16,31	0,00	16,00	16,00	0,31	16,00
36,00	16,90	1,00	16,90	0,00	16,00	16,90	0,00	16,90
37,00	17,60	0,00	17,60	0,00	18,00	17,60	0,00	17,60
38,00	17,97	-1,00	17,97	0,00	19,00	17,97	0,00	17,97
39,00	18,49	-2,00	18,49	0,00	20,00	18,49	0,00	18,49
40,00	18,81	-3,00	18,81	0,00	21,00	18,81	0,00	18,81
Sum:			16,07		Sum:	29,63		

Amount of soil to fill up per meter:	16,07
Amount of excavated soil per meter:	29,63
Balance:	13,56
Excess:	13,56

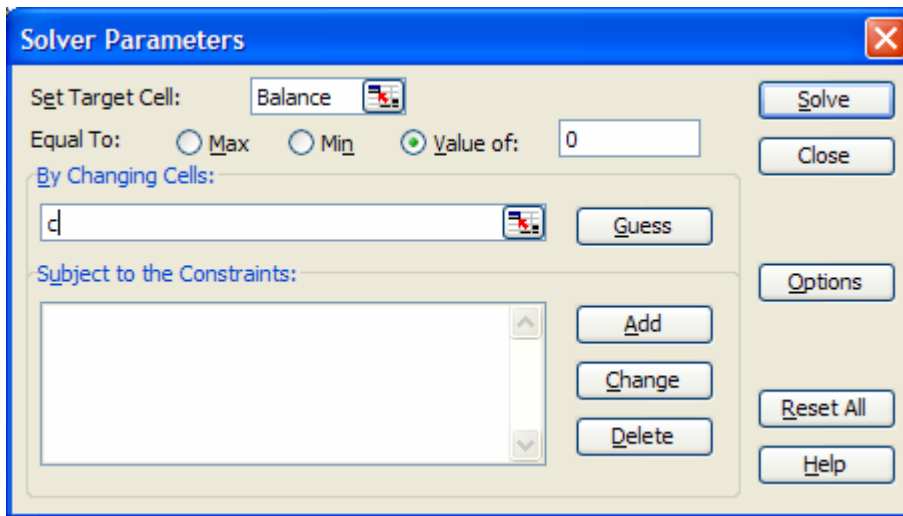
Parameters:
a: 12,00
b: 28,00
c: 9,00

IF(H53>0 ; "Excess:" ; "Deficit:")

ABS(H53)

Calculation of the ideal plateau height

If we create the adequate parameters in the table, the problem can be solved easily with solver. Changing the value of c we should obtain that the balance is 0



Solution: the height is 9.47 m above river, when the excavated and filled amount of soil is 22.43 m³ per meter.