

Handout to prepare homework Settlement Monitoring of a Building in Field Course of Structural Geodesy.

Budapest University of Technology and Economics, Department of Geodesy and Surveying.
Prepared by Bence Takács, 14 October 2019

Homework exercises in pdf format are available in the Education system (edu.epito.bme.hu) on the site of the course. Please download the file and find your page. The name of each student is given in the left-upper corner. The first option is to print out your page and carry out all the calculations using a calculator and write down the results manually. The second option is to develop an excel table and the computer does all the calculations and prepare the final documentation.

In the first part you have to calculate a levelling line. Distances, height differences and the reduced level value of the start and end point are given as follows:

point	distance	height difference [cm]					elevation [m]
		forward	backward	average	correction	corrected	
XXI							105.7891
XXII	13.1	-3.382	+3.355				
XXIII	4.8	+8.640	-8.603				
XXIV	10.6	-0.430	+0.395				
XXV	6.7	-9.664	+9.674				105.7407

Steps of calculation:

1. Calculate the mean of forward and reversed measurements. Please keep in mind that forward and reversed height differences have opposite sign, therefore the mean height difference is calculated as the mean of the absolute values of forward and reversed measurements. Furthermore the mean height difference has the same sign as the forward one. Do not forget to put the sign, even in case of positive values. Please also note that height differences are expressed in centimetre with hundredth of mm precision (with three decimals). This also means that mean values should be expressed with the same precision, not more and not less than three decimals. In case of the mean value mathematically ends with half hundredth of mm, like in the first row, the mean value according to the Hungarian customs should be rounded to the even integer value.
2. Calculate the sum of mean values which is the measured height difference of start and end points.

point	distance	height difference [cm]					elevation [m]
		forward	backward	average	correction	corrected	
XXI							105.7891
XXII	13.1	-3.382	+3.355	-3.368			
XXIII	4.8	+8.640	-8.602	+8.621			
XXIV	10.6	-0.430	+0.395	-0.412			
XXV	6.7	-9.664	+9.674	-9.669			105.7407
				$\Sigma=-4.828$			

- Calculate the height difference of start and end point from the given reduced levels.
- Compare the measured and given height differences. If they fit to each other within the preliminary given tolerance, which is a few tenth of millimetre in the exercise, the measured value should be adjusted to the given one. Their difference is called closure error (or misclosure), in this example this is -0,012 centimetre or -0,12 millimetre. Pay special attention to the sign of closure error.

point	distance	height difference [cm]					elevation [m]
		forward	backward	average	correction	corrected	
XXI							105.7891
XXII	13.1	-3.382	+3.355	-3.368			
XXIII	4.8	+8.640	-8.602	+8.621			
XXIV	10.6	-0.430	+0.395	-0.412			
XXV	6.7	-9.664	+9.674	-9.669			105.7407
				-4.828	-0.012		$\Delta=-0.0484$

- The closure error should be divided proportionally with distances. The longer the distance is the higher the correction becomes. Please note that precision is still the same (three decimals in centimetre). Check the sum of the corrections. It should be exactly equal to the closure error.

point	distance	height difference [cm]					elevation [m]
		forward	backward	average	correction	corrected	
XXI							105.7891
XXII	13.1	-3.382	+3.355	-3.368	-0.004		
XXIII	4.8	+8.640	-8.602	+8.621	-0.002		
XXIV	10.6	-0.430	+0.395	-0.412	-0.004		
XXV	6.7	-9.664	+9.674	-9.669	-0.002		105.7407
	35.2			-4.828	-0.012		-0.0484

6. Correct your measurements.
7. Calculate the sum of your corrected measurements. It should be the same as the given height difference of start and end point.

point	distance	height difference [cm]					elevation
		forward	backward	average	correction	corrected	[m]
XXI							105.7891
XXII	13.1	-3.382	+3.355	-3.368	-0.004	-3.372	
XXIII	4.8	+8.640	-8.602	+8.621	-0.002	+8.619	
XXIV	10.6	-0.430	+0.395	-0.412	-0.004	-0.416	
XXV	6.7	-9.664	+9.674	-9.669	-0.002	-9.671	105.7407
	35.2			-4.828	-0.012	$\Sigma=-4.840$	-0.0484

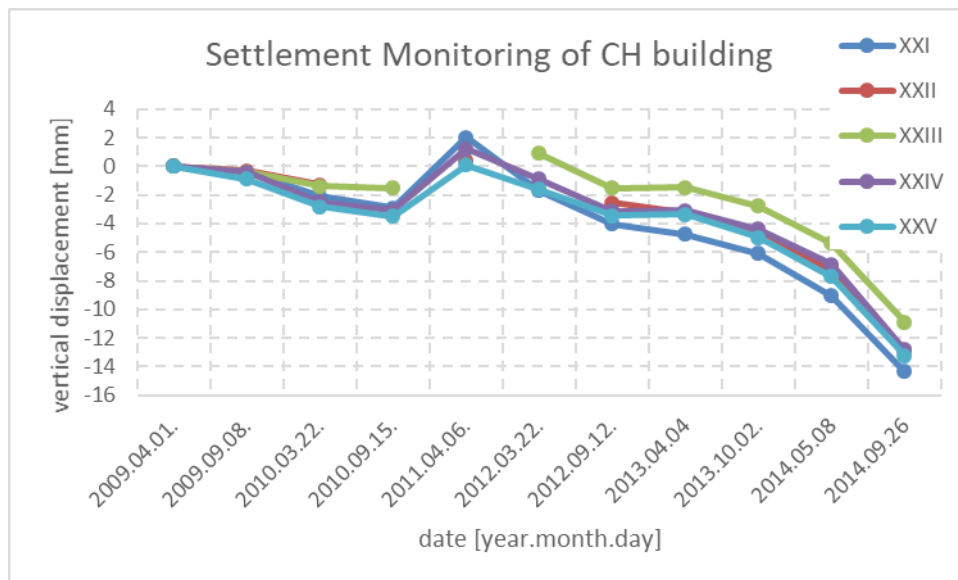
8. Calculate the height of the points in the line. Do not forget that height differences are expressed in cm, but the reduced levels are in metre. As a final check, you will get the given height of your end point. Despite the fact that the reduced level of the start and the end points are given with the precision on “only” one tenth of mm, the reduced levels should be computed with the precision of the observations (one hundredth of millimetre). The final reduced levels will be rounded later to one tenth of a millimetre, since the accuracy of the reduced levels is about a few tenth of a millimetre.

point	distance	height difference [cm]					elevation
		forward	backward	average	correction	corrected	[m]
XXI							105.7891
XXII	13.1	-3.382	+3.355	-3.368	-0.004	-3.372	105.75538
XXIII	4.8	+8.640	-8.602	+8.621	-0.002	+8.619	105.84157
XXIV	10.6	-0.430	+0.395	-0.412	-0.004	-0.416	105.83741
XXV	6.7	-9.664	+9.674	-9.669	-0.002	-9.671	105.7407
	35.2			-4.828	-0.012	$\Sigma=-4.840$	-0.0484

In the second part of your homework, you have to calculate vertical displacements. Please download the previously observed reduced levels of your points from the Education system. Calculate their vertical displacements of the points with respect to the initial and the previous measurement. Use the current reduced level of our points determined in the first part of your homework. In this calculation millimetre dimension with one tenth of a mm precision is suggested. Finally the recent displacement rates are calculated. This information in the real life is important for example to plan the epoch of the next measurement.

	XXI	XXII	XXIII	XXIV	XXV
01.04.2009	105.8034	105.7683	105.8525	105.8502	105.7539
08.05.2014	105.7943	105.7610	105.8471	105.8434	105.7462
26.09.2014	105.7891	105.7554	105.8416	105.8374	105.7407
Settlements to the the initial epoch [mm]	14.3	12.9	10.9	12.8	13.2
Settlement to the previous epoch [mm]	5.2	5.6	5.5	6.0	5.5
Present speed [mm/month]	1.1	1.2	1.2	1.3	1.2

In the third part you have to visualize the calculated vertical displacement values. The most simple way is to plot the times series of the vertical displacements. Please note that the vertical displacements must be visualized, not the reduced level of your points. Do not forget to add axis titles with the dimension. At the end of the practice other options for visualization are also presented, feel free to develop other type of graphs, drawings in accordance with the common standards.



You are expected to submit just a single page by e-mail. Please have all the three parts of the homework just on one page: (1) a table of the levelling line; (2) a table of the displacement values and (3) your plot. Do not forget to write your name, neptun code and the date. A digital photo should be taken of your sheet of paper in case of manual work or a pdf file should be generated in case of using an excel table. Pay attention to have just one file and just a single page. You must avoid sending several files in different formats.