

Student number: 1911552
Module Code: ACBA4002

Practical Assignment

Levelling Computation

Contents:

- 1.0 Introduction
- 2.0 Levelling Surveying Overview
- 3.0 Levelling Equipment
- 4.0 Levelling procedure
- 5.0 Computation and Plotting of Level
- 6.0 Conclusion

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1. Introduction

Swansea City Council intends to build a new route connecting Llandarcy and Neath. The client has requested that I conduct a levelling survey along the proposed road. I will explain how to carry out the levelling exercise step by step, illustrating the equipment I'll use for the survey and the data I'll collect. I will calculate and map the reduced level of the points using either the rise and fall or height of collimation methods using the given data set as the observed spot levels taken at every 25m interval along the stretch of the proposed path. I will also estimate the volume of earthwork required by assuming the road's slope and a straight line connecting the TBM's reduced level and the reduced level of station 40. I will be discussing levelling surveying in general as well as showing my working out using the information from the levelling survey already completed. I will illustrate my work through tables and graphs

2. Levelling Surveying Overview

The method of assessing the height of one level in relation to another is known as levelling. It is used in surveying to determine a point's elevation, relative to a datum or to establish a point's elevation relative to a datum. There are a few types of levelling, the first being Profile Levelling. Profile levelling is a surveying technique used to determine the central line of a land track on which a linear engineering work is to be built or laid. Profile levelling is the process of assessing the elevation of the ground surface at small spatial intervals along a line. Another type is Reciprocal levelling. While using the reciprocal levelling method, to eliminate potential atmospheric and curvature errors, height measurements are taken in both directions between two points at great distances. The last form of Levelling surveying is Differential levelling, this is a method for determining elevation variations between points that are far apart. A surveyor's level and graduated measuring rods are needed for differential levelling. A vertical distance above or below a referenced datum is referred to as elevation.

Why is levelling important? Well, it helps the surveyor in creating a contour map of the land surface or sea surface. as well as assisting surveyors in establishing a ground level on which to construct a building. Also, it helps the pipe transport engineer in ensuring an appropriate slope of land that will allow for the smooth movement of liquid. While levelling the objective is to gain data from relevant field work. To calculate reduced level of different points/station.

Here are some terms involved in levelling.

Line of Sight- The line that extends from the optical centre of the eyepiece to the eye.

Benchmark- The elevation of a point is known as a benchmark. Typically, we use MSL (Mean Sea Level) or have a surveyor shift the benchmark based on the field.

Back sight- The first reading we take after calibrating an instrument or setting a benchmark on the field.

Fore sight- The last reading we take before shifting our instrument, or at a change or turning point.

Intermediate sight- The reading between the Back sight and fore sight is called an intermediate sight.

3. Levelling Equipment

The level instrument is mounted on a tripod and either roughly or precisely levelled using foot screws (Levelling screws), depending on the style. The surveyor looks through the telescope's eyepiece, while an assistant stands vertically at the measuring point with a tape measure or graduated staff. During site surveys, the instrument and a staff are used to collect and/or pass elevation. The measurement usually begins at a known height established by a previous survey, or at an arbitrary point with an assumed height. A dumpy level is an older-style instrument that requires precision setting. To ensure accuracy during a complete 360-degree traverse, the instrument must be levelled in each quadrant.

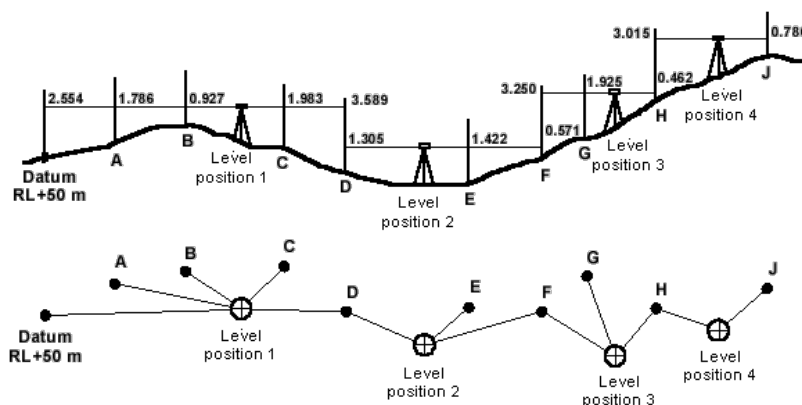
Another levelling instrument is a digital electronic level, which is usually mounted on a tripod and reads a bar-coded staff using electronic laser methods. On a graphical monitor, the height of the staff where the level beam crosses the staff is shown. This degree eliminates a person's interpolation of graduation, eliminating a source of error and improving accuracy.

A telescopic sight is the first type of sight. A long spirit level is connected to the bubble and adjusted so that the bubble centres when the line of sight is horizontal, like that of a transit but with a slightly higher magnification. A dumpy level is also known as a levelling instrument, a builder's auto level, or an automatic level. It is an optical instrument used to pass measure or set horizontal levels in surveying and construction. A tilting level is a variant of the dumpy that was commonly used by surveyors when greater accuracy and error checking were needed. Without spinning the head, this instrument allows the telescope to be easily flipped through 180 degrees. The telescope is hinged to one side of the instrument's axis, and flipping it requires raising the telescope to the opposite side of the central axis.

A level staff, also known as a levelling rod, is a graduated wooden or aluminium rod that can be used to determine variations in metric graduation on the left and imperial graduation on the right. Some levelling rods are one piece, but many are sectional and can be shortened for storage and transport or lengthened for use. The length of aluminium rods can be adjusted by telescoping parts within each other, while wooden rod sections are connected by sliding connections or slip joints. Rods come in a variety of shapes and sizes, with names that indicate the graduations' shape and other characteristics. The units of measurement may be in imperial or metric. Some rods have just one side labelled, while others have both sides marked.

4. Levelling Procedure

A 'series' of levels must be undertaken to assess the difference in level between points on the ground's surface; this is known as a level traverse or level run. This is illustrated in the figure below;



Student number: 1911552

Module Code: ACBA4002

The procedure

First you set the level at point 1. Take a reading while keeping the staff on the Datum. As this is the first staff reading after the levelling instrument has been set up, it will be a back sight. Move the staff to the next point which in this case will be 25m apart from each other and take a reading. This will be an intermediate sight. These intermediate sights will be 25m apart but the last point before the level will be moved will be called a fore sight. The distances between points will be measured and logged as well as the readings. This process will be repeated over 1km.

The data I gathered has been recorded and the reduced level has been worked out in the table below:

Back Sight	Intermediate Site	Fore Sight	Height of Collimation	Reduced Level	Chainage	Remarks
1.371			553.371	552.000	0.000	TBM
	2.354			551.017	25.000	STN. 1
	1.222			552.149	50.000	STN. 2
	2.591			550.780	75.000	STN. 3
1.432		3.587	551.216	549.784	100.000	STN. 4 / Change PT. A
	1.872			549.344	125.000	STN. 5
3.250		0.573	553.893	550.643	150.000	STN. 6 / Change PT. B
	1.913			551.981	175.000	STN. 7
3.015		0.496	556.412	553.397	200.000	STN. 8 / Change PT. C
1.456		0.499	557.369	555.913	225.000	STN. 9 / Change PT. D
	3.853			553.516	250.000	STN. 10
	5.433			551.936	275.000	STN. 11
	5.200			552.169	300.000	STN. 12
	4.000			553.369	325.000	STN. 13
3.876		3.067	558.178	554.302	350.000	STN. 14 / Change PT. E
	4.533			553.645	375.000	STN. 15
	5.433			552.745	400.000	STN. 16
	5.867			552.311	425.000	STN. 17
	5.133			558.178	450.000	STN. 18
1.734		3.064	556.848	555.114	475.000	STN. 19 / Change PT. F
	1.280			555.568	500.000	STN. 20
	1.390			555.458	525.000	STN. 21
3.467		2.076	558.239	554.772	550.000	STN. 22 / Change PT. G
	4.147			554.092	575.000	STN. 23
3.371		1.976	559.634	556.263	600.000	STN. 24 / Change PT. H
	2.395			557.239	625.000	STN. 25
	2.562			557.072	650.000	STN. 26
	2.591			557.043	675.000	STN. 27
1.432		3.587	557.479	556.047	700.000	STN. 28 / Change PT. I
	1.872			555.607	725.000	STN. 29
1.675		0.573	558.581	556.906	750.000	STN. 30 / Change PT. J
1.734		3.064	557.251	555.517	775.000	STN. 31 / Change PT. K
	2.280			554.971	800.000	STN. 32
	2.390			554.861	825.000	STN. 33
3.467		3.000	557.718	554.251	850.000	STN. 34 / Change PT. L
	4.147			553.571	875.000	STN. 35
3.371		1.976	559.113	555.742	900.000	STN. 36 / Change PT. M
	1.395			557.718	925.000	STN. 37
	1.562			557.551	950.000	STN. 38
	1.859			557.254	975.000	STN. 39
		2.587		556.526	1000.000	STN. 40
34.651		30.125				
Check						
BS SUM		FS SUM				
34.651		30.125				
	34.651 - 30.125 =	4.526				
	556.26 - 552 =	4.526				

A check has been run by myself to ensure that there is no mistake made in the mathematical process of creating this table.

Computation and plotting of the levels

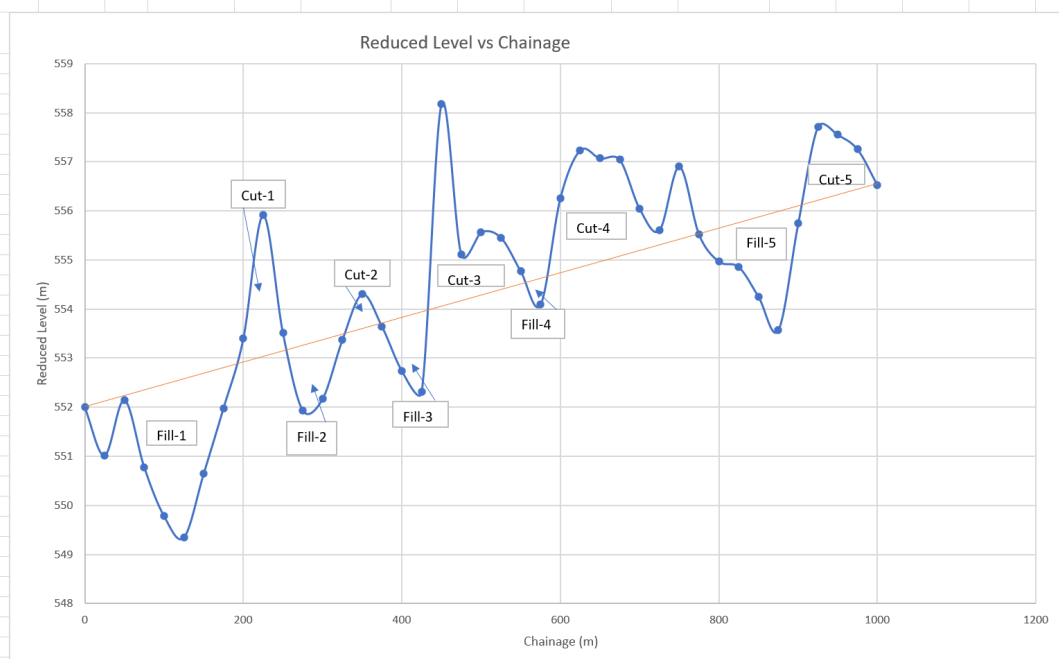
Student number: 1911552

Module Code: ACBA4002

Using the data from the previous table. I have made a line graph with a line running from the TBM to the final point. This allows us to see the necessary changes needed to create a smooth and flat surface by cutting out earthwork that is above the line and using it to fill in the dips below the line. The Smaller table below shows the working out of the estimated earthwork needing to be removed and filled. According to my calculations, there should be an estimated 110 cubic meters left over after using the earth to fill in the required areas.

By using the rectangles from the 'reduced level vs chainage' chart (which are 200 cubic meters), I have estimated how many of these rectangles/ units will fit into the dips in the line and where the earth needs removing. This allows us to use (unit volumeXunit) to calculate the cubic meters of earth needed. Then use (cut-fill) to equal how much earthwork needed removing or delivered to the site.

X-axis / Chainage	Y-axis / Reduced Level
0	552
25	551.017
50	552.149
75	550.78
100	549.784
125	549.344
150	550.643
175	551.981
200	553.397
225	555.913
250	553.516
275	551.936
300	552.169
325	553.369
350	554.302
375	553.645
400	552.745
425	552.311
450	558.178
475	555.114
500	555.568
525	555.458
550	554.772
575	554.092
600	556.263
625	557.239
650	557.072
675	557.043
700	556.047
725	555.607
750	556.906
775	555.517
800	554.971
825	554.861
850	554.251
875	553.571
900	555.742
925	557.718
950	557.551
975	557.254
1000	556.526



Volume of Earthworks			
Cut	Unit Volume	Number	Total Volume
1	200	0.75	150
2	200	0.2	40
3	200	1	200
4	200	1.3	260
5	200	0.75	150
			800
Fill	Unit Volume	Number	Total Volume
1	200	1.8	360
2	200	0.4	80
3	200	0.35	70
4	200	0.1	20
5	200	0.8	160
			690
Total Earthwork Vol			Cut-Fill 110

Conclusion

To conclude, the survey has completed its aims as the differences in elevation was determined. Over the span of 1km the plotted points all look relatively correct with no point extremely out of place and close to the mean line.

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