

ACBA 4002

LEVELLING PROCEDURE AND REDUCED LEVEL COMPUTATION
FOR UWTSD ROAD RECONSTRUCTION

Mariah Edwards
UWTSD | 2114464

Contents

Introduction	2
Procedure	3
Computation and plotting of levels.....	6
Conclusion.....	11
References.....	17

Introduction

Levelling survey is the procedure of obtaining the elevations of different points on a horizontal reference point by using an optical levelling instrument and a level staff.

Objectives

- To find the difference in height of points with respect to the assumed temporary benchmark having a reduced level of 464 m.
- To record spot levels along the campus.
- To compute and plot the reduced levels of points using the height of collimation method or rise and fall method.
- Estimate the volume of earthwork involved in the reconstruction of the road along the campus.

Equipment

Levelling Staff – graduated instrument that was held vertically to determine the difference in height between points.

Level – optical instrument that was used establish heights between points by peering through a telescope on to the face of the levelling staff.

Tripod – a supporting mechanism that the level was mounted on.

Tape – the tape was used to measure 20 m distance from each levelling station.

Field book – was used to record the different levelling data observed in the field.

Levelling survey terms and abbreviations:

Levelling Position (L.P) – this is the position where the level is set up.

Datum- is the reference point for recorded vertical measurements.

Temporary Benchmark (TBM) – fixed, semi-permanent reference point of known height above the assumed datum.

Reduced level (R.L) – is the height of a point or an object with reference to assumed datum.

Backsight (B.S) – the first sight or reading recorded from a level staff when a levelling instrument is set- up at the start of a fieldwork and at a changepoint.

It is taken from a point where an elevation is known, has been assumed or can be calculated.

Foresight (F.S) – this is the last sight or reading that is taken at a change point before the instrument is moved and at the end of the levelling operation.

Intermediate sight (I.S)- this is the reading taken after the backsight and before sighting or recording the change point.

Change point/ Turning point (C.P/ T.P)- this allows the levelling survey to continue at a new levelling position when there are obstructions in the line of sight during an exercise. It is where the B.S and F.S positions are recorded.

Line of collimation/ line of sight- the true level line observed through the optical centre of the level's telescope.

Procedure

Spot levels were taken at 20 m intervals between two points and recorded in the levelling book at each survey point along the route around the campus. (Figure 3)

The tripod was set up then the automatic level was attached to the tripod and adjusted so that the bubble was centred, the recital was adjusted until the crosshairs were seen clearly and before any reading was recorded the lens were adjusted so that the levelling staff being sighted was seen clearly.

1. The Levelling instrument was set up at levelling position 1 so that a BM be observed from the level position. (Figure1)
2. The levelling staff was then held vertically at the BM by the staff man. The first B.S reading was taken of the BM and recorded in levelling book. (Figure 2)
3. The levelling staff was then moved to station A and held vertically to record an I.S reading.
4. The levelling staff was then moved to station B and held vertically to record an F.S reading. This was identified as change point 1 as there was an obstruction in line of sight and the levelling instrument needed to be moved after.
5. The levelling instrument was then moved and levelled at level position 2 while the staff was left at station B to record a backsight of station B.
6. The level staff was then moved to station C to record a I.S reading.
7. The level staff was moved at station D and an I.S reading was taken.
8. The level staff was moved at station E and an I.S reading was taken.

9. The levelling staff was then moved to station F and held vertically to record an F.S reading. This was identified as change point 2 as there was an obstruction in line of sight and the levelling instrument needed to be moved after.
10. The levelling instrument was then moved and levelled at level position 3 while the staff was left at station F to record a backsight of station F.
11. The levelling staff was then moved and an I.S reading was taken at station G.
12. The levelling staff was then moved and an I.S reading was taken at station H.
13. The levelling staff was then moved and an I.S reading was taken at station I.
14. The levelling staff was then moved and an I.S reading was taken at station J.
15. The levelling staff was then moved and an I.S reading was taken at station K.
16. The levelling staff was then moved and an I.S reading was taken at station L.
17. The levelling staff was then moved to station M and held vertically to record an F.S reading. This was identified as change point 3 as there was an obstruction in line of sight and the levelling instrument needed to be moved after.
18. The levelling instrument was then moved and levelled at level position 4 while the staff was left at station F to record a backsight of station M.
19. The levelling staff was then moved and an I.S reading was then taken at station N.
20. The levelling staff was then moved and an I.S reading was then taken at station O.
21. The levelling staff was then moved and an I.S reading was then taken at station P.
22. The levelling staff was then moved and an I.S reading was then taken at station Q.
23. The levelling staff was then moved and an I.S reading was then taken at station R.
24. The levelling staff was then moved to station S and held vertically to record an F.S reading. This was identified as change point 4 as there was an obstruction in line of sight and the levelling instrument needed to be moved after.

25. The levelling instrument was then moved and levelled at level position 5 while the staff was left at station S to record a backsight of station S.
26. The levelling staff was then moved and an I.S reading was then taken at station T.
27. The levelling staff was then moved and an I.S reading was then taken at station U.
28. The levelling staff was then moved and an I.S reading was then taken at station V.
29. The levelling staff was then moved and an I.S reading was then taken at station W.
30. The levelling staff was then moved to station X the final point and held vertically to record the last F.S reading. (Figure 4)

Computation and plotting of levels

Computation of reduced levels can be done using two methods of booking, rise and fall method or height of collimation. Height of collimation method was used in this practical.

- The reduced level of the line of collimation was assumed as 464.000 m. The height of collimation at temporary benchmark position was then obtained by adding the staff reading which is the backsight reading (1.170 m) to the known reduced level (464.000 m) to get (465.170 m).
- The reading at Point A, (I.S 1.350 m) was deducted from the height of collimation (465.170 m) to get a reduce level of (463.820 m).
- The reduced level (463.860 m) at change point B was determined by deducting the F.S reading (1.310 m) from the height of collimation at benchmark position.
- The height of collimation (465.460 m) at point B was computed by adding the backsight reading (1.600 m) to the reduced level of (463.860 m).
- The reduced level at Point C (463.850 m) was obtained by deducting the I.S reading (1.610 m) from the new height of collimation (465.460 m) to get (463.850 m).
- This was repeated until the instrument change position / change point F. The reduced level at change point F was determined by deducting the F.S reading (1.630 m) from the height of collimation (465.460 m) to get a value of (463.830 m).
- The height of collimation (465.380 m) at point F was determined by adding the reduced level of (463.830 m) to the backsight reading of (1.550 m).
- The reduced level at point G was calculated by deducting the I.S reading (1.378 m) from the new height of collimation (465.380 m).

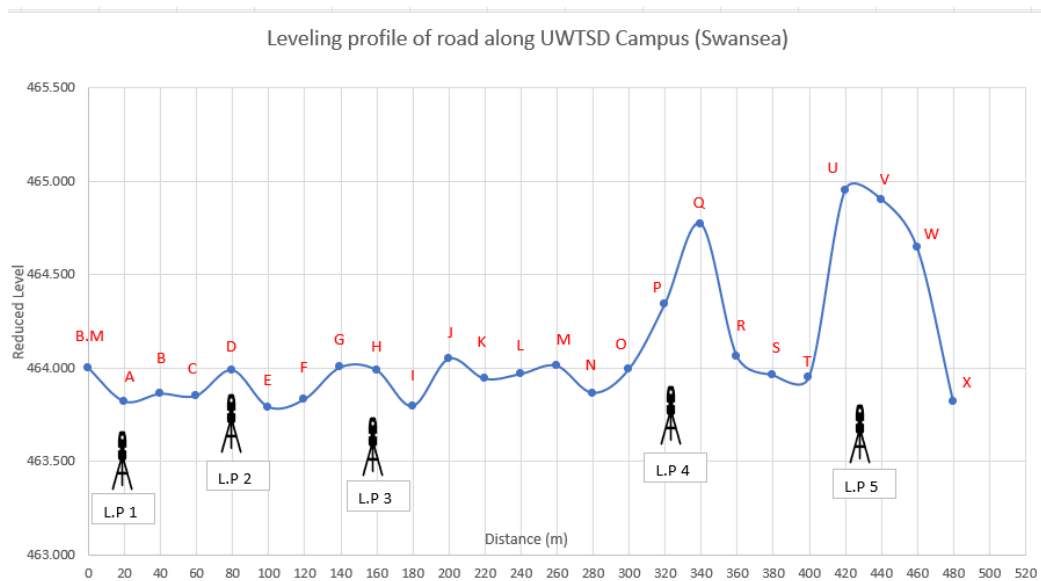
- This was repeated until change point M. The reduced level at change point M was determined by deducting the F.S reading (1.370 m) from the height of collimation (465.380 m) to get a reduced level of (464.010 m).
- The height of collimation at point M was determined by adding the reduced level (464.010 m) to the backsight reading (1.280 m) to get a value of (465.290 m).
- The reduced level at point N was calculated by deducting the I.S reading (1.425 m) from the new height of collimation (465.290 m).
- This was repeated until change point S. The reduced level at change point S was determined by deducting the F.S reading (1.330 m) from the height of collimation (465.290 m) to get a value of (463.960 m).
- The height of collimation at Point S (466.408 m) was determined by adding the reduced level of (463.960 m) to the backsight reading (2.448 m).
- The reduced level of point T was determined by deducting the I.S reading (2.459 m) from the height of collimation (466.408 m), the was repeated for each reading until the final point X.
- An arithmetical check ($\Sigma (B.S) - \Sigma (F.S) = \text{Last R.L} - \text{First R.L}$), was done by deducting the sum of all foresight readings from the sum of all backsight readings, which was equal to the first reduced level, deducted from the last reduced level.

Arithmetic Check	
$\Sigma \text{ B.S} - \Sigma \text{ F.S}$	Last R.L - First R.L
-0.183	-0.183

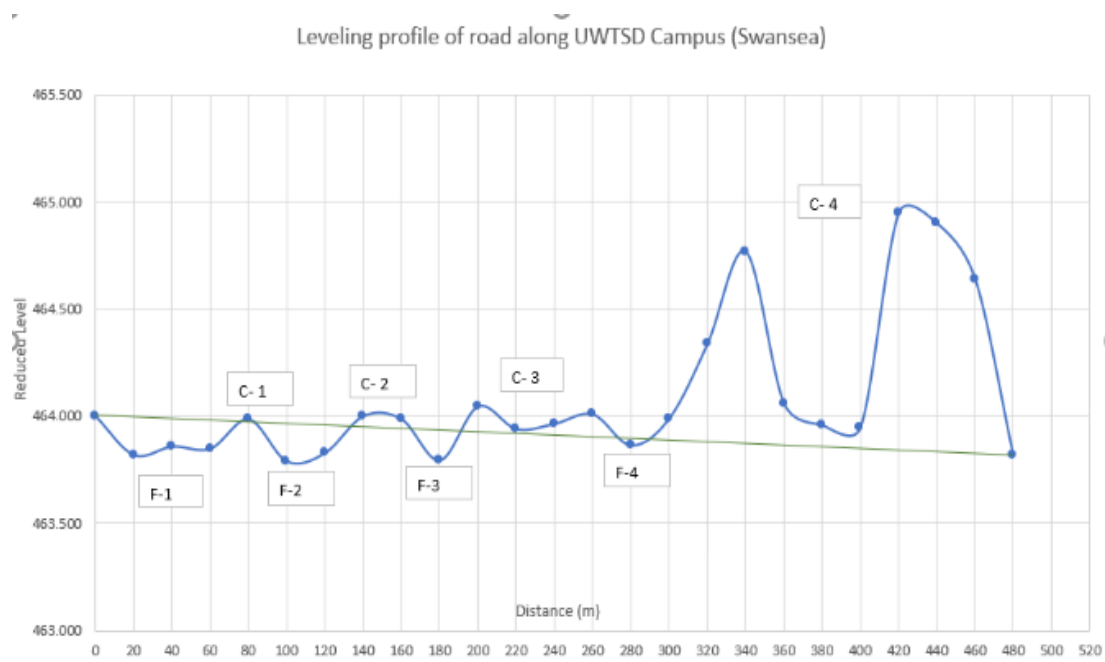
Table 2 showing Arithmetic Check

Point	Station	Back sight	Intermediate sight	Fore sight	Height of Collimation	Reduced Level	Distance/ Chainage (m)	Remarks
1	Benchmark	1.170			465.170	464	0	
2	A		1.350			463.820	20	
3	B	1.600		1.310	465.460	463.860	40	Change point B
4	C		1.610			463.850	60	
5	D		1.473			463.987	80	
6	E		1.670			463.790	100	
7	F	1.550		1.630	465.380	463.830	120	Change point F
8	G		1.378			464.002	140	
9	H		1.393			463.987	160	
10	I		1.585			463.795	180	
11	J		1.333			464.047	200	
12	K		1.439			463.941	220	
13	L		1.414			463.966	240	
14	M	1.280		1.370	465.290	464.010	260	Change point M
15	N		1.425			463.865	280	
16	O		1.299			463.991	300	
17	P		0.950			464.340	320	
18	Q		0.520			464.770	340	
19	R		1.229			464.061	360	
20	S	2.448		1.330	466.408	463.960	380	Change point S
21	T		2.459			463.949	400	
22	U		1.458			464.950	420	
23	V		1.506			464.902	440	
24	W		1.766			464.642	460	
25	X			2.591		463.817	480	

Table 1 showing Height of Collimation method of Computation



Graph 1 showing each point A to X and levelling positions 1-5



Graph 2 showing Cut and fill area (C representing Cut and F representing Fill)

The green line is assumed as the slope of the line. C-1 to C-4 represents the volume of earthwork to be cut and F-1 to F-4 represents the volume of earth to be filled. The amount of earthwork / volume of earthwork is calculated in the table below. The total volume of earthwork was then computed by adding the sum of all the volume of cut and all the volume of fill.

Volume of Earthwork Computation			
Cut	Unit Volume/ Constant	Number/ Quantity	Total Volume
C- 1	1	0.01	0.01
C- 2	1	2	2
C- 3	1	6.5	6.5
C- 4	1	96.25	96.25
Total Cut			104.76 m ³
Fill	Unit Volume/ Constant	Number/ Quality	Total Volume
F-1	-1	8.25	-8.25
F-2	-1	5.5	-5.5
F-3	-1	1.75	-1.75
F-4	-1	0.03	-0.03
Total Fill			-15.53 m ³
Total Volume of Earthwork		Cut + Fill	89.23 m ³

Table 3 showing the Volume of Earth work

Possible errors in levelling procedure

1. Not accurately reading staff readings by misplacing the decimal point or not estimating decimal places correctly.
2. Staff reading could have been placed in wrong column in levelling book or the wrong value copied in the book.
3. It is possible that the staff wasn't held vertically, and it was possibly tilted
4. It is possible that at change points the staff not placed in the exact spot for both the foresight reading and the backsight reading.
5. It is possible that the level was not properly adjusted so that the line of sight was perfectly horizontal.

Conclusion

The area above the roads surface is material that is to be excavated which is 104.76 m^3 . The area below the roads surface is to be filled with -15.53 m^3 .



Figure 1 Levelling staff set up at Benchmark position



Figure 2 Levelling instrument set up to record B.M reading



Figure 3 The tape was used to measure 20 m from each point



Figure 4 Final reading being taken at point X

List of Tables

Table 1 showing Height of Collimation method of Computation.....	8
Table 2 showing Arithmetic Check	8
Table 3 showing the Volume of Earth work	10

List of Graphs

Graph 1 showing each point A to X and levelling positions 1-5	9
Graph 2 showing Cut and fill area (C representing Cut and F representing Fill)	9

List of Figures

Figure 1 Levelling staff set up at Benchmark position	12
Figure 2 Levelling instrument set up to record B.M reading.....	13
Figure 3 The tape was used to measure 20 m from each point.....	14
Figure 4 Final reading being taken at point X.....	15

References

Bannister, A. (Arthur), Baker, R. and Raymond, S. (1992) Surveying. 6th ed. Harlow: Longman.

Clancy, J. (1991) Site surveying and levelling. 2nd ed. London: Edward Arnold.

Irvine, W. and MacLennan, F. (2006) Surveying for construction. 5th ed. Maidenhead: McGraw-Hill.

Schofield, W. and Breach, M. (2007) Engineering surveying. 6th ed. Amsterdam ;: Butterworth-Heinemann.