Surveying

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Lectures
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Lecture 5/   **BUILDING SITE SURVEY AND SET OUT**

Carrying out a level traverse

To determine the difference in level between points on the surface of the ground a 'series' of levels will need to be carried out; this is called a *level traverse* or *level run*.

Leveling or Field Procedures

The leveling or field procedure that should be followed is shown in Figure 1 below.

Figure 1
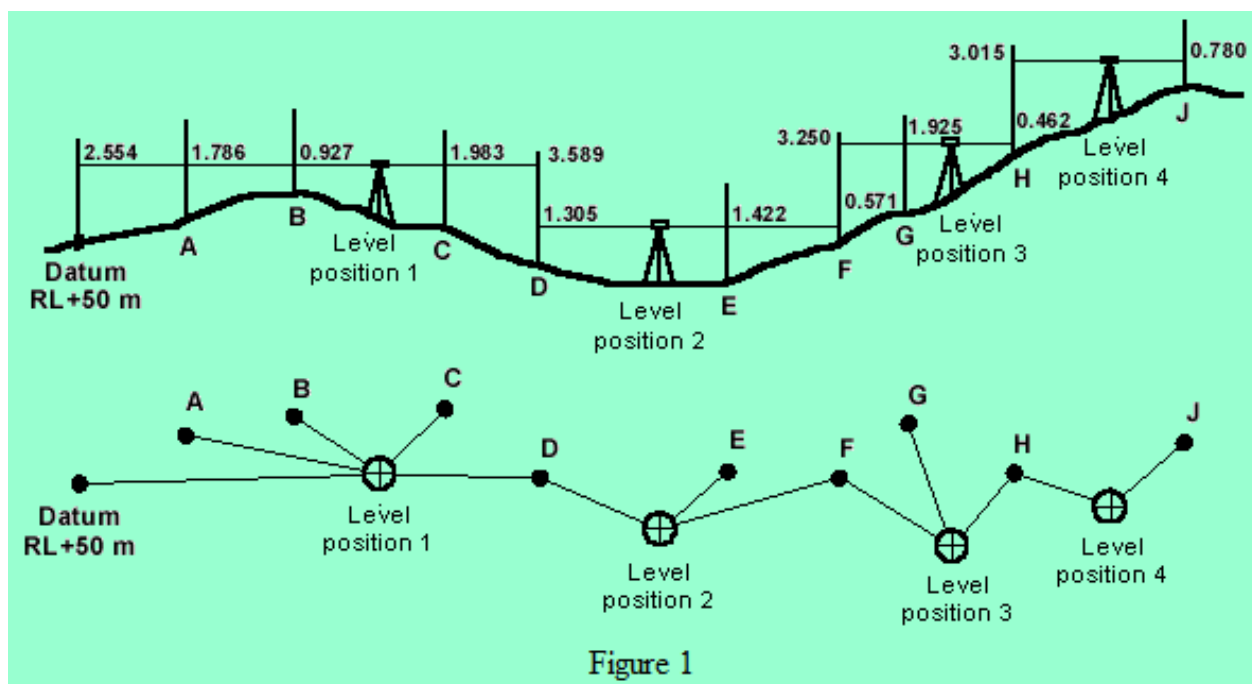
Procedure:

1. Set up the leveling instrument at Level position 1.

2. Hold the staff on the Datum (RL+50 m) and take a reading. This will be a back sight, because it is the first staff reading after the leveling instrument has been set up.

3. Move the staff to A and take a reading. This will be an intermediate sight.

4. Move the staff to B and take a reading. This also will be an intermediate sight.

5. Move the staff to C and take a reading. This will be another intermediate sight.

6. Move the staff to D and take a reading. This will be a foresight; because after this reading the level will be moved. (A change plate should be placed on the ground to maintain the same level.)

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7. The distance between the stations should be measured and recorded in the field book (see Table 1)

8. Set up the level at Level position 2 and leave the staff at D on the change plate. Turn the staff so that it faces the level and take a reading. This will be a back sight.

9. Move the staff to E and take a reading. This will be an intermediate sight.

10. Move the staff to F and take a reading. This will be a foresight; because after taking this reading the level will be moved.

11. Now move the level to Leveling position 3 and leave the staff at F on the change plate.

Now repeat the steps describe 8 to 10 until you finished at point J.

Field procedures for leveling

All staff readings should be recorded in the field book. To eliminate errors resulting from any line of sight (or collimation) back sights and foresights should be equal in distance. Length of sight should be kept less than 100 meters. Always commence and finish a level run on a known datum or benchmark and close the level traverse; this enables the level run to be checked.

Table 1 Rise & Fall Method

Back-sight	Inter-mediate	Fore-sight	Rise	Fall	Reduced level	Distance	Remarks
2.554					50.00	0	**Datum** RL+50 m
	1.783		0.771		50.771	14.990	**A**
	0.926		0.857		51.628	29.105	**B**
	1.963			1.037	50591	48.490	**C**
1.305		3.587		1.624	48.967	63.540	**D** / change point 1
	1.432			0.127	48.840	87.665	**E**
3.250		0.573	0.859		49.699	102.050	**F** / change point 2
	1.925			1.325	51.024	113.285	**G**
3.015		0.496	1.429		52.453	128.345	**H** / change point 3
		0.780	2.235		54.688	150.460	**J**
10.124		**5.436**	**7.476**	**2.788**	**54.688**		Sum of B-sight & F-sight, Sum of Rise & Fall
-5.436			-2.788		-50.000		Take smaller from greater
4.688			**4.688**		**4.688**		Difference should be equal

Booking levels

There are two main methods of booking levels:

- Rise and fall method

- Height of collimation method

The millimeter reading may be taken by estimation to an accuracy of 0.005 meters or even less.

1. Back sight, intermediate sight and foresight readings are entered in the appropriate columns on different lines. However, as shown in the table above back sights and foresights are place on the same line if you change the level instrument.

2. The first reduced level is the height of the datum, benchmark or R.L.

3. If an intermediate sight or foresight is smaller than the immediately preceding staff reading, then the difference between the two readings is place in the rise column.

4. If an intermediate sight or foresight is larger than the immediately preceding staff reading, then the difference between the two readings is place in the fall column.

5. A rise is added to the preceding reduced level (RL) and a fall is subtracted from the preceding RL

Arithmetic checks

While all arithmetic calculations can be checked there is no assurance that errors in the field procedure will be picked up. The arithmetic check poves only that the rise and fall is correctly recorded in the appropriate rise & fall columns. To check the field procedure for errors the level traverse <u>must</u> be closed. It is prudent to let another student check your reading to avoid a repetition of the level run.
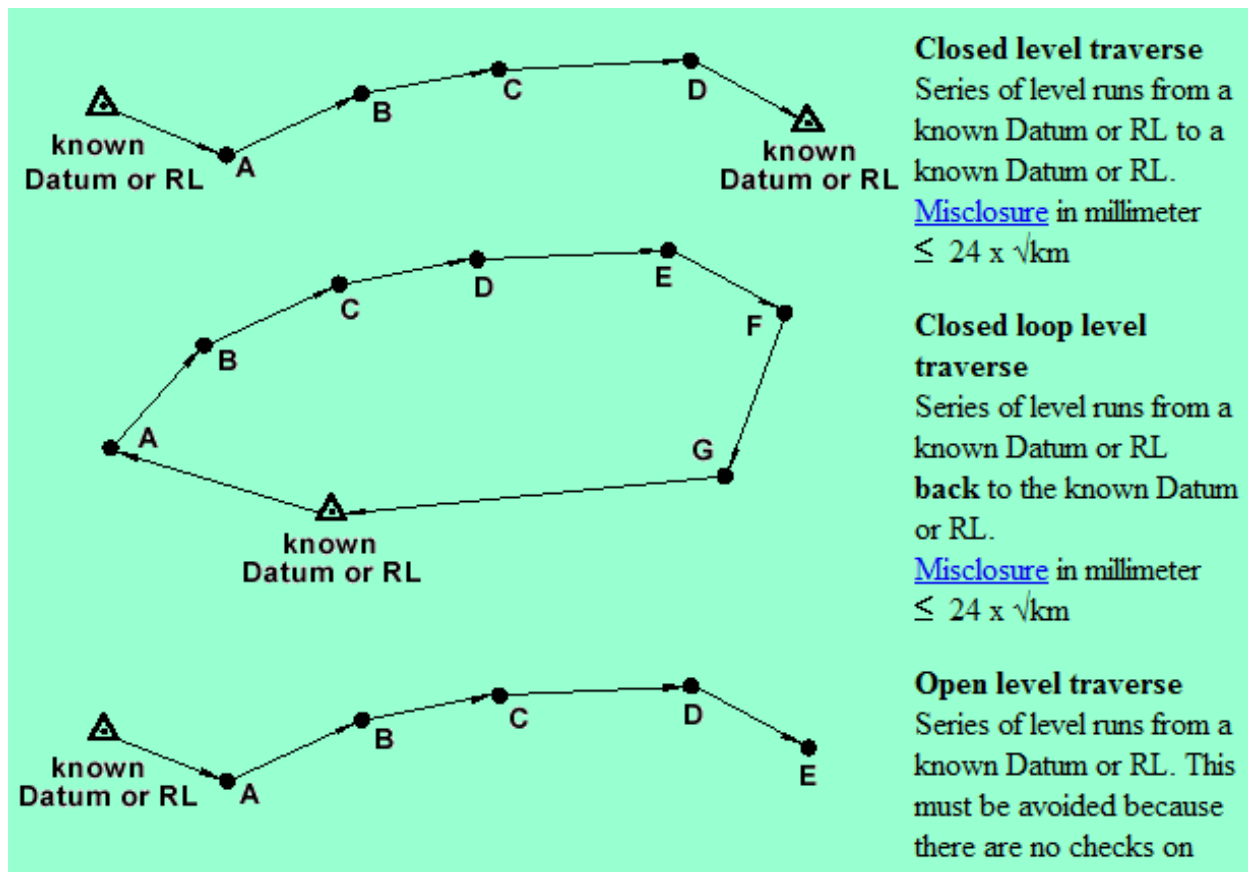
If the arithmetic calculation is correct, the difference between the sum of the back sights and the sum of the foresights will equal:

- the difference between the sum of the rises and the sum of the falls, and

- the difference between the first and the final R.L. or vice versa. (there are no arithmetic checks made on the intermediate sight calculations. Make sure you read them carefully)

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Table 2 Height of collimation method (height of instrument)

Back-sight	Inter-mediate	Fore-sight	Height of collimation	Reduced level	Distance	Remarks
2.554			52.554	50.00	0	**Datum** RL+50 m
	1.783			50.771	14.990	**A**
	0.926			51.628	29.105	**B**
	1.963			50591	48.490	**C**
1.305		3.587	50.272	48.967	63.540	**D** / change point 1
	1.432			48.840	87.665	**E**
3.250		0.573	52.949	49.699	102.050	**F** / change point 2
	1.925			51.024	113.285	**G**
3.015		0.496	55.468	52.453	128.345	**H** / change point 3
		0.780		54.688	150.460	**J**
10.124		**5.436**		**54.688**		Sum of B-sight & F-sight, Difference between RL's
-5.436				-50.000		Take smaller from greater
4.688				**4.688**		Difference should be equal

1. Booking is the same as the rise and fall method for back-, intermediate- and foresights. There is no rise or fall columns, but instead a height of collimation column.

2. The first back sight reading (staff on datum, benchmark or RL) is added to the first RL giving the height of collimation.

3. The next staff reading is entered in the appropriate column but on a new line. The RL for the station is found by subtracting the staff reading from the height of collimation

4. The height of collimation changes only when the level is moved to a new position. The new height of collimation is found by adding the back sight to the RL at the change point.

5. Please note there is no check on the accuracy of intermediate RL's and errors could go undetected.

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Closed level traverse
Series of level runs from a known Datum or RL to a known Datum or RL.
Misclosure in millimeter
$\leq 24 \times \sqrt{km}$

Closed loop level traverse
Series of level runs from a known Datum or RL **back** to the known Datum or RL.
Misclosure in millimeter
$\leq 24 \times \sqrt{km}$

Open level traverse
Series of level runs from a known Datum or RL. This must be avoided because there are no checks on

The rise and fall method may take a bit longer to complete, but a check on entries in all columns is carried out. The RL's are easier to calculate with the height of collimation method, but errors of intermediate RL's can go undetected. For this reason, students should use the rise and fall method for all leveling exercises.

Closed and open traverse

Always commence and finish a level run on a datum, benchmark or known RL. This is what is known as a *closed level traverse*, and will enable you to check the level run.

Errors in Levelling

First: Instrumental error:

1. Errors due to imperfect adjustment.

2. Errors due to sluggish bubble.

3. Errors due to imperfect joint.

4. Rod not standard length.

Second: Natural error:

1. Earth curvature.

2. Atmospheric refraction.

3. Variation in temperature.

4. Settlement of tripod or turning points.

5. Wind and vibration.

Third: Personal errors:

1. Mistakes in manipulation.

2. Rod handling.

3. Mistakes in reading the rods.

4. Errors in sighting.

5. Mistakes in recording.

Degree of Precision

It is depending on:

1. Type of instrument.

2. Atmospheric condition.

3. Skill of observer or surveyor.

4. Character of country.

-For a given instrument and atmospheric condition, the precision depends upon the number of set ups and also upon the length of sights.

The permissible closing error can be expressed as:

$$E = C\sqrt{K}$$

When: E: Permissible closing error (mm).

K: Distance (km).   C: Constant.

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Types of leveling	Value of C
Rough leveling	± 100
Ordinary leveling	± 24
Accurate leveling	± 12
Precise leveling	± 4

Correction of Errors

Procedure:

1- Find the error due to levelling in the field.

$$Error = Calculated\ R.L - Known\ R.L$$

2- Find permissible closing error:

$$E = C\sqrt{K}$$

If value (2) < Value (1) - (Repeat field work).

If Value (2) > Value (1) - (Adjustment will be done).

3- The adjustment will apply by (Bowditch method) for all R.L.:

$$Adj.mark\ 1 = L1/\sum L * Error$$
$$Adj.mark\ 2 = L1 + L2/\sum L * Error$$
$$Adj.mark\ 3 = L1 + L2 + L3/\sum L * Error$$

4- Adding these values in opposite sings to R.L

Example (1): Given a level ABCD a distances AB, BC, and CD are 200m, 175m and 150m respectively. Find correction value for the data? The table below shows the given and deduced data:

Point	Deduced R.L. (m)	Given R.L. (m)	Correction value (m)
A		24.886	24.886
B	20.070		20.076
C	22.376		22.387
D	23.281	23.296	23.296

Error = Deduced −Known

Error = 23.281 −23.296

Error = −0.015m

Total distance = 200 +175+150

Total distance = 525m

$$correction\ (B) = \frac{200}{525} * -0.015 = -0.0057\ m \cong -0.006\ m$$

$$correction\ (C) = \frac{200 + 175}{525} * -0.015 = -0.0107\ m \cong -0.011\ m$$

$$correction\ (D) = \frac{200 + 175 + 150}{525} * -0.015 = -0.015\ m$$

Adding these values to deduced with opposite sign.