TAYLOR'S UNIVERSITY

Wisdom • Integrity • Excellence

SCHOOL OF

ARCHITECTURE, BUILDING AND DESIGN

BACHELOR OF QUANTITY SURVEYING (HONOURS)

SITE SURVEYING [QSB 60103]

FIELD WORK REPORT 1

LEVELING

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1. INTRODUCTION TO LEVELING

WHAT IS LEVELING?

Survey is the methodology of modern or local ways of gathering the information about the civil engineering to enable the engineer to make right decision. Leveling is the initial stages before construction has actually started which function to be the way of cutting a hill area to bring the level or filling the curve area or shape to give the level for construction. It is the process of measuring the difference in elevation (height) between two or more points. In other words is the determination of relative heights (attitudes) of different points in the area under study. Leveling deals with measurements in a vertical plane.

USES OF LEVELING

1. To establish bench mark as vertical control points which serve as references for other levelling.
2. To enable surveyor calculate whether two points are inter-visible from each other on the ground surface.
3. To enable surveyor measurements to be reduced to the horizontal at sea level.
4. To enable drainage works to be surveyed so that water way flow in the desired direction.
5. To provide information for scientists about the shape and structure of the earth and its movement.

DEFINITION OF TERMS USED IN LEVELING

TERM	DEFINITION
Level Surface	A surface parallel to the mean spheroid of the earth is called a level surface and the line drawn on the level surface is known as a level line.
Horizontal Surface	A surface tangential to level surface at a given point is called horizontal surface at that point. Hence, a horizontal line is at right angles to the plumb line at that point.
Vertical line	A vertical line at a point is the line connecting the point to the centre of the earth. It is plumb line at that point. Vertical and horizontal lines at a point are at right angles to each other.
Datum	The level of a point of the surface with respect to which levels of other points or planes are calculated.
Benchmark (B.M.)	A benchmark is a relatively permanent reference point, the elevation of which is known. It is used as a starting point for leveling or as a point upon which to close for a check.
Reduced Level (R.L.)	The level of a point taken as height above or below the datum surface.
Back-sight (B.S.)	It is the first sight/reading taken after setting of the instrument.
Foresight (F.S.)	It is the last sight/reading taken before shifting the instrument.
Intermediate Sight (I.S.)	These are sights/readings taken between F.S and B.S.
Change Point (C.P.) / Turning Point	It is the last position of staff after which the instrument was shifted. It is also the point at which foresight and back-sight are taken.
Height of Instrument (H.I.)	The height of the line of collimation above the datum.
The Line of Collimation	The truly horizontal line of sight which passes through the optical center of the telescope of the level.

VERTICAL CONTROL SURVEY / BENCHMARK SURVEY

1. **Height of collimation method -** In which the height of the instrument is written as it is calculated for each different instrument position.

Back sight	Inter-Mediate	Fore Sight	Collimation	Reduced Level	Distance	Correction	Adjusted RL	Remarks

Arithmetical check for height of collimation method

The sum of each collimation height multiplied by the number of reduced levels obtained from it is equal to the sum of all the intermediate sights, foresights, and reduced levels excluding the first reduced level.

$\Sigma (BS) - \Sigma (FS) = \text{Last RL} - \text{First RL}$

2. **Rise and fall method -** In which the rises and the falls are written as they are calculated from the observations of the staff.

Back sight	Inter-mediate	Fore Sight	Rise	Fall	Reduced Level	Distance	Correction	Adjusted RL	Remarks

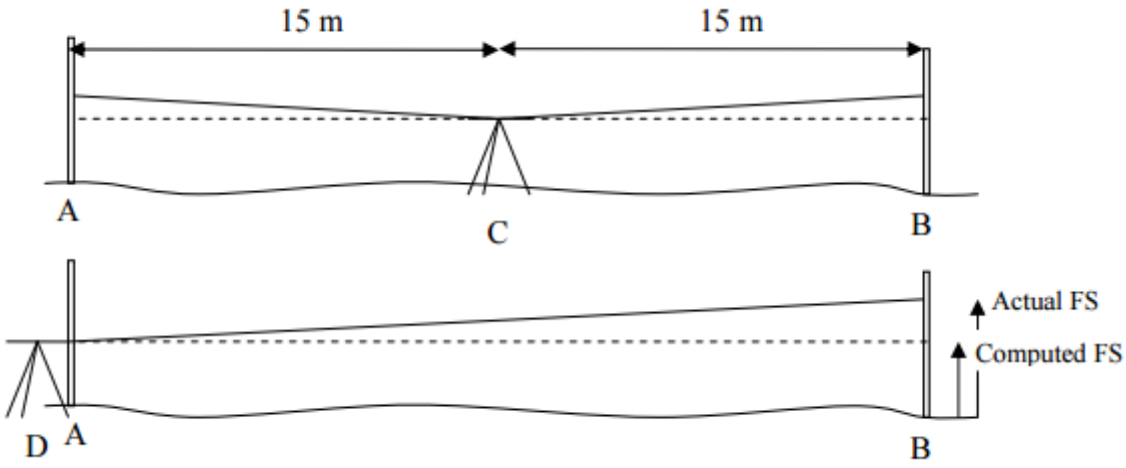
Arithmetical check for rise and fall method

The sum of the back-sights minus the sum of the foresights is equal to the sum of the rises minus the sum of the falls, and is also equal to the first reduced level minus the last reduced level.

$\Sigma (BS) - \Sigma (FS) = \Sigma R - \Sigma F = \text{Last RL} - \text{First RL}$

TWO-PEG TEST

The purpose of two-peg test is to do the checking of the collimation error of the tilting level. The two-peg test is very simple, but provides a way to test the accuracy of a level. The basic principle is that since the error in level readings results from the instrument not sighting exactly horizontally, is thus looking up or down at some angle, and that this angle is the same whichever way it's sighting: if you place the instrument exactly midway between two rod sightings, the vertical error reading on the rod is the same for each, thus the difference in reading between the rods will still give you an accurate elevation difference. Knowing this, we can accurately determine the elevation of B relative to A above. If we then move the instrument to sight from A to B, with the instrument exactly on a reading at A, we can detect the error at that distance, and can adjust the reading to give us the true reading predicted for B.



2. OBJECTIVES

1. To have the basic knowledge on how to set up the tripod and auto level using the correct method.
2. To find the elevation of a given point with respect to the given or assumed reference line called datum.
3. To enable student identify the reduced level of the benchmark and also the specific staff stations.
4. To establish a point at a given elevation with respect to the given or assumed datum.
5. To enable student to apply the theories that have been taught in class to a hand on situation.
6. To enable student have the opportunities to learn on how to record the site measurement and find the reduced level of each station using the rise and fall method or the height of collimation method.
7. To understand the methods used in levelling.
8. To enhance the student's knowledge in the levelling procedure.
9. To learn on how to determine the error of misclosure in order to know whether levelling is acceptable or unacceptable.
10. To understand the error distribution to have adjustment in levelling.

3. OUTLINE OF APPARATUS

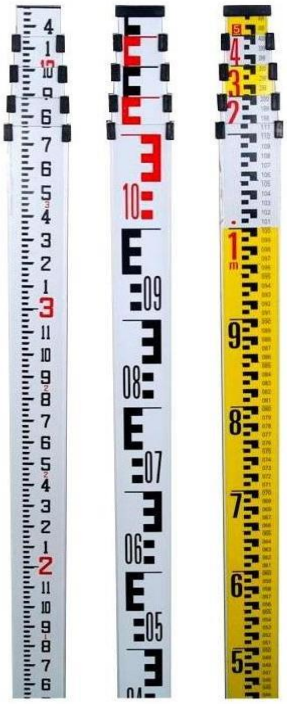
Automatic Level

An automatic level can also known as a Dumpy Level or Builder's Auto Level. It is a professional levelling tools commonly used by land surveyors, contractor and engineers. It is an instrument used to establish or verify points in the same horizontal plane and angle for both long and short distances. The auto level have to be carried properly and required special care to prevent the lens inside being damaged. Before using the auto level, we must make sure that the spirit bubble is within the black circle to make sure the instrument is levelled. From there, the internal compensator takes over and precisely level itself. After that, the surveyor will then look through the telescope attached to the instrument while the staff person will hold a graduated staff at the specific position under measurement. However, an auto level is ideal instrument to be used as it provides consistent levelling accuracy every time and easier to use.

Tripod

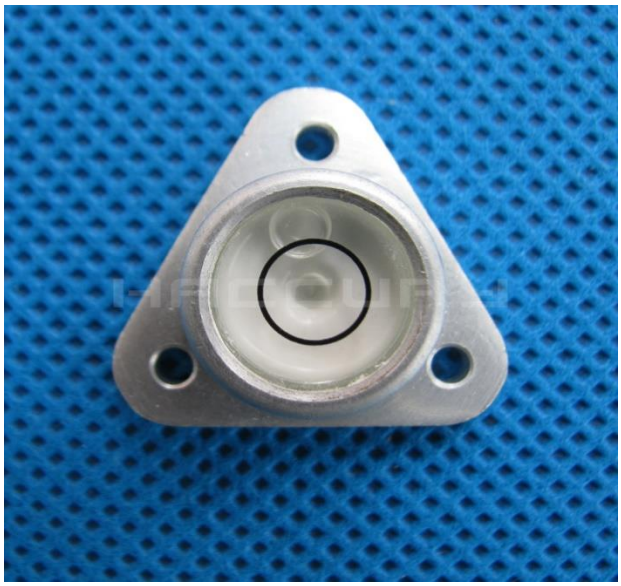
A tripod is an instrument with three-legged support platform used to support the auto level. The primary material for a tripod can be made from steel, wood, plastic or fiber-glass. However, many modern tripod are made from aluminium as it is lighter in weight and can be easily carry around in construction. The leg of the tripod can also be adjusted to the required vertical height and roughly level. If the tripod is required to be placed on soil, we are required to press down on the leg platform to securely anchor the leg in the soil. Once it is secure and position, the auto level is then placed on the flat top and mounting screw is pushed up under the instrument to hold the instrument's base and screwed tight if the instrument is adjusted to the correct position. Lastly, the primary function of the tripod is used to maintain the stability of the auto level.

Levelling Staff



Levelling staff also called the levelling rod is a levelling instrument that can be made from wood or aluminium. The features of these rod is that it can be extended up to 5 meters vertically. It is used to determine the difference in height between points or height of points above a datum surface. Some rods are graduated on one side only while others are marked on both sides. If marked on both sides, the markings can be identical or can have imperial units on one side and metric on the other. However, without using this instrument the surveyor is unable to get the proper reading of that particular point. In addition, to ensure that the levelling is rod is vertical, we must ensure that the spirit bubble with are within the black circle at all the time.

Spirit Bubble



A spirit bubble also called the bubble level is an instrument used to indicate whether the surface is horizontal or vertical. It is normally located on the optical plummet of the auto level and the levelling rod. This instrument is frequently being used for levelling and traversing. To ensure the auto level or levelling rod is level and plumb, the bubble inside the instrument must be within the black circle. An out of adjustment spirit bubble will cause accumulative error in angle, distance and level line.

Optical Plummet

An optical plummet also called the Tribrach is a detachable base of all auto level and theodolite and being placed on a tripod. It is a device used in place of a plumb bob to center transit and theodolites over a given point, preferred for its steadiness in strong winds. It also allows the survey instrument to be repeatedly placed in the same position with sub-millimeter precision, by just loosening and re-tightening a locking handle or lever. This instrument also protect the auto level from dropping which may cause damages to it. The tribrach are equipped with a bull's eye bubble for levelling and for setting up precisely on a survey mark.

4. LEVELING FIELDWORK

The picture attached above show the area and the location of points of the leveling at Taylor's University Lakeside Campus, Car Park Area.

5. FIELD DATA

Collimation Method

BS	IS	FS	Height of collimation	RL	Remarks
1.411			101.411	100.00	BM101
1.389		3.684	99.116	97.727	TP1
1.399		1.399	99.116	97.717	TP2
1.455		1.500	99.071	97.616	TP3
1.489		1.491	99.069	97.580	TP4
1.343		1.210	99.202	97.859	TP5
1.335		1.380	99.157	97.822	TP6
1.361		1.540	98.978	97.617	TP7
1.515		1.369	99.124	97.609	TP8
3.663		1.368	101.419	97.756	TP9
1.461		1.400	101.480	100.019	TP10
		1.506		99.974	BM101
∑BS = 17.821		**∑FS = 17.847**			

Arithmetical check:

∑BS - ∑FS = Last RL – First RL

∑BS - ∑FS = 17.821 – 17.847 = -0.026

Last RL – First RL = 99.974 – 100.000 = -0.026

Rise and Fall Method

BS	IS	FS	Rise	Fall	RL	Remarks
1.411					100.00	BM101
1.389		3.684		2.273	97.727	TP1
1.399		1.399		0.010	97.717	TP2
1.455		1.500		0.101	97.616	TP3
1.489		1.491		0.036	97.580	TP4
1.343		1.210	0.279		97.859	TP5
1.335		1.380		0.037	97.822	TP6
1.361		1.540		0.205	97.617	TP7
1.515		1.369		0.008	97.609	TP8
3.663		1.368	0.147		97.756	TP9
1.461		1.400	2.263		100.019	TP10
		1.506		0.045	99.974	BM101
∑BS =17.821		**∑FS =17.847**	**∑Rise =2.689**	**∑Fall =2.715**		

Arithmetical check:

∑BS - ∑FS = ∑Rise - ∑Fall = Last RL – First RL

∑BS - ∑FS = 17.821 – 17.847 = -0.026

∑Rise - ∑Fall = 2.689 – 2.715 = -0.026

Last RL – First RL = 99.974 – 100.000 = -0.026

Maximum allowable error of closure = $\pm 12\sqrt{k}$

= $\pm 12\sqrt{11}$

= $\pm$39.79mm = $\pm$0.039

∴ The accuracy of this work is **acceptable.**

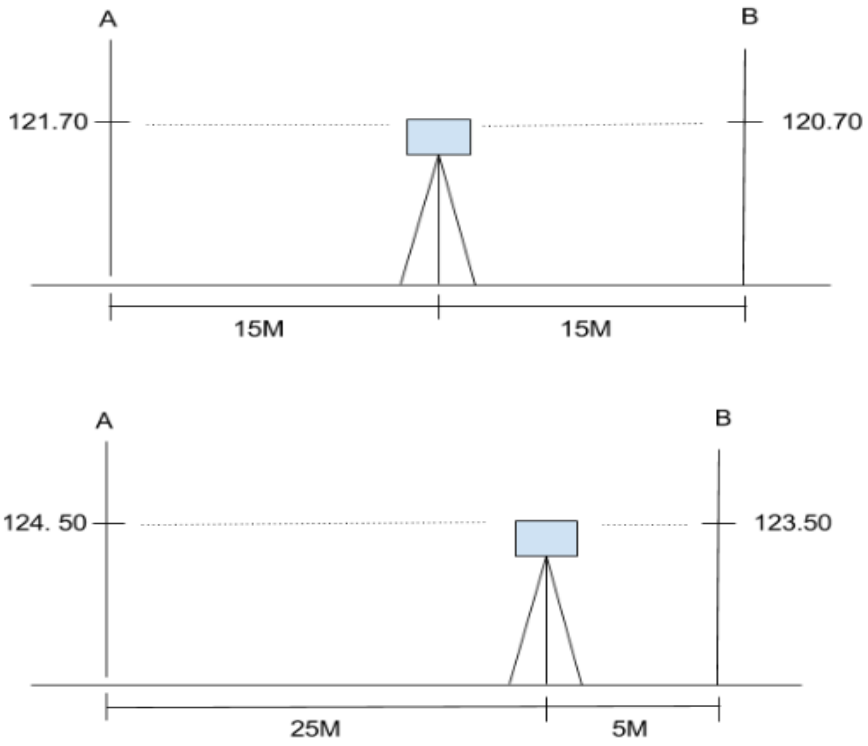
6. ADJUSTED FIELD DATA

Correction = Error of closure / number of set up = -0.026 / 11

= -0.0024

BS	IS	FS	Rise	Fall	RL	Adj.	Final RL	Remarks
1.411					100.00		100.000	BM101
1.389		3.684		2.273	97.727	0.0024	99.729	TP1
1.399		1.399		0.010	97.717	0.0048	97.722	TP2
1.455		1.500		0.101	97.616	0.0072	97.623	TP3
1.489		1.491		0.036	97.580	0.0096	97.590	TP4
1.343		1.210	0.279		97.859	0.0120	97.871	TP5
1.335		1.380		0.037	97.822	0.0144	97.836	TP6
1.361		1.540		0.205	97.617	0.0168	97.634	TP7
1.515		1.369		0.008	97.609	0.0192	97.628	TP8
3.663		1.368	0.147		97.756	0.0216	97.778	TP9
1.461		1.400	2.263		100.019	0.0240	100.043	TP10
		1.506		0.045	99.974	0.0264	100.000	BM101
∑BS =17.821		∑FS =17.847	∑Rise =2.689	∑Fall =2.715				

7. TWO-PEG TEST



The auto level was first set up exactly midway between two pegs A and B lying 30m apart and the following readings were obtained to a staff held vertically on the peg in turn.
Reading to A: 121.700
Reading to B: 120.700

However, when the instrument is shift to 25m from A and 5m from B, the following information was obtained:
Reading to A: 124.500
Reading to B: 123.500

Calculation:
Instrument midway between A and B:
True difference in level AB = 121.700 - 120.700 = 1.000m
Instrument then set 25m from A and 5m from B:
Apparent difference in level AB = 124.500 - 123.500 = 1.000m
Since the apparent difference and the true difference is the same in level, mean there is no error occur.

8. DISCUSSION

After compiling our results, we have discussed with other groups' data. From our discussion, it would seem to be a few factors which can allow us to get more accurate reading.

1. **Doing our test in the afternoon/morning where there is sufficient sunlight**
    - This can help drastically as the sunlight helps the crosshair of the instrument become more visible to the user
2. **Using more turning points with closer distances**
    - With more turning points of the instrument, the distance between the instrument and the level staff has reduced. With the reduced distance, readings become more accurate as it is easier to pinpoint the accurate reading
    - However, distances which are too close may affect the reading.

9. CONCLUSION

From this fieldwork, we have learnt much more about the auto-level and its uses. We have also learnt how to set-up the instrument and take the readings more efficiently and accurately. It is without doubt that using the auto-level require multiple tries and practice to be able to use it correctly.

Even though we took one try to complete our fieldwork, it really was tricky and time consuming just setting up the instrument as it was our first time setting-up on our own. It was a good experience learning how to use the auto-level and take readings from it. This experience has been really great and I believe will help us when we are in the working industry.