UNIVERSITY OF MAIDUGURI

FACULTY OF ENGINEERING

DEPARTMENT OF CIVIL AND WATER RESOURCES ENGINEERING

LAND SURVEYING PRACTICAL LABORATORY

PRACTICAL REPORT ON SETTING OUT OF CURVES AND ROUTE SURVEYING FOR A ROAD; (PRACTICAL SITE: GATE THREE (3) TO TEACHING WORKSHOP JUNCTION, UNIVERSITY OF MAIDUGURI)

BY

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CERTIFICATION

We certify that this report has been conducted by all the listed members of the group under the supervision of Engr. Buba A. Umdagas of Civil and Water Resources Engineering, Faculty of Engineering, University of Maiduguri.

DEDICATION

This Practical Report is dedicated to Almighty God, Our Lovely Parents and Guardians.

ACKNOWLEDGEMENT

First of all, we thank Almighty God who has given us ability to sail through the undulating pathways. May his peace and blessings be upon on us and our families. Our ample thanks and inevitable appreciation with great honour to goes to our parents, for their unending supports and prayers, care and non-fading love from cradle to adulthood. Our profound gratitude and appreciation goes to our erudite lecturer and supervisor, Engr. Buba A. Umdagas. We will not forget our friends and colleagues, indeed you have inspired something into our work and life.

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ABSTRACTS

The report covers a view and a detailed explanation of the transformation of a proposed road required to be carried out on the main access road linking gate three (3) of the university of Maiduguri to the university teaching workshop. The need for easing the flow of traffic on this access road has risen, since it is an academic as well as commercial centre in the institution. It is required that the road be an asphaltic road. The study transformations therefore involve the assessment of the propose road's present condition, involving carrying out site test and surveys etc. as to what could be done and how best to enhance traffic flow. The study involves certain civil engineering processes such as highway surveying, alignment survey and geometric design of routes/roads. It also reports the earthworks including the average cut level and average fill level as well as the estimated volume of fill and the estimated volume of cu, including the bills of quantity plot out for the survey.

AIMS AND OBJECTIVES

- To design curves of constant radius to join straight section of the road.
- To set out the centreline of circular curves.
- To calculate the through chainage values along the centreline of the circular curves.
- To prepare the bills of engineering measurements and evaluations (BOQ) for the route.

INTRODUCTION

Surveying is the process of determining relative positions of different objects on the surface of the earth by measuring horizontal distances between them and preparing a map to any suitable scale. Measurements are taken in horizontal plane only [12]. Surveying is the art of determining the relative positions of points on, above or beneath the surface of the earth by means of direct or indirect measurements of distance, direction and elevation [13]. Leveling is a branch of surveying the object of which is to find the elevations of points with respect to a given or assumed datum and to establish points at a given elevation or at different elevations with respect to a given or assumed datum [14].

Engineering Survey is undertaken whenever sufficient data is to be collected for the purpose of planning and designing engineering works such as roads, bridges and reservoirs. Data is collected by marking physical observation and some measurements using simple survey instruments. Reconnaissance survey is done to examine the general character of the area for the purpose of determining the most feasible route or routes for further more detailed investigations. Data collected from reconnaissance survey is used for feasibility study of all different routes, preparation of approximate estimates of quantities and costs. This helps in selection of most suitable alternatives. This survey also helps in determining any deviations required in the basic geometric standards to be adopted for the highway facility. Reconnaissance survey is generally not required for the work consisting of improvements to existing roads unless bypass roads are involved [15].

A route survey supplies the data necessary to determine alignment, grading and earthwork quantities for the design and construction of various engineering projects such as roads, railroads, pipelines, and utilities [16]. Highway surveys involve measuring and computing horizontal and

vertical angles, elevation, and horizontal distances. The results of these surveys are used to prepare detailed plan and profile base maps of proposed roadways. In addition, the elevations determined in the survey serves as the basis for calculation of construction cut and fill quantities, and determining roadways banking [17].

In the design of roads or railways, straight sections of road or track are connected by curves of constant or varying radius. The purpose of these curves is to deflect a vehicle travelling along of the straights safely and comfortably through a deflection angle to enable it to continue its journey along the other straight [18]. The two main types of horizontal curves are the circular curves, curves of constant radius and transition curves, curves of varying radius.

According to [19], In alignment survey, traverse networks involve placing survey stations along a line or path of travel, and then using the previously surveyed points as a base for observing the next point. Traverse networks have many advantages, including:

1. Less reconnaissance and organization needed;
2. The traverse can change to any shape and thus can accommodate a great deal of different terrains;
3. Only a few observations need to be taken at each station, angular observations need to be made and considered;
4. Traverse networks are free of the strength of figure considerations that happen in triangular systems;
5. Scale error does not add up as the traverse is performed. Azimuth swing errors can also be reduced by increasing the distance between stations.

Earthworks are engineering works created through the processing of parts of the earth's surface involving quantities of soil or unformed rock. Earthworks are engineering works created through the moving and/or processing of massive quantities of soil or unformed rock. Earthwork is done to reconfigure the topography of a site to achieve the design levels. Earthwork involves cutting and filling to achieve the required topography [20].

Cutting is the process of excavating earth material from a work location to achieve the desired topography [21]. Filling is the process of moving the excavated material or additional earth material to a work location to achieve the desired topography [21].

METHODOLOGY

APPARATUS

APPARATUS FOR LEVELLING

- 1. DUMPY LEVEL:** Is essentially a telescope which is used to sight on to a levelling staff. It must be set up so that it is level at all points when swung through 360°. It has controls to adjust focus, slowly traverse/clamp and to increase the definition of the crosshairs (black lines on eyepiece used to read the staff).
- 2. LEVELLING STAFF:** A levelling staff or rod is a graduated wooden or aluminum rod, which is graduated to allow the differences in elevation to be read and determined.
- 3. TRIPOD STAND:** is a portable three-legged frame, used as a platform for supporting the weight and maintaining the stability of some other object. A tripod provides stability against downward forces and horizontal forces and movements about horizontal axes. The positioning of the three legs away from the vertical centre allows the tripod better leverage for resisting lateral forces.
- 4. MEASURING TAPE:** is a flexible ruler. It consists of a ribbon of cloth, plastic, fibre glass, or metal strip with linear-measurement markings. It is a common measuring tool. Its design allows for a measure of great length to be easily carried in pocket or toolkit and permits one to measure around curves or corners.
- 5. GPS:** It is a global navigation satellite system that provides geo-location and time information to a GPS receiver anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.

APPARATUS FOR ALIGNMENT SURVEY AND SETTINGOUT OF CURVES

1. **THEODOLITE:** is an instrument used in surveying to measure horizontal and vertical angles. It is also used for leveling, indirect measure of distances and prolonging a line etc.

DESCRIPTION OF PARTS & TERMS

- **Circle clamp (CC):** Small silver lever that locks the horizontal circle so that no change in the circle reading takes place when you rotate the theodolite.
- **Circle viewer (CV):** Small eyepiece beside the telescope eyepiece for viewing the circles.
- **Circle viewer focus knob (CVFK):** Small knob on the end of the circle viewer to clearly focus on the circle numbers.
- **Circular bubble (CB):** Small circular bubble near the longitudinal bubble.
- **Horizontal alignment knob (HAK):** Large coaxial knob that precisely rotates the theodolite in the horizontal direction.
- **Horizontal circle:** The series of numbers that you see above Hz when you look into the circle viewer
- **Horizontal clamp (HC):** Lower clothes peg type lever that clamps the horizontal rotation of the theodolite.
- **Longitudinal bubble (LB):** Long levelling bubble in the centre of the theodolite.
- **Optical plumb (OP):** Viewer on side of theodolite for looking vertically onto point A.
- **Vertical clamp (VC):** Upper clothes peg type lever that clamps the vertical rotation of the telescope.
- **Telescope:** The centre part of the theodolite that rotates up and down.
- **Telescope focus knob (TFK):** The large knob near the end of the telescope for focusing the crosshairs.

- 2. RANGING POLES:** is a surveying instrument used for marking the position of stations and for sightings of those stations as well as for ranging straight lines. Initially these were made of light, thin and straight bamboo or of well-seasoned wood such as teak, pine or deodar. They were shod with iron at the bottom and surmounted with a flag about 25 cm square in size.
- 3. TRIPOD STAND:** is a portable three-legged frame, used as a platform for supporting the weight and maintaining the stability of some other object. A tripod provides stability against downward forces and horizontal forces and movements about horizontal axes. The positioning of the three legs away from the vertical centre allows the tripod better leverage for resisting lateral forces.
- 4. MEASURING TAPE:** is a flexible ruler. It consists of a ribbon of cloth, plastic, fibre glass, or metal strip with linear-measurement markings. It is a common measuring tool. Its design allows for a measure of great length to be easily carried in pocket or toolkit and permits one to measure around curves or corners.
- 5. PEGS:** are wooden arrows or pins for marking stations and important points in engineering and survey works.
- 6. NAILS:** were driven into the top of the pegs to help hook the tape over the pegs.
- 7. HAMMER:** it was used to drive the nails as well as the pegs into the ground firmly.

PROCEDURES

PROCEDURE FOR RECONNAISSANCE SURVEY FOR HIGHWAY ROUTE

SELECTION

The reconnaissance survey was conducted in the following sequence:

a. Study of Survey Already Available Maps:

- i. We Study the topographical survey map, agricultural, soil, geological and meteorological maps available to our reach.
- ii. We also use a satellite imagery map as a substitute for the Aerial photography.

Reconnaissance survey starts with a study of the all available maps. After study of the topographical features on the maps, a number of economical alignments feasible in a general way are selected keeping in view the following points:

1. The alignment to take into account all the control points and to be shortened and more economical compatible with requirements of gradients and curvature.
2. Shape of the alignment.
3. Avoidance as far as possible of marshy ground, steep terrains, unstable hill features and areas subject to severe climatic conditions, flooding and inundation.
4. Need of connecting important villages and towns.
5. Bridging problems, and
6. Need to preserve environment and maintain ecological balance.

b. Ground Reconnaissance Survey:

- i. We also conduct the ground reconnaissance including another round of serial reconnaissance for inaccessible and difficult stretches, where required, we walked all around collecting data on both natural and artificial features.

- ii. Ground reconnaissance consists of general examination of ground by walking or riding along the probable routes and collecting all available information necessary for evaluating the same. In the case of hill sections, it may be advantageous sometime to start the reconnaissance from an obligatory point situated close to the top. If an area is inaccessible for the purpose of ground reconnaissance, aerial method should be used to clear the doubts.
- iii. While reconnoitering on the ground, it is advisable to leave reference pegs to facilitate further survey operations.

PROCEDURE FOR PROFILE AND CROSS SECTIONAL LEVELLING.

Setting up a Dumpy Level:

- i. Setting up the tripod involves standing it upright, releasing the screws clamps on the legs and extending the top of the tripod to about the forehead level of the user.
- ii. The screw clamps are tightened; the legs are spread and pushed firmly into the ground. Selected clamps may now be loosened to allow rough levelling of the top of the tripod and these are of course re-tightened prior to fixing the instrument. The tripod plate should be reasonably level at this point.
- iii. The level is attached to the tripod using a brass screw thread and handle, which is part of the tripod assembly. The screw housing on the base of the instrument ensures that the instrument is securely fixed, but should never be over tightened.

Key points in levelling the instrument ready for use:

- i. Level the instrument by adjusting the levelling screws.
- ii. The bubble (not visible on the above image) should be central in the circle.
- iii. Turn the telescope through 180° , the level is accurate if the bubble remains in the centre of the circle.
- iv. If the level is inaccurate the bubble will move outside the circle.
- v. Parallax is the apparent movement of the cross-hairs over the levelling staff when the eye is moved up and down while sighting through the instrument.
- vi. To eliminate parallax, the eye piece should be perfectly focused on the cross-hairs and the Telescope should be perfectly focused on the levelling staff.

Reading the Staff

A reading is taken through the lens of the instrument onto the rod and the reading of the level is recorded. This is done using the follow steps:

- Sight onto the levelling staff.
- Focus the telescope on the staff.
- Always ensure the bubble is central
- Take the reading of height.
- Each square is 1cm (10mm)
- First meter is black and second meter is red/yellow.
- Each E is 100mm (0.1m) apart

Booking the Levels

The booking of the levels is done at the same time that a reading is taken. There are two methods of booking levels:

Collimation Method: (The height of collimation is the height of the horizontal line of sight above the datum, and is sometimes called the height of instrument).

Rise and Fall Method: considers the difference of two different reading of the same instrument station and a new difference start over when there is change in the instrument station.

Advantages of the two methods of booking:

- The advantage of the **collimation method** is that it is ideal for setting out reduced levels on site. The reduced level of points/pegs on site can easily and quickly be found by measuring down (or up, for inverted reduced levels) from the height of collimation.
- The advantage of the **rise and fall method** is that it is the simplest method of booking and checking the calculations on site.

Rules of Booking

- **The Back sight** - the first reading from a new instrument position. The survey starts with a known level. This will be an Ordnance Bench Mark (OBM) or a Temporary Bench Mark (TBM). It is good practice to make the final reading for the complete survey to be at this point to check accuracy. The **Back sight** is added to the reduced level to give the height of collimation, entered on the same line.
- **An Intermediate sight** will occur between the **Back sight** and **Foresight**
- **The Foresight** is always the last reading from an instrument Position. The **Foresight** or **intermediate sight** is subtracted from the height of collimation to give the reduced level, entered on the same line as the **foresight** or **intermediate sight**. The height of collimation only changes when the instrument is moved to a new position. Every **Back sight** reading gives a new height of collimation, entered on the same line.

All readings referring to the same point on the ground are entered on the same line.

Rise and Fall

Rules used when booking levels;

- The first (and last) reduced level is on an Ordnance Bench Mark (OBM) or a Temporary Bench Mark (TBM)

- Following line by line down the page calculating the rise or fall between consecutive staff readings.
- A **rise** occurs if the **first** staff reading is **greater** than the **second** staff reading in any consecutive pair of staff readings.
- A **fall** occurs if the **first** staff reading is **less** than the **second** staff reading in any consecutive pair of staff readings.
- Add the rise or subtract the fall from the preceding reduced level to obtain the new reduced level, entered on the same line as the rise or fall.

Accuracy Issues

For all types of survey, the accuracy of level values should be as follows:

- Site TBM relative to Ordnance Survey bench mark $\pm 10\text{mm}$
- Spot levels relative to TBM within 10mm on hard surfaces 90% should be to $\pm 5\text{mm}$.
- If the closing error exceeds these values, the survey should be repeated.

Checks on Calculations

Check on reduced levels obtained from back sights and foresights

Sum of back sights - sum of foresights = first reduced level – last reduced level.

- **Rise & Fall**

Sum of back sights - sum of foresights = first reduced level – last reduced level = sum of rises - sum of falls = first reduced level – last reduced level.

- **Height of Collimation**

The Height of Collimation is the height of the line of sight of the instrument over the station above which it is centered, such as the specified datum level or Ordnance Bench Mark (OBM).

Precautions:

- a. We make sure that the instrument is always level before taking observations.
- b. We also make sure that the levelling Staff is standing erect and always vertical throughout the levelling exercise.

Procedure:

- a. Set up the levelling instrument at level position 1.
- b. Hold the staff vertically on the datum and take a reading. This reading will be the back sight, because it is the first staff reading after setting the instrument.
- c. Move the staff to point A and take a reading. This will be an intermediate sight.
- d. Move the staff to point B and take a reading. This will also be an intermediate sight.
- e. Move the staff to point C and take a reading. This will be an intermediate sight.
- f. Move the staff to point D and take a reading. This will be a fore sight, because after this reading the level will be moved.
- g. The distance between the stations should be measured and recorded into the field book as well.
- h. Set up the level at level position 2 and level the staff at point D, then take a reading. This will be a back sight.
- i. Move the staff to point E and take a reading. This will be an intermediate sight.
- j. Move the staff to point F and take a reading. This will be a fore sight, because after this reading the level will be moved.
- k. Now move the level to level position 3 and leave the staff at point F.
- l. Repeat the above procedure until you reached your destination point.

The cross sectional levels were taken perpendicular to the line of travel of the profile levels at every 50m. The profile levels were taken at an interval of 25m.

PROCEDURE FOR ALIGNMENT SURVEY (TRAVERSE).

Setting up a Theodolite:

- i. Setting up the tripod involves standing it upright, releasing the screws clamps on the legs and extending the top of the tripod to about the forehead level of the user.
- ii. The screw clamps are tightened; the legs are spread and pushed firmly into the ground. Selected clamps may now be loosened to allow rough levelling of the top of the tripod and these are of course re-tightened prior to fixing the instrument. The tripod plate should be reasonably level at this point.
- iii. The Theodolite is attached to the tripod using a brass screw thread and handle, which is part of the tripod assembly. The screw housing on the base of the instrument ensures that the instrument is securely fixed, but should never be over tightened.

Key points in levelling the instrument ready for use:

- i. Level the instrument by adjusting the levelling screws.
- ii. The bubble (not visible on the above image) should be central in the circle.
- iii. Turn the telescope through 180° , the level is accurate if the bubble remains in the centre of the circle.
- iv. If the level is inaccurate the bubble will move outside the circle.
- v. Parallax is the apparent movement of the cross-hairs over the ranging pole when the eye is moved up and down while sighting through the instrument.
- vi. To eliminate parallax, the eye piece should be perfectly focused on the cross-hairs and the Telescope should be perfectly focused on the ranging pole.

The following procedure was followed to obtain data for the alignment survey;

- a. Setup the theodolite at **station A**.
- b. Position a ranging pole at station **B** and another **Temporary point (TP₁)**.
- c. Turn the telescope clockwise and sight the ranging pole at station **A**.
- d. Bisect the ranging pole at **station A**, with the theodolite vertical circle on your left hand side after bisecting the ranging pole, take a reading from both the horizontal and vertical circles, record it as face left one (**FL₁**).
- e. Turn the telescope clockwise to bisect the ranging pole at the **Temporary point one (TP₁)**, with the theodolite vertical circle on your left hand side after bisecting the ranging pole, take a reading from both the horizontal and vertical circles, record it as face left two (**FL₂**).
- f. Turn the telescope clockwise to bisect the ranging pole at the **Temporary point one (TP₁)**, with the theodolite vertical circle on your right hand side after bisecting the ranging pole, take a reading from both the horizontal and vertical circles, record it as face left two (**FR₁**).
- g. Turn the telescope clockwise to bisect the ranging pole at the **station B**, with the theodolite vertical circle on your right hand side after bisecting the ranging pole, take a reading from both the horizontal and vertical circles, record it as face left two (**FR₂**).
- h. Now change the instrument's location to another station in line, in this case to **station B**. And repeat the same procedure as above, only that this time around the ranging poles will be at **station A** and **station C**.
- i. The procedure is repeated on all control point or control station.

Precautions:

- a. We make sure that the instrument is always level before taking observations.
- b. When taking readings from the horizontal and vertical circle, we make sure that the reflective mirror is in the opposite direction of the sun.
- c. We also make sure that the ranging pole is standing erect and always bisected at its centreline.

Setting out Horizontal Curves on Site

The importance of a centreline on site is that it provides a reference line from which other features such as channels, verges, tops and bottoms of embankment etc., can be located from. Thus it is important that:

- ✓ The centreline is set out and marked (pegged) with a high degree of accuracy.
- ✓ The pegs are protected and marked in such a way that site traffic can clearly see them and avoid accidentally hitting them.
- ✓ If a peg is disturbed it can easily be relocated with same high degree of accuracy as before.

There are a number of different methods by which a centreline can be set out, all of which can be summarised in two categories;

- **Traditional Methods:**

- i. Tangential Angle Method.
- ii. Offsets from the Tangent Lengths.
- iii. Offset from the Long Chord.

- **Theodolite and Tape or Total Station Method:** In this method a total station or theodolite is set up at the tangent point and used to turn the tangential angles. If you are

to Use the theodolite a tape is needed but in the case of the total station a tape might not be of need, because of the total stations distance measuring component used for measuring distance electronically.

- **Coordinate Methods:** Coordinate methods are used nowadays in preference to the traditional methods as they are more efficient methods of setting out. Setting out of horizontal curves using coordinate methods can be done using either intersection; bearing and distance or GPS methods.

PROCEDURE FOR SETTINGOUT HIGHWAY CURVES.

The method adopted for this exercise was the theodolite and tape method of settingout curves:

DIAGRAMATIC PROCEDURE:

KEYS:

Theodolite's Position

First Tangent Point

Theodolite's Line Of Sight for Different Horizontal Circle Readings

Lining the length of the chord A, B, C, D on Tape to Find the Exact Point on Curve.

Imaginary Line of Curve

Points on Curve

Intersection Angle

P_1, P_2, P_3, P_4

Represents Points on Curve As Point 1, 2, 3, 4 Respectively.

A, B, C, D

Represents Tangential Angles to the Chords A, B, C, D Respectively.

Theodolite's Line Of Sight at the Straight with H.C.R at $0^\circ 00' 00''$.

This method of setting out curves requires a theodolite to be setup at the tangent point and used to turn the tangential angles to define the direction of each centre line peg. The exact positions of these pegs are fixed by measuring with a tape from peg to peg in sequence. The exact and detail procedure are as follows;

- a. Identify the tangent points and set the theodolite at the first tangent point.
- b. Sight and bisect the ranging pole positioned at the intersection point, then lock the vertical slow motion clamp and set the horizontal circle to read **zero (0° 00' 00")** using the horizontal circle clamp.
- c. Rotate the theodolite such that the tangential angle to the first chord which was derived from the calculation of the curve is set or reading on the horizontal circle, then lock the horizontal slow motion clamp.
- d. The first chord is then set out by lining the tape with the theodolite along the direction and marking off the length of the first chord as derived from the calculation of the curve, starting from the tangent point marked as zero to the length of the first chord as derived from the calculation of the curve.
- e. Once the first position is located it is marked with a peg and nail to define the exact location of the first point.
- f. Then turn the telescope according to the direction of the curve (that is from first tangent point to last tangent point) as the first tangential angle to the first chord is already set on the horizontal circle keep turning the telescope until the horizontal circle reads or is set to the tangential angle to the second chord as derived from the calculation of the curve, then stop and lock the horizontal slow motion of the theodolite. Put the hook of the tape over the nail on the peg at the first point, line the tape until the length of the second chord is on

the intersection formed by the angle set or read on the horizontal circle. Mark the position with a peg and nail to define the exact location of the second point.

- g. This procedure is repeated for all the other points on the curve until you reach your last tangent point. Then the theodolite is moved to the last tangent point and the tangential angle is measured, which should be equal to $\frac{\theta}{2}$.

Precautions:

- a. We make sure that the instrument is always level before taking observations.
- b. When setting the horizontal circle readings for the chords, we make sure that the reflective mirror is in the opposite direction of the sun.
- c. We also make sure that the ranging pole that marks the horizontal circle readings is standing erect and always bisected at its centreline.

PROCEDURE FOR PREPARING BILLS OF ENGINEERING MEASUREMENT AND EVALUATIONS.

1. ESTIMATE OF QUANTITIES:

- a. **Taking off:** This is the part where you are required to find the amount per item.
- b. **Working off:** This is the part where you are required to find the number of items.
- c. **Abstracting:** This is the part where you are required to arrange the items of the same class.
- d. **Squaring:** This is the part where you are required to times (multiply) the items by their numbers (from working off) and the final amount is the quantity of the item.
- e. **Description:** This is the part where you are required to describe the work to be done.

2. BILLING OF QUANTITIES:

- a. **Quantifying:** This is the part where you are required to record the quantities of the items.
- b. **Dimensioning (Units):** This is the part where you are required to indicate the unit of each item.
- c. **Rating:** This is the part where you are required to indicate the rate or the charging price of an item per unit quantity (although rate does change from location to location and time to time).
- d. **Pricing:** This is the part where you are required to times (multiply) the rate by the quantity of the items to obtain the price.
- e. **Description:** This is the part where you are required to describe with specification the items you are pricing and the work should be done.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION FOR RECONNAISSANCE SURVEY FOR HIGHWAY

ROUTE SELECTION

Figure 1

Recce Diagram

RECONNAISSANCE SURVEY REPORTS:

Based on information collected during the reconnaissance survey, a report has been prepared. The report include all relevant information collected during the survey and a plan to the scale of 1:50000 showing the alternative alignments studied along with their general profile and rough cost estimate. Which can be seen as it is located in the appendix of this report.

SITE DESCRIPTION: the description of details around site considering activities and features are;

- **Geology and topography of the area:** According to our reconnaissance survey and review of maps, the topography of the area is of undulating, sloping and flat nature all together, considering the surface soil it can be said that its geology shows no much of a rocky land, but due to some limitations there is no available sub-soil report.
- **Economic activities in the area:** According to our reconnaissance survey, the economic activity in the area is farming practices.
- **Plantation types in the area:** According to our reconnaissance survey, the type of plantations available in abundant type and that is the **Neem** Tree. And hence there is **four** (4) hectares of **Neem plantation** alongside the path of travel to the teaching workshop junction.
- **Structures and houses affected in the cause of project:** According to our reconnaissance survey, there are no structures or houses that are actually affected, thus one of our curve's its radius has fall in the premises of the nearby Building (Curve C).
- **The inventories:** According to our reconnaissance survey, the following are found to be the only records;
 1. Trees.

2. Rock Outcrops.
3. Steep Cut or Fill Slopes (1:3 or steeper).
4. Sidewalks.
5. Utilities poles.
6. Roadway Surfaces and Dimensions.
7. Gate.

BORROW PITS:

There are a number of factor in the selection of a potential borrow pits. The main influences or reasons for choice of borrow pits that have to be evaluated includes;

- **Technical considerations:** It is concern with the material/soil from the burrow pits, considering whether it can be suitable for the job or not, whether it should be stabilized or not.
- **Economic considerations:** It is concern with the impact of cost of using the potential burrow pits whether it is economical or not, what is the economic difference between the burrow pit material/soil cost and the cost of laterite or soil from a vendor.
- **Social and environmental considerations:** It is concern with the impact of using the potential burrow pit on the social life of peoples around the burrow pits and the impact of the burrow pits to the environment as a whole.

In our case, there are limitations to selection of burrow pits, because there is no time and resources to conduct a burrow pit site investigation of soil considering the following soil tests by digging trial pits, boreholes investigations, rotary drill holes etc.;

- i. Moisture content test
- ii. Grading test

- iii. Plastic and liquid limits test
- iv. CBR test
- v. MCV test
- vi. Tri-axial Shear Strength test
- vii. Soil Bulking test etc.

Finally, when everything is ready, a certificate is obtained from site authorizes to start excavation of burrow pits.

Need for Burrow Pits

The only two needs for burrow pits are;

- When earthwork in filling exceeds the earthwork in excavation, and then earth has to be brought from somewhere else.
- When the cost of buying laterite from vendors is high or project funding is to be economized.

It can be an external burrow pits brought from outside the channel or internal burrow pits brought from within the channel. But yet internal burrow pits are more preferred than external ones.

RESULTS AND DISCUSSION FOR PROFILE AND CROSS SECTIONAL LEVELLING.

<i>Station</i>	<i>B.S</i>	<i>I.S</i>	<i>F.S</i>	<i>RISE</i>	<i>FALL</i>	<i>CHANGE</i>	<i>INITIAL R.L</i>	<i>ADJ</i>	<i>FINAL R.L</i>	<i>REMARK</i>
<i>CP₁</i>	1.127					0+000	323.000	0.002	323.002	TBM 323.002m
		1.300			0.173	0+025	322.827	0.002	323.004	
<i>CP₂</i>	0.392		1.830		0.530	0+050	322.297	0.004	323.008	℄ at 50m on proposed Road
		1.750			1.358		320.939	0.004	323.012	Xs at 3m L
		1.095		0.655			321.594	0.004	323.016	Xs at 6m L
		1.620			0.525		321.069	0.004	323.020	Xs at 9m L
		1.600		0.020			321.089	0.004	323.024	Xs at 3m R
		1.850			0.250		320.839	0.004	323.028	Xs at 6m R
		1.480		0.370			321.209	0.004	323.032	Xs at 9m R at (electric pole)
		1.195		0.285		0+175	321.494	0.004	323.036	
		1.815			0.620	0+100	320.874	0.004	323.040	℄ at 100m on proposed Road
		1.800		0.015			320.889	0.004	323.044	Xs at 3m L
		1.675		0.285			321.014	0.004	323.048	Xs at 6m L
		1.710			0.035		320.979	0.004	323.052	Xs at 9m L
		1.850			0.140		320.839	0.004	323.056	Xs at 3m R
		1.911			0.061		320.778	0.004	323.060	Xs at 6m R
		1.609		0.302			321.080	0.004	323.064	Xs at 9m R

CP ₃	1.729		0.120	0+106.78	320.960	0.004	323.068	℄ at 106.78m on proposed Road at Slope Ending.
	1.830		0.101		320.859	0.004	323.072	Xs at 3m L
	1.039	0.791			321.650	0.004	323.076	Xs at 6m L
	1.699		0.660		320.990	0.004	323.080	Xs at 9m L (at tree)
	1.275	0.424			321.414	0.004	323.084	Xs at 3m R
	1.729		0.454		320.960	0.004	323.088	Xs at 6m R
	1.056	0.673			321.633	0.004	323.092	Xs at 9m R at (electric pole).
	1.745		0.689	0+125	320.944	0.004	323.096	
	1.440	1.617	0.128	0+150	321.072	0.006	323.102	℄ at 150m on proposed Road
	1.614		0.174		320.898	0.006	323.108	Xs at 3m L
	1.445	0.169			321.067	0.006	323.114	Xs at 6m L
	1.499		0.054		321.013	0.006	323.120	Xs at 9m L
	1.940		0.441		320.572	0.006	323.126	Xs at 3m R
	1.717	0.223			320.795	0.006	323.132	Xs at 6m R
	1.387	0.330			321.125	0.006	323.138	Xs at 9m R
	1.554		0.167	0+175	320.958	0.006	323.144	
	1.540	0.014		0+200	320.972	0.006	323.150	℄ at 200m on proposed Road
	1.450	0.090			321.062	0.006	323.156	Xs at 3m L
	1.214	0.236			321.298	0.006	323.162	Xs at 6m L
	1.494		0.280		321.018	0.006	323.168	Xs at 9m L

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Field Survey Measurements and Computations, 2017.

Station	B.S	I.S	F.S	RISE	FALL	CHANGE	INITIAL R.L	ADJ	FINAL R.L	REMARK
CP ₄		1.817			0.323		320.695	0.006	323.174	Xs at 3m R
		1.601		0.216			320.911	0.006	323.180	Xs at 6m R
		1.399		0.202			321.113	0.006	323.186	Xs at 9m R
		1.975			0.576	0+225	320.537	0.006	323.192	
		1.621		0.354		0+250	321.891	0.006	323.198	Ø at 250m on proposed Road
		1.910			0.289		321.602	0.006	323.204	Xs at 3m L
		1.560		0.350			321.952	0.006	323.210	Xs at 6m L
		1.810			0.250		321.702	0.006	323.216	Xs at 9m L
		2.050			0.240		321.462	0.006	323.222	Xs at 3m R
		1.901		0.149			321.611	0.006	323.228	Xs at 6m R
		1.680		0.221			321.832	0.006	323.234	Xs at 9m R
	1.075		1.571	0.109		0+275	321.941	0.008	323.242	
		1.143			0.068	0+300	321.873	0.008	323.250	Ø at 300m on proposed Road
		1.487			0.344		321.529	0.008	323.258	Xs at 3m L
		1.211		0.276			321.805	0.008	323.266	Xs at 6m L
		1.534			0.323		321.482	0.008	323.274	Xs at 9m L
		1.799			0.265		321.217	0.008	323.282	Xs at 3m R

CP ₅	1.627	0.172		321.389	0.008	323.290	Xs at 6m R
	1.691	0.064		321.325	0.008	323.298	Xs at 9m R
	0.860	0.831	0+325	322.156	0.008	323.306	
	2.135	1.275	0+350	320.881	0.008	323.314	Ø at 350m on proposed Road
	1.120	1.015		321.896	0.008	323.322	Xs at 3m L
	0.990	0.130		322.026	0.008	323.330	Xs at 6m L
		0.110		321.916	0.008	323.338	Xs at 9m L
		0.110		321.806	0.008	232.346	Xs at 3m R
		0.199		322.005	0.008	323.354	Xs at 6m R
		0.109		321.896	0.008	323.362	Xs at 9m R
	0.860	2.953	1.833 0+375	320.063	0.010	323.372	
		0.790	0+400	319.273	0.010	323.382	Ø at 400m on proposed Road
		0.650		319.923	0.010	323.392	Xs at 3m L
		0.248		320.171	0.010	323.402	Xs at 6m L
		0.259		319.912	0.010	323.412	Xs at 9m L
		0.110		319.802	0.010	323.422	Xs at 3m R
		0.150		319.952	0.010	323.432	Xs at 6m R
		0.049		319.93	0.010	323.442	Xs at 9m R

	0.368	0+425	320.271	0.010	323.452	
	1.699	0+450	318.572	0.010	323.462	Ø at 450m on proposed Road

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Station	B.S	I.S	F.S	RISE	FALL	CHANGE	INITIAL R.L	ADJ	FINAL R.L	REMARK
CP ₆		2.114		0.237			318.809	0.010	323.472	Xs at 3m L
		2.511			0.397		318.412	0.010	323.482	Xs at 6m L
		2.198		0.313			318.725	0.010	323.492	Xs at 9m L
		2.997			0.799		317.926	0.010	323.502	Xs at 3m R
		2.699		0.298			318.224	0.010	323.512	Xs at 6m R
		2.108		0.591			318.815	0.010	323.522	Xs at 9m R
		2.351			0.243	0+475	318.572	0.010	323.532	
	1.608		1.282	1.069		0+500	319.641	- 0.012	323.544	Ø at 500m on proposed Road
		1.173		0.435			320.076	0.012	323.556	Xs at 3m L
		1.120		0.053			320.129	0.012	323.568	Xs at 6m L
		1.880			0.760		319.369	0.012	323.580	Xs at 9m L
		1.420		0.460			319.829	0.012	323.592	Xs at 3m R
		1.103		0.317			320.146	0.012	323.604	Xs at 6m R
		1.200			0.097		320.049	0.012	323.616	Xs at 9m R
		1.740		0.540		0+525	319.509	0.012	323.628	(Starting of Curve A). TBM 323.628
		1.807			0.067	0+536.50	319.442	0.012	323.640	Ø at Depression along proposed Road

CP ₇	1.768	0.039		319.481	0.012	323.652	Xs at 3m L
	1.811	0.043		319.438	0.012	323.664	Xs at 6m L
	1.729	0.082		319.520	0.012	323.676	Xs at 9m L
	1.620	0.109		319.629	0.012	323.688	Xs at 3m R
	1.424	0.196		319.825	0.012	323.700	Xs at 6m R
	1.589	0.165		319.660	0.012	323.712	Xs at 9m R
	2.807	1.218	0+550	318.442	0.012	323.724	∅ at 550m on proposed Road
	2.768	0.039		318.481	0.012	323.736	Xs at 3m L
	2.711	0.057		318.538	0.012	323.748	Xs at 6m L
	2.698	0.013		318.551	0.012	323.760	Xs at 9m L
	2.749	0.051		318.500	0.012	323.772	Xs at 3m R
	2.703	0.046		318.546	0.012	323.784	Xs at 6m R
	2.598	0.105		318.651	0.012	323.796	Xs at 9m R
	1.361	2.906	0.308	0+575	318.343	- 0.014	323.810
	1.302	0.059	0+600	318.402	0.014	323.824	∅ at 600m on proposed Road
	1.220	0.082		318.484	0.014	323.838	Xs at 3m L
	1.055	0.165		318.649	0.014	323.852	Xs at 6m L
	1.240	0.185		318.464	0.014	323.866	Xs at 9m L
	1.673	0.433		318.031	0.014	323.880	Xs at 3m R
	1.097	0.576		318.607	0.014	323.894	Xs at 6m R
	1.250	0.153		318.454	0.014	323.908	Xs at 9m R

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Station	B.S	I.S	F.S	RISE	FALL	CHANGE	INITIAL R.L	ADJ	FINAL R.L	REMARK
CP ₈		1.626			0.376	0+625	318.078	0.014	323.922	
		2.350			0.724	0+650	317.354	0.014	323.936	Ø at 650m on proposed Road
		2.211		0.139			317.493	0.014	323.950	Xs at 3m L
		2.111		0.100			317.593	0.014	323.964	Xs at 6m L
		2.240			0.129		317.464	0.014	323.978	Xs at 9m L
		2.417			0.177		317.287	0.014	323.992	Xs at 3m R
		2.100		0.317			317.604	0.014	324.006	Xs at 6m R
		2.120			0.020		317.584	0.014	324.020	Xs at 9m R
		2.349			0.229	0+656.89	317.355	0.014	324.034	Ø at Curve A TBM 324.034m
		1.555		0.794			317.149	0.014	324.048	Xs at 3m L
		2.120			0.565		317.584	0.014	324.062	Xs at 6m L
		1.989		0.131			317.715	0.014	324.076	Xs at 9m L
		2.098			0.109		317.606	0.014	324.090	Xs at 3m R
		2.040		0.058			317.664	0.014	324.104	Xs at 6m R
		1.878		0.162			317.058	0.014	324.118	Xs at 9m R
	1.617		2.484		0.606	0+675	317.465	- 0.016	324.134	
		1.210		0.407		0+700	317.459	0.016	324.150	Ø at 700m on Proposed Road
		1.216			0.006		317.556	0.016	324.166	Xs at 3m L
		1.119		0.097			317.515	0.016	324.182	Xs at 6m L
		1.160			0.041		317.278	0.016	324.198	Xs at 9m L
		1.397			0.237		317.544	0.016	324.214	Xs at 3m R

1.131	0.266		317.464	0.016	324.230	Xs at 6m R
1.211	0.080		317.205	0.016	324.246	Xs at 9m R
1.470	0.259	0+725	317.189	0.016	324.262	
1.486	0.016	0+736.70	317.366	0.016	324.278	Ø at Depression along Proposed Road.
1.309	0.177		317.461	0.016	324.294	Xs at 3m L
1.214	0.095		317.255	0.016	324.310	Xs at 6m L
1.420	0.206		317.174	0.016	324.326	Xs at 9m L
1.501	0.081		317.093	0.016	324.342	Xs at 3m R
1.220	0.281		317.374	0.016	324.358	Xs at 6m R
1.319	0.099		317.275	0.016	324.374	Xs at 9m R
1.467	0.148	0+750	317.127	0.016	324.390	Ø at 750m on Proposed Road
1.430	0.037		317.164	0.016	324.406	Xs at 3m L
1.111	0.319		317.483	0.016	324.422	Xs at 6m L
1.211	0.100		317.383	0.016	324.438	Xs at 9m L
1.431	0.220		317.163	0.016	324.454	Xs at 3m R
1.201	0.230		317.393	0.016	324.470	Xs at 6m R

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Station	B.S	I.S	F.S	RISE	FALL	CHANGE	INITIAL R.L	ADJ	FINAL R.L	REMARK
	1.119			0.082			317.475	0.016	324.486	Xs at 9m R
	1.870				0.751	0+769.30	316.724	0.016	324.502	Ø at Projection/heap along Proposed Road

CP ₉	1.798	0.072		316.796	0.016	324.518	Xs at 3m L
	1.699	0.099		316.895	0.016	324.534	Xs at 6m L
	1.857	0.158		316.737	0.016	324.550	Xs at 9m L
	1.729	0.128		316.865	0.016	324.566	Xs at 3m R
	1.700	0.029		316.894	0.016	324.582	Xs at 6m R
	1.819	0.119		316.775	0.016	324.598	Xs at 9m R
	1.853	2.271	0.452	0+775	316.323	- 0.018	324.616 (Ending of Curve A) TBM 324.616m
	1.981	0.128	0+790.24	316.195	0.018	324.634	℄ at Depression along Proposed Road
	1.870	0.111		316.306	0.018	324.652	Xs at 3m L
	1.798	0.072		316.378	0.018	324.670	Xs at 6m L
	1.699	0.099		316.477	0.018	324.688	Xs at 9m L
	1.857	0.158		316.319	0.018	324.706	Xs at 3m R
	1.729	0.128		316.447	0.018	324.724	Xs at 6m R
	1.719	0.010		316.457	0.018	324.742	Xs at 9m R
	1.312	0.407	0+800	316.864	0.018	324.760	℄ at 800m on Proposed Road
	1.211	0.101		316.965	0.018	324.778	Xs at 3m L
	1.112	0.099		317.064	0.018	324.796	Xs at 6m L
	1.214	0.102		316.962	0.018	324.814	Xs at 9m L
	1.201	0.013		316.975	0.018	324.832	Xs at 3m R
	1.119	0.082		317.057	0.018	324.850	Xs at 6m R (at tree)
	1.431	0.312		316.745	0.018	324.868	Xs at 9m R (at tree)

CP ₁₀	1.714		0.283	0+825	316.462	0.018	324.886	
	1.873		0.159	0+846.47	316.303	0.018	324.904	℄ at Depression along Proposed Road
	1.811	0.062			316.365	0.018	324.922	Xs at 3m L
	1.620	0.191			316.556	0.018	324.940	Xs at 6m L
	1.729		0.109		316.447	0.018	324.958	Xs at 9m L
	1.424	0.305			316.752	0.018	324.976	Xs at 3m R
	1.220	0.204			316.956	0.018	324.994	Xs at 6m R
	1.111	0.109			315.440	0.018	325.012	Xs at 9m R
	2.436	2.627	1.516	0+850	313.924	- 0.020	325.032	℄ at 850m on Proposed Road
	2.410	0.026			313.950	0.020	325.052	Xs at 3m L
	2.489		0.079		313.871	0.020	325.072	Xs at 6m L
	2.409	0.080			313.951	0.020	325.092	Xs at 9m L
	2.400	0.009			313.960	0.020	325.112	Xs at 3m R
	2.413		0.013		313.947	0.020	325.132	Xs at 6m R

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Station	B.S	I.S	F.S	RISE	FALL	CHANGE	INITIAL R.L	ADJ	FINAL R.L	REMARK
	2.423			0.010			313.937	0.020	325.152	Xs at 9m R
	1.998		0.425			0+862.15	314.362	0.020	325.172	℄ at Depression along Proposed Road
	2.094			0.096			314.266	0.020	325.192	Xs at 3m L
	2.011		0.083				314.349	0.020	325.212	Xs at 6m L

1.998	0.013			314.326	0.020	325.232	Xs at 9m L
2.104		0.106		314.256	0.020	325.252	Xs at 3m R
2.098	0.006			314.262	0.020	325.272	Xs at 6m R
2.011	0.087			314.349	0.020	325.292	Xs at 9m R (at tree)
1.950	0.061	0+875		314.410	0.020	325.312	
1.963		0.013	0+900	314.397	0.020	325.332	Ø at 900m on Proposed Road
1.969		0.006		314.391	0.020	325.352	Xs at 1m L
1.954	0.016			314.407	0.020	325.372	Xs at 2m L
1.960		0.006		314.401	0.020	325.392	Xs at 2m L
1.911	0.049			314.450	0.020	325.412	Xs at 1m R
1.929		0.018		314.432	0.020	325.432	Xs at 2m R
1.933		0.004		314.428	0.020	325.452	Xs at 2m R
1.999		0.066	0+916.34	314.362	0.020	325.472	Ø at Depression along Proposed Road
1.981	0.018			314.380	0.020	325.492	Xs at 1m L
2.054		0.073		314.307	0.020	325.512	Xs at 2m L
2.114		0.060		314.247	0.020	325.532	Xs at 2m L
1.996	0.118			314.365	0.020	325.552	Xs at 1m R
2.123		0.127		314.238	0.022	325.572	Xs at 2m R
2.020	0.103			314.341	0.022	325.592	Xs at 2m R
2.361		0.341	0+925	314.000	0.022	325.612	
1.428	3.070	0.709	0+950	313.291	- 0.022	325.632	Ø at 950m on Proposed Road
2.473		1.045		312.246	0.022	325.654	Xs at 1m L

2.477	0.004		312.242	0.022	325.676	Xs at 2m L
2.412	0.065		312.307	0.022	325.698	Xs at 2m L
2.454	0.042		312.265	0.022	325.720	Xs at 1m R
2.400	0.054		312.319	0.022	325.742	Xs at 2m R
2.419	0.019		312.300	0.022	325.764	Xs at 2m R
2.064	0.355	0+964.50	312.655	0.022	325.786	Ø at Depression along Proposed Road
2.134	0.070		312.585	0.022	325.808	Xs at 1m L
2.141	0.007		312.578	0.022	325.830	Xs at 2m L
2.077	0.064		312.642	0.022	325.852	Xs at 2m L
2.020	0.057		312.699	0.022	325.874	Xs at 1m R
1.987	0.033		312.732	0.022	325.896	Xs at 2m R

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<i>Station</i>	<i>B.S</i>	<i>I.S</i>	<i>F.S</i>	<i>RISE</i>	<i>FALL</i>	<i>CHANGE</i>	<i>INITIAL R.L</i>	<i>ADJ</i>	<i>FINAL R.L</i>	<i>REMARK</i>
		1.966		0.021			312.753	0.022	325.918	Xs at 2m R
		1.889		0.077		0+968.92	312.830	0.022	325.940	Ø at culverts along Proposed Road
		1.889		0.000			312.830	0.022	325.962	Xs at 1m L
		1.889		0.000			312.830	0.022	325.984	Xs at 2m L
		1.889		0.000			312.830	0.022	326.006	Xs at 2m L
		1.889		0.000			312.830	0.022	326.028	Xs at 1m R
		1.889		0.000			312.830	0.022	326.050	Xs at 2m R
		1.889		0.000			312.830	0.022	326.072	Xs at 2m R
		1.549		0.340		0+975	312.720	0.022	326.094	

CP ₁₂	1.905		0.356	1+000	312.364	0.022	326.116	℄ at 1000m on Existing Road
	1.710	0.195			312.559	0.022	326.138	Xs at 1m L
	1.880		0.170		312.389	0.022	326.160	Xs at 2m L
	1.698	0.182			312.571	0.022	326.182	Xs at 2m L
	2.095		0.397		312.174	0.022	326.204	Xs at 1m R
	1.890	0.205			312.379	0.022	326.226	Xs at 2m R
	1.789	0.101			312.480	0.022	326.248	Xs at 2m R
	0.686	2.138	0.349	1+025	312.131	0.024	326.272	(starting of curve B) TBM 326.272m
	1.186		0.500	1+050	311.631	0.024	326.296	℄ at 1050m on Existing Road
	1.157	0.029			311.660	0.024	326.320	Xs at 1m L
	1.110	0.047			311.707	0.024	326.344	Xs at 2m L
	1.160		0.050		311.657	0.024	326.368	Xs at 2m L
	1.320		0.160		311.497	0.024	326.392	Xs at 1m R
	1.119	0.201			311.698	0.024	326.416	Xs at 2m R
	1.181		0.062		311.636	0.024	326.440	Xs at 2m R
	1.143	0.038		1+075	311.674	0.024	326.464	
	1.168		0.025	1+100	311.649	0.024	326.488	℄ at 1100m on Existing Road
	1.128	0.040			311.689	0.024	326.512	Xs at 1m L
	1.210		0.082		311.607	0.024	326.536	Xs at 2m L
	1.228		0.018		311.589	0.024	326.560	Xs at 2m L
	1.214	0.014			311.603	0.024	326.584	Xs at 1m R

	1.198		0.016		311.619		0.024	326.608	Xs at 2m R	
	2.024		0.826		311.793		0.024	326.632	Xs at 2m R	
	0.861		1.163		1+124		311.956	0.024	326.656	Ø at Curve B TBM 326.656
	1.100		0.239		311.717		0.024	326.680	Xs at 1m L	
	1.040		0.060		311.777		0.024	326.704	Xs at 2m L	
	1.180		0.140		311.637		0.024	326.728	Xs at 2m L	
	1.150		0.030		311.667		0.024	326.752	Xs at 1m R	
Station	B.S	I.S	F.S	RISE	FALL	CHANGE	INITIAL R.L	ADJ	FINAL R.L	REMARK
CP ₁₃	1.067				311.750		0.024	326.776	Xs at 2m R	
	1.100		0.033		311.717		0.024	326.800	Xs at 2m R	
	0.930		0.730		0.370		1+125	312.087	0.026	326.826
	1.143		0.213		1+150		311.874	0.026	326.852	Ø at 1150m on Existing Road
	1.216		0.073		311.801		0.026	326.878	Xs at 1m L	
	1,157		0.059		311.860		0.026	326.904	Xs at 2m L	
	1.211		0.054		311.806		0.026	326.930	Xs at 2m L	
	1.340		0.129		311.677		0.026	326.956	Xs at 1m R	
	1.143		0.197		311.874		0.026	326.982	Xs at 2m R	
	1.231		0.088		311.786		0.026	327.008	Xs at 2m R	
	0.996		0.235		1+175		312.021	0.026	327.034	(Ending of Curve B & stating of Curve C) TBM 317.034
	0.431		0.565		1+200		312.586	0.026	327.060	Ø at 1200m on Existing Road
	0.613		0.182		312.404		0.026	327.086	Xs at 1m L	

CP ₁₄	0.114	0.499		312.903	0.026	327.112	Xs at 2m L
	0.550		0.436	312.467	0.026	327.138	Xs at 1m R
	0.610		0.060	312.407	0.026	327.164	Xs at 2m R
	0.894	0.918	0.308	1+225	312.099	- 0.028	327.192
	1.319		0.425	1+250	311.674	0.028	327.220
							Ø at 1250m on Existing Road
	1.511		0.192		311.482	0.028	327.248
	1.280	0.231			311.713	0.028	327.276
	1.520		0.240		311.473	0.028	327.304
	1.648		0.128		311.345	0.028	327.332
	1.310	0.338			311.683	0.028	327.360
	1.580		0.270		311.413	0.028	327.388
	1.440	0.140		1+275	311.553	0.028	327.416
	1.382	0.058		1+300	311.611	0.028	327.444
							Ø at 1300m on Existing Road
	1.250	0.132			311.743	0.028	327.472
	1.120	0.130			311.873	0.028	327.500
	1.225		0.105		311.768	0.028	327.528
	1.490		0.265		311.503	0.028	327.556
	1.218	0.272			311.775	0.028	327.584
	1.321		0.103		311.672	0.028	327.612
	0.582	1.345	0.024	1+325	311.648	- 0.030	327.642
	1.056		0.474	1+350	311.174	0.030	327.672
							Ø at 1350m on Existing Road
	1.211		0.155		311.019	0.030	327.702
							Xs at 1m L

CP₁₅

1.109	0.102	311.121	0.030	327.732	Xs at 2m L
1.199	0.090	311.031	0.030	327.762	Xs at 2m L

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Field Survey Measurements and Computations, 2017.

Station	B.S	I.S	F.S	RISE	FALL	CHANGE	INITIAL R.L	ADJ	FINAL R.L	REMARK
Cp ₁₆		1.209			0.010		311.021	0.030	327.792	Xs at 1m R
		1.111		0.098			311.119	0.030	327.822	Xs at 2m R
		1.219			0.108		311.011	0.030	327.852	Xs at 2m R
		1.232			0.013	1+375	310.998	0.030	327.882	
		1.100		0.132		1+400	311.130	0.030	327.912	∅ at 1400m on Existing Road
		1.110			0.010		311.120	0.030	327.942	Xs at 1m L
		0.901		0.209			311.329	0.030	327.972	Xs at 2m L
		0.999			0.098		311.231	0.030	328.002	Xs at 2m L
		1.086			0.087		311.144	0.030	328.032	Xs at 1m R
		0.978		0.108			311.252	0.030	328.062	Xs at 2m R
		1.108			0.130		311.122	0.030	328.092	Xs at 2m R
	1.213		1.036	0.072		1+425	311.194	- 0.032	328.124	
		1.293			0.080	1+450	311.114	0.032	328.156	∅ at 1450m on curve C TBM 328.156m
		1.114		0.179			311.293	0.032	328.188	Xs at 1m L
		1.120			0.006		311.287	0.032	328.220	Xs at 2m L
		1.308			0.188		311.099	0.032	328.252	Xs at 2m L
		1.250		0.058			311.157	0.032	328.254	Xs at 1m R
		1.214		0.036			311.193	0.032	328.316	Xs at 2m R

Cp ₁₇	1.128		0.086		311.279		0.032		328.348		Xs at 2m R					
	1.106		0.022		1+475		311.301		0.032		328.380					
	1.136		1.062		0.044		1+500		311.345		- 0.034		328.414		Ø at 1500m on Existing Road	
	1.100		0.036				311.381		0.034		328.448		Xs at 1m L			
	1.086		0.014				311.395		0.034		328.482		Xs at 2m L			
	1.114				0.028		311.367		0.034		328.516		Xs at 2m L			
	1.286				0.172		311.195		0.034		328.550		Xs at 1m R			
	1.110		0.176				311.371		0.034		328.584		Xs at 2m R			
	1.209				0.099		311.272		0.034		328.618		Xs at 2m R			
	1.183		0.026				1+525		311.298		0.034		328.652			
	1.167		0.016				1+550		311.314		0.034		328.686		Ø at 1550m on Existing Road	
	1.213				0.046		311.268		0.034		328.720		Xs at 1m L			
	1.114		0.099				311.367		0.034		328.754		Xs at 2m L			
	1.250				0.136		311.231		0.034		328.788		Xs at 2m L			
	1.210		0.040				311.271		0.034		328.822		Xs at 1m R			
	1.163		0.047				311.318		0.034		328.856		Xs at 2m R			
	1.096		0.067				311.385		0.034		328.890		Xs at 2m R			
	1.042		0.054				1+575		311.439		0.034		328.924			

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Field Survey Measurements and Computations, 2017.

Station	B.S	I.S	F.S	RISE	FALL	CHANGE	INITIAL R.L	ADJ	FINAL R.L	REMARK
CP ₁₈	1.153		0.980	0.062		1+600	311.501	0.036	328.960	Ø at 1600m on Existing Road
		1.077		0.076			311.577	0.036	328.996	Xs at 1m L
		0.752		0.325			311.902	0.036	329.032	Xs at 2m L
		0.987			0.235		311.667	0.036	329.068	Xs at 2m L
		1.100			0.113		311.554	0.036	329.104	Xs at 1m R
		1.119			0.019		311.535	0.036	329.140	Xs at 2m R
		1.201			0.082		311.453	0.036	329.176	Xs at 2m R
		1.319			0.118	1+625	311.335	0.036	329.212	
		1.339			0.020	1+650	311.315	0.036	329.248	Ø at 1650m on Existing Road
		1.613			0.274		311.041	0.036	329.284	Xs at 1m L
		1.114		0.499			311.540	0.036	329.320	Xs at 2m L
		1.550			0.436		311.104	0.036	329.356	Xs at 2m L
		1.610			0.060		311.044	0.036	329.392	Xs at 1m R
		1.520		0.090			311.134	0.036	329.428	Xs at 2m R
		1.310		0.210			311.344	0.036	329.464	Xs at 2m R
		1.260		0.050		1+675	311.394	0.036	329.500	(Ending of Curve C) TBM 329.500m
CP ₁₉	1.308		1.110	0.150		1+700	311.544	- 0.038	329.538	Ø at 1700m on Existing Road
		1.198		0.110			311.654	0.038	329.576	Xs at 1m L
		1.776			0.578		311.076	0.038	329.614	Xs at 2m L
		1.678		0.098			311.174	0.038	329.652	Xs at 2m L

1.189	0.489		311.663	0.038	329.690	Xs at 1m R
1.173	0.016		311.679	0.038	329.728	Xs at 2m R
1.112	0.061		311.740	0.038	329.766	Xs at 2m R
1.178	0.066	1+725	311.674	0.038	329.804	
1.119	0.059	1+750	311.733	0.038	329.842	Ç at 1750m on Existing Road
1.108	0.011		311.744	0.038	329.880	Xs at 1m L
1.123	0.015		311.729	0.038	329.918	Xs at 2m L
1.098	0.025		311.754	0.038	329.956	Xs at 2m L
1.111	0.013		311.741	0.038	329.994	Xs at 1m R
1.120	0.009		311.732	0.038	329.032	Xs at 2m R
1.087	0.033		311.765	0.038	329.070	Xs at 2m R
1.100	0.013	1+775	311.752	0.038	329.108	
1.163	0.063	1+800	311.689	0.038	329.146	TBM 330.146m

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Field Survey Measurements and Computations, 2017.

RESULTS AND DISCUSSION FOR ALIGNMENT SURVEY (TRAVERSE).

HORIZONTAL ANGLES

STATION	FACE	TARGET	HORIZONTAL CIRCLE READINGS	REDUCED ANGLE	MEAN ANGLES	TO
A	FL ₁	A	295 ⁰ 40' 50"	148 ⁰ 04' 40"	148 ⁰ 22' 05"	B
	FL ₂	B	83 ⁰ 45' 30"	148 ⁰ 39' 30"		
	FR ₁	B	303 ⁰ 45' 00"			
	FR ₂	A	155 ⁰ 05' 30"			
B	FL ₁	B	78 ⁰ 30' 47"	146 ⁰ 24' 43"	146 ⁰ 32' 08"	C
	FL ₂	C	224 ⁰ 55' 30"	146 ⁰ 39' 33"		
	FR ₁	C	44 ⁰ 55' 30"			
	FR ₂	B	258 ⁰ 15' 57"			
C	FL ₁	C	358 ⁰ 00' 00"	149 ⁰ 50' 56"	150 ⁰ 03' 03"	D
	FL ₂	D	147 ⁰ 50' 56"	150 ⁰ 15' 10"		
	FR ₁	D	27 ⁰ 50' 10"			
	FR ₂	C	237 ⁰ 35' 00"			

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Field Survey Measurements and Computations, 2017.

CHECKED AND ADJUSTED MEAN ANGLES

STATION	MEAN ANGLES	CORRECTION	ADJUSTED MEAN ANGLES
A	148° 22' 05"	+ 0° 00' 27"	148° 22' 32"
B	146° 32' 08"	+ 0° 00' 27"	146° 32' 35"
C	150° 03' 03"	+ 0° 00' 27"	150° 03' 30"

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Field Survey Measurements and Computations, 2017.

VERTICAL ANGLES

STATION	FACE	TARGET	VERTICAL CIRCLE READINGS	REDUCED ANGLE	MEAN ANGLES	TO
A	FL ₁	A	89° 35' 35"	00° 24' 30"	00° 47' 15"	B
	FL ₂	B	89° 35' 30"			
	FR ₁	B	268° 50' 00"	00° 10' 00"		
	FR ₂	A	270° 10' 00"			
B	FL ₁	B	90° 35' 20"	00° 35' 40"	00° 17' 53"	C
	FL ₂	C	90° 45' 40"			
	FR ₁	C	269° 45' 35"	00° 00' 05"		
	FR ₂	B	269° 45' 30"			
C	FL ₁	C	89° 45' 05"	00° 49' 23"	00° 37' 12"	D
	FL ₂	D	89° 10' 37"			
	FR ₁	D	270° 25' 00"	00° 25' 00"		
	FR ₂	C	269° 50' 39"			

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Field Survey Measurements and Computations, 2017.

From the alignment survey exercise, we can say that alignment survey is all about setting control points linking straights and observing both their vertical and horizontal angles. As seen in the above tables, the vertical and horizontal angles obtained during the traversing (alignment survey) are to be used as the intersection angle of the control point or intersection point of the exact two straight that actually meet as plotted. In order to help for the calculation of the curves.

RESULTS AND DISCUSSION FOR SETTINGOUT HIGHWAY CURVES.

PLOTTING OF CURVES

SCALE 1:500

Data for Curve A:

R=216m

Chainage I = 0+656.89

$\theta = 32^\circ 22' 32''$

Interval = 50m

Solution

Tangent Length (T.L) = $R \tan \frac{\theta}{2} = 216 \tan (32^\circ 22' 32''/2) = 62\text{m}$

Length of curve (L.C) = $\frac{R\theta\pi}{180} = \frac{216 \times 32.376 \times 3.14}{180} = 122.05\text{m}$

Chainage A = Chainage I - T.L = 656.89 - 62 = 594.89m

Chainage B = Chainage A + L.C = 594.89 + 122.05 = 716.94m

First Sub-Chord = 5.11m

General Chord = 50.00m

Last Sub-Chord = 16.94m

$S_0 \text{ Initial} = \frac{90}{\pi} \times \frac{Ls}{R} = \frac{90}{\pi} \times \frac{5.11}{216} = 00^\circ 40' 39.85''$

$S_1 \text{ General} = \frac{90}{\pi} \times \frac{Ls}{R} = \frac{90}{\pi} \times \frac{50}{216} = 06^\circ 37' 53.24''$

$S_2 \text{ Final} = \frac{90}{\pi} \times \frac{Ls}{R} = \frac{90}{\pi} \times \frac{16.97}{216} = 02^\circ 07' 5.11''$

<i>Point</i>	<i>Chainage</i>	<i>Chord Length</i>	<i>Individual Tangential Angle</i>	<i>Cumulative Tangential Angle</i>
T	594.89	_____	_____	_____
P_0	600.00	5.11	00° 40' 39.85"	00° 40' 39.85"
P_1	650.00	50.00	06° 37' 53.24"	07° 18' 33.09"
P_2	700.00	50.00	06° 37' 53.24"	13° 56' 26.33"
P_L	716.94	16.94	02° 07' 5.11"	16° 03' 31.44"

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Field Survey Measurements and Computations, 2017.

PLOTTING OF CURVES

SCALE 1:500

Data for Curve B:

$$R=220\text{m}$$

$$\text{Chainage I} = 1+124$$

$$\theta = 34^\circ 32' 35''$$

$$\text{Interval} = 50\text{m}$$

Solution

$$\text{Tangent Length (T.L)} = R \tan \frac{\theta}{2} = 220 \tan (34^\circ 32' 35''/2) = 68.5\text{m}$$

$$\text{Length of curve (L.C)} = \frac{R\theta\pi}{180} = \frac{220 \times 34.598 \times 3.14}{180} = 132.64\text{m}$$

$$\text{Chainage A} = \text{Chainage I} - \text{T.L} = 1124 - 68.5 = 1055.5\text{m}$$

$$\text{Chainage B} = \text{Chainage A} + \text{L.C} = 1055.5 + 132.64 = 1188.14\text{m}$$

$$\text{First Sub-Chord} = 44.5\text{m}$$

$$\text{General Chord} = 50.00\text{m}$$

$$\text{Last Sub-Chord} = 38.14\text{m}$$

$$S_0 \text{ Initial} = \frac{90}{\pi} \times \frac{Ls}{R} = \frac{90}{\pi} \times \frac{44.5}{220} = 05^\circ 47' 40.87''$$

$$S_1 \text{ General} = \frac{90}{\pi} \times \frac{Ls}{R} = \frac{90}{\pi} \times \frac{50}{220} = 06^\circ 30' 39.18''$$

$$S_2 \text{ Final} = \frac{90}{\pi} \times \frac{Ls}{R} = \frac{90}{\pi} \times \frac{38.14}{220} = 04^\circ 57' 59.41''$$

<i>Point</i>	<i>Chainage</i>	<i>Chord Length</i>	<i>Individual Tangential Angle</i>	<i>Cumulative Tangential Angle</i>
<i>T</i>	1055.5	_____	_____	_____
<i>P₀</i>	1100.00	44.5	05° 47' 40.87"	05° 47' 40.87"
<i>P₁</i>	1150.00	50.00	06° 30' 39.18"	12° 18' 20.05"
<i>P₂</i>	1200.00	50.00	06° 30' 39.18"	18° 48' 59.23"
<i>P_L</i>	1182.71	32.71	04° 57' 59.41"	23° 46' 58.64"

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Field Survey Measurements and Computations, 2017.

PLOTTING OF CURVES

SCALE 1:500

Data for Curve C:

$$R=215\text{m}$$

$$\text{Chainage I} = 1+450$$

$$\theta = 30^\circ 03' 30''$$

$$\text{Interval} = 50\text{m}$$

Solution

$$\text{Tangent Length (T.L)} = R \tan \frac{\theta}{2} = 215 \tan (30^\circ 03' 30''/2) = 57.5\text{m}$$

$$\text{Length of curve (L.C)} = \frac{R\theta\pi}{180} = \frac{215 \times 30.076 \times 3.14}{180} = 112.79\text{m}$$

$$\text{Chainage A} = \text{Chainage I} - \text{T.L} = 1450 - 57.5 = 1392.50\text{m}$$

$$\text{Chainage B} = \text{Chainage A} + \text{L.C} = 1392.50 + 112.79 = 1505.29\text{m}$$

$$\text{First Sub-Chord} = 7.50\text{m}$$

$$\text{General Chord} = 50.00\text{m}$$

$$\text{Last Sub-Chord} = 5.29\text{m}$$

$$S_0 \text{ Initial} = \frac{90}{\pi} \times \frac{Ls}{R} = \frac{90}{\pi} \times \frac{7.50}{215} = 00^\circ 59' 57.64''$$

$$S_1 \text{ General} = \frac{90}{\pi} \times \frac{Ls}{R} = \frac{90}{\pi} \times \frac{50}{215} = 06^\circ 39' 44.28''$$

$$S_2 \text{ Final} = \frac{90}{\pi} \times \frac{Ls}{R} = \frac{90}{\pi} \times \frac{5.29}{215} = 00^\circ 42' 17.54''$$

<i>Point</i>	<i>Chainage</i>	<i>Chord Length</i>	<i>Individual Tangential Angle</i>	<i>Cumulative Tangential Angle</i>
<i>T</i>	594.89	_____	_____	_____
<i>P₀</i>	600.00	7.50	00° 59' 57.64"	00° 59' 57.64"
<i>P₁</i>	650.00	50.00	06° 39' 44.28"	07° 39' 41.92"
<i>P₂</i>	700.00	50.00	06° 39' 44.28"	14° 19' 26.20"
<i>P_L</i>	716.94	5.29	00° 42' 17.54"	15° 01' 43.74"

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Field Survey Measurements and Computations, 2017.

RESULTS FOR PREPARING BILLS OF ENGINEERING MEASUREMENT AND
EVALUATIONS

LONGITUDINAL SECTIONS

Estimating Average Depth for Earthworks;

Considering the reduce levels as obtained from the leveling exercise to estimate the average depth of earths, taking **326.000m** as the ground level of the proposed road;

- ESTIMATING THE AVERAGE DEPTH OF CUT:**

GROUND LEVEL	AVERAGE DEPTH OF CUTTING	WEIGHING	WEIGHTED DEPTH OF CUTTING	COMMENT
326.000	0.15	1	0.15	Top Soil
327.000	1.00	1	1.00	
327.000	1.00	3	3.00	
327.000	1.00	2	2.00	
328.000	2.00	2	4.00	
327.000	1.00	3	3.00	
327.000	1.00	3	3.00	
329.000	3.00	2	6.00	
328.000	2.00	1	2.00	
333.000	7.00	4	28.00	
330.000	4.00	4	16.00	
329.000	3.00	3	9.00	
328.000	2.00	2	4.00	
327.000	1.00	4	4.00	
328.000	2.00	3	6.00	
328.000	2.00	2	4.00	
327.000	1.00	2	2.00	
329.000	3.00	2	6.00	

327.000	1.00	4	4.00	
328.000	2.00	4	8.00	
330.000	4.00	3	12.00	
329.000	3.00	4	12.00	
327.000	1.00	2	2.00	
329.000	3.00	2	6.00	
329.000	3.00	4	12.00	
328.000	2.00	3	6.00	
327.000	1.00	3	3.00	
331.000	5.00	2	10.00	
330.000	4.00	1	4.00	
328.000	2.00	1	2.00	
326.000	0.15	1	0.15	Top Soil
		Σ78	Σ184.30	

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Field Survey Measurements and Computations, 2017.

$$\text{AVERAGE DEPTH OF CUTTING} = \frac{184.30}{78} = 2.363\text{m.}$$

Therefore, the average cut for all the areas that are higher than the reference level adopted as ground level should be cut down by 2.363meters in order to obtain a level ground.

- ESTIMATING THE AVERAGE DEPTH OF FILL:**

GROUND LEVEL	AVERAGE DEPTH OF FILLING	WEIGHING	WEIGHTED DEPTH OF FILLING	COMMENT
326.000	_____	1	_____	Negligible
323.000	3.00	1	3.00	
322.000	4.00	3	12.00	
322.000	4.00	2	8.00	
310.000	16.00	3	48.00	
316.000	10.00	2	20.00	
325.000	1.00	4	4.00	
324.000	2.00	4	8.00	
325.000	1.00	3	3.00	
324.000	2.00	2	4.00	
325.000	1.00	2	3.00	
325.000	1.00	3	3.00	
325.000	1.00	3	3.00	
325.000	1.00	3	3.00	
325.000	1.00	4	4.00	
325.000	1.00	2	2.00	
322.000	4.00	1	4.00	
325.000	1.00	4	4.00	
325.000	1.00	4	4.00	
323.000	3.00	3	9.00	
324.000	2.00	2	4.00	
324.000	2.00	3	6.00	

325.000	1.00	3	3.00	
322.000	4.00	2	8.00	
321.000	5.00	1	5.00	
323.000	3.00	2	6.00	
323.000	3.00	1	3.00	
324.000	2.00	4	8.00	
325.000	1.00	3	3.00	
325.000	1.00	2	2.00	
326.000	—	1	—	Negligible
		Σ78	Σ196.00	

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Field Survey Measurements and Computations, 2017.

$$\text{AVERAGE DEPTH OF CUTTING} = \frac{196.00}{78} = 2.663\text{m.}$$

By adding the replacement depth of top soil on fill = 2.513 + 0.15

AVERAGE TOTAL DEPTH OF FILL = 2.663m.

Therefore, the average fill depth for all the areas that are lower than the reference level adopted as ground level should be filled up by 2.663meters in order to obtain a level ground.

Estimating Volumes for Earthworks;

Considering the average depth of both cutting and filling as obtained from the above estimate of earths the length of the propose road as well as the width is taken as;

- Length of propose road = **970m**
- Width of propose road is **12m** plus **1.5m** shoulder by each side making the total width to be = **15m**
- Top soil = **150mm** for clearance.

- ESTIMATING THE VOLUME OF TOP SOIL:**

TIMESING	DIMENSION	SQUARING	DESCRIPTION
1/	970.00	2182.5	General excavation of top soil maximum depth 150mm. The total volume of top soil = 2182.5m ³ .
	15.00		
	0.15		

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Field Survey Measurements and Computations, 2017.

- ESTIMATING THE VOLUME OF CUT:**

<i>TIMESING</i>	<i>DIMENSION</i>	<i>SQUARING</i>	<i>DESCRIPTION</i>
1/	970.00	34381.65	General cutting maximum depth of 2.363m. Total volume of cutting = 34381.65m ³ .
	15.00		
	2.363		

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Field Survey Measurements and Computations, 2017.

- **ESTIMATING THE VOLUME OF FILL:**

<i>TIMESING</i>	<i>DIMENSION</i>	<i>SQUARING</i>	<i>DESCRIPTION</i>
1/	970.00	38746.65	General filling maximum depth of 2.663m, with approved and selected material other than top soil.
	15.00		Total volume of filling = 38746.65m ³ .
	2.663		

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Field Survey Measurements and Computations, 2017.

From the tables of volume for the top soil, cut and fill, we can observe that the average depth of filling is very high, it is so, because the reference datum adopted is leaving the filling side with much more to fill than to cut, it is usually ideal and cost saving for the cutting side to be higher, since it is cheaper to cut than to fill.

Billing of the Cut and Fill Volumes for Earthworks;

Considering quantities as obtained from the above estimate for the propose road the billing is as follows;

The rating is affected by so many factors such as location, type of equipment, method of the job, because of that; the billing is divided into two parts;

- a. Cost of materials.
- b. Cost of work done (labour).
- c. Cost of machinery and equipment (Purchasing, hiring or leasing).

CROSS SECTIONS

HORIZONTAL
VERTICAL

1:250

1:50

CH 300

CH 350

CH 400

CH 450

HORIZONTAL
VERTICAL

SCALE

1:250

1:50

CH500

CH550

CH600

CH650

HORIZONTAL
VERTICAL

SCALE

1:250

1:50

CH 700

CH 750

CH 800

CH 850

HORIZONTAL
VERTICAL

SCALE

1:250

1:100

2m 2m 1m ϕ 1m 2m 2m

CH 900

2m 2m 1m ϕ 1m 2m 2m

CH 950

2m 2m 1m ϕ 1m 2m 2m

CH 1000

2m 2m 1m ϕ 1m 2m 2m

CH 1050

CALCULATING VOLUME FOR CUTTING

<i>Cross section</i>	<i>Depth</i>	<i>Width at the top of cutting(m)</i>	<i>Weighing</i>	<i>Mean width (m)</i>
CH 50	1.698	$15+(2 \times 2)(1.698)$	1	$21.792+15/2=18.396$
CH 100	1.788	$15+(2 \times 2)(1.788)$	4	$22.152+15/2=18.576$
CH 150	1.609	$15+(2 \times 2)(1.609)$	2	$21.436+15/2=18.218$
CH 200	1.518	$15+(2 \times 2)(1.518)$	4	$21.076+15/2=18.038$
CH 250	1.720	$15+(2 \times 2)(1.720)$	2	$21.880+15/2=18.440$
CH 300	1.351	$15+(2 \times 2)(1.351)$	4	$20.260+15/2=17.702$
CH 350	1.614	$15+(2 \times 2)(1.614)$	2	$21.456+15/2=18.228$
CH 400	1.315	$15+(2 \times 2)(1.315)$	4	$20.260+15/2=17.630$
CH 450	2.395	$15+(2 \times 2)(2.395)$	2	$24.580+15/2=19.790$
CH 500	1.299	$15+(2 \times 2)(1.299)$	4	$20.196+15/2=17.598$
CH 550	2.756	$15+(2 \times 2)(2.756)$	2	$26.024+15/2=20.512$
CH 600	1.279	$15+(2 \times 2)(1.279)$	4	$20.116+15/2=17.558$
CH 650	2.275	$15+(2 \times 2)(2.275)$	2	$24.100+15/2=19.550$
CH 700	1.208	$15+(2 \times 2)(1.208)$	4	$19.832+15/2=17.416$
CH 750	1.359	$15+(2 \times 2)(1.359)$	2	$20.436+15/2=17.718$
CH 800	1.264	$15+(2 \times 2)(1.264)$	4	$20.056+15/2=17.528$
CH 850	2.522	$15+(2 \times 2)(2.522)$	2	$25.088+15/2=20.044$
CH 900	1.953	$15+(2 \times 2)(1.953)$	4	$22.812+15/2=18.906$
CH 950	2.755	$15+(2 \times 2)(2.755)$	2	$26.020+15/2=20.510$
CH 1000	1.687	$15+(2 \times 2)(1.687)$	1	$21.748+15/2=18.374$

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Field Survey Measurements and Computations, 2017.

$$\Sigma \text{Area} = 1,754,728 \text{m}^2$$

$$\text{Volume} = \Sigma \text{Area} \times \frac{1}{3} (\text{Interval of the Cross-Sections})$$

$$\text{Volume} = 1,754,728 \times \frac{1}{3} (50)$$

$$\text{Volume} = 1,754,728 \times 16.67$$

$$\text{Volume} = 29,251.316 \text{m}^3$$

Therefore, the volume of the excavation is **29,251.316m³**.

<i>TIMENSING</i>	<i>DIMENSION</i>	<i>SQUARING</i>	<i>DESCRIPTION</i>
1/	18.396 1.698	31.236	Cs1 To Reduce Level
4/	18.576 1.788	132.856	Cs2
2/	18.218 1.609	58.626	Cs3
4/	18.038 1.518	109.527	Cs4
2/	18.440 1.720	63.434	Cs5
4/	17.702 1.351	95.662	Cs6
2/	18.228 1.614	58.840	Cs7
4/	17.630 1.315	92.734	Cs8
2/	19.790 2.395	94.794	Cs9
4/	17.558 1.299	91.440	Cs10
2/	20.512 2.756	113.062	Cs11

4/	17.558	89.827	Cs12
	1.279		
2/	19.550	88.953	Cs13
	2.275		
4/	17.416	84.154	Cs14
	1.208		
2/	17.718	48.158	Cs15
	1.359		
4/	17.528	88.622	Cs16
	1.264		
2/	20.044	101.102	Cs17
	2.522		
4/	18.906	147.694	Cs18
	1.953		
2/	20.510	113.010	Cs19
	2.755		
1/	18.374	30.997	Cs20
	1.687		

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Field Survey Measurements and Computations, 2017.

CONCLUSION

In conclusion, the alignment survey exercise as seen from the result section of this report displays the horizontal angles obtained during the traversing is used as the intersection angle of the control point or intersection point of the exact two straight it was plotted on. The amount of cutting was much thus, reducing the cost of materials for filling and by taking the lower level as the reference level, it increases the amount of cut however reducing the amount of fill. Cutting is more economical as there are no new materials brought in unlike filling where new materials are introducing into the play. From the results, the average depth of filling is very high, because of the reference level used as ground level, which has left the earthworks with much more to fill than to cut, it is usually cost saving for the cutting to be higher, because it is cheaper to cut than to fill.

RECOMMENDATIONS

The following recommendations were made because of our limitations to do some of the works;

- A similar practical should be conducted taking into consideration time and resources to conduct the practical.
- A fully review and equipped burrow pits site investigation should be a part of such practical survey.
- A complete road construction survey to be carried out as it will impact the knowledge of route surveying as well as highway survey.
- A drainage levelling and sloping practical survey to be carried as it will impact knowledge of drainage engineering.

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