

Route Survey of The Polytechnic Unwana Back Gate to Medical Centre

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Abstract: This project focused on route survey of back gate to medical centre Akanu Ibiam federal polytechnic Unwana Afikpo, Ebonyi State. The project was executed in order to provide relevant information on the said route for rehabilitation purpose. The survey operation carried out to achieve the said aim include reconnaissance, making of chainage distance, establishment of controls, data capture of editing, cross section and longitudinal along the route using leica total station. The final coordinates are used to produce detail, profile and cross section plans and the design. This research identified poor drainage as a major factor that causes early deterioration of roadways. He concluded that in order to avoid early deterioration of roadways, and enhance its performance, it is necessary to provide adequate drainages for the roadway. Other factors including; poor maintenance of already built roads, use of low-quality materials in construction of roads, climate change, applying of heavy traffic on roads that were not designed to accommodate such traffic, was identified in this research. The purpose of this paper is to find lasting solutions to factors that cause early deterioration of constructed roads in Nigeria.

Keywords: Longitudinal Profile, Cross-section, Profile Levelling, Control Establishment.

1. Introduction

Route surveying deals with road construction, it may be defined as the survey operation carried out in establishing the horizontal and vertical alignment of specified area of land needed for social utilities such as highways,

Railways, transmission lines, pipeline, flyover, etc. Route surveying can also be applied when alignment is needed in expansion or rehabilitation of existing route (roads) e.g. for traffic purpose.

Route survey is the survey of a narrow strips of land stretching over a long-distance interval for the purpose of designing and construction of linear engineering work such as transportation system, oil and gas pipeline, highway, canals and tunnels, reservoir and power transmission line. (Barnister et al 2008).

In route survey, centre line traverse of the route is carried out by the use of theodolite, total station or differential GPS to present the actual shape of the route, while the longitudinal and the cross-sectional profile levelling is done by the use of levelling instruments. At the end of the survey, the traverse plan, the longitudinal and the cross-sectional levelling are

plotted using AUTO-CAD software for future design and construction of the proposed site.

The major stages involved in carrying out route surveying are:

- i. *Reconnaissance survey:* This is a rapid approximate survey carried out to examine the area through which the alignment lines have to pass. It also involved location of control points, planning for easy execution and establishing all traverse point along the proposed route.
- ii. *Investigation survey:* This is the survey carried out initially in order to get the ground view or terrain configuration of the existing route to accomplish the tasks of the project. A third order traversing will be carried out along and at cross section to the points establish during the stage of recce., also topographic detailing, and benchmarking will be carried out at this stage.
- iii. *Location survey:* It involves actual planning and designing of the proposed alignment of the route on paper and location of such design on the ground. The proper location was done by drawing proposed centre line of the investigation survey plan taking into consideration all the features that characterizes the road.

A. Background of the Survey

Engineering survey is one of the branches of surveying which forms the general expression for any survey work carried out in connection with the building and construction of engineering project such as highway, railway, tunnels and canals, dams and pipelines etc. In the world of engineering and environmental development, surveying has been recognized as the inevitable operation being described as the bedrock of every meaningful development. The general part of its responsibility is seen from the various types of surveying which geared towards promoting route ways, convenience accessibility and spatial declination of both natural and social environments. Engineering in the other hand implies the activities of planning, designing, construction, development and rehabilitation of roads and other construction projects depending on the survey data required. Route survey which is an aspect of engineering surveying refers to the survey operation carried out for the

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establishment of vertical alignment of the transportation facilities, it involves the planning, designing and setting out of any route such as highway, railways, pipeline canals and tunnels. This type of survey is applied when there is need for alignment, expansion and rehabilitation on any existing route. Route survey provides a plan/map which shows the alignment details, longitudinal and cross-sectional levelling profile which depicts the nature of the terrain of a given strip of land which serves the purpose of location, designing and construction of any road network. Good road network is one of the basic amenities needed by human being as movement is one of the characteristics of living things, so there is need for people to move from one place to another and also the transportation of goods and services. Therefore, for any meaningful development in any country, good road is always needed and its achievement is made through route survey.

B. Project Site Location

The project site is located within school premises from back gate to medical centre and lies within the geographical coordinate latitude.

Latitude: 5° 47' 0''E

Longitude: 7° 56' 0''N

Scope of the Project:

The scope of the project entails the following

- i. Reconnaissance survey
- ii. Control Establishment
- iii. Chainage Marking
- iv. Determination of position of chainage points and cross section
- v. Detailing
- vi. Data processing
- vii. Road design

C. Aim of the Project

The aim of the project is to carryout route survey for the acquisition of baseline data and computations for engineering design and rehabilitation of the road.

D. Objective of the Project

- Identification of existing features within the project location.
- Identification of ground control points to be used for the project.
- Determination of centerline and marking of chainages at 25m interval.
- Marking out some selected points at the interval of 9m to both left and right sides of the road across the centerline for cross- sectioning.

Centerline traversing, longitudinal and cross-sectional levelling was also carried out to determine the shape of the road, the spot heights along the centerline and across the centerline, for the purpose of producing the traverse plan, the longitudinal and the cross-sectional profile of the road.

- Detailing of all the features within the project location.
- Production of the plan and profile which is the graphic

representation of the surveyed road using appropriate and suitable scale.

2. Methodology

Methodology entails the method and procedures employed in executing the project both in the office and in the field. The method adopted for the purpose of this project was based on the principle of surveying which is “working from whole to part” aimed at acquiring reliable and accurate data needed for the computation and presentation of information in form of a plan. The procedures adopted in carrying out the project followed a pattern in which one step leads to another. For easy operation so that the aim and objectives of the project can be realized, the operation was planned as under listed below.

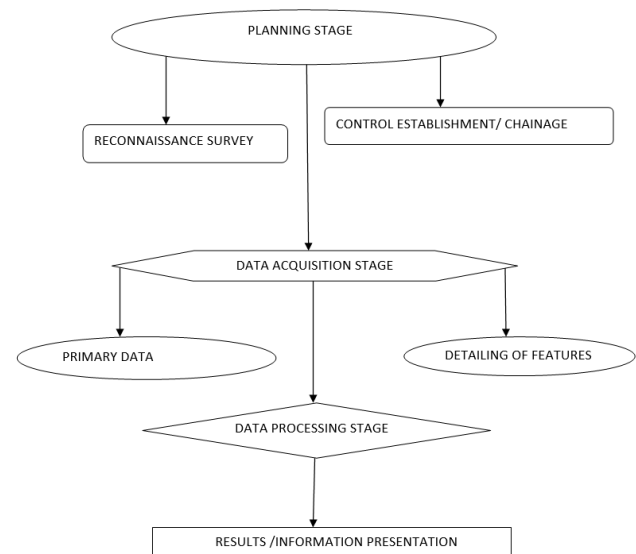


Fig. 1. Flowchart of the project

A. Reconnaissance

This is a very important aspect of surveying that involves planning and preliminary inspection of all the area before the commencement of the actual data acquisition on the project site. This is done for the purpose of planning on how to execute the project, fixing stations, locating controls etc. Its importance prior to the actual surveying operation cannot be underestimated as it helps the surveyor to obtain a picture of the project area so as to work on the project execution.

The two phase of reconnaissance are:

- i. Office reconnaissance.
- ii. Field reconnaissance.

B. Office Reconnaissance

This involves the office work carried out before the actual field work. This aspect involves the compilation and study of the available information about the project site as this helps in yielding of result within the expected accuracy. It comprises of the following.

- i. Understanding the purpose of the survey from the project instructor.
- ii. Obtaining the specification for the accuracy required leading to the choice of suitable scale.

- iii. Deciding the method to be employed for the measurement.
- iv. Determining the kind of instrument to be used in executing the project.

Table 1

Shewing the coordinates of existing ground control

Station	Easting (M)	Northing (M)	Heights
GPS 1	380642.001	641239.002	5.000
GPS 2	380542.074	641241.004	7.932
GPS 3	380543.990	641160.884	8.880

Table 2

Observed coordinate

Station	Easting (M)	Northing (M)
GPS 1	380462.006	641239.005
GPS 3	380543.986	641160.879

Table 3

Difference between the observed and given coordinate

Station	Easting (M)	Northing (M)
GPS 1	0.005	0.003
GPS 3	0.004	0.005

Table 4

Difference between the observed and given angle

Station ID	Given	Observed	Difference
GPS 2 TO GPS 1	268° 34' 34"	268° 33' 58"	00° 00' 36"
GPS 2 TO GPS 3	178° 37' 07"	178° 37' 54"	00° 00' 22"

Table 5

Difference between the given and observed distance

Station ID	Given	Observed	Difference
GPS2 TO GPS1	80.098	80.105	0.007
GPS2 TO GPS3	80.143	80.872	0.009

Table 6

Difference between the given and observed height

Station ID	Given	Observed	Difference
GPS1	5.000	5.006	0.006
GPS3	8.880	8.872	0.008

Traverse Misclosure:

Table 7

First loop

Stn.	Given cord.	Observed Cord.	Misclosure
GPS1	380642.001	380642.006	0.005 E(m)
	641239.002	641239.005	0.003 N(m)

Table 8

Second loop

Stn.	Given cord.	Observed Cord.	Misclosure
GPS3	380543.990	380543.986	0.004 E(m)
	641160.884	641160.879	0.005 N(m)

Linear Accuracy:

$$1/\sum \text{DIST}$$

$$1/1.525$$

$$= 0.00583$$

$$= 0.00382$$

$$\text{Linear accuracy} = 1:3000$$

C. Field Reconnaissance

This involves visiting the project site in order to have the general over view of it. Field reconnaissance comes after the planning stage. The site was visited not to only have the general over view but to also locate the control to be used at the commencement and termination of the route, the instruments were selected and the whole length walked around in order to ascertain how the staking out of chainage points will be done.

This includes the following,

- i. The selection and marking of points that links the starting control points to the project site and to the closing controls. These points were used for horizontal alignment. The points selected were marked with nails and bottle covers for easy identification during the execution of the project.
- ii. Selection and marking of points along the centreline at regular interval of 25m which was used for the longitudinal profile and centreline traversing.
- iii. The marking of 9m interval to both sides from the centre line for cross-sectioning.
- iv. Clearing of bush, since the distance from the centre line was up to 25m and there was need for pegging for easy identification and data acquisition. This enables the production of Recce Diagram.

D. In Situ Check

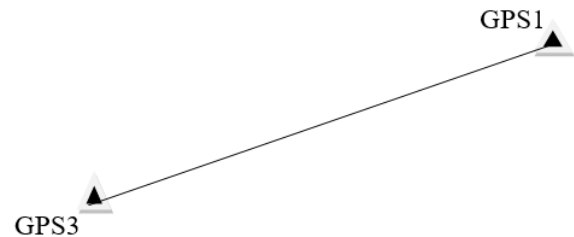


Fig. 2. Showing test for in situ

The essence of carrying out this operation is to ascertain the reliability of all the control to be used for the project whether they were in-situ. The check was carried out by setting the total station instrument on GPS1 and all necessary temporary station adjustment (i.e. cantering, levelling, and focusing) carried out, the reflector at back station on GPS3 was then bisected, read and recorded.

The coordinate obtained were compared with the coordinates collected from the surveying and geo informatics department. The result showed that the discrepancy was very little and lowers than the allowable standard for the specifications of this project and therefore it is reliable enough for the third order survey project at hand.

From the above results, it was discovered that the control was not in conformity with second order accuracy standard and hence cannot be used for second order survey job but can be used for the project at hand which is the third order.

E. Hardware Used

1. Dell laptop (window 10 operating system).
2. HP desk jet A3 printer.

F. Software Used

1. Auto-cad civil 3D land desktop companion (2009)
2. Microsoft excel.
3. Microsoft word.

G. Data Acquisition

This entails the procedures and method used for obtaining all the necessary data for the project execution. Data acquisition can be primary data acquisition which means using survey instrument to carry out field observation and recording of all the observed parameters

Secondary data acquisition which means converting analogue map into digital format to obtain your data, it also includes detailing of all the features found within the project location. For the sake of this project, primary means of data acquisition is used. Therefore, field operation was carried out as follows.

H. Field Observation

1) Centerline Traversing

This was carried out by removing the instrument from its case fixing it on tripod and levelling it by spreading its legs over the station mark on control FPI2004. I signalled the staff man to hold the reflector on the next control station PBJ982 while I carry out observation by bisecting the target and observed to compare the new coordinates with the old one and found out that the instrument is in good condition and ready for use, the reflector was held on the station 0+000 while I took readings to obtain the coordinates of each chainage points at 25m interval along the centerline, I continued in that order at 25m interval along the centerline of the road until the end of the project. I also record the readings of each station points to enable me to produce the centerline traversing plan of the road which will depict the meandering nature of the road and that determines the road alignment

2) Longitudinal Levelling

This was carried out at each chainage points along the centreline at 25m interval starting from zero point to the end of the road by taking observation and recording the sports heights of each chainage and as well recording on field book, this will be used to produce the longitudinal profile of the road to show the area to cut and the area to be filled during the road construction.

3) Cross-Sectional Levelling

This was carried out across the centreline from each of the 25m chainage to both the left and the right hand side of the road by off-setting 3m in three places making the total of 9m in each of the two sides of the road and observe the readings to obtain the spot heights for the production of cross-sectional profile used for the determination the volume earthwork quantities.

4) Detailing

This was done by using the instruments to observe the coordinates of all the existing features within the project location and record them on field book.

I. Data Processing

Data processing is the method of collecting raw data and translating it into usable information. The raw data was

collected, filtered, sorted, analyzed and stored to be able to be presented in a readable or graphic format.

Methods of data processing:

- i. *Manual method:* In this method, the entire process of data collection, filtering, sorting, calculations and other logical operations are all done with human intervention without the use of any other electronic devices or automation software. It is a low-cost method and requires little or no tools but high error, labour cost and time consumption are involved.
- ii. *Mechanical method:* In this method, data is processed by the use of mechanical devices such as calculator, typewriter, printing press etc. This method of data processing is applied in a simple data processing operations where few number of data are used. It has lesser error than the manual method.
- iii. *Electronic method:* This is the modern technological means of data processing using computer system integrated with data processing software and programs. A set of instructions are given to the software to translate data into meaningful output. This method is the most expensive but produces the fastest processing speed with the highest reliability and accuracy of output.

Stages of Data Processing:

- i. *Collection stage:* This stage involves the collection or gathering of raw data. The type of raw data collected has a huge impact on the output to be produced. Hence, raw data should be gathered from a defined and accurate source so that the subsequent findings are valid and usable.
- ii. *Preparation stage:* This stage involves the cleaning, sorting and filtering of raw data in order to remove any unnecessary and uncorrected data. Raw data are checked for errors, duplication, miscalculation or missing data and transformed into a suitable form for further analysis. This is done to ensure that only the highest quality of data is fed into the processing unit
- iii. *Input stage:* In this stage, the raw data is converted into machine readable form and fed into the processing unit. This can be in the form of data entry using keyboard, scanner, or any other means of data input.
- iv. *Processing stage:* The raw data is subjected to various data processing methods using machine learning and artificial intelligent algorithms to generate a desirable output. This method may vary slightly from processing to processing depending on the source of data being processed and the intended use of the output.
- v. *Output stage:* Here the data is finally transmitted and displayed to the user in a readable form such as graphic, table etc. This can be stored and further processed in the next data processing cycle.
- vi. *Storage stage:* This is the last stage where the processed data is stored for further use. This allows for quick access and retrieval of information whenever needed. In this project work, the data acquired from

the field, underwent the above explained data processing stages and methods to enable us produce results and information presented in the next chapter

J. Plotting and Designing of the Route

Longitudinal Profile of the Road: This was first created before the design was done. The longitudinal profile was created using Auto-CAD Civil3D 2009 model by launching on Auto-CAD Civil3D 2009 software and perform the following operations.

- Auto-CAD Civil3D 2009 was launched.
- A new job was created.
- The unit icon was clicked to set the units of the drawing as follows.
- Length type = decimal, units = meter, precision = 0.000.
- Insertion of scale.
- Angle type = Deg/min/sec, precision = 00d 00' 00".
- The clockwise block was clicked.
- The direction control box was clicked and the direction dialogue box opened, the north was selected and OK was clicked to exit the dialogue box.
- The point menu was clicked in the menu bar and the point setting was selected and the point style was set.

Horizontal line was created by clicking on line icon and switched on my Auto, typed a distance of 1km and click enter and the line was drawn, I then off-set the line horizontally at interval by clicking on off-set icon and dial 25 and click enter and the off-sets were created.

- I then clicked on line icon and clicked on each of the 25m vertically, type height of that point e.g., 198.254 and clicked enter bottom and the vertical line representing that height was drawn. I continued in that order until the whole lines were established.
- I then joined the surfaces of the vertical lines and the longitudinal profile was created.

Centerline Traverse Plan of the Road: This was achieved by clicking on point icon after setting Auto-CAD Civil3D 2009 as described above and type in the coordinates of each station and the points will appear, after typing all the whole coordinates then the points were joined with line to create the centreline traverse plan.

Cross-Sectional Profile of the Road: This was created by off-setting 25m at the centreline and 3m into three places in both left and right sides from the centre, type their heights as described in longitudinal profile and click enter and the whole line will be drawn, hence join the surfaces with a line and the cross-sectional profile will be created.

K. Area and Volume Computation

Area and volume computation are constantly required before, during and after construction of any engineering work which route should not be exceptional for the following reasons.

- At the design stage for planning of work and estimation of quantities of materials.
- During construction so that the correct quantities of materials can be ordered and placed.

- After construction so that appropriate payment can be made.

For the sake of this project, mean coordinate was used for area computation while prismoidal rule was used for the volume computation.

$A1 = \text{area1}$, $y1 = \text{offset height1}$, $y2 = \text{offset height2}$, $d = \text{distance interval}$.

We offset 3m intervals into three places from the centre line to both the left and right side of the route to form a cross-section.

L. Materials Used

- Total Station (LEICA)
- Reflectors
- Tripod
- Steel Tape (50m)
- Cutlass
- Hammer
- Peg

M. Total Station

This is a modern survey instrument that integrates an electronic theodolite and electronic distance measuring instrument (EDM) for its operation. Total station uses electronic theodolite in conjunction with electronic distance measurements to determine and read any slope distance from the instrument station to a target. In total station, all the needed parameters such as the coordinates, distance, heights, bearing etc. are determined on one observation at a single station. The development of total station has remarkably increased the productivity of surveying profession in the following ways,

- Improved accuracy: Total station measures its parameters to a higher degree of accuracy of up to 0.5 arc seconds.
- Efficiency and functionality: It can be operated in a longer distance, some total station requires just one operator, with automatic target recognition (ATR), a survey is reduced to one man's job.
- Total station also includes up-to-date image capture technology which can record any image or screen view from the surveying site thereby eliminating the cost of revisiting and producing high resolution image of the site condition.
- It has electronic documentation and sketching function which reduces the need for paper field book in case of wet or damage.
- The data processed and stored in the total station can be down loaded to other computer system for archiving or distribution for retrieval.

Like horizontal collimation error, this error can be overcome by observing on both face left and face right.

N. Test for Accuracy and Adjustment of Total Station

Total station should have an independent checks and adjustments performed on them at least once in a year or at a point when you feel that it is no longer giving you the accuracy you expect from it. Different types of checks and adjustments

carried out on total station depends on the type of total station you are checking but before carrying out those checks, it is prudent that the tripod on which the instrument is mounted is properly checked before use. The reason is that if your tripod is not in good condition, the calibration being undertaken will be poor and it may lead you to think that the instrument needs calibration while it is not. The following are tests and adjustments to be carried out on total station before it can be deployed to the field for observation.

Plate bubble test and adjustment:

Procedure-1

- Set up the instrument on a sturdy tripod.
- Turn the total station until the level bubble is parallel to the two of the three foot screws.
- Turn the total station through 90° and level the bubble using the third foot screw carefully.
- Turn the instrument through 90° and r-level if necessary; keep repeating the procedures in (iii) above until you are confident that the bubble is centred.
- Turn the total station through 180° and the bubble should be centered if correctly adjusted.
- If the bubble is not centred, therefore the instrument needs adjustment.

Optical plummet test and adjustment: Having set up the instrument and carry out plate level test as described above, level the tribrach with the total station mounted on a point defined by a cross.

Level and centre the total station on that point defined by across.

Rotate the total station 120° and observe the cross, the cross should remain central if perfectly in adjustment.

Repeat the (iii) above, if the cross is not at the center each time you rotate through 120°, the instrument needs to be adjusted by specialists.

EDM test and adjustment: Set up a well-defined distance between two known points of over 30m and place a two nails of the same heights over the points.

Measure the distance accurately with steel tape.

Set up and level the instrument over one of the nails, using a prism on the other nail far away from the instrument station, measure and record the distance. This is a gross error check for distance measurement and errors of the order of 2 or 3mm will be usually acceptable.

If the result is greater than the accuracy on the instrument, there is need for adjustment.

The expected angular accuracy for this project which is the third order survey project is $30''/\sqrt{n}$ where n is the number of station occupied, $n=1$ therefore, the angular accuracy of the instrument is $30''/\sqrt{1}=30''$ the above analysis and results showed that the instrument is in good condition suitable for the project at hand since the accuracy obtained is within allowable limit.

3. Result and Discussion

This refers to the assemblage of collected and processed data in a form that allows for clear understanding and interpretation of the information by others. Data can be presented in form of

plans, maps, and graphics or diagrams to show the features on the earth surface in graphic form using appropriate scale, conventional signs and calculated values, the suitable method of representing information depends on the types of survey work. The following results were realized at completion of the project.

Centre line traverse plan of the route: This is the traverse plan that shows the distance and direction of the route along the centre line including all the details.

Longitudinal profile of the route: This is the graphic representation of the undulations of the route at each chainage point along the centre line. It also shows the area to be cut and the area to be fill in order to maintain a uniform elevation.

Cross-sectional profile of the route: This is the levelling profile that represents the ground surface on both sides of the route at a selected point across the route perpendicularly to the centreline.

A. Discussion

This project was conducted using all the appropriate and required survey instruments, the computation was also done with some suitable software and the results which is the end product of the survey was obtained, processed, analyzed and presented using suitable and appropriate scale. From the research and studies conducted on the result, it was discovered that there are lots of cut and fill in the route which will require a lot of economic implication the actual construction of the route.

4. Summary, Problems Encountered, Conclusion, Recommendation

A. Summary

The project centred on route survey which is a type of survey under the broad engineering survey. It outlines the techniques, equipment and personnel involved in executing the project and thereby producing the plan showing the route details, longitudinal and cross-sectional plotting of the project site. The data acquisition was achieved in the field by use of total station (LEICA). Computer aided design (CAD) plotting and other digital cartographic operations were performed in Auto Cad 3D Land Desktop companion 2009 software.

The output was produced in both softcopy and hardcopy format and finally a report on all the activities involved in the project execution was written

B. Problem Encountered

- i. Some of the station points were sloppy, therefore setting instrument on them became a difficult task. But was surmounted.
- ii. Some features and stations were located on difficult position therefore making observations on them was quiet challenging.
- iii. There are lots of brush along the route thereby causing viewing obstruction and reflection of rays from the instrument's line of sight.

- iv. As the project covered a long distant interval of about 2km, trekking along the road from the starting till completion of the project was quiet tasking.

C. Conclusion

In spite of all odds and challenges, this project work was eventually carried out successfully, the aim and objectives of the project was also achieved through the adherence to the supervisor's instruction, the accurate equipment deployed to the project site and collective efforts made by the individual members of the team was helpful in achieving our aim. I hereby conclude that route survey is a team work which requires not only the knowledge and effort of one individual but also the contribution of ideas and co-operation from the individual members and the deployment of good equipment to the project site to achieve the desired aim.

D. Recommendation

Due the numerous advantages gained by final year students of tertiary institution in carrying out surveying field practical field work and the important of surveying in environmental development, I wish to recommend the following.

- i. Surveying department of both universities and polytechnics should provide adequate support to train and upgrade surveying students on the methodologies and applications of modern surveying equipment in carrying out surveying operations.
- ii. Both federal and state government should join with (SURCON) and other survey departments to modernize the study and practicing of surveying in the country so that the upcoming and future surveyors will

gain more knowledge about their profession to discharge their duties effectively in accordance with survey rules and regulations.

- iii. The department of surveying in this institution should continue to embrace this course for its importance and contribution to the development of the academic environment of this institution through the provision of data for the construction of the access road within the school premises and other environmental designs

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