

# Assessment of Passive Geodetic Control Network in Anambra State, Nigeria

**Comment [AC1]:** There are two types of Geodetic control Network. It can be active or passive. I believe you assessed the passive ones. So, better to be specific.

## ABSTRACT

Anambra State is facing a number of environmental challenges that require geodetic infrastructure for effective solutions. Unfortunately, much remains to be done in this area as many control stations have been removed from their original locations, leaving some of their pillars in disrepair. To address this issue, a study was conducted to assess the reliability of the geodetic control network in Anambra for various applications. The study involved identifying the location of control stations within the state, assessing the status of the geodetic control network, and confirming the status of individual control stations. Using a handheld GNSS receiver, the control stations were located and critically assessed for their physical condition. In addition, in situ checks were carried out to determine if they were still maintaining their original positions. The results of the study showed that 36% of the visited and located control stations are still intact in their original positions, while 56% have been removed and 8% require maintenance.

**Keywords:** geodetic, control, station, network geodetic control network, geodetic control stations, GNSS

## 1. INTRODUCTION

A geodetic control network serves as a crucial foundation for consistent and accurate mapping, Geographic Information System (GIS), and surveys. A geodetic control network plays a crucial role in monitoring the deformation and environmental conditions of various structures such as dams, tunnels, high towers, landslides and bridges[1]. This network consists of monument beacons and survey points strategically placed on the earth's surface, with precisely determined horizontal and vertical positions [2]. By providing a means of controlling infrastructure development and laying the groundwork for geospatial data infrastructure, the geodetic control network plays a vital role in any country's development [3]. The establishment of these control infrastructures begins with the geodetic datum, a tool that defines the earth's shape and size, as well as the reference point for various coordinate systems used in earth's surface mapping.

Over the years, the existing 2-D network has been found inadequate in supporting the basic spatial framework for the sustained management and development of the environment and natural resources in Anambra State. Furthermore, the coverage is sparse, many of the monuments have been destroyed or defaced and the reliability is confirmed to be very low [2].

In today's ever-evolving world, new technologies and methods of data collection are constantly emerging. Unfortunately, in Anambra State, a number of environmental issues require geodetic infrastructure, but not enough action has been taken. One of the main issues is that many geodetic control stations have been displaced from their original locations, with some of their pillars either missing or damaged. This study was conducted to assess the reliability of the geodetic control network in Anambra State for a variety of geodetic applications. It involved identifying control stations within the state, assessing the status of the geodetic control network, and confirming the status of individual control stations.

### 1.1 The Area of Study

Anambra State is a Nigerian state located in the southeastern region of the country. It was established on August 27th, 1991 and is bordered by Delta State to the west, Imo State and Rivers State to the south, Enugu State to the east, and Kogi State to the north. The state is comprised of 21 Local Government Areas and has Awka as its capital city. Onitsha, which is one of the largest metropolis areas in Africa, is the state's largest city. The majority of the population is made up of Igbos (<https://www.britannica.com/place/Anambra>).

Anambra State lies between latitudes 6° 00'N and 7° 00'N and longitudes ~~and~~ 6° 45'E and 7° 20'E, ~~and has with~~ a landmass of approximately 4844 km<sup>2</sup>. It consists of ~~21~~ 21 ~~Twenty one local government areas~~ Local Government Areas with a total of ~~179~~ one hundred and seventy nine communities [4]. The state has a projected population of 6,149,744 in 2022, according to Okpala, O.V. et al. (2021)[5]. Figure 1 shows the map of Anambra State.



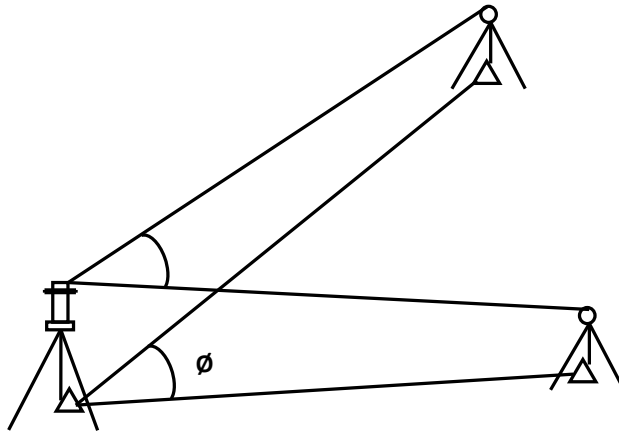


Fig. 3. Insitu Check with a Total Station

An in situ check is also carried out with GNSS receivers by observing the control stations relative to other existing reliable controls and comparing the newly determined coordinates with the known coordinates of the control stations in question.

In this study, both methods were used. For the control stations that were intervisible, the total station method was used while the relative stations that were far from each other were checked using the GNSS method. The models for the computation of the bearings of the two survey lines and the distances between the controls are given respectively by [Eteje, S. O. and Okpeahior, A. C. \(2021\)](#) as

$$\text{Bearings } (\alpha_{AB}) = \tan^{-1} \left( \frac{\Delta E_{AB}}{\Delta N_{AB}} \right) = \tan^{-1} \left( \frac{\text{Departure}}{\text{Latitude}} \right) \quad (1)$$

$$\text{Distance } (D_{AB}) = \sqrt{(\Delta N_{AB})^2 + (\Delta E_{AB})^2} \quad (2)$$

Where,

$\Delta N_{AB} = (N_B - N_A)$  = Change in northing between points A and B

$\Delta E_{AB} = (E_B - E_A)$  = Change in easting between points A and B

The angle ( $\theta$ ) subtend at one of the control stations is computed using

$$\theta = \alpha_{AC} - \alpha_{AB} \quad (3)$$

Where  $\alpha_{AC}$  is bearing of line AC and  $\alpha_{AB}$  bearing of line AB

### 3. RESULTS AND DISCUSSION

#### 3.1 Presentation of Results

Tables 1 to 3 show the current status of the first, second and third-order controls in various parts of Anambra State. The control stations are in Awka South and North, Nnewi South and North, Onitsha South and North, Anambra East and West, Idemili North and South, Anaocha, Oyi, Njikoka, Dunukofia, Ihiala, Aguata, Orumba North and Orumba South.

**Comment [AC9]:** How will you ascertain that those visible on ground did not slightly move.?

Table 1. Status of First (Primary) Order Federal Controls in Anambra State

| S/N | CONTROL POINTS | LOCATION | DISTRICT                   | STATUS/CONDITION  |
|-----|----------------|----------|----------------------------|-------------------|
| 1   | XVS 982        | Awka     | UNIZIK Postgraduate Office | Visible on Ground |
| 2   | XVS 983z       | Awka     | UNIZIK Gate                | Visible on Ground |
| 3   | XVS 992        | Oko      | FED Poly Oko               | Uprooted          |
| 4   | XVS 993        | Onitsha  | Oyigluetze                 | Uprooted          |

|    |          |            |   |                                  |
|----|----------|------------|---|----------------------------------|
| 5  | XVS 994  | Ogboji     | Central School Ogboji                     | Visible on Ground                |
| 6  | XVS 995  | Adazinnuku | Union Primary School,<br>Adazinnukwu      | Visible on Ground                |
| 7  | XVS 091  | Achalla    | Awka North Secretariat<br>Achalla         | Visible on Ground                |
| 8  | XVS 779  | Nzam       | Anambra West Secretariat<br>Nzam          | Visible on Ground But<br>Defaced |
| 9  | XVS 911  | Ukpo       | Dunukofia Secretariat Ukpo                | Visible on Ground But<br>Defaced |
| 10 | XVS 91 2 | Nnewi      | Nnewi North Secretariat Nnewi             | Visible on Ground                |
| 11 | XVS 913  | Ajali      | Orumba North Secretariat Ajali            | Visible on Ground                |
| 12 | XVS 914  | Ihiala     | Ihiala Local Govt.<br>Headquarters Ihiala | Visible on Ground                |
| 13 | XVS 855  | Abagana    | Njikoka Secretariat Abagana               | Visible on Ground                |
| 14 | XVS 856  | Neni       | Aniocha Secretariat Neni                  | Uprooted                         |
| 15 | XVS 857  | Ekwulobia  | Aguata Secretariat<br>Headquarter         | Visible on Ground                |

**Table 2. Status of Second (Secondary) Order Federal Controls in Anambra State**

| S/N | CONTROL STATION | LOCATION | DISTRICT   | STATUS/CONDITION              |
|-----|-----------------|----------|--|-------------------------------|
| 1   | FGPANY001       | Onitsha  | Old Hospital Road, Onitsha                                       | Physically Not on Ground      |
| 2   | FGPANY002       | Onitsha  | Onitsha Recreation Centre,<br>Court Road                         | Physically not on Ground      |
| 3   | FGPANY003       | Onitsha  | Court Road by Enugu Road   | Visible on Ground             |
| 4   | FGPANY004       | Onitsha  | Chinese Restaurant, Trans<br>Nkisi                               | Physically not on Ground      |
| 5   | FGPANY005       | Onitsha  | Magazine Junction, Onitsha                                       | Visible on Ground But Defaced |
| 6   | FGPANY006       | Onitsha  | Garden of Light and Power<br>Church                              | Physically not on Ground      |
| 7   | FGPANY007       | Umunya   | Odumodu Junction, Along<br>Enugu - Onitsha Express<br>Way,Umunya | Uprooted by RCC Company       |
| 8   | FGPANY008       | Umunya   | NYSC Camp Along Enugu -<br>Onitsha Express<br>Way,Umunya         | Uprooted by RCC Company       |
| 9   | FGPANY009       | Umunya   | NYSC Camp, Along Enugu -<br>Onitsha Express Way,<br>Umunya       | Uprooted by RCC Company       |

**Table 3. Status of Third (Tertiary) Order Federal Controls in Anambra State**

| S/N | CONTROL POINT | LOCATION | DISTRICT   | CONDITION                |
|-----|---------------|----------|--|--------------------------|
| 01  | ANSG GPS A1   | AWKA     | Amansea JXN, Old Enugu-<br>Onitsha Express Way                   | Physically not on Ground |
| 02  | ANSG GPS A2   | AWKA     | UNIZIK Gate, B/W Two Arms of<br>Road, Express Way                | Physically not on Ground |
| 03  | ANSG GPS A3   | AWKA     | Ikenga Hotel JXN, Awka   | Physically not on Ground |
| 04  | ANSG GPS A4   | AWKA     | Queen Anglican Convent, Ifite<br>Awka Road                       | Physically not on Ground |
| 05  | ANSG GPS A5   | AWKA     | Before Amawbia JXN By<br>Express Road, Ascending Hill to<br>Osha | Physically not on Ground |
| 06  | ANSG GPS A6   | AWKA     | Amawbia Junction By Express<br>Road                              | Physically not on Ground |
| 07  | ANSG GPS A7   | AWKA     | Enugu Agidi Junction   | Physically not on Ground |

|    |                          |      |  |                          |
|----|--------------------------|------|--|--------------------------|
| 08 | ANSG GPS AS              | AWKA | Ukpo Junction<br>Road to Nawgu, 2km From Ukpo Junction | Physically not on Ground |
| 09 | ANSG GPS A9<br>ANSG GPS  | AWKA | Community Council Hall, Enugu                          | Visible on Ground        |
| 10 | A10                      | AWKA | Agidi  | Visible on Ground        |
| 11 | ANSG GPS All<br>ANSG GPS | AWKA | Girls Secondary Amawbia<br>JXN B/W Achalla And Regina  | Physically not on Ground |
| 12 | A12                      | AWKA | Celli, Awka  | Physically not on Ground |

### 3.2 Discussion of Results

It can be seen in Table 1 that there are 15 primary controls in the state, 10 (XVS 982, XVS 983z, XVS 994, XVS 995, XVS 091, XVS 912, XVS 913, XVS 914, XVS 855 and XVS 855) are visible on the ground, 3 (XVS 992, XVS 993 and XVS 856) have been removed while 2 (XVS 779 and XVS 911) are on the ground but defaced. It implies that 10 of the 15 primary controls in Anambra are in good physical condition, 3 need to be re-established, and 2 need physical maintenance. It also indicates that 77% of the visited primary controls are physically intact on the ground, 8% of them have been removed while 15% that exist on the ground require maintenance.

It can also be seen in Table 2 that 1 (FGPANY 003) of the 9 second order controls is physically intact on the ground, 7 (FGPANY 001, FGPANY 002, FGPANY 004, FGPANY 006, FGPANY 007, FGPANY 008 and FGPANY 009) have been removed and 1 (FGPANY 005) is visible on the ground, but defaced. It shows that 1 of the 9 secondary control stations located in the state is still intact in its position, 7 need to be reestablished while 1 is visible on the ground but requires maintenance. It also implies that 15% of the visited and located secondary controls are physically intact on the ground, 35% have been removed while 50% of them that exist on the ground need maintenance.

It can again be seen in Table 3 that 2 (ANSG GPS A9 and ANSG GPS A10) of the 12 third order controls located are physically on the ground while 10 (ANSG GPS A1, ANSG GPS A2, ANSG GPS A3, ANSG GPS A4, ANSG GPS A5, ANSG GPS A6, ANSG GPS A7, ANSG GPS A8, ANSG GPS 11 and ANSG GPS A12) have been removed. It shows that 2 of the 12 visited tertiary order control stations exist physically on the ground while 10 are no longer in existence. It also implies that 17% of the visited and located third order control stations are physically intact on the ground while 83% of them have been removed.

In situ checks were carried out on the physically existing geodetic controls and were found to be intact in their original positions.

### 4. CONCLUSIONS

The study has evaluated the status of the geodetic control network in Anambra State by identifying the locations of some control stations to assess their physical conditions and confirm the stability of the controls. The study shows that 36% of the visited and located control stations are intact in their original positions, 56% have been removed, and 8% require maintenance.

### REFERENCES

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**Comment [AC10]:** What are the possible reasons of the removal of some control stations. Better to provide some information.

**Comment [AC11]:** What are your recommendations for this study? Is it safe to assume that the output is accurate?

**Comment [AC12]:** Format of the references is not consistent. For instance, 1<sup>st</sup> reference has parenthesis before mentioning the name while the rest do not have.

- (2021). Population seroprevalence of SARS-CoV-2 antibodies in Anambra State, South-East, Nigeria. *International Journal of Infectious Diseases*, Vol.110 pp 171–178.
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