OPEN ACCESS
Global Journal of Research in Humanities & Cultural Studies
ISSN: 2583-2670 (Online)
Volume 06 | Issue 02 | March-April | 2026
Journal homepage: https://gjrpublication.com/gjrhcs/
Research Article

A Geophysical Study of Certain Building Foundations in Kano Metropolis using Electrical Resistivity Tomography (ERT)

*Amina Aminu Mado[1], Musa Ahmed Abubakar[2], Huzaifa Ahmad Ibrahim[3], Ibrahim Usman Aikawa[4], Rufa'i Baffa Saleh[5]

[1, 2] Department of Science Laboratory Technology, School of Technology, Kano State Polytechnic, Nigeria.
[3]Department Electrical Engineering, Bayero University Kano (BUK), Kano State, Nigeria.
[4]Department of Mechanical Engineering, Kano State Polytechnic, Nigeria.
[5]School of General and Remedial Studies

DOI: 10.5281/zenodo.18878281 **Submission Date: 10 Jan. 2026 | Published Date: 05 March 2026**

***Corresponding author: Amina Aminu Mado**
Department of Science Laboratory Technology, School of Technology, Kano State Polytechnic, Nigeria.

Abstract
Characterization of surface soil is essential for foundation design of important civil engineering structures. The current study investigates the subsurface conditions of some building foundations in Kano Metropolitan area; Kano-Municipal, Kano State, using geophysical electrical resistivity techniques with the aim of studying structural defects which may be responsible for future problems and characterizing the soil conditions of the site. The affected structure is a three storey building leaning at relative rotational angle of about 5.5^0 and having severe foundation-based cracks. Terrameter SAS 4000 Model aided by Electrode Selector was utilized for data collection while RES2DIV software was employed for data processing. Four profiles of various spread lengths and offsets from the building were laid parallel to Building's walls. Inversion model resistivities of range 1-1000 Ωm were obtained and this range encompasses the resistivities for sand, clay, sandy clay, soil water and laterite. These results were complemented and confirmed by tomography and free swell test of soil samples at foundation depths. Therefore, this research has shown that the causes of the cracks and distress on the walls within the site may have been influenced by the differential settlement, resulting from the incompetent subsoil materials and the fractured bedrock on which the foundation of the building was laid. These thereafter most probably gave rise to differential consolidation settlements which has led to the structural cracks. Thus, the study could serve as a scientific basis for addressing challenges in building foundation in Kano Metropolitan.

Keywords: *Geophysical; Resistivity Tomography; Building Foundation; Bedrocks; Soil Instability; Urban Development.*

1.0 INTRODUCTION

With the growing demand for site development and unpleasant experience of building failure, there is increasing number of necessary site investigations to reveal possible subsurface problems. Therefore, geophysical investigations are important in evaluating the physical properties of the subsurface in terms of its *soil type, soil com- petence, soil corrosivity, depth to bedrock and lithologic sequence.* Site engineers, for reasons of cost and other considerations such as assumptions in structural design, sometimes fail to incorporate pre-construction investigations in their job schedule. A geophysical investigation is therefore necessary for the site to reveal possible future subsurface problems and proffer possible solutions before the erection of buildings (Akhtar, 2021; Al-garni, 2009).

The developments of new cities as well as new generally require a detailed evaluation of the subsurface of the site so proposed. Foundation study of a new site is necessary so as to provide subsurface and aerial information that normally assist civil engineers, builders and town planners in the design and siting of foundation of civil engineering structures (Omoyoloye, *et al.,* 2008; Akintorinwa and Adeusi (2009).

Moreover, according to Griffiths and King (1965), an electrical method in which current is applied by conduction to the ground through electrodes depends on the fact that, any subsurface variation in conductivity alters the form of current flow within the earth and this affects the distribution of electrical potential. The degree to which the potential at the surface is affected depends on the *nature, size, shape, location and electrical resistivity* of the subsurface masses. It is therefore possible to obtain information about the subsurface distribution of these bodies from potential measurements made at the surface. This method is used in finding of suitable target for structural surface development. Therefore, the study was aimed to study structural defects which may be responsible for future problems and characterizing the soil conditions of the site using electrical resistivity tomography (ERT) approach.

2.0 METHODOLOGY

2.1 Emerging Trends in Geophysical Techniques for Building Foundation Analysis

The integration of Artificial Intelligence (AI) and Machine Learning (ML) into geophysical data interpretation represents a transformative trend in the field. Singh and Gupta (2023) highlight how Al algorithms can enhance the analysis of complex datasets, allowing for quicker and more accurate interpretation of subsurface conditions. By training models on historical geophysical data, Al can identify patterns and anomalies that may not be readily apparent through traditional analysis methods. Zhang *et al.,* (2021) further emphasized the potential of ML techniques to automate the interpretation process, reducing the time and expertise required for data analysis. These advancements enable geophysicists to focus on critical decision-making rather than being bogged down in the intricacies of data processing. Additionally, Al-driven approaches can continuously improve as they ingest new data, making them adaptable to different geological settings and challenges.

2.2 Development of Portable and Wireless Resistivity Tomography Equipment

Recent advancements in technology have led to the development of portable and wireless resistivity tomography equipment, significantly improving the feasibility of geophysical surveys in urban environments. Duan *et al.,* (2022) discusses how these innovative tools facilitate easier deployment and data collection, minimizing disruption to urban infrastructure while providing high-quality data. Wireless technology allows for greater flexibility in electrode placement and can reduce the logistical challenges associated with traditional wired systems.

Moreover, portable equipment often comes with user-friendly interfaces and real-time data processing capabilities, allowing for immediate visualization of results. This trend not only enhances field efficiency but also encourages the adoption of geophysical methods among practitioners who may lack extensive technical expertise.

2.3 Use of Geophysical Methods for Long-Term Monitoring of Structural Health

The application of geophysical techniques for long-term monitoring of structural health in buildings is gaining traction as an essential practice in civil engineering. Ahmed and Kahraman (2021), emphasize the role of geophysical surveys in assessing the condition of building foundations over time, enabling proactive maintenance strategies. By implementing continuous monitoring systems, engineers can detect early signs of structural distress, such as shifts in moisture content or changes in soil resistivity, which could indicate potential failure. This proactive approach not only enhances the safety and longevity of structures but also provides valuable data for future construction projects. The use of geophysical methods in monitoring aligns with the increasing emphasis on sustainability and resilience in urban development, ensuring that infrastructure remains robust amidst changing environmental conditions.

In summary, the emerging trends in geophysical techniques for building foundation analysis highlight the integration of advanced technologies such as Al and ML, the development of portable equipment, and the application of continuous monitoring practices. These innovations promise to enhance the effectiveness of geophysical investigations and contribute to safer and more sustainable urban infrastructure.

2.4 Methodology Flow-chart

The relative abilities of materials to conduct electricity where a voltage is applied are expressed as conductivities. Conversely, the resistance offered by a material to current flow is expressed in terms of resistivity. For almost all electrical geophysical methods, the true or more scientifically, the specific resistivity of the rock is of interest (Ahmed & Khedr, 2023). The true resistivity of a rock unit is destined as being equal to the resistance of a unit cube of the rock. All resistivity methods employ an artificial source of current. Which is introduced into the ground through point electrodes or long line contacts; the latter arrangement is rarely used nowadays. The procedure is to measure potentials at other electrodes in the vicinity of the current flow because the current is measured as well. It is possible to determine an effective or apparent resistivity of the subsurface. In this regard the resistivity technique is superior, at least theoretically, to all the other electrical methods, because quantitative results are obtained by using a controlled source of specific dimensions. Practically, as in other geophysical methods, the maximum potentialities of resistivity are never realized (Telford *et al.,* 2021; Aliyu *et al.,* 2021).

2.5 Elementary Theory

Consider a current flowing in a cylindrical conductor of length L., cross-sectional area A, with current I, flowing through it, as presented in Figure 2.1. The resistance R from ohm's law is expressed as:

3.1 Ra $\frac{L}{A}$

3.2 $R = \frac{pL}{A}$

Where p is the constant of proportionality called resistivity

A is the unit cross-sectional area (m^2)

L is the length (m)

R is the Resistance of medium between two points measured in ohms.

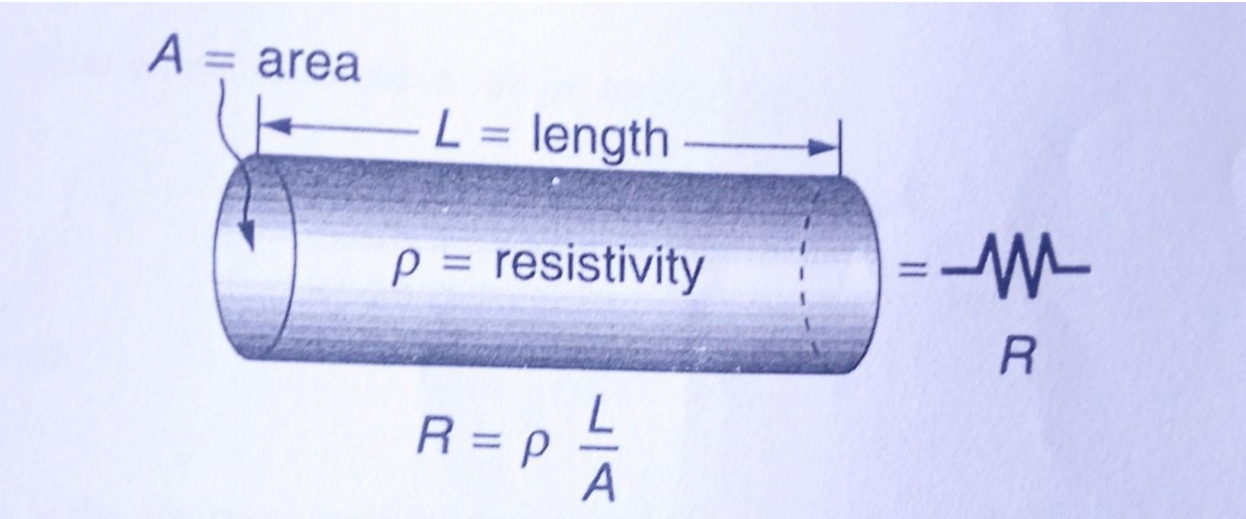

Figure 2.1: Current flow in a cylindrical conductor

But from Ohm's law,

$R = \frac{\Delta v}{1}$

Combining equation 3.2 and 3.3

3.4 $\frac{\Delta v}{1} = \frac{pL}{A}$

Making p the subject of formula;

3.5 $P = \frac{A\Delta v}{LI}$

Equation 3.5 can be used to determine resistivity, p of any homogeneous and isotropic medium provided the geometry is simple e.g. cylinders, parallel pipes and cubes.

For a semi-infinite medium the resistivity at every point must be defined. Where parameters A and L of an element within the semi-infinite medium are shrunk to infinitesimal size;

$P \frac{\lim l -> 0 \frac{\Delta v}{L}}{\lim A -> 0 \frac{I}{A}}$

Where J = the current density measured in ampere/meter square (A/m)

E= the electric field measured in volt per meter (V/m)

Hence:

$J = \frac{E}{P} = Q E$

Where o is the electrical conductivity measured in ohms-meter (m)

The electric field is the negative gradient of scalar potential, i.e

3.9 E= -VV

Thus combining equation (8) and (9) gives

3.10 J=QVV

Assuming that the source is buricd beneath the earth surface such that it gives radial current flow lines of radius (r); the current crossing the spherical surface is given by the equation:

3.11 I =jA
But (A) in meter square (m²), for the sphere is $4nr^2$
Hence:
3.12 l= $4nr^2$ J
Or
3.13 I== $4nr^2$ QVV
3.14 I= $4nr^2 Q\frac{av}{ar}$
3.15 $dV= -\frac{1}{4\,n\,2\,Q}\,dr = \frac{Ipdr}{4nr2}$

Equations were used according Abubakar and Yilmaz (2019), to determine resistivity of any homogeneous and isotropic medium providing the geometry is simple e.g. cylinders parallel pipes and cube. For a semi-infinite medium the resistivity at point must be defined. Where parameters and of an element within the semi-infinite medium are shrunk to infinitesimal size.

2.6 Materials and methods

Some of the field instruments/equipment used are as followers:

- Terrameter SAS 4000 Model
- RES2DIV software
- Cables
- Electrodes
- Measuring tape
- Hammer

Research Procedure

Based on the procedure been documented by Abdullahi *et al.,* (2022), e-research was observed; below step-by-step methodology procedure;

Step 1: Site Selection
The research team identified and selected multiple building sites across Kano Municipal local government within the Kano metropolitan area. The selection included buildings with known foundation issues as well as stable ones for comparative analysis. The team ensured a diverse representation of soil types, building ages, and construction methods to gather comprehensive data on subsurface conditions.

Step 2: Preliminary Survey and Data Collection
The team conducted a preliminary site visit to gather information on the buildings, including construction history, known issues, and previous geotechnical investigations (if available). They will record GPS coordinates, site descriptions, and any observable surface features (e.g., cracks, tilting, and water seepage). The team obtained relevant geological and geotechnical data for the study area, such as soil type, water table depth, and existing borehole logs.

Step 3: Survey Design and Equipment Setup
The research team designed the resistivity survey by determining the survey lines, electrode spacing and depth of investigation, depending on the size of the building and the required resolution. Appropriate resistivity tomography equipment was chosen (e.g., Wenner-Schlumberger or dipole-dipole arrays) based on the expected depth of penetration and subsurface features to be investigated. The team also calibrated and tests the equipment to ensure accurate and consistent measurements.

Step 4: Conduct Resistivity Tomography Surveys
The team deployed electrodes along the selected survey lines, ensuring proper spacing and connection to the resistivity meter. They measured the apparent resistivity at different points by injecting electrical current into the ground and recording the potential difference. Measurements were repeated along multiple lines around and across the building foundation to obtain a comprehensive subsurface image. The team ensured data were recorded in both vertical and horizontal profiles to identify potential anomalies at various depths.

Step 5: Data Processing and Inversion
The collected resistivity data were imported into specialized software for processing and inversion (e.g., RES2DINV or ZondRes2D). The team applied data filtering to remove noise and correct any distortions that may affect the accuracy of the subsurface imaging. They performed 2D or 3D inversion modeling t0 convert raw resistivity measurements into resistivity tomograms that visually represent subsurface conditions.

Step 6: Interpretation of Resistivity Profile
The research team analyzed the resistivity tomograms to identify variations in subsurface properties. This included recognizing zones with high or low resistivity, which may indicate differences in soil type, moisture content, or the presence of voids and fractures. The resistivity anomalies were correlated with known geological and geotechnical data (e.g. borehole logs, previous investigations) to validate interpretations. The team identified specific areas of concern, such as weak soil zones, high moisture areas, or fractures that may compromise foundation stability.

Research Location

Kano Metropolitan is the site of the research study, especially *Kano Municipal.* The population of the Local Government Areas (LGAs) of Metropolitan Kano according to census results and latest population projections are given in the Table below. The population projection assumes the same rate of growth for all Local Government Areas within a State. The undercount of the 1991 census is estimated to be about 25 million. All population figures for Nigeria show high error rates; census results are disputed. Area figures are computed using geospatial data.

Table 1: Shows Kano Metropolitan site indicating Local Government Areas

S/N	Name	Population Census 1991-11-26	Population Census 2006-03-21	Population 2022-03-21
1.	Dala	…	418,759	688,700
2.	Fagge	…	200,095	329,100
3.	Gwale	…	357,827	588,500
4.	Kano Municipal	…	371,243	610,600
5.	Kumbotso	166,558	294,391	484,200
6.	Nasarawa	…	596,411	980,900
7.	Tarauni	…	221,844	364,900
8.	Ungogo	168,373	365,737	601,500

Source: National Population Commission of Nigeria (web), National Bureau of Statistics (web). The population projection assumes the same rate of growth for all L.GAs within a state. The undercount of the 1991 census is estimated to be about 25 million. All population figures for Nigeria show high error rates, census results are disputed. Area figures are computed using geospatial data.

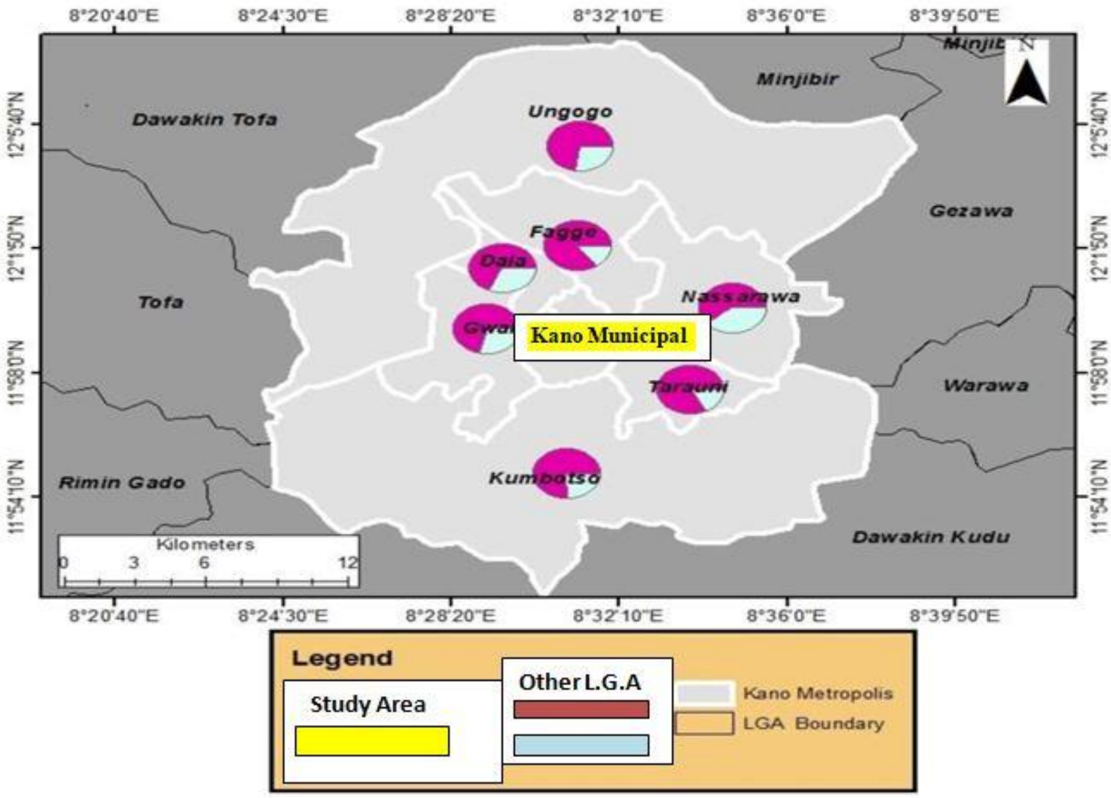

Figure3.1: Map of Kano State Metropolis Showing the Study Location

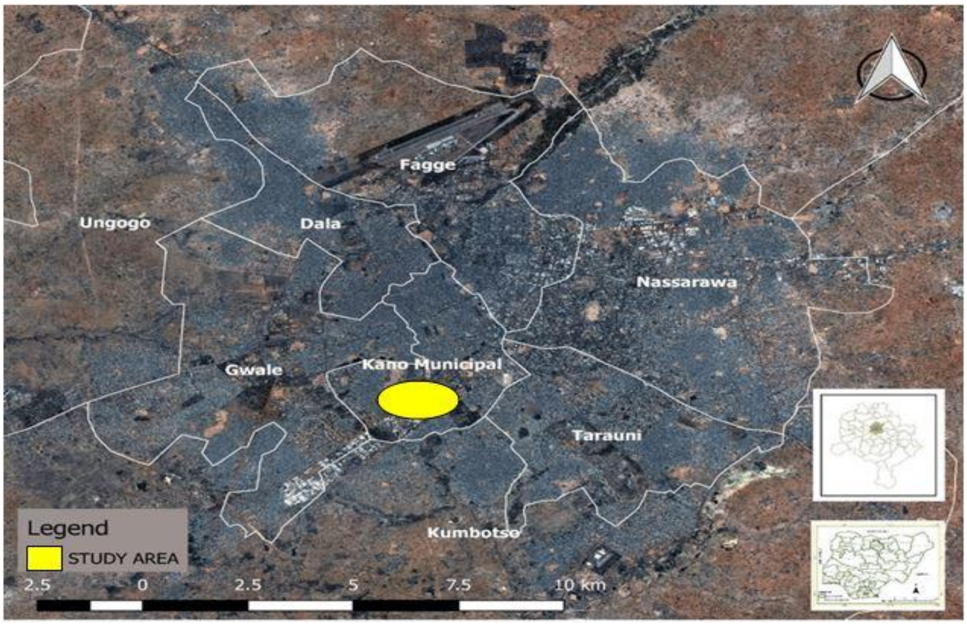

Figure 3.2 Satellite imagery of Kano Metropolis (Source: Quick-bird, 2014). Kano metropolis is one of the largest metropolitan cities in West Africa and is primarily an indigenous city with principal inhabitants which are Hausas; other ethnic groups constitute smaller proportions of the population.

Kano area is underlain by rocks of the Nigerian basement complex comprising migmatites-gneiss complex, younger meta sediments, older and younger granites Bala *et al.,* (2011). MacDonald (1986), established that, it is dominantly underlain by undifferentiated metamorphic suite, older granite, coarse pink granite and porphyritic biotite granite. The predominant rock type is older granite. The older granite is composed of coarse-grained granite, granodiorite, diorite and aplite. The lithological varieties are less common than in metamorphic suite. They were emplaced during the Pan African orogeny which was dated about 650-850 ma. The most abundant and typical member of the older granite suite is a coarse porphyritic granite (Oyawoye, 1986). It is typified by the abundant large feldspar set in a ground mass rich in biotite or hornblende. The feldspar may be white, purple, pink, yellowish brown and dark grey. Magdi (1999), shows that granidiorite constitute a significant part of Kano area. It outcrops as large, massive boulders or as low-laying bodies. The rock is porphyritic in texture, with phenocrysts of plagioclase easily recognizable on hand specimens. Generally, light in color, but with segregation of more mafic portion which are mainly hornblende and biotite.

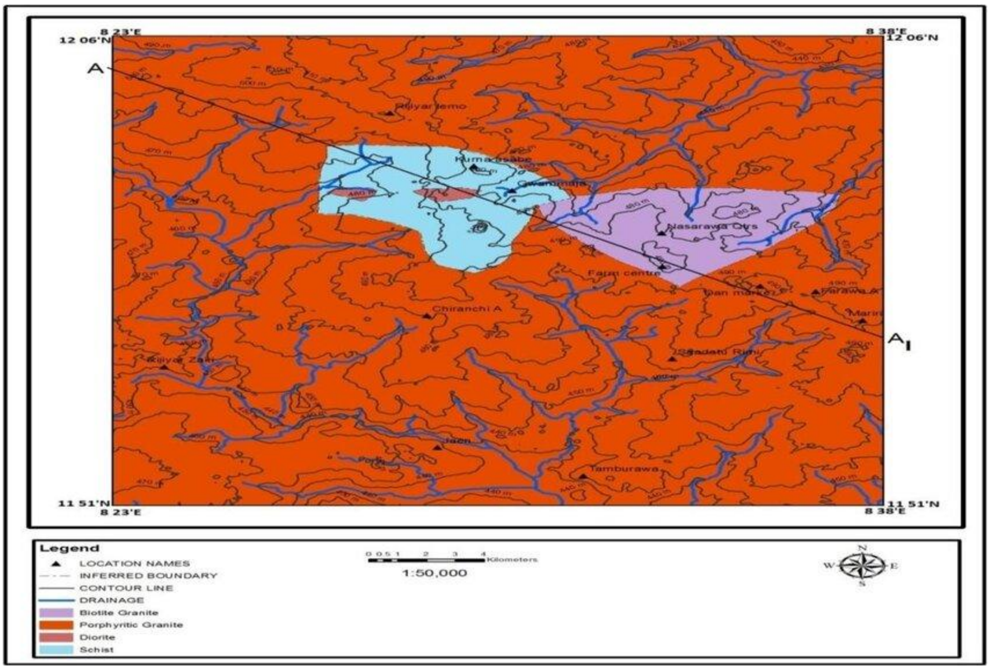

Figure 3.3: Geological map of the study area (Kano metropolis). The study area is bounded by longitudes 11°51´ to 12°06´N and latitudes 8°23´ to 8°38´ E. It is accessible through the Kano-Zaria, Kano Maiduguri, Kano-Katsina, Kano-Hadejia highway roads and numerous intra state roads, as well as footpaths.

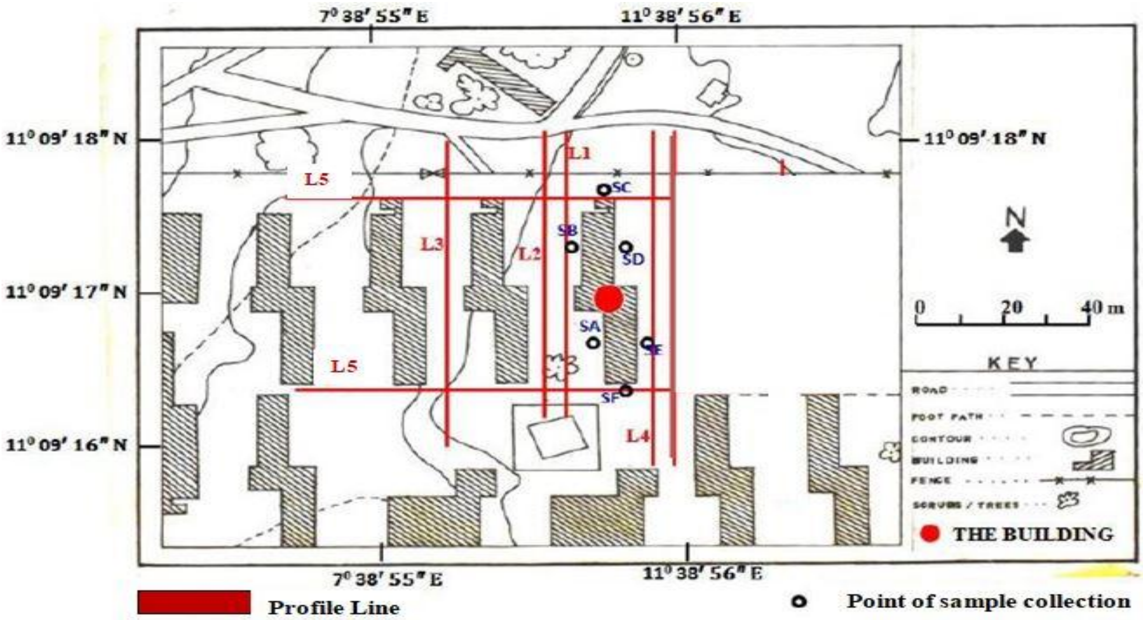

Figure 3: The study site indicating the Profile Lines Occupied for the determination and the Points of sample collection

3.0 RESULTS AND DISCUSSION

Based on resistivity tomography, the electrical resistivity imaging was conducted along five (5) profiles laid around the building under study in order to delineate the resistivity of the subsurface materials. The technique was used so as to delineate the overburden, weathered zones, fractured columns and where possible, the bedrock at the site (Kano Municipal). Apparent resistivity data were collected with a Lund Imaging system comprising *Terrameter SAS 4000* and Electrode Selector *ES464* which is a relay switching unit having 42 electrodes. Four (4) out of the five (5) profiles for the resistivity survey were laid in N-S direction while the other one (1) was laid in W-E direction (Figure 3). Electrode spacing ranged from 1.50 m to 2.50 m depending on the length of each profile which depended on available space. It was ensured that the ground was amenable to the electrode insertion. A few electrodes were unavoidably skipped during the data collection owing to the presence of special features like concrete slabs and road tars. Table 1 shows the summary of the data collection at the site.

Table 2: Summarizes the Parameters used for Data Collection at the study site

Profile Name	Profile Orientation	Offset of profile from the building under study (m)	Profile Length (m)	Electrode Spacing (m)	Number of skipped electrodes	Remark
L1	N-S	2.5 west of the building	80.0	2.00	1	-
L2	N-S	5.0 west of the building next to the building	60.0	1.50	_	Profile across a buried tank
L3	N-S	2.5 east of the building	60.0	1.50	-	_
L4	N-S	5.0 east of the building next to the building	60.0	2.00	3	_
L5	E-W	4.5 south of the building	80.0	2.50	5	Profile across several sewage pipes

Interpretation of Results

RES2DINV Software was used for the processing of the raw data. The software automatically determines a two-dimensional (2-D) resistivity model of the subsurface (Griffiths and Barker, 1993). A forward modeling subroutine was used to calculate the apparent resistivity values, and a non-linear least-squares optimization technique, was used for the inversion routine based on the smoothness-constrained least-squares method (Sasaki, 1992; Loke and Barker 1996).

The least–squares inversion was used to convert the measured apparent resistivity values to true resistivity values and plots were obtained in cross – sections. Hence, three sections namely the observed section, calculated apparent resistivity pseudo-sections and the inverted model section were obtained. In situation where much discrepancy existed, the iteration was repeated until the minimum discrepancy was reached. Due to sharp resistivity contrast noticed in some sections, robust constrain inversion modeling technique was also used for the inversion of some of the profiles.

Figures 1-5 showed some of the 2D model electrical resistivity sections obtained for the five profiles. The range of the root mean square (RMS) errors shown on the pseudo-sections 4.5% -6.1% which is 6%, indicates that there were good fits between the measured and the calculated apparent resistivity data.

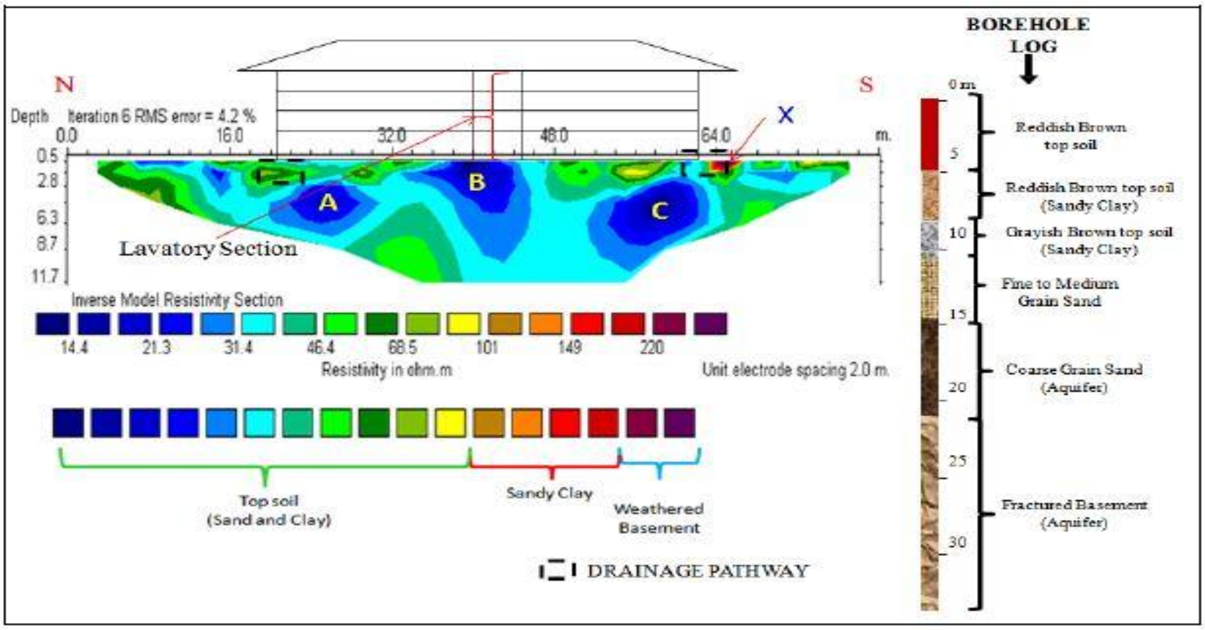

Figure 3.5: Resistivity Section for Profile L1 (2D Inversion Model)

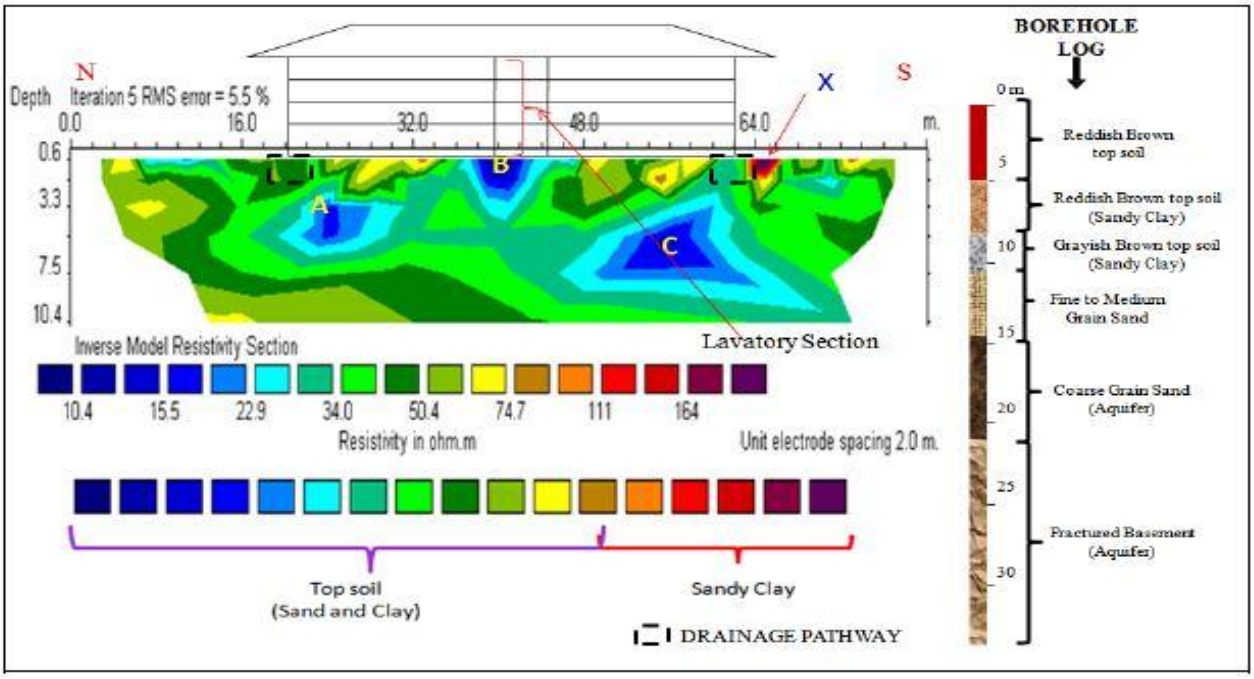

Figure 3.6: Resistivity Section for Profile L2 (2D Inversion Model)

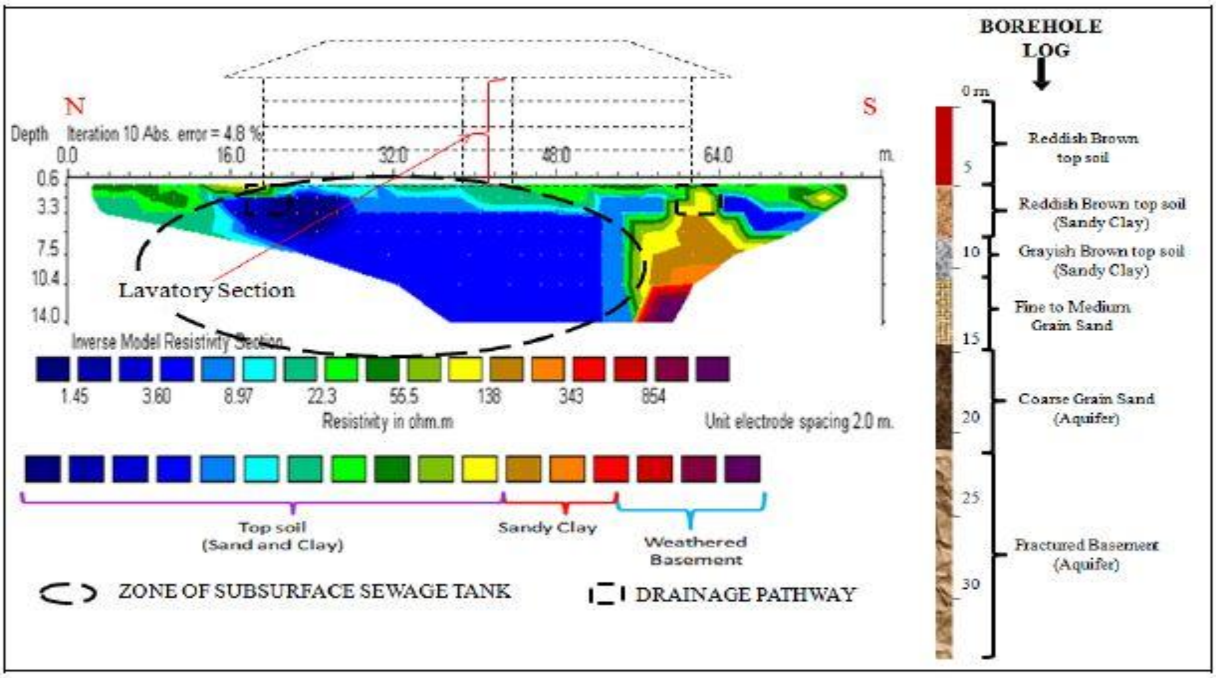

Figure 3.7: Resistivity Section for Profile L3 (2D Inversion Model)

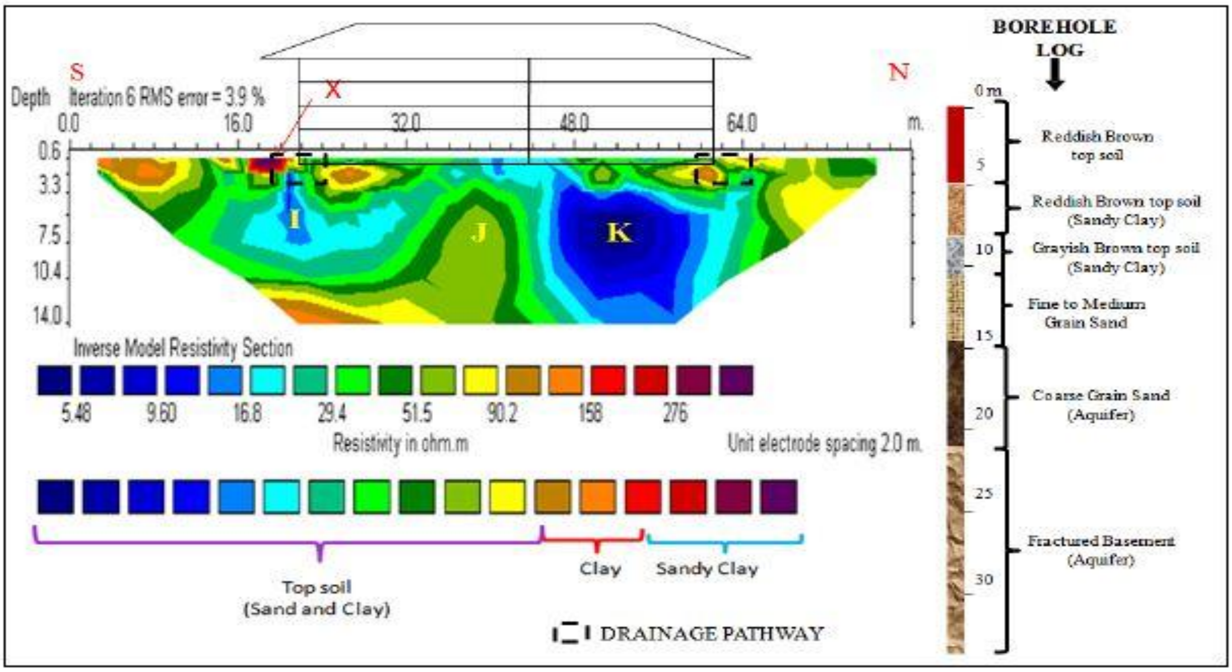

Figure 3.8: Resistivity Section for Profile L4 (2D Inversion Model)

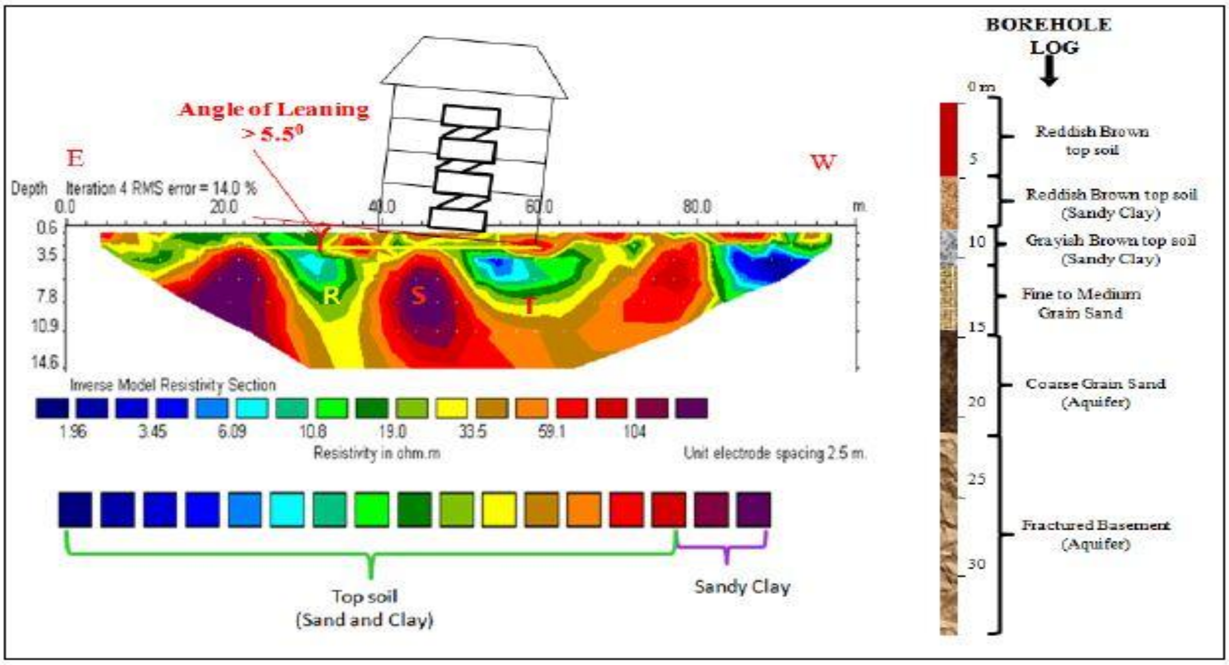

Figure 3.9: Resistivity Section for Profile L5 (2D Inversion Model)

The geoelectric sections obtained are characterized by resistivity range of 1–1000 Ωm. This range indicates the occurrence of **sand, sandy clay, clay and soil water** whose ranges are; 10 - 1000 Ωm, 100 – 200 Ωm, 1-100 Ωm and 10 -100 Ωm , respectively (Table 2). First of all, borehole log recorded from the closest borehole to the building H1 (Figure 3) was obtained. The borehole logs which were interpreted by Hydro Skill and Engineering Services, Kaduna (2005) were used as a control for the interpretation of the entire pseudo-sections obtained in this survey.

Table 3: Representative Resistivities for the Interpreted Materials

S/N	Interpreted Subsurface Material	Standard Resistivity (Ωm)
1.	Sand	500-1000
2.	Sandy Clay	100-200
3.	Clay	1-100
4.	Gneiss	6.7 x 104(wet) – 3 x 106(dry)
5.	Granite	3 x 102-106

Discussion

The 2D model tomograms of all the profiles were characterized by relatively low resistivity values of the range (1-1000 Ωm). This suggests that the subsurface at the site is less compacted and relatively conductive. The pseudo-sections revealed other features which have physical properties that can lead to structural failure.

Profiles L1 and L2 (Figures 3.5 and 3.6) showed three distinct zones of relatively low resistivities namely; A, B and C. These zones in the range of (10-30 Ωm) suggest that they are most probably saturated clayey zones. In profile L1 (Figure 3.5), zones A and C directly underlie a major drainage path which is characterized by severe cracks and breakages, while zone „B", directly underlay the lavatory section of the building which is also characterized by severe foundation-based cracks. The cracks and breakages which occur on both the drainage path and the lavatory section of the building provide route for seepage of sanitary effluents into the ground. This most likely contributed to the distinct saturation at A, B, C in the foundation depths. These three zones (A, B and C) are also shown on profile L2 (Figure 3.6) pseudo-sections as in profile L1 but with reduction in size and at greater depths. It can therefore be deduced that beyond the usual occurrence of swelling in wet seasons, the frequent seepage of the sanitary effluents due to continuous domestic activities most likely sustains high level of saturation in the subsoil throughout the year. This invariably might have led to the subsurface weakness at the western side of the building.

There is a noticeable but insignificant portion on the pseudo-section region of a relatively high resistivity (X) at the top right of the profiles L1 and L2 (Figures 3.5 and 3.6), and at the top left of Profiles L3 (Figure 3.7). This zone by its relative resistivity value (> 1000 Ωm) reveals that it is most likely concrete foundation pavement which underlay the major passage linking other buildings. Profiles L5 (Figure 3.9) shows the end views of southern and northern subsurface of the building.

Therefore, according to Gibbs and Holtz (1956), soils with free swell values less than 50% are not likely to show expansive properties but values of 100% or more are associated with clays which could swell considerably when wetted. The test results also show that the subsoil is relatively more expansive at the western side of the building toward which the building leans than at the eastern side of it.

Four layered-type curves were obtained from the VES points in the study area of Kano Municipality. They have varying geologic characteristics, showing different degrees of weathering and other second porosity in form of fracturing of the bedrock. Plots of some calculated apparent resistivity in ohm-m against electrode spacing in m are presented. These layers could be grouped as follows: -

1st layer - Top soil;

2nd layer – Weathered layer;

3rd layer – Fractured layer;

4th layer – Bedrock layer.

4.1 Top soil: This is a surface dry layer of high resistivity. Its thickness varies from 1.12m to 11.5m. The low resistivity end is diagnostic of sandy clay and clay while a high resistivity end indicates laterite. However, very high resistivity could be an intruded fresh basement.

4.2 Weathered layer: This layer is thought to be highly decomposed crystalline rock. The thickness varies from 5.29m to 54.34m. According to Dan-Hassan and Olorunfemi (2013), it consists of clayey sand/ sandy clay layer. The layer is highly decomposed by weathering to form sand and clayey sand depending on the local variation of the mineralogy.

4.3 Fractured layer: Dan Hassan and Olorunfemi (2023) identified this layer to be the major aquifer unit. In some places, fractured zones occur immediately beneath the weathered horizon. The fractured zones are difficult to detect geophysically, unless it is of greater thickness.

4.4 Bedrock: This is fresh basement layer. Naturally, it has a very high resistivity with infinite thickness. But where it is fractured and saturated; the resistivity reduces. It is not a source of groundwater unless fractured. However, when the shape of the VES curves approaches a very steep gradient of about 45^{o}, it may indicate a fresh basement rock without fractures.

Table 4: Summarizes the Subsurface Conditions at the Study Sites and their Potential effects on the Buildings‟ Foundation

S/N	Interpreted Subsurface Condition	Potential failure Mechanism of the Building
1.	All season saturation of the subsurface due to seepages into the foundation depths at the drainage paths/lavatory section (at western side) of the building (Figures 3.5 and 3.6)	Weakness of the subsurface materials underlying the western side of the building more than that at the eastern side of the building resulting to the leaning towards its western side (Figures 3.8 and 3.9).
2.	Significant contrast in the subsurface resistivity and p wave velocity (Figures 3.8 and 3.9)	Differential subsurface consolidation between the eastern and the western sides of the building‟s subsurface resulting to differential settlement of the building (Figures 3.8 and 3.9).
3.	Significant swell–shrink movement at foundation depths due to the presence of expansive clay (Tables 2).	Severe foundation-based cracks at many parts of the building.
4.	Probable occurrence of dipping layer and anticline at depths beneath the building (Figures 3.8 and 3.9).	Decelerated settlement up-dip (at the eastern side of the building) while progressive settlement take place at the western side of the building (Figures 3.8 and 3.9).
5.	Synclinal structure underlie the side at depth towards which the building lean (Figure 5).	Prolonged subsurface consolidation due to the thickness of clayey overburden at the western side of the building (Figure 5).

CONCLUSION

Based on the investigation in the foregoing, the inversion resistivity models of the profiles revealed that the foundation depths of the site are predominantly characterized by *sandy clayey and clayey soils.* The peculiar tilting of the building is invariably attributable to the consistent swelling and shrinkages of its clayey subsurface. Therefore, the most probable major causes of the failure at the study site are the occurrence of active clay at shallow depths, low strength of intact rocks and some underlying geological structures. The result of this research also showed that the causes of the cracks and distress on the walls within the site may have been influenced by the differential settlement resulting from the incompetent subsoil materials and the fractured bedrock on which the foundation of the building was built. Conclusively, the study of geophysical investigation could serve as a scientific basis for addressing challenges in building foundation in Kano Metropolitan.

ACKNOWLEDGEMENTS

We are immensely grateful to Tertiary Education Trust Fund (TETFUND), NIGERIA and the Department of Science Laboratory Technology (SLT), Kano State Polytechnic, for providing both the grants and the field equipment for the study.

REFERENCES

1. Abdullahi, M., Abubakar, B., & Garba, A. (2022). The role of non-invasive geophysical techniques in urban infrastructure development in Northern Nigeria. Nigerian Journal of Engineering Research, 25(1), 45–55.
2. Abubakar, A., & Yilmaz, T. (2019). Comparison of geophysical methods for subsurface investigation in construction projects. Journal of Geotechnical Engineering, 45(3), 287–299.
3. Ahmed, S. F., & Khedr, M. (2023). Geophysical monitoring of structural health: Techniques and applications. Structural Control and Health Monitoring, 30(1), e3124.
4. Akhtar. (2021). Fractional current flow in the subsurface using electrical resistivity method: A laboratory approach. https://doi.org/10.2478/rmzmag-2020
5. Akintorinwa, O. J., & Adeusi, F. A. (2009). Integration of geophysical and geotechnical investigations for a proposed lecture room complex at the Federal University of Technology, Akure, SW Nigeria. Ozean Journal of Applied Sciences, 2(3).
6. Al-Garni, M. A. (2009). Geophysical investigations for groundwater in a complex subsurface terrain, Wadi Fatima, KSA: A case history. Jordan Journal of Civil Engineering, 3, 118–136.
7. Aliyu, A. A., Bala, A. N., & Suleiman, S. (2021). Integrated geophysical techniques for urban subsurface investigations: A case study from Kano, Nigeria. Geophysical Journal International, 227(3), 1473–1485.
8. Bala, A. E., Eduvie, O. M., & Byomi, J. (2011). Borehole depth and regolith aquifer hydraulic characteristics of bedrock types in Kano area, Northern Nigeria. African Journal of Environmental Science and Technology, 5(3), 228–237.
9. Dan-Hassan, M. A., & Olorunfemi, M. O. (2013). Hydro-geophysical investigation of a basement complex terrain in the north-central part of Kano State, Nigeria. Journal of Mining and Geology, 35(2), 189–200.
10. Duan, Y., Wang, J., & Li, H. (2022). Innovations in portable resistivity tomography for urban applications. Geophysical Journal International, 229(2), 919–934.
11. Duman, S., & Sönmez, H. (2021). Application of geophysical methods for foundation investigations in Turkey. Engineering Geology, 292, 106071.
12. Griffiths, D. H., & King, R. F. (1965). Applied geophysics for geologists and engineers. Pergamon Press.
13. MacDonald, M. (1986). Rural water supplies report (Vol. 1). Sir MacDonald Press Ltd.
14. Magdi, O. (1999). Geological and geochemical investigation of lateritic profiles around Kano with special reference to the distribution of base metals (Master's thesis, Ahmadu Bello University).
15. Omoyoloye, N. A., Oladapo, M. I., & Adeoye, O. O. (2008). Engineering geophysical study of Adagbalaye Newtown development, Southwestern Nigeria. Journal of Earth Sciences, 2(2), 55–63.
16. Oyawoye, M. O. (1972). The basement complex of Nigeria. In F. Dessauvagie & A. J. Whiteman (Eds.), African geology (pp. 18–27). University Press.
17. Telford, W. M., Geldart, L. P., & Sheriff, R. E. (2021). Applied geophysics. Cambridge University Press.
18. Zhang, Y., Duan, Y., & Chen, L. (2021). 3D and 4D resistivity tomography: Principles, advancements, and applications. Geophysics Today, 35(8), 329–346.

CITATION

Mado, A. A., Abubakar, M. A., Ibrahim, H. A., Aikawa, I. U., & Saleh, R. B. (2026). A Geophysical Study of Certain Building Foundations in Kano Metropolis using Electrical Resistivity Tomography (ERT). In Global Journal of Research in Humanities & Cultural Studies (Vol. 6, Number 2, pp. 5–16).
https://doi.org/10.5281/zenodo.18878281