

Geophysical Investigation of Damped Patches on Foundational Wall: A Case Study of Jalala, Tanke-Oke-Odo, Ilorin, Nigeria

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© 2025 جامعة العلوم والتكنولوجيا، المركز الرئيس عدن، اليمن. يمكن إعادة استخدام المادة المنشورة حسب رخصة مؤسسة المشاع الإبداعي شريطة الاستشهاد بالمؤلف والمجلة.

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Geophysical Investigation of Damped Patches on Foundational Wall: A Case Study of Jalala, Tanke-Oke-Odo, Ilorin, Nigeria

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Abstract— The issue of dampness in buildings in Jalala Oke-Odo, Ilorin, Kwara State, Nigeria, poses significant concerns due to its potential to compromise both the health of occupants and the structural integrity of affected buildings. To investigate the underlying causes of this widespread problem, non-destructive geophysical methods—particularly the Electrical Resistivity Method—were employed to assess soil and subsurface conditions. This approach enabled the identification of anomalies in soil composition and the detection of subsurface water sources contributing to dampness. A key objective of the study was to produce detailed subsurface maps around building foundations, providing engineers and contractors with critical data for designing targeted interventions to mitigate damp-related issues and prevent long-term structural damage. The study underscores the serious risks associated with prolonged dampness, including the progressive weakening of foundation walls and the potential for building collapse, posing a grave threat to resident safety. Resistivity measurements revealed variations in the water retention capacity of subsurface lithology. Geoelectric cross-sections showed area with low resistivity at various depths, indicating the existence of impermeable or semi-permeable weathered rock materials, which are major contributors to persistent damp patches. Hence, this geophysical investigation offers important insights into the geological factors influencing dampness in Jalala Oke-Odo. The research serves as bases for effective remediation policies to enhance the resilience of structures and protect life. It also highlights the need for proper understanding of subsurface conditions to tackle dampness issues in developing regions.

Keywords— Dampness, Patches, Resistivity, Foundation, Retention

I. INTRODUCTION

The disturbing issue of dampness in foundation of structures in Nigeria with its attendant consequences on health and building integrity has become a great concern. Apart from creating unhealthy living conditions dampness can also cause widespread structural damage to building walls and foundations [1]. This problem arises from insufficient ventilation and excessive moisture, which can result in structural deterioration [2].

Buildings are composed of several materials and construction techniques, each with distinct performance characteristics. This performance depends on numerous factors such as its location, environmental conditions, the quality of construction materials, and its usage [3]. Structures regardless of age, are susceptible to deterioration occasioned by human-made and natural factors [4] [5]. More concerning is the problem of dampness as collapse of building resulting from poor construction material quality, old age, or faulty foundations is rising in Nigeria [6]. The dampness

issues can be reduced by certain construction materials, such as granite which can place heavy demands on the performance of bedding, leading to issues with penetrating dampness [7], [8]. The need for proper structural ventilation and moisture control cannot therefore be overemphasized. The non-invasive geophysical methods like ground-penetrating radar (GPR), electrical resistivity tomography (ERT), and infrared thermography, are effective tools for identifying the causes of dampness in buildings. Through geophysical investigations, the underlying causes of dampness, including moisture infiltration and structural damage, can be identified, enabling targeted repairs to prevent further damage [9], [10].

The importance of these geophysical methods is further highlighted by the increasing research interest in their application for addressing damp patches in foundational walls. These techniques offer a non-invasive way to assess the subsurface conditions of a building, allowing for early detection of issues such as voids, water seepage, and structural defects, all of which may contribute to dampness and other building-related problems [6], [11]. This proactive approach helps building owners and managers ensure the safety, comfort, and longevity of structures while promoting healthy indoor environments for occupants.

The aim of this study is to conduct a geophysical analysis of damp spots on foundational walls in Jalala Oke-Odo, with the goal of identifying the source and extent of the dampness, as well as any potential structural issues caused by it.

A. Climate/Geology of the study area

Geological setting

The Nigerian Basement Complex, a series of Precambrian igneous and metamorphic rocks, underpins the city of Ilorin. The basement complex is mostly homogeneous and accounts for around half of Nigeria's bedrock. Massive granite and augen-gneiss outcrops. It is supported by the Precambrian to Cambrian Migmatite-Gneiss-Quartzite complex.

The study area is within Tanke Oke-Odo, off University Road, Ilorin Kwara State. The area is located between Latitude 8.471200 and 8.477600 and Longitude 4.629000 and 4.632500 (Figure 1). Tanke is a neighborhood of Ilorin, the capital of Kwara State in Nigeria. The area is situated in the tropical/humid rainforest region, with a climate characterized by wet and dry seasons. The wet season usually occurs from March to October and is dominated by a heavy thunderstorm. The dry season occurs from November to March when the area is under the influence of north-easterly winds.

B. Understanding Dampness on Foundation Walls

Dampness in foundation walls can be a common issue in buildings and can lead to various problems if not addressed properly. Understanding the causes of dampness in foundation walls is important to effectively deal with the issue. In this response, we will discuss the causes of dampness in foundation walls and some possible solutions to prevent or mitigate the problem.

One of the main causes of dampness in foundation walls is poor waterproofing [13]. If the foundation walls were not properly waterproofed during construction or if the waterproofing has deteriorated over time, water can easily penetrate through the walls and cause dampness. This can happen due to cracks, gaps, or improperly sealed joints in the foundation walls. Another common cause of dampness in foundation walls is poor drainage around the building.

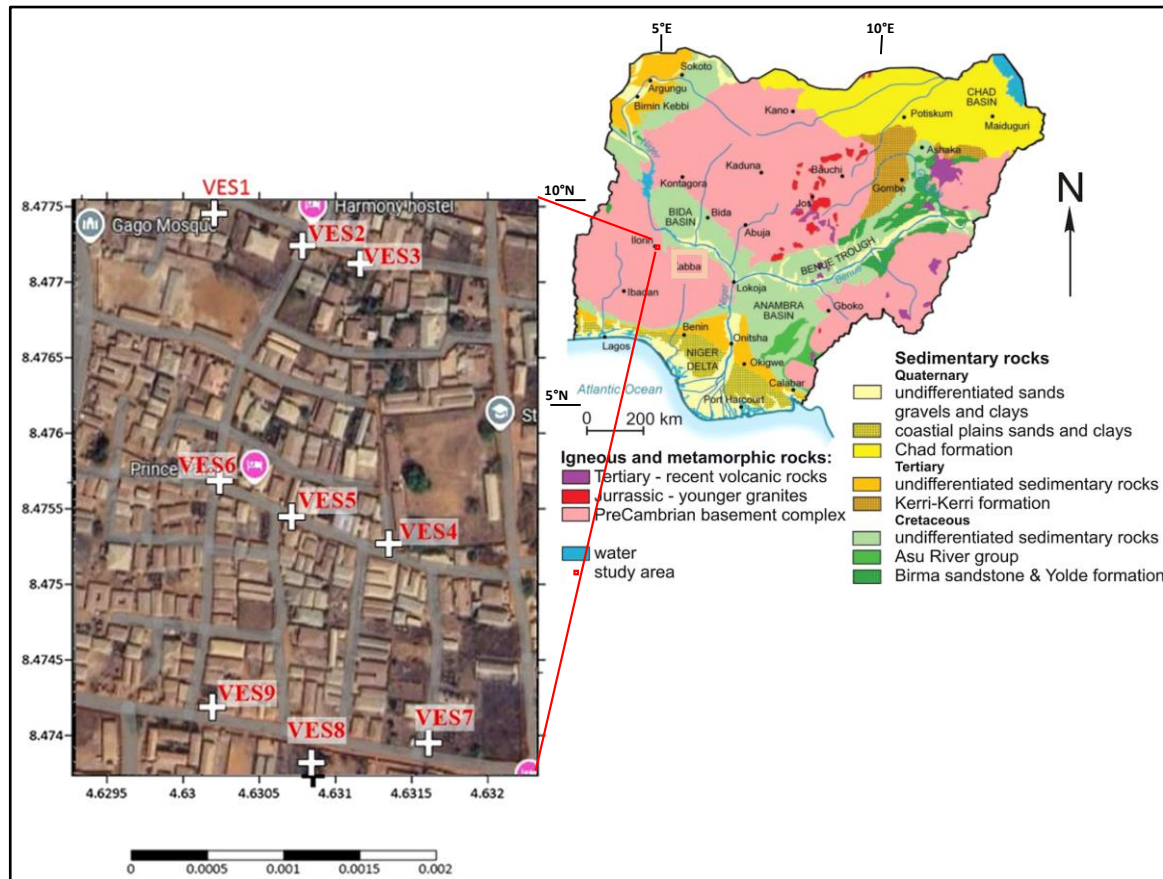


Figure 1: Basemap of the Study Area (Inset is the Geological Map of Nigeria (After [12])).

If the surrounding soil does not have proper grading or the gutters and downspouts are not directing water away from the foundation, excess moisture can accumulate around the walls and seep into the interior. Example of dampness in building wall is shown below (Figure 2).

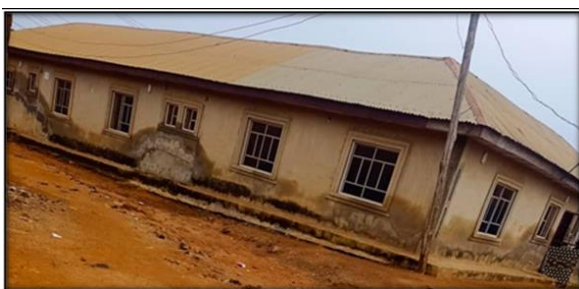


Figure 2: Example of wall Dampness.

II. METHODOLOGY

A. Geophysical Survey

The survey was carried out using electrical resistivity method, a proposed layout map for data acquisition was used as a guard line at the field. Nine vertical electrical sounding data were acquired using schlumberger array, which was used to generate maps and geoelectric-sections.

Field Procedure

The Omega Campus Terameter was used for resistivity data acquisition. Other equipment included 200m multi-conductor cables, measuring tape, steel rod electrodes, and hammers. A Schlumberger array was employed due to its sensitivity to vertical structures and deeper depth of penetration. Nine Vertical Electrical Sounding (VES) stations were set up along three profiles, containing three sounding points. The stations were arranged in a grid, and resistivity readings were taken by passing current into the ground via a pair of current electrodes, with the resultant resistance recorded through a pair of potential electrodes. The current electrodes were

spaced symmetrically, and the distance between them was gradually increased to ensure the measurement reached greater depths, with the maximum spread of AB/2 set at 110m and MN/2 at 27.5m.

Electrode Configuration

The Vertical Electrical Sounding (VES) method was used, where the current and potential electrodes were progressively expanded from a fixed central point. This method is useful in geotechnical surveys for determining overburden thickness and in hydrogeology for identifying porous strata.

B. Data processing and Interpretation

Apparent resistivity values at each station were plotted against the half current electrode spacing (AB/2) using log-log graph to generate field curves. Qualitative interpretation involved visually inspecting the curves to determine the number and nature of subsurface layers. These curves were then interpreted quantitatively using partial curve matching and computer iteration techniques. Data interpretation was done using software like WinResist2, Surfer15, and Publisher to create geo-electric sections and maps.

Interpretation Methods

Curve Matching Technique: Master curves, constructed for assumed geo-electric sections, were matched with field curves to derive geo-electrical parameters.

Auxiliary Curve Method: Used in terrains with multi-layered field curves, the method involves matching smaller segments of the field curve with theoretical two-layered curves.

Computer Interpretation: Computerized interpretation minimizes errors by comparing field data with modeled data, adjusting parameters until the model matches field measurements. This technique provides accurate geo-electrical parameters, essential for determining subsurface conditions such as bedrock depth or aquifer locations. This methodology ensures the accurate interpretation of subsurface resistivity data, providing valuable insights into the geological structure of the study area.

III. RESULT AND INTERPRETATION

The results were presented in Sounding curves, geoelectric sections and maps.

A. Sounding curves

The sounding curves from these readings varies from 3 layer to 4 layers curves with KH curve type being the only curve generated twice (Figure 3).

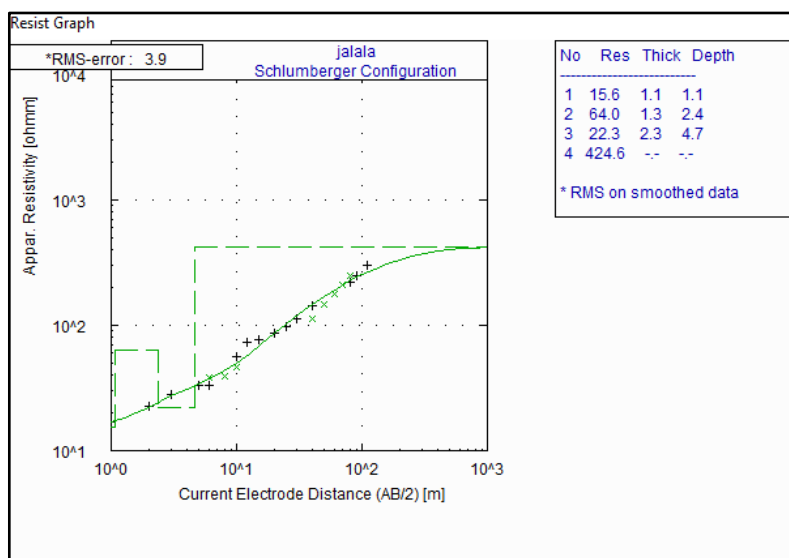


Figure 3: Typical KH curve (VES 2)

B. Geoelectric Sections and Contour Maps

Geoelectric Sections

Three geoelectric sections were generated (profile 1, 2,3). The first profile cut across 3 VES points which includes VES 1, 5 and 9 (Figure 4). Profile 2 includes VES 3, 5 and 7 (Figure5) while profile 3 includes VES 4, 5 and 6 (Figure 6). Profile 1

This profile consists of 3 VES points as listed above, 4 geoelectric layers were recorded

across the section which includes topsoil, lateritic layer, clay and the basement rock. The top soil resistivity varying from 26 Ω m to 101 Ω m with thickness ranging from 0.6m to 4.7 m. lateric layer resistivity varies from 290 Ω m to 775 Ω m maximum thickness of 2.7 m across the section. The clayey medium resistivity varies from 3 Ω m to 52 Ω m with thickness ranging from 0.5 m to 3.3 m, while the bedrock has a resistivity ranging from 210 Ω m to 831 Ω m.

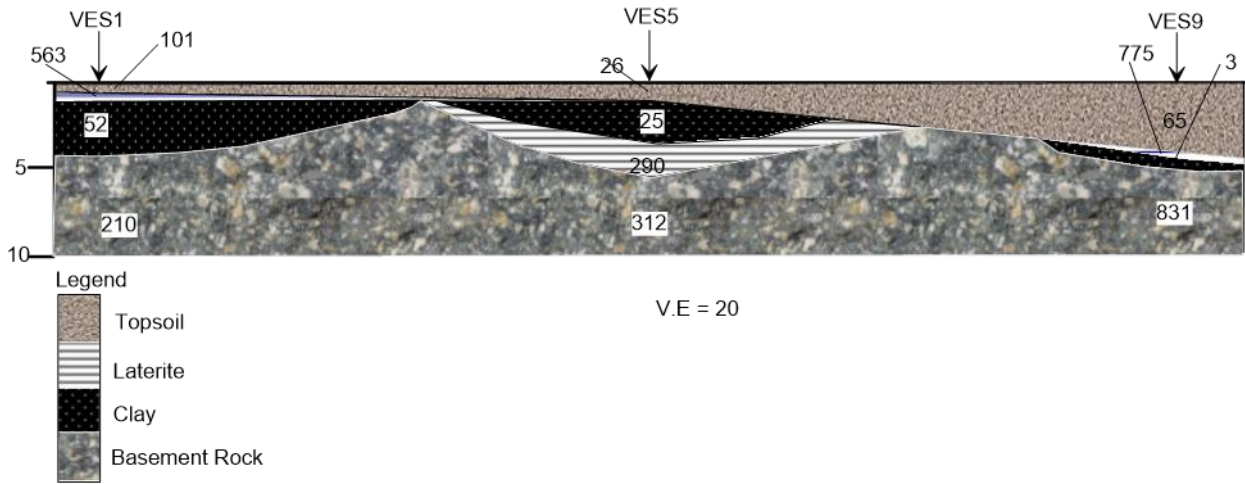


Figure 4: Profile 1

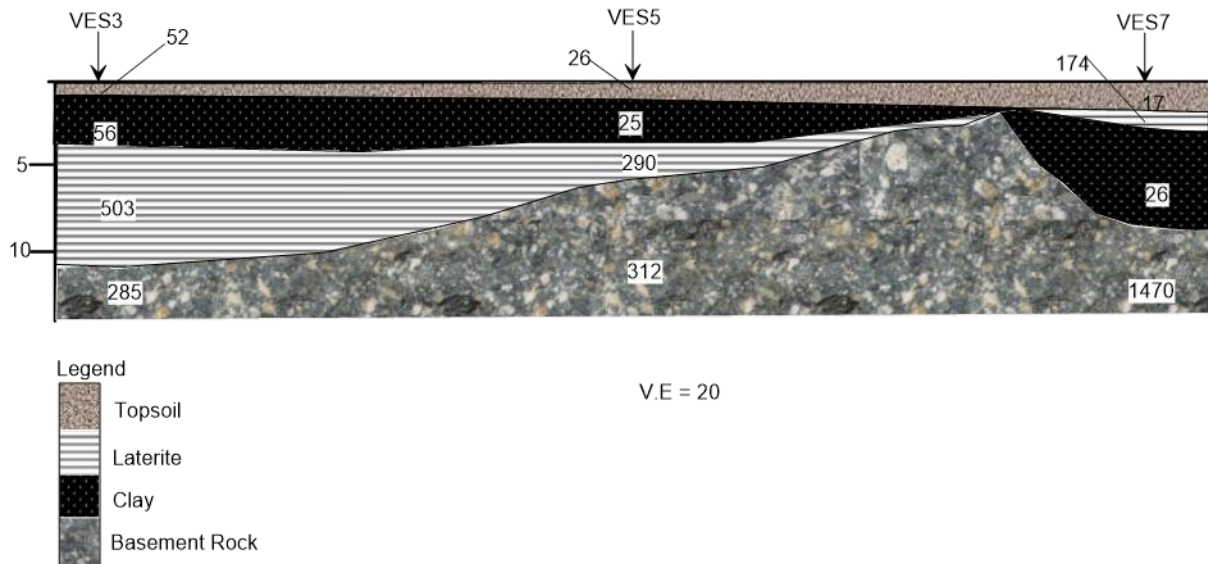


Figure 5: Profile 2

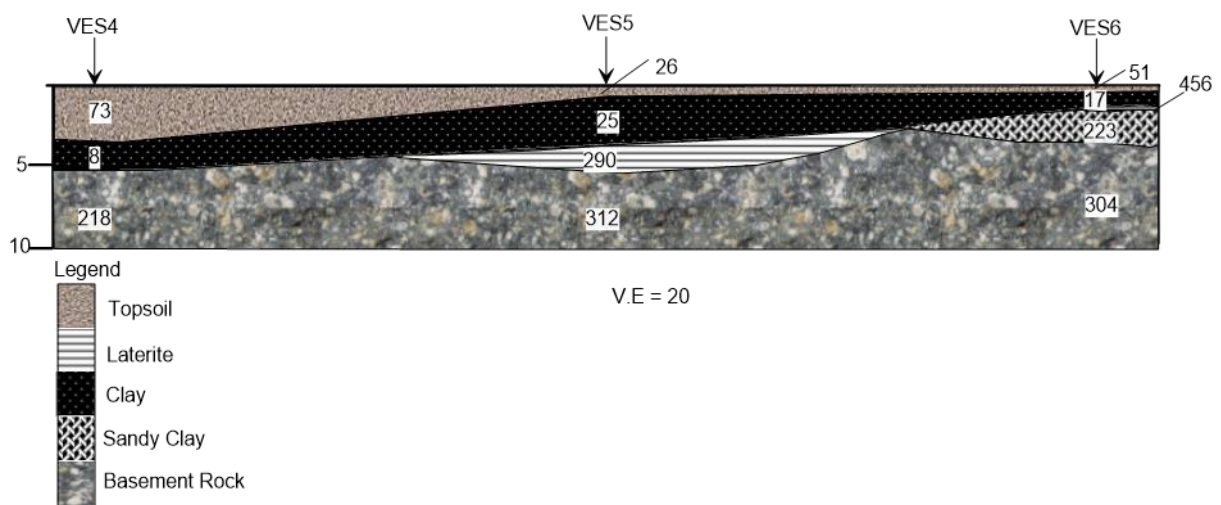


Figure 6: Profile 3

Profile 2

This profile cut across VES 3,5 and 7, total number of 4 geoelectric layers were recorded across the section which includes topsoil, lateritic layer, clay and the fresh bedrock. The top soil resistivity varies from 17 Ωm to 52 Ωm with thickness ranging from 0.1 m to 1.4 m. The clayey layer resistivity varies from 26 Ωm to 56 Ωm with thickness ranging from 2.7 m to 5.7 m. Lateric layer resistivity varies from 174 Ωm to 503 Ωm with maximum thickness of 7.2 m. and the fresh bedrock has a resistivity ranging from 285 Ωm to 1470 Ωm .

Profile 3

Profile 3 comprises of 3 VES points in which 4 to 5 geoelectric layers were generated which consist of topsoil, laterite, clay, sandy clay and the fresh bedrock. The topsoil resistivity value varies from 26 Ωm to 73 Ωm thick, ranging from 0.8 m to 3.5 m, the laterite was recorded in VES 5 and 6 with resistivity of 290 Ωm and 456 Ωm with maximum thickness of 2 m, the clayey layer serve as the second layer across this section with resistivity with varying from 8 Ωm to 25 Ωm and thickness of 1.2 m to 2.7 m. Sandy clay with resistivity value of 223 Ωm and maximum thickness of 2.5 m was recorded in VES 6 underlain by the fresh bedrock.

The geosections has shown lower resistivity values for topsoil in most case and also within the weathered layers.

Contour Maps

To have a clearer view about the subsurface information, The thickness and resistivity map of the depth to the basement were generated (Figure 7 and 8), the depth to the basement rock ranges from less than 1 m to 18 m with an average of 5 m in most part of the study area. The area around VES 3,7,9, shows depth above 9 m. Figure 8 indicates low resistivity within the overburden thickness across most part of the study area, with resistivity values less than 300 Ωm in most part of the study area.

Figures 7 and 8 have shown and given reasonable idea on the overburden materials content. It has also indicated that the overburden consists of weathered rocks types e.g. clay, sandy clay, etc. with their peculiar engineering characteristics.

The interpreted data indicates a generally low resistivity value in most cases with clay materials being inferred in many cases. The overburden materials from second layer to the top of the basement being semi-permeable layers (clay and laterite) which retain water and of course perpetuate the wetness to the surroundings.

mainly due to semi-permeable clayey overburden materials retaining water.

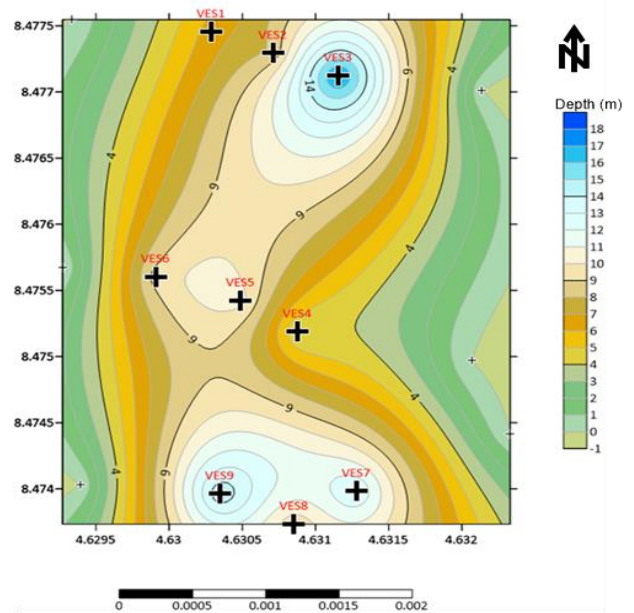


Figure 7: Contour Map of Depth to Basement

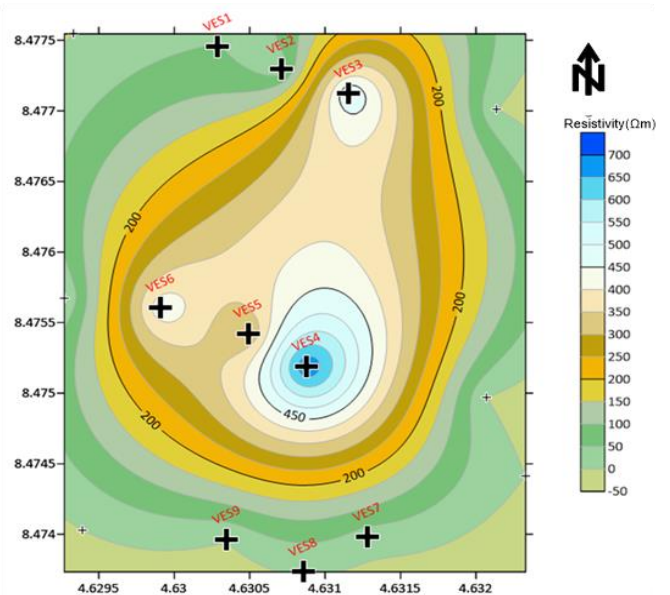


Figure 8: Contour Map Showing Overburden Resistivity
 The findings from the study area highlight the urgent need to address dampness problems in buildings, particularly due to their prevalent nature. The geophysical investigation has offered important insights into the subsurface conditions and the underlying causes of dampness. This information is essential for developing effective remediation strategies aimed at ensuring the long-term stability and safety of buildings in Jalala Oke-Odo and comparable regions across Nigeria.

IV. CONCLUSIONS AND RECCOMENDATIONS

In the rapidly urbanizing Jalala Oke-Odo metropolis, driven by the presence of the thriving university community, the construction of numerous contemporary buildings has raised concerns about dampness in both new and older structures. Damp patches on foundational walls can indicate severe structural issues, necessitating a geologic investigation in Jalala Tanke Oke Odo, Kwara State. This investigation pinpointed the geologic factors contributing to damp patches, including groundwater infiltration, soil composition, and hydrological conditions. In the study area, a significant observation is the widespread presence of damp patches in most houses, posing a risk to foundational walls and building stability. Variations in topsoil resistivity values were also noted, indicating areas prone to surface and near-surface water retention, which can harm foundations. The geoelectric section illustrated low resistivity values at various depths,

ETHICAL AND COMPETING INTEREST

I declare that I have no known competing financial interests or personal relationships which have or could be perceived to have influenced the work reported on this article.

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