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Geotechnical Failures of Pavement Structures in Abakaliki, Southeastern Nigeria

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This article presents a focused geotechnical investigation of the Abakaliki-Ogoja Road in southeastern Nigeria, based on original field and laboratory work. It examines how poor subgrade conditions, high soil plasticity, inadequate base and sub-base thicknesses, and ineffective drainage systems contribute to premature pavement failure. The study highlights construction flaws observed on-site and provides targeted recommendations such as proper soil stabilization, moisture-controlled compaction, and improved drainage design, emphasizing practical solutions drawn from engineering assessment and field data.

1. Motivation/Introduction

Having experienced the frustrations of driving on deteriorating roads in southeastern Nigeria, I was compelled to investigate the root causes of these persistent failures. Among the most notorious examples is the Abakaliki-Ogoja Road, a key economic artery linking Ebonyi State to neighboring regions. Despite several rehabilitation efforts, this road continues to suffer from severe pavement degradation. As a geologist, I suspect that the problem lies not merely in surface treatments or budget limitations but within the ground, specifically in the properties of the soils and the construction practices used. This study focuses on understanding how ground properties, material quality, and pavement design contribute to the rapid failure of flexible pavements along the Abakaliki-Ogoja Road. The article provides practical recommendations based on localized data and field observations.

2. Geotechnical and Construction Realities on the Abakaliki-Ogoja Road

The Abakaliki-Ogoja Road is primarily a flexible pavement, designed to support heavy commercial traffic. Yet, recurrent failures such as rutting, cracking, and potholing are commonplace, especially during and after the rainy season. Visual assessments of the road surface revealed extensive fatigue

cracking and deformation. These defects prompted a detailed geotechnical investigation of the subgrade and pavement structure.

Both visual inspections and test data indicate that the asphalt layer is often too thin (less than 40 mm in some segments) and lacks durability (Figure 1). The base course and sub-base layers were measured to be below the standard thresholds, ranging between 100–150 mm, with some stretches having no distinct sub-base layer at all. These thin and sometimes poorly compacted layers, combined with the absence of geotextiles or proper separation between layers, result in structural instability. Additionally, the subgrade soil, composed largely of clay-rich silty material exhibiting expansive behavior due to its clay fraction, shows high plasticity and is prone to swelling and shrinkage. Without proper stabilization (e.g., with lime or cement), the subgrade fails to provide a firm foundation, leading to rutting and cracking under repeated traffic loads. Thus, the deficient layer thickness, poor materials, and lack of stabilization techniques contribute to the pavement failures observed along the Abakaliki-Ogoja Road.

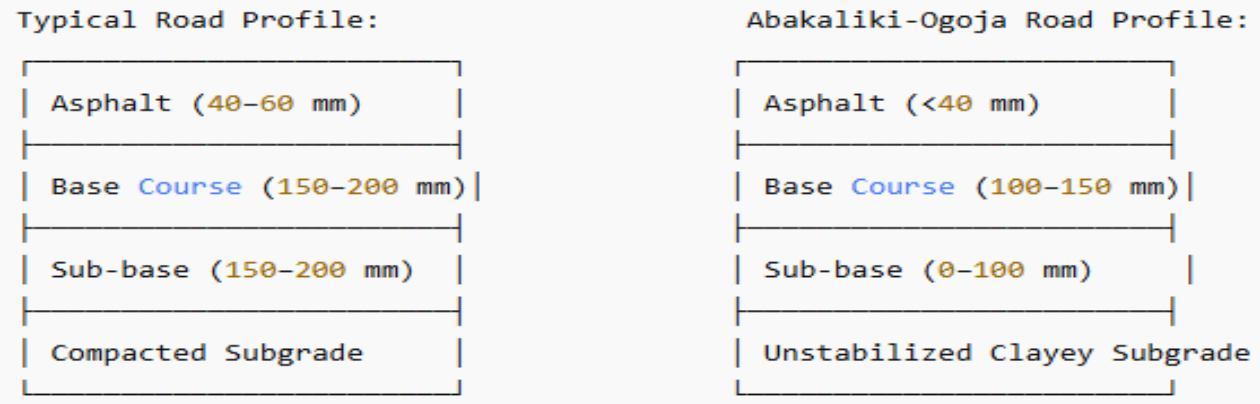

Figure 1 Comparison between a typical flexible pavement profile and the observed profile of the Abakaliki-Ogoja Road (Typical profile data adapted from FMWH, General Specifications for Roads and Bridges in Nigeria, 2nd Edition, 1997; Observed profile from Author's field-based measurements, 2025).

Further field and laboratory tests were conducted, such as grain size distribution, Atterberg limits, compaction, and California Bearing Ratio (CBR). The results revealed weaker load-bearing characteristics as some road segments were well graded, while some extensions were poorly graded; consistency tests revealed that the soil had high plasticity indices due to its silty-clayey composition

derived from shale bedrock. The presence of poorly graded and high plasticity soils reduces the strength and stability of the pavement structure. These soil types retain water and swell when wet, leading to heaving and shrinkage cracks during dry conditions.

There exists uneven compaction due to inconsistency in the Maximum Dry Density and Optimum Moisture Content caused by uncontrolled moisture conditions during construction, which compromises the bond between pavement layers, resulting in delamination, surface rutting, and premature cracking.

Finally, the result revealed inconsistent subgrade strength, often falling below the 30% CBR benchmark (as specified by FMWH, 1997), suggesting that certain sections of the road may not provide sufficient support for anticipated traffic loads. Combined with inadequate soil stabilization (needed because of the high fines content) and poor drainage, these factors lead to water infiltration, softening of the subgrade, and eventual collapse of the pavement. Hence, the observed damage, such as potholes, fatigue cracking, and deformation, can be expected.

Drainage infrastructure also played a critical role. Although U-shaped concrete drains (Fig.2) were installed, some medians were porous and unlined, allowing water infiltration. This led to subgrade saturation and swelling of the clay-rich soils, reducing the pavement's bearing capacity. The combination of high plasticity soils, inadequate sub-base thickness, and poor drainage explains the recurrence of rutting and alligator cracking in specific locations.

Figure 2 The Enugu - Abakaliki Road with potholes, ruts, alligator cracking, fatigue concrete & U-Shaped concrete drains (Source: Babadiya & Igwe 2021)

3. Conclusion

The recurring pavement issues along the Abakaliki-Ogoja Road underscore the need for more detailed geotechnical assessment and consistent implementation of design and construction guidelines to improve service life. This case study demonstrates that compliance with minimum standards is not sufficient if localized ground behavior and environmental conditions are ignored. The clayey nature of the subgrade, combined with limited use of stabilization techniques, variable layer thicknesses, and insufficient drainage provisions, appear to have influenced the structural performance of the pavement. Lasting infrastructure cannot be achieved by surface-level fixes; it requires an understanding of ground conditions, appropriate material selection, and adherence to structural standards. Roads must be built from the ground up, not patched from the top down. As the saying goes, *"A structure is only as strong as its foundation,"—and in southeastern Nigeria, that foundation begins with the soil.*

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