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Application of Electrical Resistivity Surveys on Constraining Causes of Highway Pavement Failure along Ajaokuta-Anyigba Road, North Central Nigeria

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Abstract : Integrated geophysical methods involving Vertical Electrical Sounding (VES) and 2D resistivity survey were deployed to gain an insight into the influence of the two varying rock types (mica-schist and granite gneiss) underlying the road alignment to the incessant highway failure along Ajaokuta-Anyigba, North-central Nigeria. The highway serves as a link-road for the single largest cement factory in Africa (Dangote Cement Factory) and two major ceramic industries to the capital (Abuja) via Lokoja. 2D Electrical Resistivity survey (Dipole-Dipole Array) and Vertical Electrical Sounding (VES) (Schlumberger array) were employed. Twenty-two (22) 2D profiles were occupied, twenty (20) conducted about 1 m away from the unstable section underlain by mica-schist with profile length each of approximately 100 m. Two (2) profiles were conducted about 1 m away from the stable section with a profile length of 100 m each due to barriers caused by the drainage system and outcropping granite gneiss at the flanks of the road. A spacing of 2 m was used for good image resolution of the near-surface. On each 2D profile, a range of 1-3 VES was conducted; thus, forty-eight (48) soundings were acquired. Partial curve matching and WinResist software were used to obtain the apparent and true resistivity values of the 1D survey, while DiprofWin software was used for processing the 2-D survey. Two exposed lithologic sections caused by abandoned river channels adjacent to two profiles as well as the knowledge of the geology of the area helped to constrain the VES and 2D processing and interpretation. Generally, the resistivity values obtained reflect the parent rock type, degree of weathering, moisture content and competency of the tested area. Resistivity values < 100; 100 – 950; 1000 – 2000 and > 2500 ohms-m were interpreted as clay, weathered layer, partly weathered layer and fresh basement respectively. The VES results and 2-D resistivity structures along the unstable segment showed similar lithologic characteristics and sequences dominated by clayey substratum for depths range of 0 – 42.2 m. The clayey substratum is a product of intensive weathering of the parent rock (mica-schist) and constitutes weak foundation soils, causing highway failure. This failure is further exacerbated by several heavy-duty trucks which ply the section round the clock due to proximity to two major ceramic industries in the state and lack of drainage system. The two profiles on the stable section show 2D structures that are remarkably different from those of the unstable section with very thin topsoils, higher resistivity weathered substratum (indicating the presence of coarse fragments from the parent rock) and shallow depth to the basement (1.0 – 7. 1 m). Also, the presence of drainage and lower volume of heavy-duty trucks are contributors to the pavement stability of this section of the highway. The resistivity surveys effectively delineated two contrasting soil profiles of the subbase/subgrade that reflect variation in the mineralogy of underlying parent rocks.

Keywords : clay, geophysical methods, pavement, resistivity
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