

Index and Mechanical Geotechnical Properties and Their Control on the Strength and Durability of the Cainozoic Calcarenes in KwaZulu-Natal, South Africa

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Abstract : Calcarene is a clastic sedimentary beach rock composed of more than 50% sand sized (0.0625 – 2 mm) carbonate grains. In South Africa, these rocks occur as a narrow belt along most of the coast of KwaZulu-Natal and sporadically along the coast of the Eastern Cape. Calcarenes contain a high percentage of calcium carbonate, and due to a number of its physical and structural features, like porosity, cementing material, sedimentary structures, grain shape, and grain size; they are more prone to chemical and mechanical weathering. The objective of the research is to study the strength and compressibility characteristics of the calcarenes along the coast of KwaZulu-Natal to be able to better understand the geotechnical behaviour of these rocks, which may help to predict areas along the coast which may be potentially susceptible to failure/differential settling resulting in damage to property. A total of 148 cores were prepared and analyzed. Cores were analyzed perpendicular and parallel to bedding. Tests were carried out in accordance with the relevant codes and recommendations of the International Society for Rock Mechanics, American Standard Testing Methods, and Committee of Land and Transport Standard Specifications for Road and Bridge Works for State Road Authorities. Test carried out included: x-ray diffraction, petrography, shape preferred orientation (SPO), 3-D Tomography, rock porosity, rock permeability, ethylene glycol, slake durability, rock water absorption, Duncan swelling index, triaxial compressive strength, Brazilian tensile strength and uniaxial compression test with elastic modulus. The beach-rocks have a uniaxial compressive strength (UCS) ranging from 17,84Mpa to 287,35Mpa and exhibit three types of failure; (1) single sliding shear failure, (2) complete cone development, and (3) splitting failure. Brazilian tensile strength of the rocks ranges from 2.56 Mpa to 12,40 Ma, with those tested perpendicular to bedding showing lower tensile strength. Triaxial compressive tests indicate calcarenes have strength ranging from 86,10 Mpa to 371,85 Mpa. Common failure mode in the triaxial test is a single sliding shear failure. Porosity of the rocks varies from 1.25 % to 26.52 %. Rock tests indicate that the direction of loading, whether it be parallel to bedding or perpendicular to bedding, plays no significant role in the strength and durability of the calcarenes. Porosity, cement type, and grain texture play major roles. UCS results indicate that saturated cores are weaker in strength compared to dry samples. Thus, water or moisture content plays a significant role in the strength and durability of the beach-rock. Loosely packed, highly porous and low magnesian-calcite bearing calcarenes show a decrease in strength compared to the densely packed, low porosity and high magnesian-calcite bearing calcarenes.

Keywords : beach-rock, calcarene, cement, compressive, failure, porosity, strength, tensile, grains

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