IMPACT OF PARTICLE MORPHOLOGY ON THE SHEAR BEHAVIOR OF QUARRY DUST/SEA SAND - CONCRETE INTERFACE IN GEOTECHNICAL STRUCTURES

K.A.M.M. Deshan [1], K.H.S.M. Sampath [1, *]

[1] Department of Civil Engineering, University of Moratuwa, Moratuwa

Soil-structure interaction is a fundamental consideration in geotechnical and structural engineering, influencing various applications such as pile systems, retaining walls, and other foundational structures. In recent years, the use of alternative materials like quarry dust and sea sand as complete replacements for traditional materials in ground improvement projects has gained attention due to their potential to enhance soil properties and overall geotechnical performance. This study focuses on the shear strength of the soil-concrete interface, particularly when utilizing quarry dust, river sand, and sea sand. The primary objective is to evaluate the influence of particle morphology on the shear behavior of these materials through a series of direct shear tests.

Quarry dust, river sand, and sea sand samples were collected from different regions in Sri Lanka and subjected to thorough testing, including sieve analysis and direct shear tests, to investigate their gradation and interface shear behavior. The samples were tested in fully dry conditions, with particle sizes ranging from 0.075 mm to 2.36 mm. Additionally, particle morphology parameters such as angularity, roughness, roundness, and sphericity were quantified using image analysis techniques. These parameters were then correlated with the shear strength characteristics of the soil-concrete interface.

Experimental results indicate that angular-shaped quarry dust particles exhibit an enhanced friction angle and interface friction angle by 10.8% and 12.4%, respectively, with an increase in angularity from 1.091 to 1.122, compared to spherical or rounded particles. Additionally, with an increase in regularity from 0.76 to 0.81, the interface friction angle decreased from 27.4^0 to 24.8^0, and the friction angle decreased from 32.4^0 to 28.9^0, marking percentage decreases of 9.7% and 11.0%, respectively. When comparing the coefficient of uniformity (C_u) values of the quarry dust, river sand, and sea sand samples, it was identified that higher C_u values correspond to higher friction angles and interface friction angles. The friction angle has increased by 4.7% and 15.6%, respectively, at the soil interface and the soil-concrete interface when the C_u value rises. Additionally, an increase in particle sizes increases the shear strength of samples. For instance, for a normal stress of 150 kPa, when the particle size increases from 0.075 mm to 2.36 mm, the shear strength increases by 21.2%.

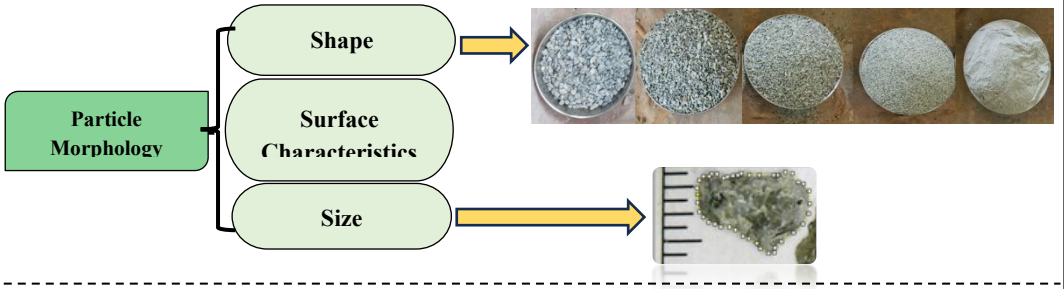
The study concludes that quarry dust, with its angular and irregular particles, can enhance the shear strength of soil-concrete interfaces, making it a suitable material for geotechnical applications. However, the developed correlations are valid only within the analyzed particle size range, and further studies are recommended to extend the applicable range and include the effects of moisture content on interface shear strength.

Keywords: Interface shear behaviour, Particle size, Gradation, Particle morphology, Image analysis

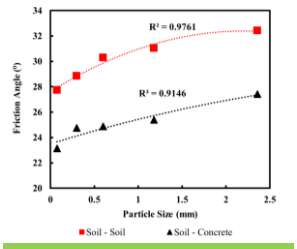
[*] Correspondence: sampathkh@uom.lk

Impact of Particle Morphology on the Shear Behavior of Quarry Dust/Sea Sand - Concrete Interface in Geotechnical Structures

1. Background & Methodology

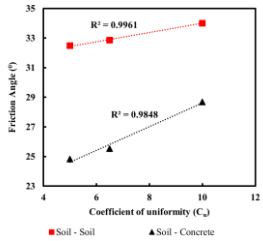


2. Results



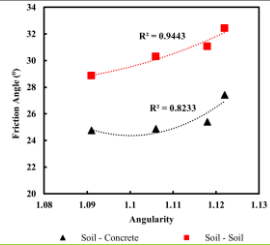
$\emptyset = -0.98PS^2 + 4.34PS + 27.61$

$\delta = -0.22PS^2 + 2.15PS + 23.5$



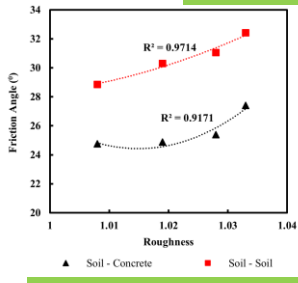
$\emptyset = 0.31C_u + 31$

$\delta = 0.8C_u + 20.6$



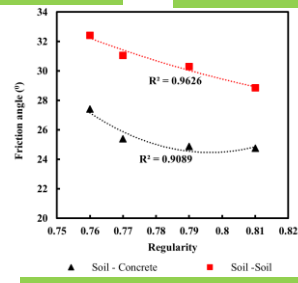
$\emptyset = 1568.6A_n^2 - 3367.8A_n + 1836$

$\delta = 5410.7A_n^2 - 11905A_n + 6573$



$\emptyset = 1963.6R_n^2 - 3874R_n + 1938.7$

$\delta = 8393.3R_n^2 - 17037R_n + 8670$



$\emptyset = 338.7RE_n^2 - 597.6RE_n + 290.8$

$\delta = 2037.2RE_n^2 - 3244.5RE_n + 1316.3$

3. Conclusions

Shear strength of the quarry dust-concrete interface increases significantly with larger particle sizes and higher coefficients of uniformity (C_u).