

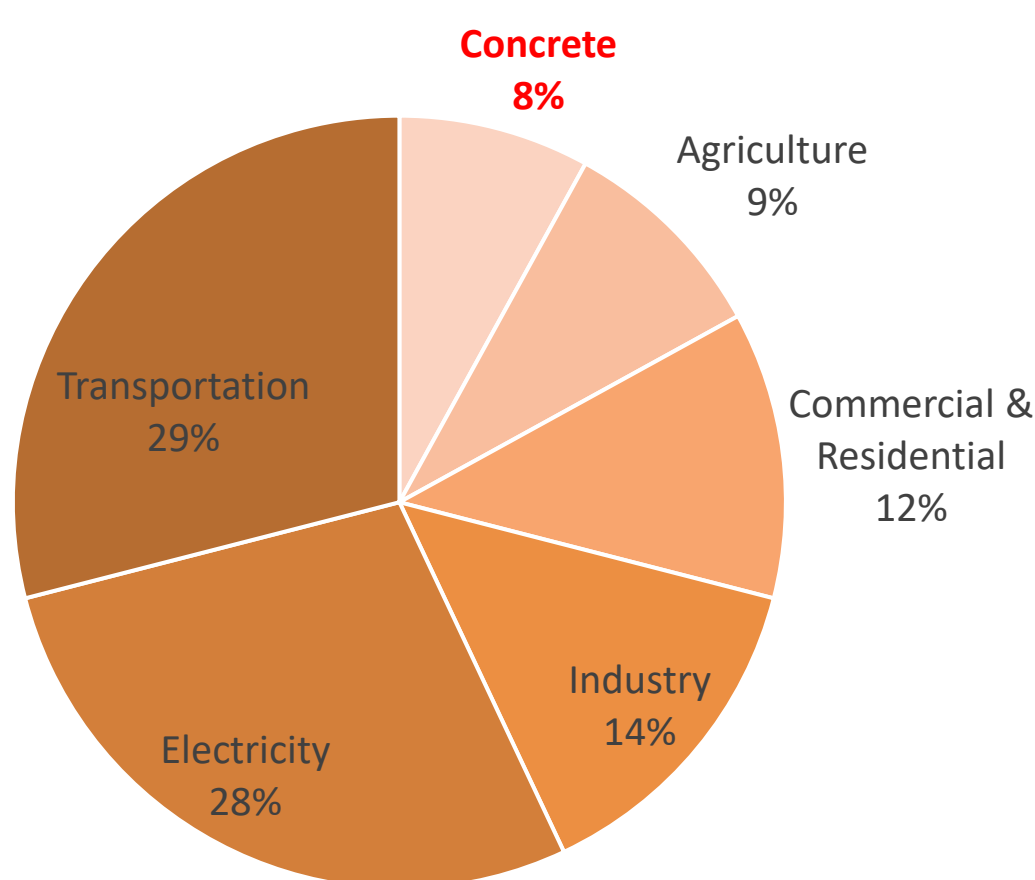
Evaluation of Durability and Strength of Clay Stabilized with Philippine Quarry Dust-based Geopolymer

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INTRODUCTION & AIM

Global CO2 Emissions by Category

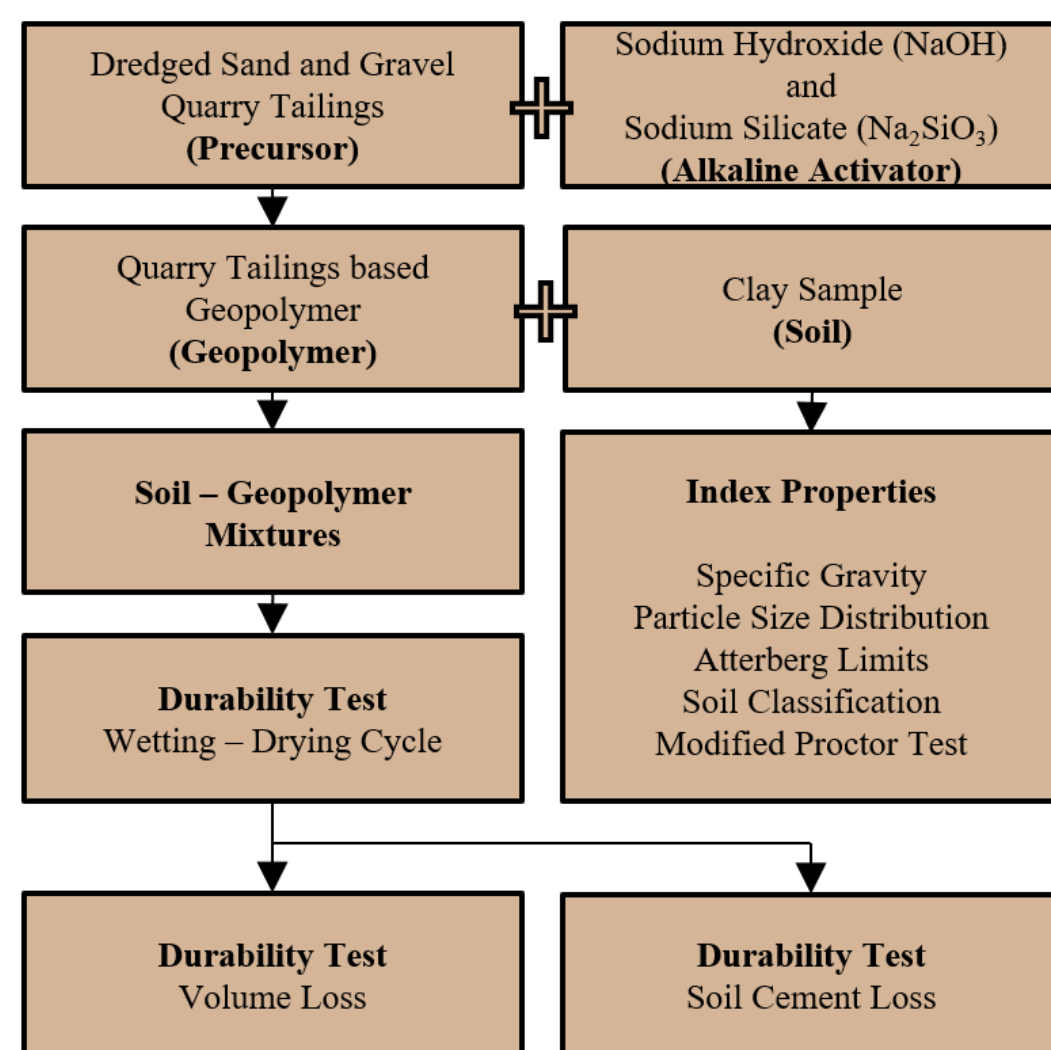


The most common types of problematic soil behavior include collapsible, expansive, and dispersive, which can be found in high plasticity clays. Consequently, structures founded in clays were reported to be damaged due to wetting and drying cycles. To remediate these problems and prevent it in the future, soil stabilization has been done in past years (Vitales et al, 2022). The most used stabilization method practiced is stabilization using ordinary Portland cement (OPC), which production is known to emit large amounts of greenhouse gases (Nie, et al., 2022). Considering this problem, the utilization of OPC alternatives, such as geopolymers is being investigated intensively. Quarry dust, a by-product of sand and gravel quarrying, is theorized to be a candidate geopolymeric precursor. The study aimed to investigate the durability of clay stabilized with quarry dust-based geopolymer. To simulate the wet and dry seasons that the Philippines experiences, the study will follow the procedures stipulated by the American Society of Testing and Materials (ASTM).

METHOD

The soil collected from Bulacan was tested for index properties to confirm if its classification is *high plasticity clay* (CH). After verification, the geopolymer was prepared by mixing the alkaline activator and quarry dust, with the following proportions:

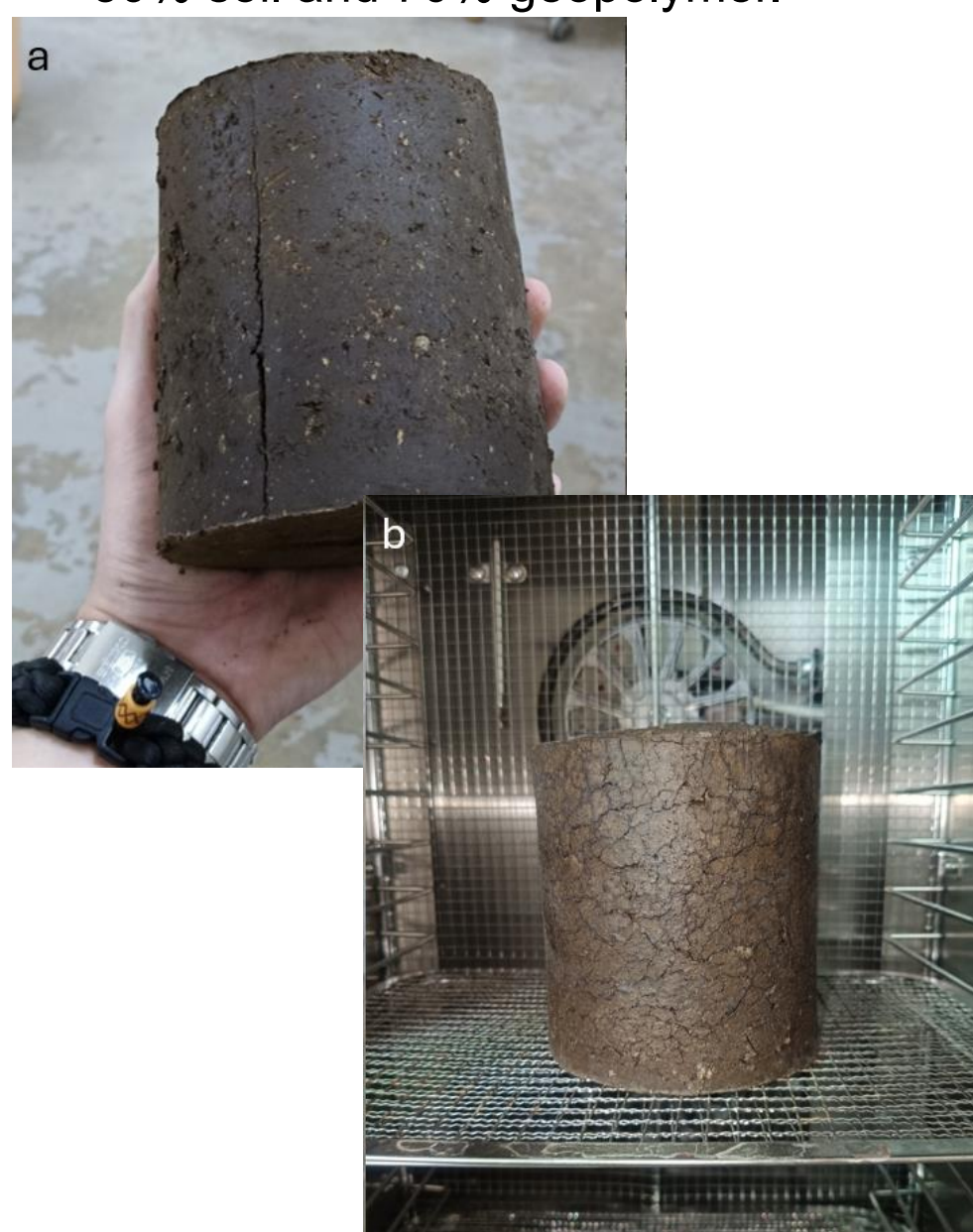
- Alkaline Activator composed of 1 part of 10 molar Sodium Hydroxide to 2.5 parts of Sodium Silicate
- Geopolymer composed of 65% Quarry Dust to 35% Alkaline Activator
- Soil-geopolymer mixture composed of 30% soil and 70% geopolymer.



Operational Framework of the Study

Three soil-geopolymer mixtures (SGMs) was molded into a split mold and left for 24 hours. Demolding was done after 24 hours and left to be cured for 28 days.

After the curing period, the SGMs was submerged to tap water for 5 hours and dried at a desiccator with 68° to 74°C for 42 hours, which constitutes to one (1) wetting and drying cycle (WD cycle). Wire brushing was done for the second sample before all samples was measured for its dimensions and mass. This was done for 12 times following the procedures stipulated by ASTM D559 and D558.



SGM sample (a) after demolding; and (b) during drying at desiccator

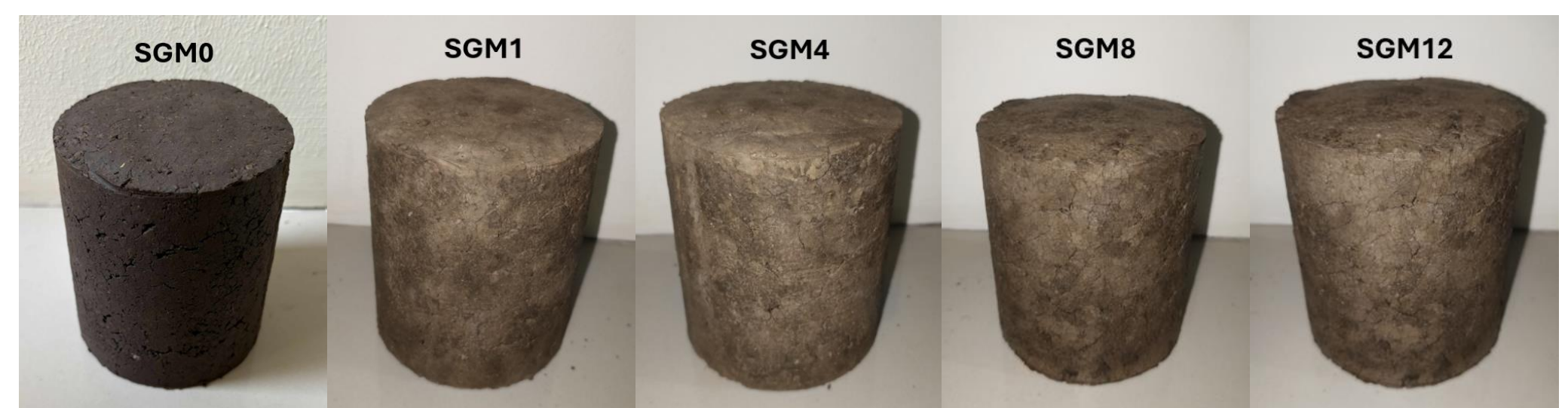
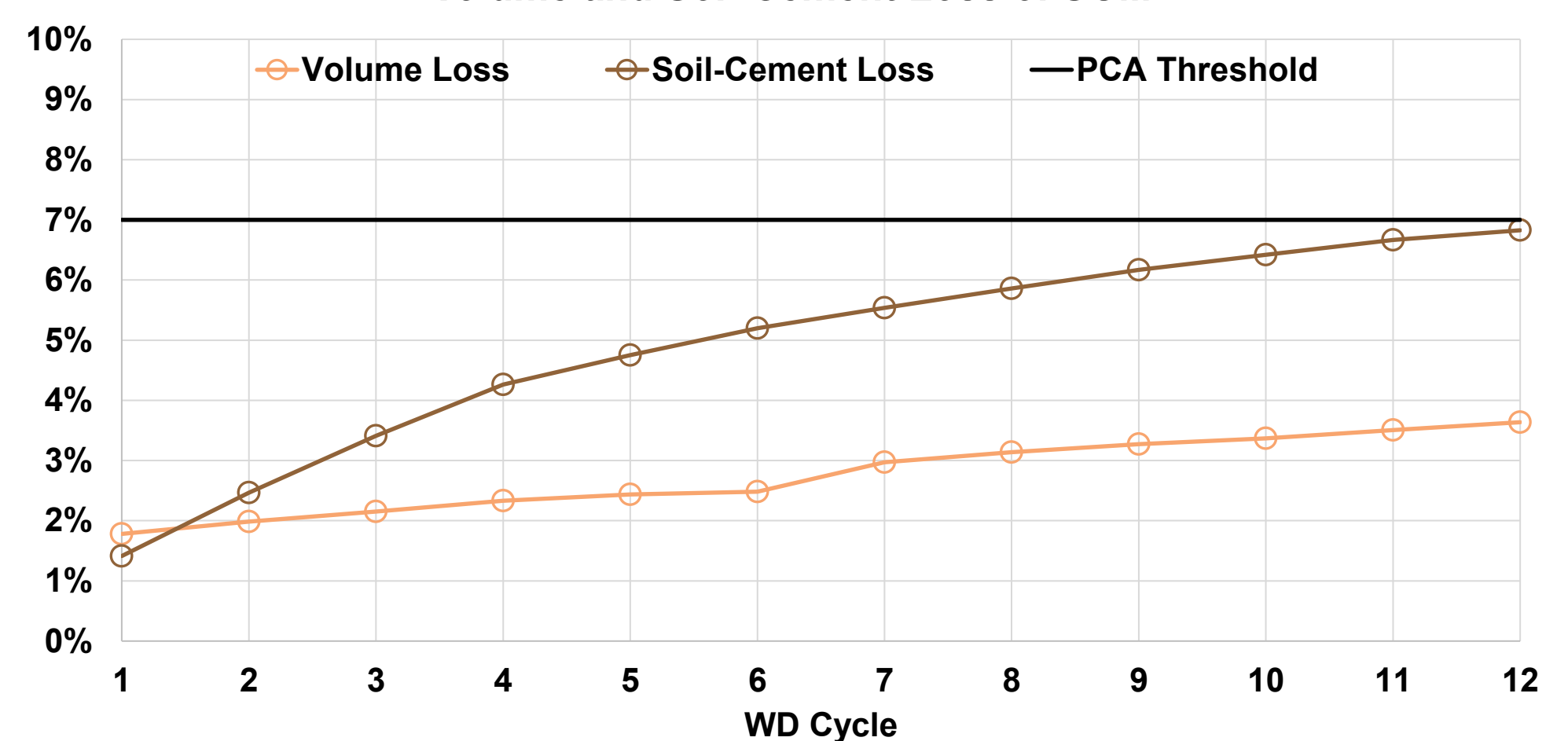
RESULTS & DISCUSSION

The pure soil specimen collapsed and degraded within the first five (5) minutes of being submerged in tap water. The collapse of the pure soil sample was also observed by other studies (Razali, et al., 2023).

The specimen fresh from demolding showed a very dark color with a moist-looking and soft texture. After subjecting it to WD cycles, the color of the specimen lightened up and looked sturdy and small cracks over the surface were visible.

The results of the durability test are presented in the figure below. It is expected that there will be losses in both volume and soil-cement value due to the immersion to water and wire brushing, which causes the decrease in the mass of the samples. For all the samples, the volume and soil-cement loss increase as the WD cycle progress.

Volume and Soil-Cement Loss of SGM



SGM samples after 0, 1, 4, 8, and 12 WD cycles

The total volume loss is recorded to be 3.64% after 12 WD cycles which is within the range of the reported results of Rivera et al (2020). The cumulative soil-cement loss almost hit the threshold set by the Portland Cement Association (PCA), which is 7% for clays and 14% for sands, on the soil-cement loss for the material to be accepted as a chemical stabilizer.

The geopolymer was able to stabilize the untreated high plasticity clay and transformed it into a material capable of engineering demands. Further applications of the material may include road embankments and lateral support structures.

CONCLUSION

Treating the clay soil with quarry-dust based geopolymer resulted to the formation of the soil-geopolymer mixture that were subjected to durability test against wetting and drying cycles. The cumulative losses were found to be 3.64% and 6.83% for volume and soil-cement loss, respectively, satisfying the criteria set by the Portland Cement Association.

FUTURE WORK / REFERENCES

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