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STRENGTH TESTS OF AGGREGATED SOIL

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1. INTRODUCTION

Urban areas, with their increased paving, buildings, and other infrastructure, can lead to the reduced permeability of the surface, which can cause more rainwater to run off on the ground surface, leading to flash flooding and other issues (Tingsanchali, 2012) (Janicka & Kanclerz, 2022). Aggregated soil is a chemically-improved soil that consists of double pores where the macro-pores allow water to flow through easily which improves water infiltration, and the micro-pores can retain water to slowly release back to the atmosphere through evaporation. The term "aggregated soil" is derived from the aggregation process after combining with cement and a crumbing agent. The cement component serves to enhance the strength of the soil, while the crumbing agent binds soil particles together to form crumbs. Since aggregated soil is a relatively new material, its properties need to be well understood before its application in large-scale projects. This paper intends to study on its strength behavior using unconfined compression test, and compare with cement-treated soil which is a common method used to improve weak soil.

2. METHODOLOGY

2.1. Materials

2.1.1. Decomposed Granite sand

Decomposed granite sand is generally referred to as Masado. The term "Masado" is often used to refer specifically to the sand-sized particles of decomposed granite soil. The grain size distribution curve is shown in **Fig. 1**. It is categorized as a poorly graded non-plastic soil with unconfined compression strength of 60 kPa (Sanjeewani, 2016).

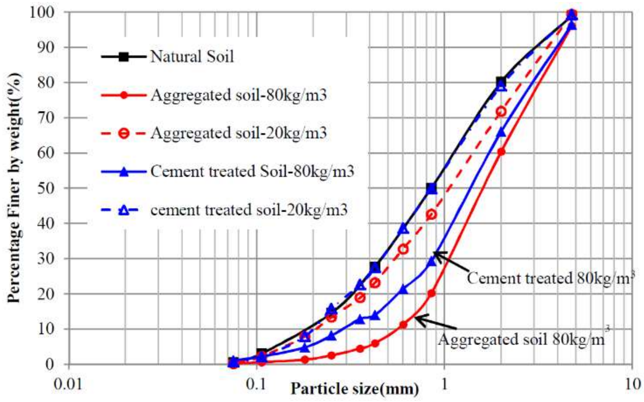

Fig. 1 Grain size distribution curve of Masado soil, aggregated soil and cement-treated soil.

2.1.2. Cement

TL-3E Sumitomo Osaka Cement was the type of cement used in this study. It is classified as a hexavalent chromium soluble cement and can provide stable long-term strength, comparable to that of Portland cement.

2.1.3. Crumb Agent

The key ingredient in creating aggregated soil is the crumb agent, which is an acrylic acid polymer. It is a viscous liquid substance that, when mixed with soil, causes fine particles to attach to larger particles, resulting in the formation of soil crumbs. This polymer is also responsible for aggregated soil's double porous structure.

Table 1 Summary of specimen properties.

No.	Specimen name	Type	Cement Content (kg/m3)	Crumb agent (l/m3)	Water Content (%)	Compaction Degree	Curing time (days)
1	A-20D-7	Aggregated soil	20	1.5	14.5	Dense	7
2	A-20D-28	Aggregated soil	20	1.5	14.5	Loose	7
3	A-20L-7	Aggregated soil	20	1.5	14.5	Dense	28
4	A-20L-28	Aggregated soil	20	1.5	14.5	Loose	28
5	A-80D-7	Aggregated soil	80	1.5	16.5	Dense	7
6	A-80D-28	Aggregated soil	80	1.5	16.5	Dense	28
7	C-20D-7	Cement-treated	20	0.0	14.5	Dense	7
8	C-20D-28	Cement-treated	20	0.0	14.5	Dense	28
9	C-20L-7	Cement-treated	20	0.0	14.5	Loose	7
10	C-20L-28	Cement-treated	20	0.0	14.5	Loose	28
11	C-80D-7	Cement-treated	80	0.0	16.5	Dense	7
12	C-80D-28	Cement-treated	80	0.0	16.5	Dense	28

2.2. Specimen Preparation

The aggregated soil was created by mixing Masado, cement, crumb agent, and water with specific proportion shown in **Table 1**. The mixing ratios of cement and crumb agent were measured for every cubic meter of natural soil, while water is measured by percentage of weight. The optimum water content was determined by Proctor compaction test. The optimum water content for natural soil, treated soil with 20kg/m3 cement content and treated soil with 80 kg/m3 cement content are 12.5%, 14.5% and 16.5%, respectively. After initial curing for 2h, soil was compacted into a 10 mm height, 5 mm diameter cylindrical mold in 5 layers. The compaction degree was set to 95% and 85% of its maximum dry density for dense and loose state respectively. After compacting into the molds, the specimens were cured for 7 days and 28 days as summarized in **Table 1**.

2.3. Testing Procedure

Unconfined compressive strength test was conducted following JGS 0511-2009. Small size, strain controlled triaxial apparatus was used. In this apparatus, the strain is controlled automatically by computer. The strain rate was 1%/min.

3. RESULT

Unconfined compression tests were conducted on cement-treated soil and aggregated soil as shown in **Table 1**. For each condition, three samples were tested, and the values are averaged with standard deviation as shown in **Fig. 2**.

From **Fig. 2,** it can be understood that both cement-treated method and the aggregated method can enhance the strength of natural soil, and with the same cement content and compaction degree, both are showing similar strength. Using higher amount of cement content, however, significantly increased strength along with steeper change between 7 days and 28 days curing time. Compaction degree also increases the strength of both aggregated soil and cement-treated soil.

4. SUMMARY

Aggregated soil can be used as an alternative to enhance the strength of the soil with similar strength properties as cement-treated soil. The development of strength is influenced by the duration of curing time, the amount of cement utilized, and the degree of compaction. Further studies on the strength behaviour is conducting using triaxial tests under saturated condition and unsaturated condition to simulate real-life conditions of aggregated soil.

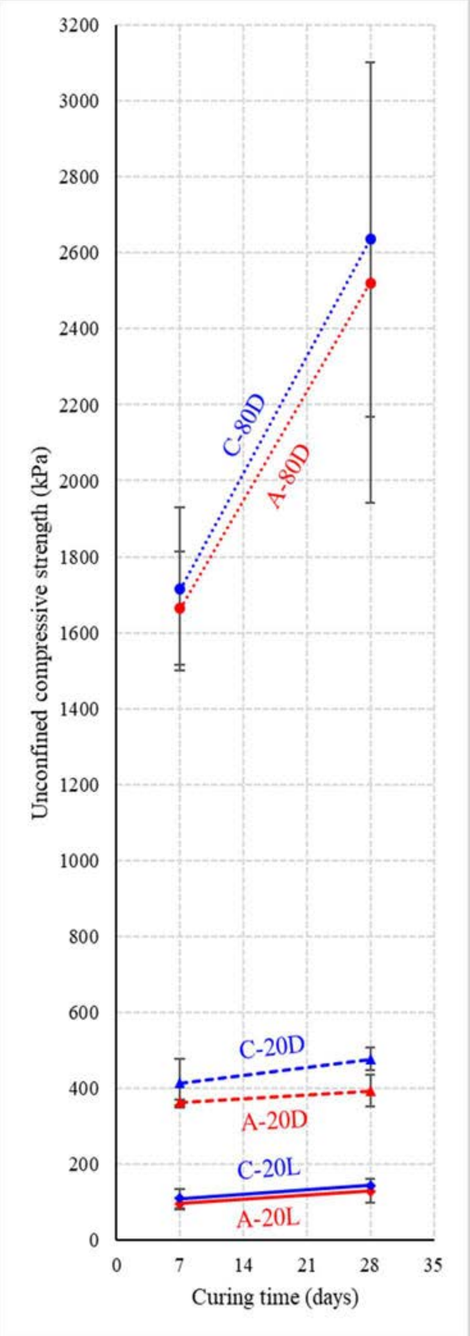

Fig. 2 Unconfined compression strength of aggregated soil and cement-treated soil.

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