ESTIMATION OF STRENGTH DEVELOPMENT IN PAPER SLUDGE ASH TREATED SOIL DUE TO TWO-STAGE CURING METHOD

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1. INTRODUCTION

Waste generation from construction work such as pile construction and tunnel construction has increased in recent times. In these cases, a large amount of soil must be removed. Such soil often exhibits mud-like properties. Mud treatment and disposal, which accounts for more than half of Japan's construction waste. In the past, construction generated soil was usually transported to the final disposal site and then landfilled. However, now the construction generated soil is treated on-site and reused. Development exercises in coastal regions require a significant number of soils for reclamation, embankment & backfilling. Likewise, there is substantial interest in reusing dredge soils at local construction sites (Kitazume et al. 2007). For treating mud, cement or lime are commonly added to increase strength where curing plays a significant role. In case of cement-treated soil, compaction is needed as soon as possible after mixing. It is because the rapid formation of hydrate will be destroyed in compaction in a longer curing period before compaction. Recently, the use of paper sludge ash (PS ash) has been increased to utilize dredge soil effectively because the disposal of paper sludge ash is a severe concern (Mochizuki et al. 2002). The objective of this paper is to present the effect of two-stage curing on the strength development of PS ash-treated soil and compare the result with cement-treated soil.

2.MATERIALS, MIXTURE CONDITION, SPECIMEN PREPARATION

Paper sludge ash is generated to decrease the weight of the wastepaper sludge by incinerating wastepaper sludge from the paper manufacturing process using a fluid bed, stoker, or cyclone incinerator. Typically, cement is mixed to solidify the soil specimen. To prepare cement-treated soil specimen for mechanical test two method is followed in the laboratory. If in the construction site no compaction is required, after mixing curing is done once. In contrast, if compaction is required, after mixing & preparation of specimen. Firstly, curing for an arbitrary condition is done (1st curing). Then soil sample is crumbled to make small pieces of soil. After crumbling, proper compaction of soil specimen is done. Finally, again curing

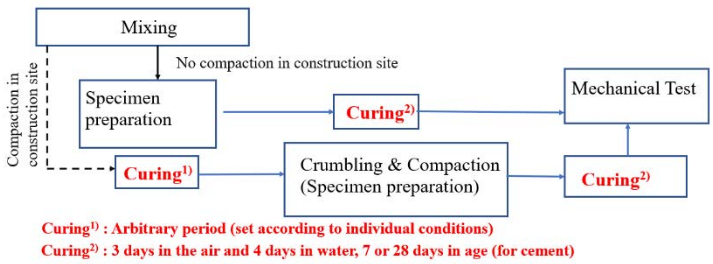

Fig. 1 Conventional flow diagram of laboratory mixture design in cement treated soil

Table 1 properties of AO clay

particle density, ρ_s	2.716g/cm^3
Liquid limit, w_L	40.7%
Plastic limit, w_P	23.7%
Plastic index, I_P	17.0

is done (2nd curing). This curing method develops strength in cement-treated soil. This paper aims to investigate the effect of the two-stage curing method on PS ash-treated soil.

Here, AO clay is used. The properties of AO clay are shown in Table 1. The particle size distribution of AO clay was evaluated based on the Japanese Geotechnical Society (JGS) standard (JGS 0131). Due to the hydration reaction, the particle size distribution of the PS ash was obtained by using laser diffraction analysis with alcohol instead of water as a medium in the analysis. (Fig.2). To investigate treated soil's strength characteristics (with PS ash & cement), cone index tests were conducted following the Japanese Geotechnical Society standards (JGS 0711, JGS 0716).

The initial water content of AO clay was adjusted to 40.7% before PS ash and cement were added at different dry mass ratios shown in Table 2. In both PS ash and cement treated cases, six samples were made with different curing conditions shown in Table 3. Here, 1st curing was done in sealed condition. Fig. 3 shows the difference in appearance between without 1st curing and 3 days 1st curing in case of PS ash and cement-treated soil, respectively. It is seen that the amount of water reduction in the sample after 3-day 1st curing is significant in both cases. After crumbling, proper compaction was conducted for each sample and soak them into the water for 2nd curing for the designated period as mentioned in Table 3.

5. STRENGTH DEVELOPMENT DUE TO TWO-STAGE CURING

Fig. 4 shows the change in q_c of the PS ash and cement-treated soil for 1, 3, and 7 days of, total curing, respectively. In both cases, the strength of soil reduces with the 1st curing time. In the case of 7-day total curing, if 3-day 1st curing is done,

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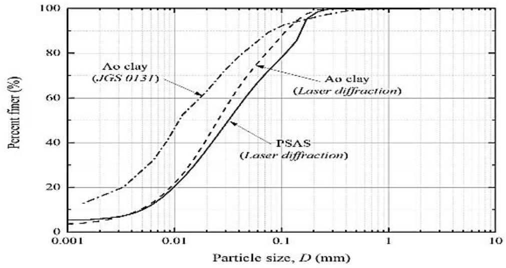

Fig. 2 Particle size distribution of PS ash and AO clay

Table 2 Mixture ratio of specimen

Initial water content of AO clay, w_0 (%)	Addition ratio of PS ash (%)	Addition ratio of cement (%)
40.7 ($w_0 = w_L$)	20	0
	0	6

Table 3 Curing condition

1st Curing (day)	2nd Curing (day)	Total (day)
0	1,3,7	1,3,7
1	2,6	3,7
3	4	7

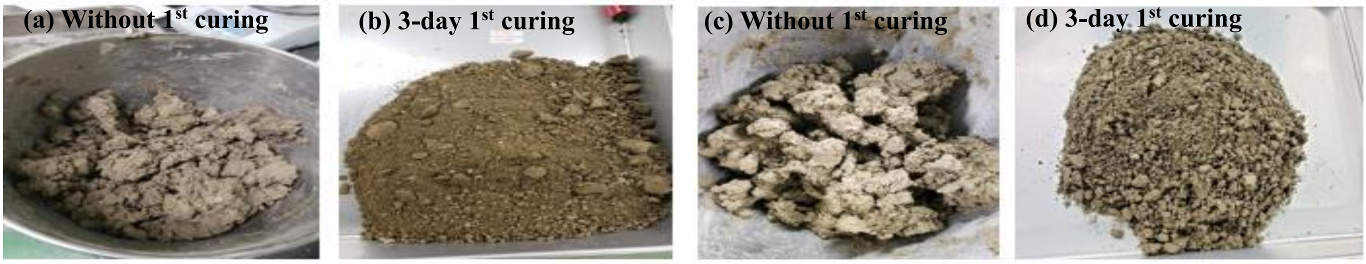

Fig. 3 Soil sample before compaction (a,b) PS ash (c,d) Cement

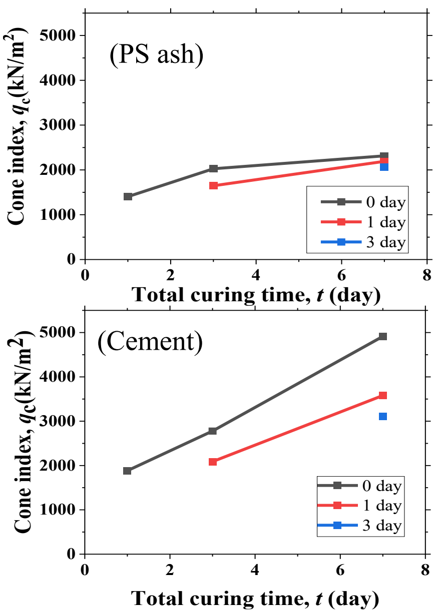

Fig. 4 Cone index of specimen

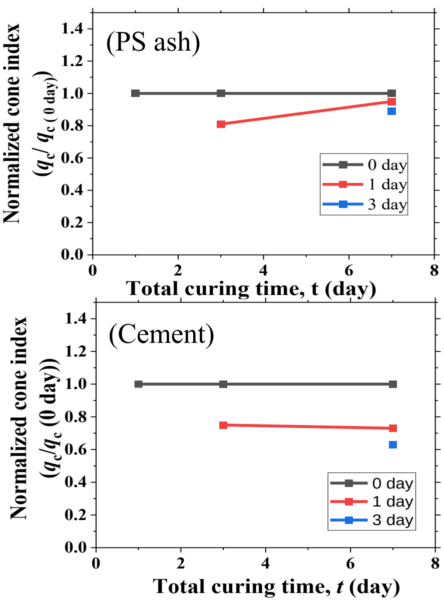

Fig. 5 Normalized cone index

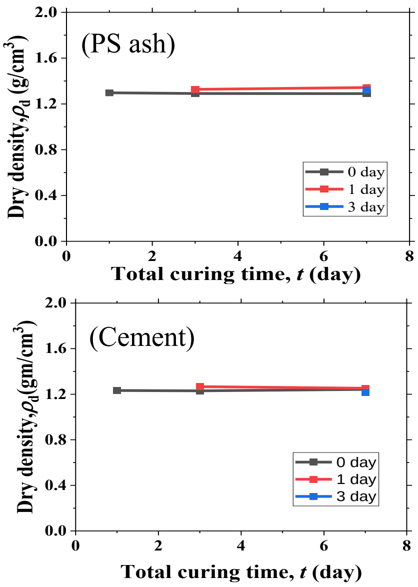

Fig. 6 Dry density of specimen

11% strength reduction has occurred compared with no 1st curing in PS ash treated soil while, in the case of 7-day total curing, if 3-day 1st curing is done, 37% strength reduction has occurred compared with no 1st curing in cement ash treated soil (Fig. 5). Fig. 6 shows the dry density of the cone index test specimens with elapsed time from the preparation of each specimen in the case of PS ash and cement-treated soils, respectively, after 2nd curing. In PS ash treated soil, it ranges from 1.28 to 1.35 g/cm^3, while in cement treated case, it ranges from 1.21 to 1.27 g/cm^3. Change in dry density is small for both cases.

4. CONCLUSION

Here, AO clay was treated with both PS ash and slag cement, and the result was then compared. In both cases, soil strength q_c reduces with 1st curing time. A slight reduction in strength is seen in PS ash-treated soil compared to cement-treated soil. The cone index test specimen's dry density shows that it does not have a significant effect with 1st curing time in both cases. A small number of hydrates generate with 1st curing in the sealed condition which is crushed during compaction. Compared with cement, the generation of hydrates in PS ash-treated soil is low. That is why a slight reduction in strength is seen in PS ash-treated soil than that of cement-treated soil.

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