LABORATORY OBSERVATION OF VOLUME EXPANSION BEHAVIOR OF PS ASH TREATED SAND PREMIXED AT DIFFERENTS WATER CONTENT

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1.INTRODUCTION

Constructions of public water supplies, waste collection pipelines, or manholes etc. require backfill sand. So far, treatment methods using cement or lime have been implemented to increase the liquefaction strength of backfill sand. However, these methods sometimes induce high alkalinity and/or excessive solidification problems. To solve these issues, this research project aims to apply Paper Sludge (PS) ash for the treatment of backfill sand. PS ash is a waste generated from paper production industries. As a preliminary step, treated sand must need cohesive strength due to chemical reaction of PS ash in the water ,therefore the premix method is investigated in this study to reduce construction period and determination of volume expansion change behaviour of Premixed PS ash treated. Moreover, evaluation of mixing adjusted water content must be important to optimize the Premixing period on the project site.

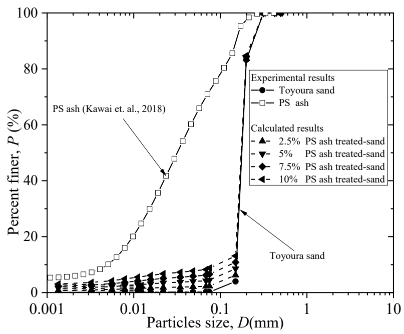

Fig. 1. PSD of Toyoura sand and PS ash

2.EXPERIMENTAL INVESTIGATION

2.1 Materials

Toyoura sand and a PS ash-based stabilizer (here after PS ash) are used. Fig. 1 shows their particle size distributions. Basically, Toyoura sand is well-known sand for use in research in Japan. According to the unified soil classification system, the sand is classified as SP (poorly graded sands), with the following properties: mean diameter, D_{50} = 0.16 mm, a coefficient of curvature, C_c = 0.83, and a coefficient of uniformity C_u = 1.47. The particles size distribution of the PS ash in the figure was obtained using laser diffraction analyses with alcohol instead of water as a medium in the analyses[1]. The PS ash used in this study has a porous structure with many complex irregularities and voids. The chemical composition is given in Fig.2a, owing to the chemical properties, PS ash can absorb and retain excess water, it is also show that its chemical component is relatively closer to that of ordinary Portland in Fig. 2b.

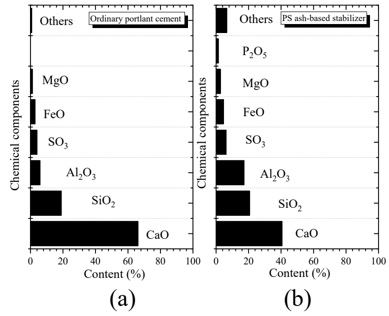

Fig. 2 Chemical component of stabilizers (Maliki et al., 2020)

2.1 Methodology of testing

The minimum and maximum density tests were first conducted to estimate the minimum and maximum void ratio, also the maximum and minimum void ratio measurement was conducted to control relative density of the specimens. Based on the results, First, dry Toyoura sand was mixed with the PS ash under various mix portions (2.5%, 5.0%, 7.5% and 10%). The maximum and minimum void ratio of the mixtures were investigated based on Japanese Geotechnical Society (2015a) standards. Fig.2 shows the e_{max} and the e_{min} plotted against the addition ratio of PS ash, A_{PS}. Here, A_{PS} is defined as the ratio of the PS ash to the Toyoura sand in dry weight. As seen in the figure, e_{min} changes little with the increase of A_{PS}, while the e_{max} increases. Therefore, the difference, e_{max}-e_{min} is increased with the increase of A_{PS}.

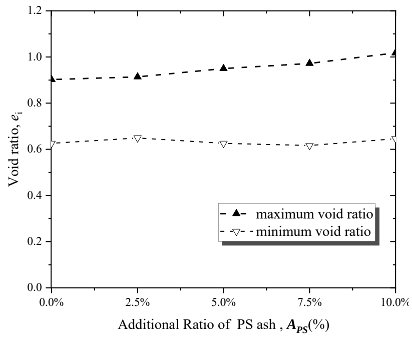

Fig. 3. e_{min} & e_{max} of sand treated by PS ash

3.PREMIXING AND EXPANSIONS TESTS

Premixing method was developed from 1985 and was used for the first time for the Tokyo Bay Aqua-line project in 1990. Since then it has been used in several projects by adding small amount of cement. In this paper Toyoura sand will be

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premixed with PS ash at different mixing water content to minimize the expansion strain of the cured specimen. Based on the fundamental studies of PS ash treated sand for re-excavation ability, 2.5% PS ash ratio was proposed by Maliki et al., therefore 2.5% PS ash sand is used to analyses the volume expansion behaviour However, to evaluate the effectiveness of the PS ash based improvements materials regarding of it expansion volume deformation, dry sand was thoroughly mixed with specific amount of PS ash at various mixing water content (ω=10%, ω=15% ,ω =20%) with the PS ash premixed at 0,1,2,3,4,5,6 and 7days in sealed plastic bag in the laboratory at a constant room temperature of 20°C. Cylindrical molds with inner diameter and height of 50mm and 100mm, respectively were utilized for all the test specimen respectively. The mixture was tamped carefully in the mold to form a specimen with a target density D_r =50%,90%. Particularly for the filling of the mixed sand tamping was conducted layer by layer, in three layers, to attain a uniform relative density D_r throughout the specimen. On top of each layer, slight kerfs were applied to avoid segregation between layers. After tamping the specimen were immersed into water for 1,2,3 and 4 days. Each of the immersed specimen was removed from the water container and the length of the specimen was measured at 0, 1, 2, 3 and 4 days using a length comparator for calculating the expansion percentage describe in this paper as immersion expansion strain.

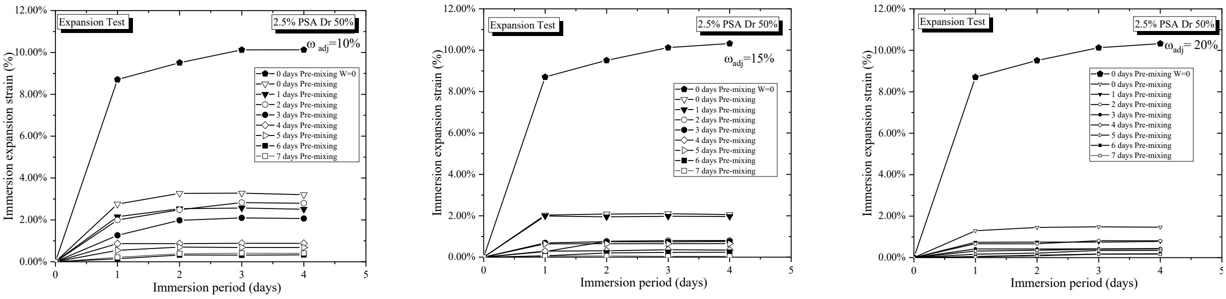

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Fig.4 Evolution of the immersion expansion with immersion period (D_r =50%)

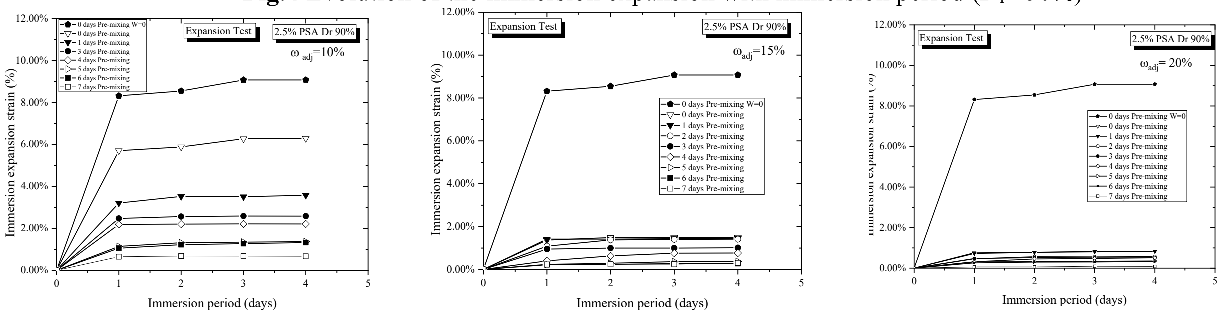

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Fig.5 Evolution of the immersion expansion with immersion period (D_r =90%)

From Fig.4 and 5 it is seen that the evolution of the immersion expansion strain with adjusted water content expands as soon as they absorb water. The immersed expansion strain is observed for all the premixed tested specimen during the first days then become constant for the rest of the immersion period inside the water for all ages, which indicate how much the water absorption capacity of PS ash treated sand can limit it expansion behaviour during the curing period in the water. The volume expansion of each specimen can be defined as a function of the premixing water content plus the immersion period since the result in fig.4 and 5 show the reduction of the volume expansion with the increase of the adjusted mixing water content. Moreover, the expansion strain is lower with specimen prepared at D_r=50% than specimen prepared at D_r= 90% which very important parameter to control during the execution on the project site.

4.CONCLUSIONS

PS ash Premixed treated sand at different relative density of 50% and 90% shows a dramatic change of the volume expansion strain which is an important parameter to control during execution on construction site. Therefore, to premixed treated sand at 15% water content showed to have a lower expansion strain and most appropriate to reducing the premixing period on construction project site.

5.REFERENCES

1- Kawai, S., Hayano, K. and Yamauchi, H. (2018), Fundamental study on curing effect and its factor on the strength deformation characteristics of PS ash-based improved soil, Journal of JSCE (C: Geotechnics), 74(3), pp. 306–317 (in Japanese).