Deterioration of cement treated soils and ground in undersea environment

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INTRODUCTION

This paper focused on the deterioration of cement treated clay soils in undersea environment. Laboratory tests were carried out to measure the strength distribution using micro cone penetration test with different cement ratio and curing environment.

MATERIALSAND METHODS

The materials used in the study are Ariake clay and Slag Portland cement B. Ariake clay used in the study was got from 0.1 m - 0.5 m deep in the ground, in Ogiogi Gun, AshikariMachi, Saga prefecture. The physical properties are summarized in Table 1.

First, Ariake clay is thoroughly mixed with seawater to obtain an initial water content of 1.5 times liquid limit (192.75%).Second, slag Portland cement with the cement factor, a_w, of 30% is mixed with the clay soil to manufacture the soil-cement mixture. Third, pour the mixture into a plastic mould with a diameter of 5cm and a height of 10cm.Finally, put samples into the artificial seawater, only one end of the cylindrical specimens are exposed to seawater.

ANALYSIS AND CONCLUSION

$1^{\#}$ the sample is curing under standard environment for 28 days, then put into artificial seawater environment curing for another 70 days, $3^{\#}$ the sample is without standard curing, it is put into artificial seawater directly after pouring into the plastic mould and curing for 70 days, $4^{\#}$ the sample is curing under standard environment for 28 days and then put into in-suit seawater which is get from saga and curing for 70 days. The result (Fig. 1) shows the cement treated clay soil with 28 days standard curing penetration resistance is higher than 0 days standard curing. There is little difference between artificial seawater and in-suit seawater curing. Curing time 70 days, the deterioration happens in depth 10mm, and the penetration resistance increase and keep a steady situation in deeper depth than 10mm. The deterioration of $1^{\#}$ and $4^{\#}$ is similar, so the artificial seawater and in-suit seawater composition may be the very close. During curing time, the strength of inner part of sample increase as hydration reaction goes on, but the aggressive ions in seawater penetrate from the surface of sample, so the deterioration happens at the same time.

$5^{\#}$ the sample is directly put into artificial seawater after pouring into plastic mould and curing for 28 days, $11^{\#}$ the sample is cured under 2 times seawater concentration environment for 28 days, $15^{\#}$ the sample is cured under ion-exchange water for 28 days. It can be seen from Fig. 2 that different curing environment has great effect on deterioration of cement treated soil, higher seawater concentration induce the deeper deterioration depth, but the penetration resistance. The penetration resistance at point 10mm and after is very near.Higher seawater concentration accelerates the ions diffusion and exchange, so accelerate the reaction of deterioration.

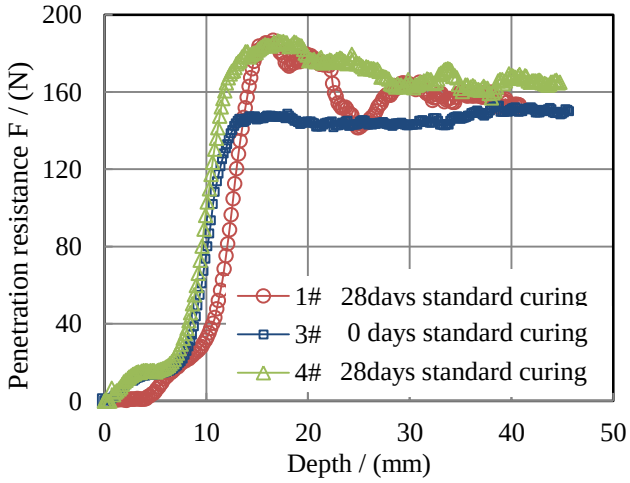

Fig. 1 Standard curing effect on penetration resistance distribution

Table 1 major characteristics of Ariake clay soil

natural water content (%)	specific gravity (g/cm^3)	consistency			soil particle distribution		
		liquid limit (%)	plastic limit (%)	plasticity index	sand (%)	silt (%)	clay(%)
160~200	2.60	128.5	52.0	76.5	0.5	29.5	70

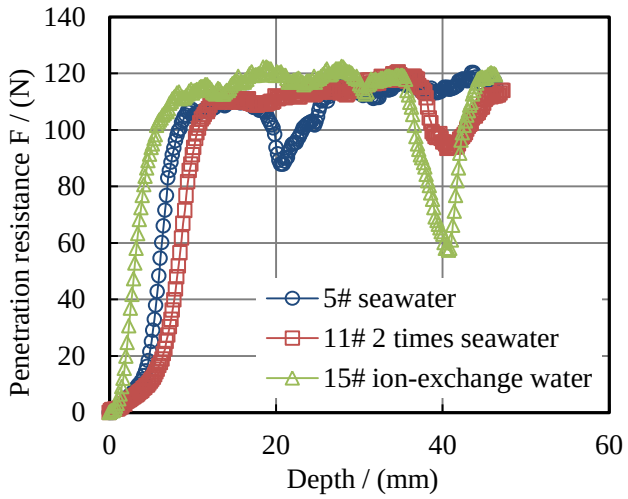

Fig. 2 Curing environment effect on penetration resistance distribution

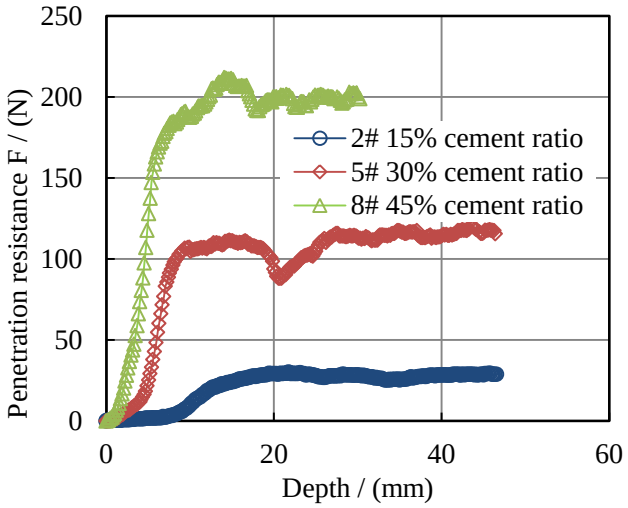

Fig. 3 Cement ratio effect on penetration resistance distribution

2# the sample is prepared by adding 15% cement ratio, where the cement factor is defined as the ratio of the dry weight of cement introduced to the dry weight of the soil, after pouring into plastic mould, put into artificial seawater directly and curing for 28 days, 5# the sample is prepared by adding 30% cement ratio and curing for 28 days, and 8# the sample is prepared by adding 45% cement ratio and curing for 28 days. Fig. 3 shows that cement ratio influence the penetration resistance obviously, higher cement ratio increase the penetration resistance, and higher cement ratio can release the deterioration of cement treated soi.

Through the test we can conclude that standard curing can increase the penetration resistance in deeper depth of cement treated soil, and higher seawater concentration induce deeper depth of deterioration of cement treated soil, but the depth more than 10 mm, the penetration resistance is similar. Higher cement ratio increase the penetration resistance, can delay the deterioration of cement treated soil.

Further research: focus on pore water pressure influence on durability of cement treated soil.

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