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Study on the settlement reduction of artificial reef

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ABSTRACT

The artificial reef project for marine resource recovery business has been actively promoted to increase fish catching and restore marine ecosystems. In the soft deposit, the ground has been dramatically settled because of the weight of artificial reefs. This study investigated the effect of the geogrid, which were reinforced on the surface in a large size tank, on the settlement reduction of artificial reef from laboratory settlement test. The test results indicated that geogrid reinforced soil had less settlement than unreinforced soil, because the bearing capacity was increased when the geogrid was reinforced on the surface.

1. INTRODUCTION

As inhabited environment of coastal area deteriorates, productivities of fisheries and marine resources decrease. Also, Fish activities and fishery income have been reduced. In order to increase fish catching and supply, the artificial reef construction of marine resource recovery business has been actively promoted. When the artificial reefs are installed in the soft seabed, the ground around artificial reefs can be settled by the weight of artificial reefs.

Many researchers have kept trying to evaluate the safety of artificial reefs. The settlement conditions of the artificial reefs that were already installed in south sea and southwest sea of Korea were investigated (Kim et al., 2010; Kim et al., 2009; Choi et al., 2009). The differences of scour/subsidence characteristics in the steady flow field and in the unsteady flow field were compared and the long-term subsidence characteristics in the unsteady flow field were investigated (Kim, 2001; Yoon et al., 2001). To reduce their settlement of artificial reefs the new models of artificial reefs were proposed. Although the new artificial reefs can reduce the settlement, the huge cost is necessary for their construction.

According to the previous studies there were not proper reduction way for settlement of the artificial reefs. Therefore, this study proposed the settlement reduction method of

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artificial reefs using geosynthetics as a reinforcement and it can save more construction cost than other reduction method of settlement of artificial reefs. Geosynthetics have been usually used in civil construction for increasing stability and the bearing capacity through the intersection with soil.

2. MATERIALS AND METHODS

2.1 Material - Clay

Kaolinite, that has normalized particle size and properties, was used to describe the standardized soft state of clay with 70 percents of moisture content. Table 1 shows the properties of clay used in this experiment, respectively.

Table 1. Physical properties of Kaolinite

Water content [ω, %]	70
Unit weight [γ, kN/m^3]	15.3
Plastic limit [PL, %]	30.64
Liquid limit [LL, %]	59.57
Plastic index [PI, %]	28.93
Specific gravity [G_s]	2.10

2.2 Laboratory settlement test

Fig 2 shows laboratory setup of equipment used in this experiment. Laboratory settlement tests were conducted in the soil tank with dimensions of 2000mm length, 500mm width and 1000mm height. The model of artificial reefs was made with dimensions of 100mm length, 100mm width and 100mm height that was downsized 20 times of the real artificial cubed reef. Clay was prepared inside of the sand tank. In order to observe the settlement of artificial reef, the dial gauge was placed up to the artificial reef and the settlement of each model were recorded by dial gauge.

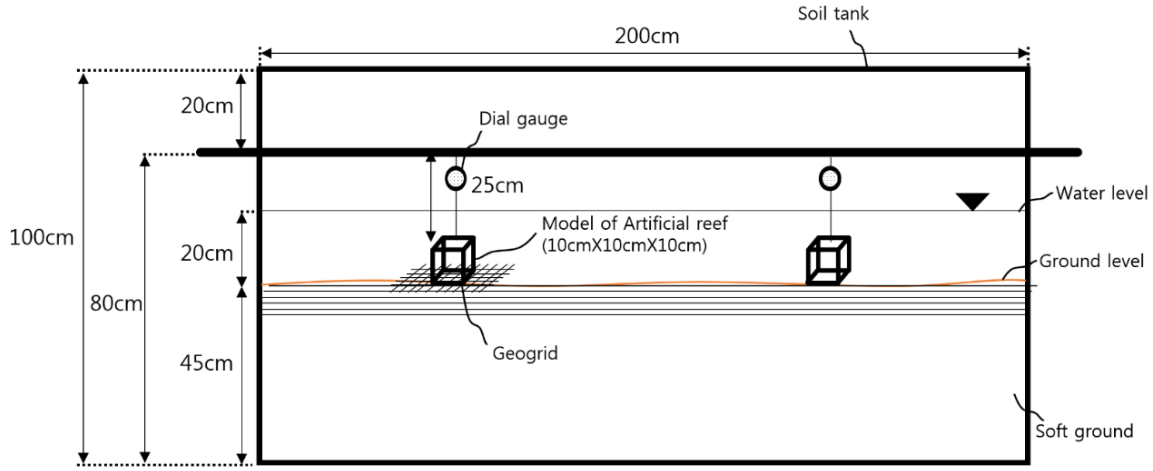


Fig 2. Map of the soil tank used for laboratory settlement test

2.3 Settlement reduction ratio (SRR)

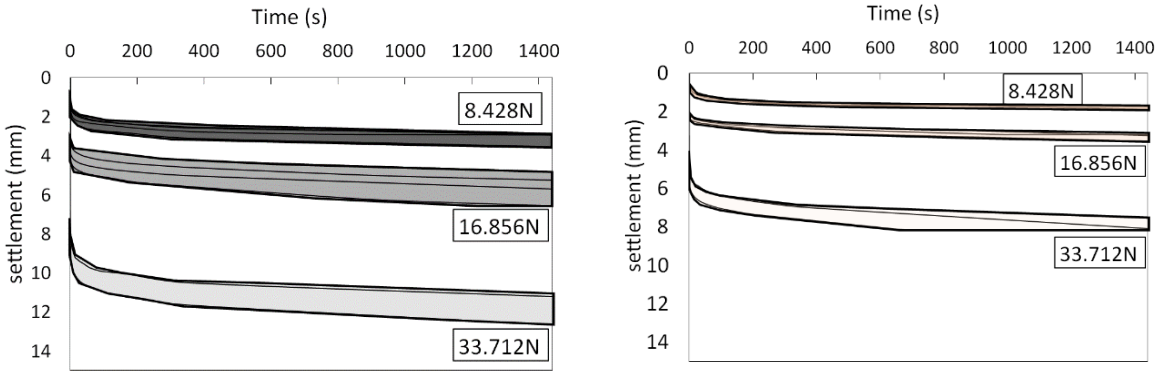
Settlement reduction ratio (SRR) is defined as the percentage reduction in settlement due to stabilized case relative to the unstabilized case at a constant load(Alawaji, 1998).

$$SRR(\%) = \frac{S - S_{(R)}}{S} \times 100 \quad \cdots\cdots (3)$$

Where S are the settlement of unreinforced soil and $S_{(R)}$ are geogrid reinforced soil at constant load. In this study, laboratory settlement test for each artificial reefs compared unreinforced state and geogrid reinforced state were conducted for confirming settlement of model of artificial reefs.

3. RESULTS AND DISCUSSIONS

Laboratory settlement test were conducted three times with constant area of geogrid (3 times) for confirming accuracy of this experiments. Fig. 3 shows the settlement of model of artificial reefs with different load in clay soil. In the clay soil, time dependent settlement was occurred and it was called primary consolidation. Settlements were occurred at whole time, also, reinforcing effect was observed during the soil reinforced.
Fig. 4 shows the SRR with different load. In the clay soil, SRR decreased as load increased because reinforced geogrid that has supported with own tensile strength and stiffness became overloaded as load increase. In addition, side of the geogrid was detached from the ground as the load increase. Also, it has caused the loss of friction and interlocking between soil and reinforcement.



(a) Unreinforced clay (b) Geogrid reinforced clay

Fig. 3 Settlement of artificial reef in clay

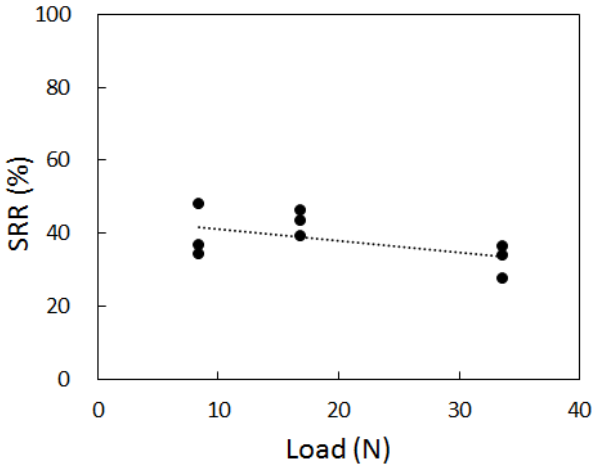


Fig. 4 SRR with different load in clay

4. CONCLUSIONS

Based on the experimental results the following conclusions can be drawn:

1. In the clay soil, time dependent settlement was called primary consolidation occurred. geogrid reinforced soil had less settlement than unreinforced soil, because the bearing capacity was increased when the geogrid was reinforced on the surface.

2. In the clay soil, SRR decreased as load increased because reinforced geogrid provided soils less tensile strength and stiffness. In addition, side of the geogrid was detached from the ground as the load increase. Also, it has caused the loss of friction and interlocking between ground and reinforcement.

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