Effects of Density and Confining Pressure on Mechanical Behavior of Crushable Soil

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ABSTRACT
Research has been conducted on mechanical behavior of crushable soils using triaxial apparatus, varying density and confining pressure of materials in addition to drainage conditions. We demonstrated what effect each factor has on the degree of particle crushing and mechanical behavior by comparing the experimental results of three different kinds of granular materials.

KEY WORDS: Crushable soil; Triaxial test; Density; Confining pressure; Continuum mechanics.

INTRODUCTION
Crushable soils are widely distributed around the world. Especially, most sands that are deposited on the ocean bottom contain a lot of seashells or corals, so these sands have crushability. When an offshore structure is constructed on crushable soils, particle crushing can lead to various problems, like piles not being able to achieve enough bearing capacity. Studies on crushable soils, which can cause several engineering problems, have been actively conducted. Most previous studies focused on crushing of individual particles from a micro perspective (e.g. McDowell et al., 1998; Nakata et al., 1999, 2001; Takei, et al., 2001). These approaches have tended to utilize distinct element methods (DEM) (e.g. Chen et al, 2003). On the other hand, there have been only a few attempts to treat crushable soil within the framework of continuum mechanics up to the present time. In this study, we researched the effects of the micro phenomenon of soil particle crushing on the macro behavior obtained from laboratory element test, with a view to describe mechanical behavior of crushable soils based on elasto-plasticity. Specifically, we researched one-dimensional compression behavior using the standard consolidation apparatus, and effect of density and confining pressure on shear behavior using the triaxial compression apparatus.

EXPERIMENTAL OVERVIEW
Materials
Toyoura sand, which is the standard sand in Japan, was used as an un-crushable soil, while a slug and Okinawa sand were used as crushable soils, where the slug is made by melting of general waste. Micrograms of the slug and Okinawa sand are shown in Photo 1. The slug is not a natural soil but an artificial material, but its particles are glassy. So it was used as a simulated crushable soil. Okinawa sand is also crushable because it contains calcareous materials, i.e. seashells or corals.

Photo 1. Micrograms of materials

Fig. 1. Original grain size distributions of materials