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MECHANICAL PROPERTIES OF SOIL MIXED WITH CORAL GRAVEL IN THE SOUTH-WEST ISLANDS OF KAGOSHIMA AND OKINAWA

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Abstract

The South-west Islands, which extend like an arc between Kagoshima Prefecture and the north-east of Taiwan, belong to the subtropical zone. Most of these islands are surrounded by coral reefs. This paper explores the mechanical properties of island-soil, mixed with coral gravel, from the view-point of geotechnical engineering.

Key words: geotechnical engineering, mechanical properties, soil mixed with coral gravel

Introduction

The South-west Islands, which extend like an arc between Kagoshima Prefecture and the north-east of Taiwan, belong to the subtropical zone. The Islands also separate the Pacific Ocean and the East China Sea. The south-west Islands can be classified roughly into two: (1) the Satunan Islands, consisting of Osumi Islands, Tokara Islands and Amami Islands, in the north and, (2) the Ryukyu Islands, consisting of Okinawa Islands and Sakishima Islands, in the south.

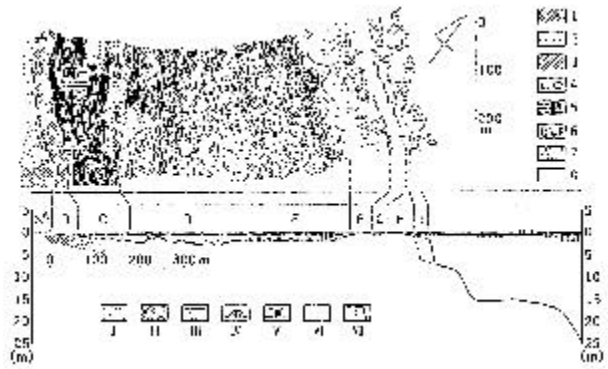

Fig. 1. Band configuration of ultramicroscopic ground in current coral reef (North-East of Yoron Island).
（堀，1980）上：平面図，下：平面図内の平均的断面図.
1：更新世の礁石灰岩，2：生物起源砕屑物の砂礫の浜，3：ビーチロック，4：溶蝕凹地，
5：枝サンゴ帯，6：サンゴ塊，7：漂砂帯，8：干潮時に離水する部分.
Ⅰ：砂浜，Ⅱ：更新世の礁石灰岩，Ⅲ：凹地，Ⅳ：砂堆と枝サンゴ（一部，海藻），Ⅴ：サンゴ塊，Ⅵ：現成サンゴ礁石灰岩，Ⅶ：礁縁部－縁脚系.
a：浜とビーチロック，b：更新世の礁石灰岩を切る潮間帯下部，c：枝サンゴ帯，d：漂砂帯，e：サンゴ塊帯，f：条溝帯，g：内堀，h：石灰藻嶺，i：外側礁原（礁縁部－縁脚系）.
なお，b～eを一括して浅礁湖または礁池，f～iを一括して礁縁とよぶ.

Most of these islands are surrounded by coral reefs which are rock reefs with lime properties formed by the dead bodies and secretions of coral worms. The coral reefs are distributed over a sea area in which the average temperature is more than 20 degrees and the water depth shallower than 60 meters.

Figure 1 shows an example of a coral reef structure. The coral reef functions as natural breakwater, and harbor facilities are usually constructed on the reef flats. The ground of a coral reef is classified roughly into hard ground like the layer of limestone and the alluvial soft ground. The hard ground is further classified into various forms according to its formation process. Most of the surface of the bottom of the sea is a layer of limestone, and the hard ground is distributed in the shape of a lens set in alluvial soft ground. In hard ground, a layer whose SPT N-value equals around 20 usually exists within a layer whose SPT N-value is more than 50. Such grounds are good for the construction of offshore buildings with due attention to the existence of void in the ground.

Alluvial soft ground generally consists of soil materials, mixed with coral gravel, which is often found inside coral reefs in the South-west Islands. So far there is no established theory about the sedimentary processes of this soil. However they can be explained as follows: when the coral reefs are found in adequate environmental conditions, they become natural breakwaters and a quiet lagoon is formed on the inside of a breakwater. Although coral reefs suffer receive the erosion action of wave power, they continue to grow by the active formation of coral. Bits of decayed coral are swept into the lagoon by waves and accumulate with sand carried from the land by rivers. Branches of coral, which are weak in sea waves but comparatively strong in fresh water, are very active on the base of the lumps of bits of coral carried from the edge of coral reefs in the lagoon. The sand carried from the land and bits of coral sediment lodged on the grown branches of coral and accumulate between the branches of coral. Thus, soil mixed with coral gravel, is formed repeatedly by the above processes over a long period. This paper explores the mechanical properties of the soil mixed with coral gravel in terms of geotechnical engineering.

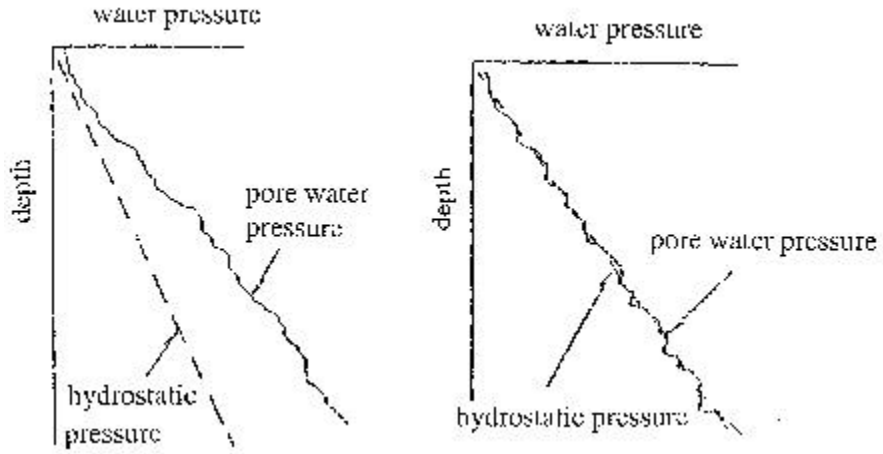

Fig. 2. Differences in pore water pressures during cone penetration.

Mechanical Properties

The soil mixed with coral gravel is classified as an intermediate soil in geotechnical engineering. It is composed of soil particles having an extensive particle size ranging from clay to gravel. The content of fine and gravel fraction and the extent of the disturbance of the sample are the indices with which to grasp the mechanical property of the soil. An optimum design has to be achieved for civil engineering structures based on ground consisting of soil mixed with coral gravel by the combination of these indices. The evaluation method must also assess the strength parameters of soil, the internal friction angle Φ and the cohesion c. Standard penetration and electric static cone penetration tests are used to investigate the structure of layers in the soil. The cone penetration test can yield various data on the mechanical properties of the ground by replacing the probe, the edge of the test device. Thus, it is considered that the cone penetration test is the best in situ test method. Figure 2 shows the results of cone penetration tests in the harbor region of Okinawa. It is found that the generation of pore water pressure is different even in ground that is classified as soil mixed with coral gravel.

Conclusuons

Several problems are still to be addressed such as establishing the mechanical properties of the soil mixed with coral gravel, and selecting appropriate methods for soil investigation and the data analysis.

References

鈴木隆介 1998. **建設技術者のための地形図読図入門，第2巻，古今書院，** pp.473-477.

沖縄総合事務局　港湾計画課 1995. **サンゴ礫混じり土調査・設計マニュアル（案），** pp.1-2.

小林正樹，土田孝，亀井健史 1992. **中間土，ジオテクノート，地盤工学会，** p.87.

新城俊也 1999. **破砕性地盤の工学的諸問題に関する研究委員会報告書，地盤工学会，** pp.106-115.