DEVELOPMENT IN SAMPLING OF COHESIONLESS SOILS IN JAPAN

AMELIORATION DANS LE PRELEVEMENT D'ECHANTILLONS DES SOLS PULVERULENTS AU JAPON

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SYNOPSIS: Recent developments in the sampling of cohesionless soils in Japan are discussed. The need for the undisturbed sampling of cohesionless soils is increasing greatly in Japan and many investigation projects are conducted. However, the undisturbed sampling of cohesionless soils is still one of the most difficult tasks in subsurface investigation.

Test results in Niigata, Japan, are introduced and discussed. Samplings of clean sands by various types of tube samplers are conducted in the Niigata site, where samplings by in situ ground freezing were made. Samples obtained by in situ ground freezing exhibit satisfactory quality, while most of the samples obtained by the tube samplers are affected by sample disturbance. Among these, the central portion of the sample obtained by a large-diameter triple tube sampler exhibits higher shear modulus and liquefaction resistance than those of the other tube samples, suggesting possibility of a measure to reduce the influence of sample disturbance.

INTRODUCTION

The need for the sampling of cohesionless soils has recently increased greatly in Japan since growing importance has been placed on the aseismic design of structures whose foundation ground is vulnerable to liquefaction. In addition, large and important structures such as nuclear power plants, bridges and offshore structures, have recently been proposed and/or constructed on cohesionless and gravelly soils, and thus the need for the study of the behavior of granular soils under static and dynamic loads has increased.

In recent years, over several hundreds of investigation projects which include the sampling of cohesionless soils are conducted every year in Japan. However, the undisturbed sampling of cohesionless soils is still one of the most difficult tasks in subsurface investigation.

In the present paper, recent developments in the sampling of cohesionless soils in Japan are discussed. Firstly, test results in Niigata, Japan are introduced and discussed. Secondly, tests at Urayasu City, Chiba, Japan, are discussed.
These 2 tests are conducted by the Japanese Committee on Soil Sampling of JSSMFE.

TEST IN NIIGATA

Niigata is well-known for the extensive soil liquefaction and resulting damage to the structures during the 1964 Niigata Earthquake. Niigata test site is located about 2.5km south of JR Niigata Station. Fig. 1 indicates the soil

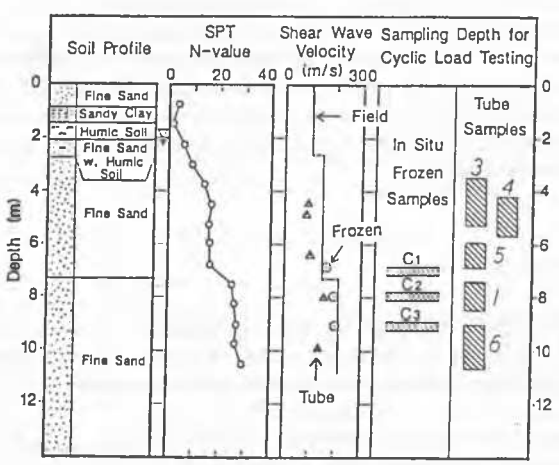

Fig. 1 Soil Profile at Sampling Site in Niigata
(Complied after Yoshimi et al., 1989)

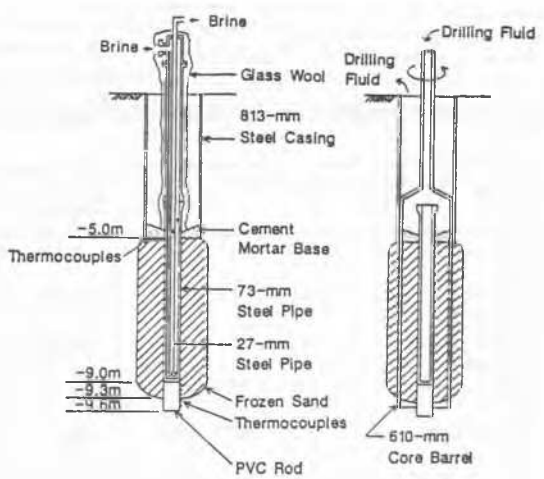

Fig. 2 Procedures of In Situ Ground Freezing Method
(Yoshimi et al., 1989)

profile at the site (Yoshimi et al., 1989). The fine sand between the depths of 3 and 7m is dune sand, and the fine sand below 7m is an alluvial stratum. As indicated in Table I, the sands at the site are very clean (fines of less than 2%) and very uniform ($U_c \fallingdotseq 1.5$).

Methods of Undisturbed Soil Sampling

Fig. 2 illustrates procedures for in situ ground freezing method conducted previously by Yoshimi et al. (1989). Chilled brine (liquid calcium chloride) was used instead of liquid nitrogen as the coolant. The brine can be recycled in the operation. The temperature of the brine was -28°C going into the freezing pipe and about -26°C coming out. The circulation of the brine was continued for about three weeks.
Table 1 summarizes the types of tube samplers used and the sampling depths.

Evaluation of Results

The SPT N-values and the S-wave velocities measured at the site are indicated in Fig. 1. The S-wave velocities estimated from the shear modulus G_o for the samples in the laboratory are also shown in Fig. 1. The relationships between the applied shear stress ratio and the number of load cycles required to cause a double amplitude axial strain of 5% are shown in Fig. 3 for samples up to the depth of 7.5m and in Fig. 4 for samples below the depth of 7.5m.

The following conclusions are drawn from the test results.

(1) By the comparison of the S-wave velocities measured in the field and the laboratory, it can be judged that the samples obtained by in situ ground freezing retain good quality. Most of the samples obtained by the tube samplers, on the other hand, are affected by sample disturbance.
(2) From the results indicated in Figs. 1, 3 and 4, it is seen that Tube Sample No.1, which is obtained by the Triple Tube Sampler ø125 mm, exhibits higher G_o and liquefaction resistance than those of the other samples obtained by the samplers with smaller diameters. This result suggests that sample disturbance effects might be reduced, if a sample is obtained with a large diameter tube sampler and if specimens are trimmed from the central portion of that sample.
(3) Undisturbed sampling from clean, uniform sands under the groundwater table is a difficult task, and further studies are still required on this subject.

Table I Type of Samplers Used and Properties of Niigata Sand

Type of Sampler	Sample No.	Depth (m)	Sand Content(%)	Mean Dia.(mm)	Uc
Triple Tube Sampler ø125mm	1	7.4 – 8.5	98.8	0.28	1.71
Pressure Balance Sampler, ø81mm	3	3.5 - 5.35	97.7	0.29	1.63
Static Push Sampler ø50 or 70mm	4	4.2 - 5.7	98.8	0.26	1.44
Triple Tube Sampler ø81mm	5	5.95 - 6.9	98.4	0.29	1.62
Triple tube Sampler ø81mm	6	9.0 - 10.7	99.1	0.26	1.28
Average			98.6	0.28	1.54

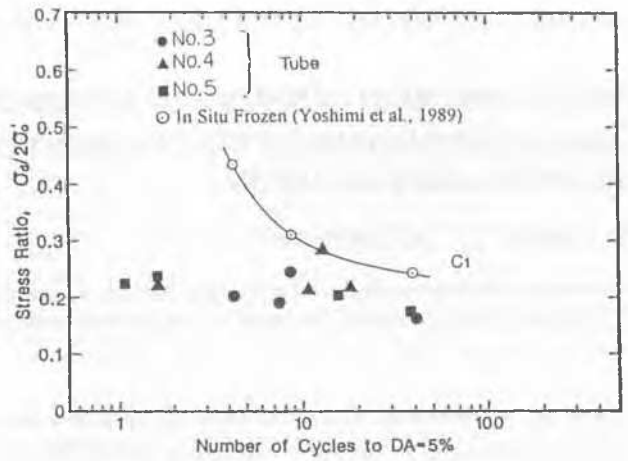

Fig. 3 Comparison between In Situ Frozen Samples and Tube Samples (for samples up to the depth of 7.5m)

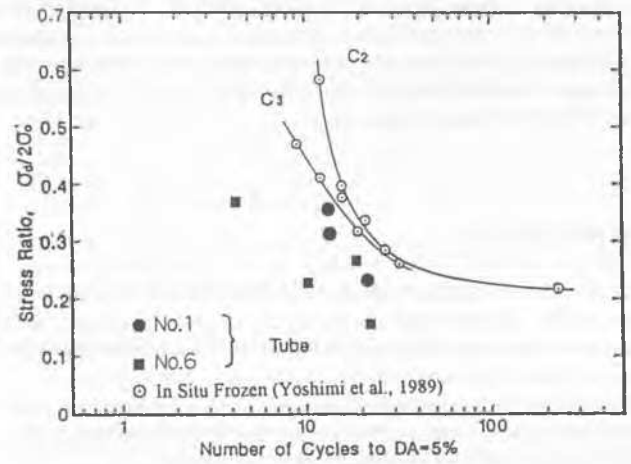

Fig. 4 Comparison between In Situ Frozen Samples and Tube Samples (for samples below the depth of 7.5m)

TEST AT URAYASU

Urayasu test site is located about 10 km east from Downtown Tokyo and is facing Tokyo Bay. An alluvial sand layer at depths between 8 and 15m is sampled. The sand layer contains 5 to 15% of fine grained material. The SPT N-value of the layer varies from 10 to 20. In situ ground freezing method and various types of tube samplers are used for the sampling of the sand layer. Tests are now in progress and detailed analysis on the results will be conducted in the near future.

REFERENCES

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