

Considerations for Judging Suitability of Filling Materials for an SCP

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ABSTRACT

For the implementation of substitute filling materials for an SCP, their evaluation needs to be made in advance by means of simple soil tests. Field site tests using such materials have been conducted so far by examining their suitability for ease of implementation and improvement effect. These procedures were time- and cost-consuming, however. This paper proposes a design flow to assess the applicability of filling materials to an SCP, based on the findings from available laboratory and field site test data. Further, the suitability of the proposed design flow is confirmed from the results gained by applying it in tests and actual implementations.

INTRODUCTION

The sand compaction pile (SCP) method has been widely used as a ground improvement method in Japan. It conforms to fundamental principles of compaction and consolidation drainage. As a result, it has been used successfully on many occasions for the improvement of all types of soft ground (ranging from sandy to clayey), using natural clean sands as filling material.

In order to lessen the environmental impact through efficient recycling of construction surplus soils and reduced use of natural sands, an improved SCP method has been developed. In this method, construction surplus soils and coal ash are used as a substitute for sands used as filling material in conventional SCP methods so as not to exhaust sand resources. Originally, the method was developed for clayey ground, and in the design the strength increase of soft clay due to dissipation of excess pore-water pressure generated through installation of sand compaction piles was newly considered. In the case of sandy ground, as the compaction effect is not significantly affected by filling material, this method has been acknowledged to be effective against liquefaction.

As this filling material has different properties from clean sands, however, it is very important to clarify the material properties for compaction pile methods. In this paper, the authors have examined the applicability of filling materials to the compaction pile—in order to improve soft ground—through laboratory tests (Tsuboi et al., 2000) and field site tests (Tsuboi et al., 2001). The availability of high-quality sand for filling material has been diminishing year by year, and it may be extremely difficult to secure an adequate supply in the future. Construction surplus soil, slag, coal ash and similar materials would then become potential

substitutes for this filling material, and their effective use would contribute to reducing the environmental load.

For the above reasons, then, a ground improvement method using construction surplus soils has been developed and modified for implementation (Matsuo et al., 1997). Further, in order to eliminate the vibration and noise generated by vibro-hammers in vibratory SCP methods, a nonvibratory SCP method has been developed and implemented for many practical cases (Tsuboi et al., 1998).

In this paper, the authors present a simplified design flow to judge whether or not filling materials can be applied to compaction pile methods through simple laboratory test data. This study is based on the findings from the available data of laboratory and field site tests of filling materials in the vibratory and nonvibratory SCP methods.

FINDINGS FROM AVAILABLE TEST DATA ON FILLING MATERIALS

Required Filling Materials Performance

Fig. 1 shows the implementation procedures for the vibratory and nonvibratory SCP methods. The former uses a vibrator; the latter, a forced lifting/driving device. However, there is no great difference in procedure between the two. Filling material (normally sand) is brought in with a wheel-loader into a bucket, from which it passes through a hopper to fall into the casing pipe (ϕ 400–500 mm). Then, through a process of raising and redriving the casing pipe, a compacted sand pile is formed in the ground.

Fig. 2 lists factors to be considered for both design and implementation. For clayey ground, a composite ground containing well-compacted sand piles is formed; shear strength and permeability tests for the SCP should be carried out in order to confirm their characteristics. For sandy ground, an SCP is often used to increase the density of ground as a countermeasure against liquefaction, and so the sand pile is required to have sufficient strength and diameter. Thus, the data of shear strength tests in a dense state are required for the design. For the implementation, clean sand is desirable, as materials with high fines content lead to clogging.

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