

Development and Application of Non-Vibratory Sand Compaction Pile Method

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ABSTRACT:

The conventional sand compaction pile (SCP) method, which is a widely applied ground improvement method, aims to increase the bearing capacity of soft ground by reinforcing it as compacted ground, or by increasing the density of loose sandy ground, through the vibratory installation of additional sand piles. However, the use of a vibro-hammer generates noise and vibration, which may adversely affect the surrounding environment. It is therefore difficult to use this method for ground improvement work in urban areas or on sites close to existing structures.

To reduce noise and vibration, the authors developed a non-vibratory SCP method, called the non-vibratory compaction method, that is based on a rotary penetration system that uses a forced lifting/driving device and a rotary drive motor.

This paper sets out the development objectives and development history of this non-vibratory SCP method, and gives details of case histories where it has been applied on land reclamation sites around coastal areas in Japan.

KEY WORDS: Sand compaction pile, non-vibratory SCP, low noise, no vibration, improvement effect

INTRODUCTION: DEVELOPMENT HISTORY

The sand compaction pile (SCP) method is a way to improve soft ground through the installation of well compacted sand piles. It conforms with 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 soil, ranging from sand to clay. In the case of sandy ground, the SCP method is widely used as a remedial measure against liquefaction. It is one of the most reliable methods for this, and its effectiveness in compacting the ground to control liquefaction has been verified in several strong earthquakes (Ishihara, K. et al. 1980, Yasuda, S. et al. 1996). However, the use of a vibro-hammer

generates noise and vibration, adversely affecting surrounding areas, and so it is not suitable for use on urban sites or those very close to existing structures. On such sites in many cases either the low-noise, low-vibration gravel drain method has been used, or a low-noise, low-vibration SCP method, known as the Mini Compozer in Japan, that uses a high frequency vibro-hammer and a small diameter casing pipe. However, both these methods are more expensive than SCP and have other drawbacks. The former method does not give as great an improvement effect as SCP, and the latter does not entirely eliminate problems associated with noise and vibration.

In an attempt to overcome these problems, a new, non-vibratory compaction method, called the non-vibratory compaction method, has been developed (Yamada, T. et al. 1996). This allows cost savings in operations close to existing structures, and minimizes noise and vibration to eliminate adverse effects on the surrounding environment.

This paper explains the operational equipment and procedure for the non-vibratory compaction method, as well as its monitoring system. It reviews the results of a number of cases (including site trials) undertaken to confirm whether or not its development objectives have in fact been achieved, and it reports on actual cases where the method has been put to use.

EQUIPMENT, OPERATION PROCEDURE AND MONITORING SYSTEM

Equipment and Operation Procedure

The non-vibratory compaction assembly is shown in Fig. 1. The major difference with the conventional SCP method lies in the means of penetration/withdrawal of the casing pipe. In conventional SCP, the casing pipe is penetrated by means of vibromotive force supplied by a vibro-hammer, and is withdrawn by winding a cable. Instead of a vibro-hammer, the non-vibratory compaction method uses a forced lifting/driving device to raise or lower the casing pipe as it is rotated.

The operation assembly consists of an SCP pile driving device as its