

The Experimental Study on Effectiveness of Water Levels for Dynamic Impacts on Reclaimed Soils

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ABSTRACT

This paper presents an evaluation for effectiveness of pre-dewatering on dynamic compaction for the reclaimed land built at near-shore. The Single-point Impact Test (SIT) and cone penetrometer are developed to perform the dynamic compaction under different water levels and drained conditions. The relationship between effective dynamic stress and cone resistance after impacts is presented. Dissipations of pore pressures measured in laboratory and field are compared. Both cone resistances and improvement ratio in soils with higher water level are less than those with lower water level and in dry soils. The observations reveal that by lowering down the groundwater table prior to dynamic compaction in field, the soil resistances can be increased in depths and the depth of improvement could be extended.

KEY WORDS: Dynamic compaction; Water level; Single-point impact test (SIT); Cone resistance; Improvement ratio

INTRODUCTION

Dynamic Compaction is regarded as one of the major techniques to improve the liquefaction resistance or bearing capacity of reclaimed land or loose ground due to its advantage of simple and fast procedure of construction. In this method, a heavy tamper is dropped onto the ground to be densified from a height of a few of 10 m. To ensure effect of the depth of improvement, the energy is generally applied in phases on a grid pattern over the area to be improved by either single or multiple passes. Nevertheless, the limitation of applied energy and ground water table restrain the depth of improvement.

Lukas (1995) reported that the depth of improvement could be expressed as follows,

$$D_i = n\sqrt{WH} \quad (1)$$

where D_i denotes the depth of improvement in meters, W weight of the tamper in tons, H drop height in meters, and n an empirical coefficient less than 1.0. The values of n for different soil types under high and low degree of saturation are listed in Table 1. Based on Eq. (1), the increase of the depth of improvement can be achieved by either by raising the applied energy WH , or by reducing the degree of saturation in soil deposits, i.e. the increase of the value of n . However, value of the depth of improvement is the square root of the value of the applied energy, i.e. raising four times of applied energy may only obtain double depth of improvement. From the viewpoint of economy for practical cases, reducing the degree of saturation in soil deposits may be a better alternative than by raising the applied energy. The way to draw down the ground water level, in practice, is the best choice to

decrease the degree of saturation in soil deposits.

During the process of the dynamic compaction, the pore pressure usually is generated in the soil deposit. In practice, a waiting period for dissipation of induced pore pressures is necessary for the next proceeding phase of dynamic compaction. In general, the waiting period can be three to five days at least for sandy soils and longer for the cohesive soils. (Yang, 2002; Lukas, 1995; Chen et al. 2007) Therefore, if the groundwater table was lowered down before dynamic compaction, the induced excess pore pressures will be significantly reduced and in consequence, the waiting period will also be minimized and the construction period will be shortened accordingly.

On the basis of the above mention, effect of the water levels on the depth of improvement is worthy to be investigated. However, there are few literatures related to the effect of the ground water level on the performance of the dynamic compaction. In this study, an experimental system, Single-point Impact Test, is developed to perform series of test on the reclaimed soils; water levels and drained conditions in test system can be simulated to fit the requirement in fields.

Table 1 Recommended n value for different soil types (Lukas, 1995).

Soil Type	Degree of Saturation	Recommended n Value
Pervious Soil Deposits- Granular soils	High	0.5
	Low	0.5 – 0.6
Semi-pervious Soil Deposits- Primarily silts with plasticity index of <8	High	0.35 – 0.4
	Low	0.4 – 0.5
Imperious Soil Deposits- Primarily clayey soils with plasticity index of >8	High	Not recommended
	Low	0.35 – 0.40
		Soils should be at water content less than the plastic limit.

EXPERIMENT PROGRAM

Single-point Impact Test

In single-point impact test, a soil sample with 160 mm in diameter and 448 mm in height (herein referred as "soil column") was prepared in an acrylic segmental cylinder mold that was supported by a metal base equipped with CO₂/water inlet device and instrument. The scheme of soil column for saturation and instrumentation is shown in Fig. 1. Three water levels of 110 mm, 220 mm, and 330 mm measured downward from the top edge of the mold are used to define the high, medium and low water levels, respectively. The segmental cylinder is perforated uniformly to simulate the porosity of soils for the purpose to