Assessing Improvement Effects of Sand Compaction Pile in an Ash Pond

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ABSTRACT

This paper presents the ground response in detail during installing sand compaction pile (SCP) in an ash pond. The response includes the pore pressure change and lateral ground deformation. Improvement effect of SCP is accurately evaluated by SPT and SCPT investigation methods through a careful planning and execution. All the results of different methods are highly consistent with each other and the corresponding ground response behavior. The results show that the effect of using SCP to improve coal ash deposit is significant except for the shallow layer above the ground water level owing to its low confining stress. The CPT investigation has the highest resolution to identify the improvement effect and is highly recommended to be used in engineering practice.

KEY WORDS: sand compaction pile (SCP); coal ash; pore pressure; lateral deformation; liquefaction; SPT; SCPT; ground improvement.

INTRODUCTION

Taichung Thermal Power Plant is located in the seashore of central Taiwan and neighboring Taichung Harbor, as shown in Figure 1, which suffered serious damage caused by soil liquefaction in the 1999 Chi-Chi earthquake. It is the largest thermal power plant in the world. The plant produced 1000 kW power per year which is 35% of total electrical power in Taiwan, and accordingly created the end products, the bottom ash and fly ash, with an amount of about 100,000 tons per year. Due to the environmental regulations, the ash can not be transported outside the plant. Therefore, almost all the bottom ash and fly ash were hydraulically mixed, transported and discharging into a pond to build a newly reclaimed land, as shown in Figure 2. The first stage ash pond, as shown in Figure 1, is estimated to finish reclamation in 2011 and sell for industrial use. The ash pond has been suspected to liquefy during Chi-Chi earthquake owing to the ash fill was in a loose state of sedimentation. The sand compaction pile (SCP) has been proved as an effective technique to improve loose sandy soils based the past experience in improving the foundation soils of Taichung power plant. Thus, SCP was chosen to improve the first stage ash pond again. However, many engineers doubted the improvement effect of SCP when using it in the very loose saturated ash deposits. They worried the improved ash ground will liquefy during earthquake and unable to provide sufficient bearing capacities to support shallow and pile foundations. Since published literatures on improvement experience of SCP in ash pond are rare, the Taiwan Power Company commissioned the authors to plan a series of in-situ tests and measurements to investigate the performance of using SCP to improve the ash ground.

Site descriptions

Figure 3 shows the hydraulic filling of ash into the pond. The ash pond is still under filling, but close to the end of reclamation. The test site is arranged in the south part of the first stage ash pond of Taichung thermal power plant. This part was improved by SCP first. According to the past data, the thickness of ash deposit at the test site is estimated to be 10m overlying the original sea bed deposits. The ground water is about 1.3-1.5m depth below the ground through a trial pit excavation. From the 15m-depth borehole data BH1, as shown in Figure 4, The geological profile mainly consists of three layers. The upper ash layer is from the ground surface to a depth of 7m with SPT-N values of 2-4. It contains an interbedded hard layer of 20cm with N=12. This thin