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Original article

Assessment of a new pluviation system designed to prepare uniform samples of sand

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ABSTRACT

In soil and soil-structure interaction laboratory experiments, the technique applied to prepare the sand deposit remarkably influence the performance of the system, including the stress–strain behavior. Air pluviation techniques represent the most suitable choice when a wide range of densities is required. This study presents the details of a simple and effective air pluviation system designed to be suitable for reconstituting small specimens of sand. Many of the previous studies have focused on traveling the pluviator in the horizontal direction only, without paying much attention to the vertical movement during pluviation. The apparatus described in this paper has the ability to overcome this issue by providing automatic lifting tools to the sand container while the thickness of the sand deposit builds up inside the collecting mold. To understand the influence of grain size distribution of sand on the achieved relative density (RD), three different samples of poorly graded sands were used in the experiments. Parametric studies, including the influence of the height of drop (HD) and deposition intensity (DI) on the relative density, were carried out on the three sand samples. It was observed that the range of obtained RDs depends mainly on the grain size distribution of the sand used. Three distinguished zones were observed in the RD-HD relationship, starting with a linear variation, followed by a nonlinear relationship until achieving a constant RD regardless of the increase of HD value. The uniformity of pluviated sand was assessed using a cone penetration test (CPT). Results of the CPT test showed that denser and more uniform samples could be obtained by raising the container up during the pluviation process.

1. Introduction

It is well-known that the circumstances of in-situ soil are extremely difficult to be scaled down or simulated completely and identically to laboratory tests. However, the inaccuracy and deviation of small-scale test results can be minimized, taking into consideration a number of steps. In soil and soil-structure interaction laboratory experiments, the first and most important step towards trusted results is using a reliable soil specimen preparation method. This process is relatively easier in consolidated clayey soils in comparison to sandy soils. The cohesion nature of clay contributes positively to obtaining and maintaining undisturbed samples in the laboratory or in the field. However, achieving a uniform density of sand sample over its three dimensions is rather difficult, especially when repeating prepared samples is required. To reduce the variation in sand density and thus confirm the reliability of soil-structure laboratory test results, researchers have suggested several techniques to prepare sand specimens ranging from simple tamping to more advanced pluviation or vibration methods, e.g. (Al-Refeai, 1992; Hossain and Ansari, 2018; Srinivasan et al., 2016; Ghosh et al., 2016; Logioia et al. 2006; Miura and Toki, 1982; Wood et al., 2008). These techniques include (1) air pluviation, where single or multiple sieving systems located at a certain height of fall are used in the stationary apparatus, and an opening or funnel moved over the entire area of the box in a certain pattern is used in the movable apparatus, (2) spreading the sand into layers of 3–10 cm in thickness, and then tamping each layer to reach the desired density. The exact value of the targeted density is difficult to achieve as the tamping energy per unit area is difficult to control in this case, and (3) placing the whole mass of the sand in the testing box and then vibrating the box by either a shaking table or tapping hammer.

The accuracy and consistency of any proposed sand preparation technique can be better checked in a time-effective manner by conducting tests using small specimens first. After conducting a calibrated investigation and studying parameters that control the

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