# Reconstruction of a Large Scale Sand Specimen Using a Sand Curtain Rainer System

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## Extended Abstract

(Paper pages 277-298)

### Introduction

Preparation of uniform and repeatable reconstituted sand specimens of required density is a prerequisite for obtaining reliable results from experimental studies. Among different methods of reconstituted specimens, sand pluviation technique is widely adopted by researchers because of its unique advantage. In this study, a new curtain traveling rainer (CTR) is developed for large model sand bed preparation in experimental studies. CTR is a simple and low-cost system which is worked on the principle of air pluviation of sand. It provides specimens with wide range of relative density of sand bed (viz, 30%-90%) and very high degree of spatial uniformity of density distribution while reducing the time of preparation the specimens. A series of laboratory tests is carried out in order to study the performance of the proposed system and the effect of the curtain speed, curtain width, height of the fall and flow rate on the relative density and uniformity of sand specimens. For the sand used in the present study, it was observed that the relative density increases with an increase in the curtain speed and height of the fall. Furthermore, increasing the curtain width results in reducing the relative density.

### Material and Methods

The calibration of geotechnical in situ tests in granular soil requires the preparation of large, uniform, and replicable specimens of a desired density. When preparing calibration chamber specimens, the adoption of techniques such as chemical impregnation and the freezing method in order to obtain undisturbed granular specimens becomes unfeasible due to the technical limitations and relatively high expense of these techniques. Conversely, the pluviation method has been widely used because of its ability to simulate the depositional mechanism of the soil and because of its applicability to a wide range of specimens, from small specimens for triaxial tests to large specimens for calibration chamber tests.

soil sample was chosen from natural white-yellow silica sand mines of Firouzkooh, which can be categorized as poorly graded sand (SP) based on unified classification system (USCS). In order to control sand flow rate at the end of the pluviation path, a series of plates is designed to have rectangular openings with a width range of 2 to 4.5 mm. It should be noted that a sand reservoir is included in the transformer, which enables a uniform sand flow over the rectangular opening. the raining height is set at 100 mm to 500 mm with 100 mm steps. For more accuracy an extra test with height fall equal 150 mm is performed.

A contiguous system of wheel-rail is operated for effective transmission of the traveling funnel over the entire sample surface in the circular container. The device's jacking system and its related components are the cause of several limitations, which lead to the implementation of two-joint methods for keeping the sand rain height constant during the pluviation and sample preparation process.

**Results and discussion**

The CTR system comprises sand transfer compartments from the main hopper to the sample container and a rectangular opening at the bottom of the hopper, which controls the pluviation flow rate. The main concept driver of this research is to reproduce large samples in the most efficient time. In order to recognize the uniformity of the reconstituted specimen in the vertical and horizontal directions, the variation of density is evaluated by placing 20 cylindrical molds within the specimen.

In this paper the effect of deposition intensity and the effect of height and flow rate on the sample relative density are evaluated.

Calibration of the sample preparatory device is very important in order to produce optional and repeatable samples with a specified relative density, in experimental studies and laboratory models. According to the test results, the effects of drop height and flow rate are investigated. Calibration graphs are presented in Figs. 1 and Fig. 2 for the proposed system in the case of 2.5 cm and 5 cm layer thickness.

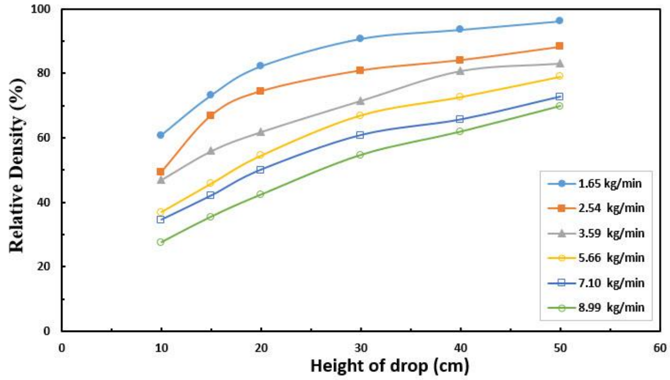


**Figure 1. Effect of the height of drop and flow rate on the sample relative density for 2.5 cm layer thickness**

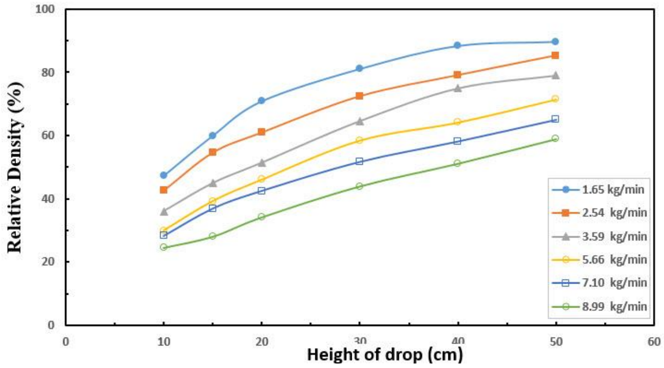


**Figure 2. Effect of the height of drop and flow rate on the sample relative density for 5 cm layer thickness**

## Conclusion

This paper aims to extend the existing apparatus to achieve consistent low and high relative density sand samples. The preparation of low relative density samples is particularly important in liquefaction studies in geotechnical earthquake engineering. The comprehensive design and calibration of the CTR system can be concluded in the following points. The proposed method can easily be deployed to produce any arbitrary sample with a wide range of relative densities. Increasing the flow rate given a constant drop height leads

to decrease in the relative density and is independent of layer thickness. Keeping constant the drop height and flow rate, higher relative densities can be achieved by increasing the curtain traveling velocity. There is a direct relationship between drop height and relative density. The results give some information about the deposition process and in particular about the terminal falling height. It can be henceforth stated that the performance of the proposed system is reliable and very acceptable due to high uniformity across the entire sample.

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