Reconstitution of sandy soil samples to their original state

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ABSTRACT

Sand concentrator methods are a means of preparing laboratory models for carrying out many geotechnical experiments. This study used five methods to determine the highest sand density. A series of practical tests were conducted to evaluate the performance of each method used, and they gave acceptable results in the test. After the single experiment in the laboratory work site, the highest density was 18.5kN/m3 When using the vibrating technique. The lowest density was with the direct soil filling method, which was 15.47 kN/m3. These methods are only for comparison because the soil in them is loose. Where other methods proved their efficiency in working, the density was 16.37 kN/m3 at sand pluviation. And 16.7 kN/m3 at sand hopper. The last one is 16.8 kN/m3 at sand suppression. It can be said that the best method is the vibrating method because it gives the highest results.

Keywords: Reconstitution, samples, original state, Sand concentrator, density, geotechnical experiments

1. Introduction

In the work of the Geotechnical Engineering Laboratory, the soil density was determined for its test application. It is usually necessary to use experimental models to study the behaviour and parameters of incredibly cohesive soil. The soil sample must be returned to its original state to achieve this end. Depending on the type of soil. The soil type selected in this test was a poorly graded sandy soil. The methods to achieve this goal are direct soil backfilling, sand funnel, sand hopper, sand immersion method, and sand vibration. Previous researchers have used these methods. A unique rain apparatus similar to that recommended by **[1]**. was designed to obtain uniform deposits of the desired density. This device has been used by previous researchers **[2,3].** Since the pluviation approach may mimic the soil's depositional process, it has found widespread application [4]. When creating a physical model, the density or soil unit weight must be consistently applied throughout the board. Building these models using the sand trainer approach is a great way to guarantee consistency. The density of reconstituted granular material has been the subject of several scientific investigations.

The empirical findings demonstrate that the rainer technique with varying deposition intensity and constant drop height is the optimum approach to construct a large sample of calibration case [5-8]. There is one fundamental issue with the moving pluviation. It is necessary to use meshes to achieve a relative density of 70–90% in this pluviation [10, 11]. Fretti et al. [9] used a 22 mm inner diameter rigid tube to execute Sand pluviation. They determined that a relative density of 20–70% could be attained using this technique if the drop height was between 5 and 70 cm. Furthermore, they

discovered that this technique had a minimal layering effect. They claimed that using a mesh for pluviation reduced sample uniformity. They reasoned that their approach was the only practical means of producing very dense

2. Methodology

Many experiments were carried out to stabilize the sand density and reach the on-site density, several of which were five actual experiments: direct soil filling, sand suppression, sand hopper, Sand pluviation method, and sand vibration.

3 Soil properties:

The sandy soil used from (Dhi Qar) in Southern Iraq. was utilized in the experiment. ASTM (D4253-2000) and ASTM (D4254-2000) standards were used to establish the upper and lower limits for soil dry unit weights. ASTM (D854-2005) standards were used to conduct the specific gravity test, ASTM (D422-2001) standards were used to analyze the grain size distribution shown in Figure (1), and ASTM (D3080) standards were used to calculate the internal friction angle. The physical characteristics of the sampled soil are detailed in Table No. 1.

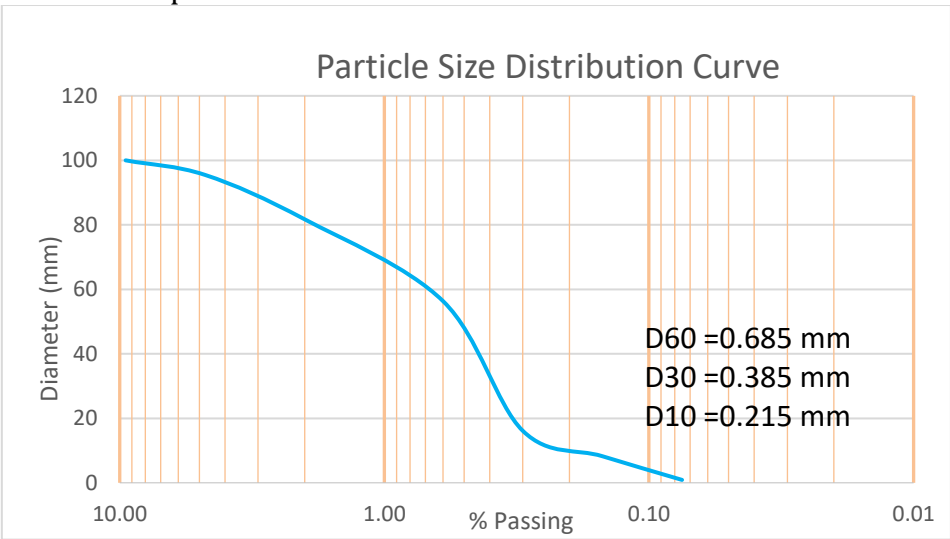

Figure (1): Grain size distribution of the Sand.

Table (1) Physical properties of the tested Sand.

Property	Value
Grain size analysis	
Classification (USCS)*	**SP**
D10	0.215 mm
Cc	1.01
Cu	3.19
Gs	2.564
Dry unit weights	
γd (max)	**18.96 kN/m^3**
γd (min)	**15.41 kN/m^3**
γd (test)	**17.76 kN/m^3**
Dr	70.73 %
Void ratio	
e max	0.664

e min	0.352
e test	0.444
ϕ	**39°**

* USCS refers to Unified Soil Classification System

4. Density proofing methods

4.1 Direct soil filling

In this way, the examination form was filled out, as shown in Figure (2). 4-inch diameter (1/30 ft 3 size) moulid used for low grit content samples. Then, the model's weight was taken, and the weight density was calculated. After repeating the experiment several times, the optimal result is. γ = 15.47 kN/m3

Figure (2) Proctor Test

4.2 Sand suppression

In this method, the cone was filled with soil, and then the cone was lifted by a manual crane to the level of free fall. Then, the neck of the cone was opened, and the Sand was made to fall freely until the moulid form was filled, as shown in Figure (2)

Then, the weight was taken, and the ideal weight density was calculated by repeating the experiment several times by changing the cone's Diameter with a fixed fall distance. And changing the fall distance with a fixed diameter. The experiment results are shown in Table (2) and Curve in Figure (3). Sample preparation methods. This technique was used by **[3].** and he explained that the greater the free fall distance, the greater the density, but to a certain extent.

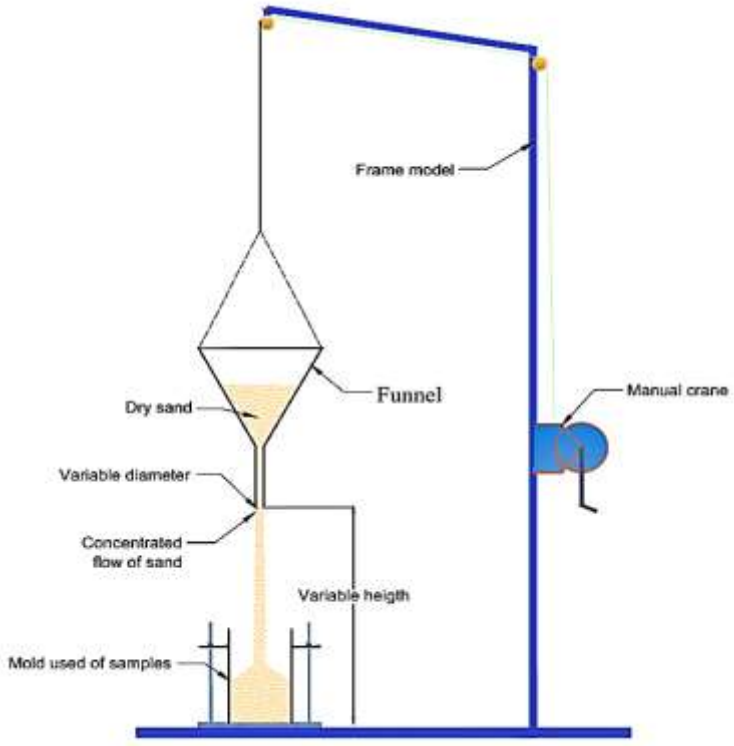

Figure (3) Sample preparation methods.

Table (2) The results of the experiment by funnel

Test	Drop (m)	γ (kg/cm³)		
		Diameter 10 mm	Diameter 20 mm	Diameter 30mm
1	0.5	1.55	1.51	1.49
2	1.0	1.59	1.52	1.50
3	1.5	1.64	1.54	1.53
4	2.0	1.68	1.55	1.53

4.3 Sand Hopper

In this method, the trolley was filled with soil, and then the trolley was lifted by a manual crane to the level of free fall. Then, the cart gate was opened, and the Sand was made to fall freely until the examination form shown in Figure (2) was filled. Then, the model's weight was taken with the soil, and the weight density of the soil was found. The process was repeated several times after changing the distance of the free fall while fixing the width of the slider slot in the carriage **[12].** (5.5mm) It was shown that there is a direct relationship between Sand's density and the settlement's height at a specific limit.

The results of the experiment are shown in Table (3). Figure (4) Illustration of the hopper method

Table (3) The results of the experiment by sand hopper

Test	Drop (m)	Diameter (mm)	γ (kg/cm³)
1	0.5	5.5	1.60

2	1.0	5.5	1.62
3	1.5	5.5	1.63
4	2.0	5.5	1.67

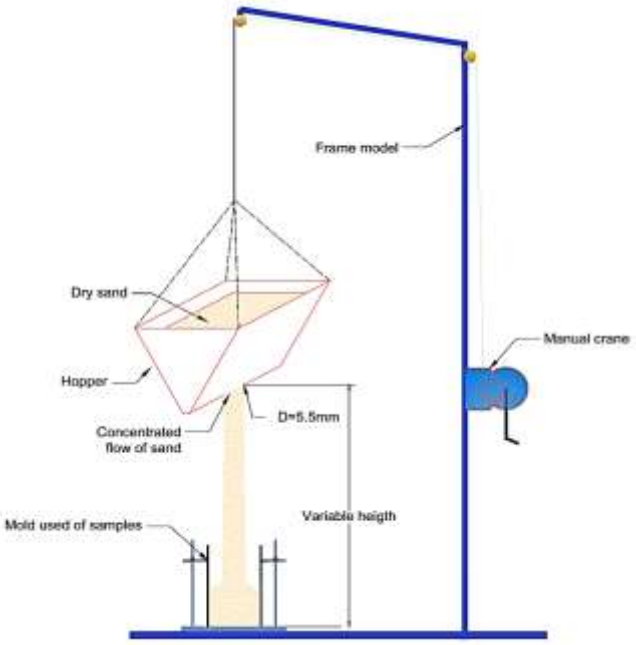

Figure (4) Illustration of the hopper method

4.4 Sand pluviation method

In this method, the sieve box was filled with soil and lifted by a manual crane to the free-falling level. Then, the barrier was removed, and the Sand was made to fall freely until the test form was filled. As shown in Figure (2), the model's weight was taken with the soil, and the weight density of the soil was. The process was repeated several times after changing the distance of the free fall with a constant diameter of the pluviation hole 10 mm. The results of the experiment are shown in Table (4). Figure (5) Sample preparation methods. **[13]** conducted pluviation research on two sand grades with varying fall and opening width heights. Because falling sand particles have more kinetic energy, their density rises with height. The density of pluvial Sand decreases with the bottom sheet opening width. With increasing opening widths, falling sand particles interact more, reducing their velocity.

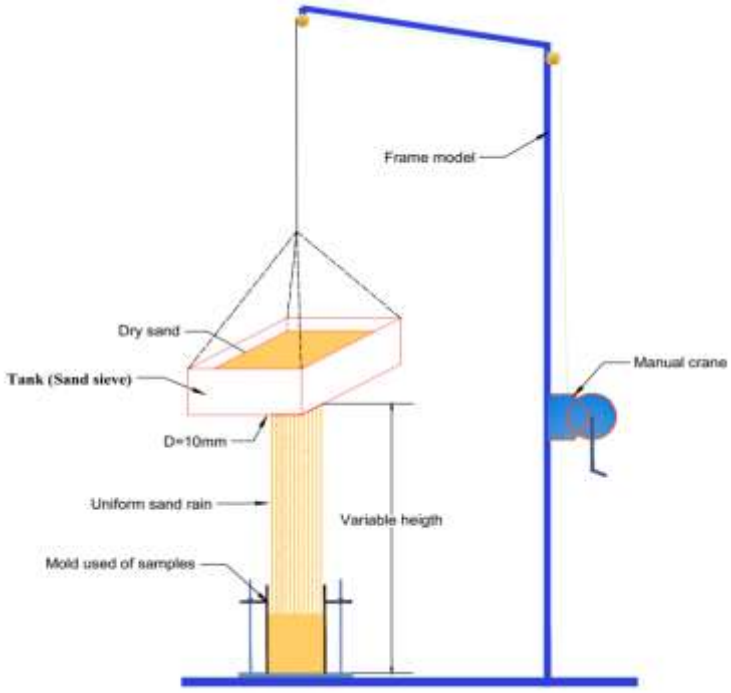

Figure (5) Sample preparation methods.

Table (4) The results of the experiment by sand sieve

Test	Drop (m)	Diameter (mm)	γ (kg/cm³)
1	0.5	10	1.583
2	1.0	10	1.602
3	1.5	10	1.625
4	2.0	10	1.637

4.5 Sand vibrating

In this experiment, the test form shown in Figure (2) was filled with layers of variable thickness by changing the vibration time. Then, the vibrator was used, as shown in Figure (6). The attempts were multiple and in two parts. The first is to fix the vibration time and change the thickness of the layers. The second part is fixing the thickness of the layers and changing the vibration time. Then, the relative density was calculated by taking the model's weight with the soil and performing mathematical calculations. The thickness of the layer (5cm) and the vibration duration (60 sec) were reached, and the result is considered optimal for this experiment. The results of the experiment are shown in Table (5). The relationship between time and relative density was also drawn, shown in Figure (7). The relationship between density and relative density, shown in Figure (8), was also drawn. This technique has been used by **[14,15]**

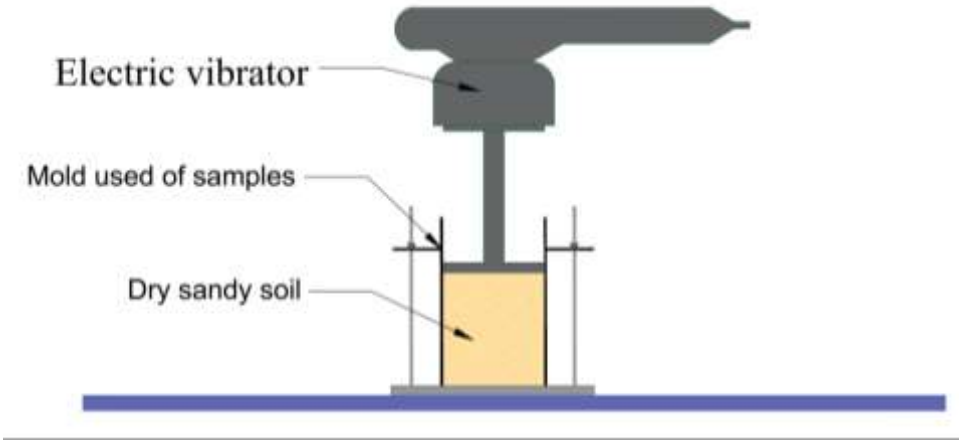

Figure (6): Sand vibrating used in the technique.

Table (5) The results of the experiment by vibration

Test	Time (sec)	γ (kg/cm³)		
		H-Layer (5 cm)	H-Layer (7 cm)	H-Layer (9 cm)
1	15	1.78	1.73	1.73
2	30	1.81	1.79	1.77
3	60	1.85	1.80	1.78

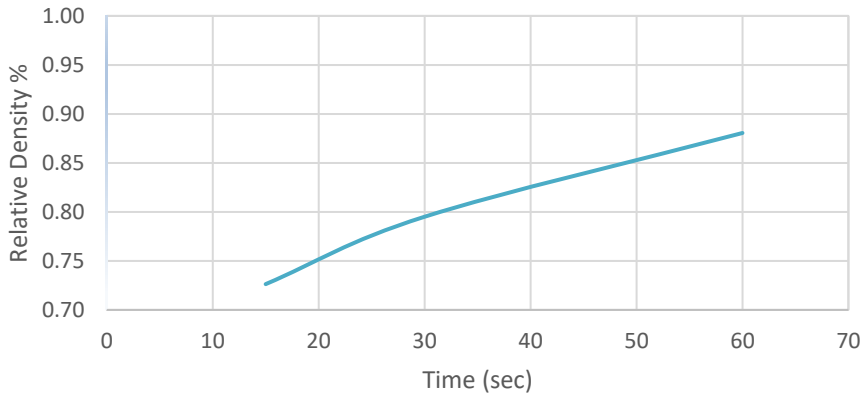

Figure (7): Relative density calibration curve

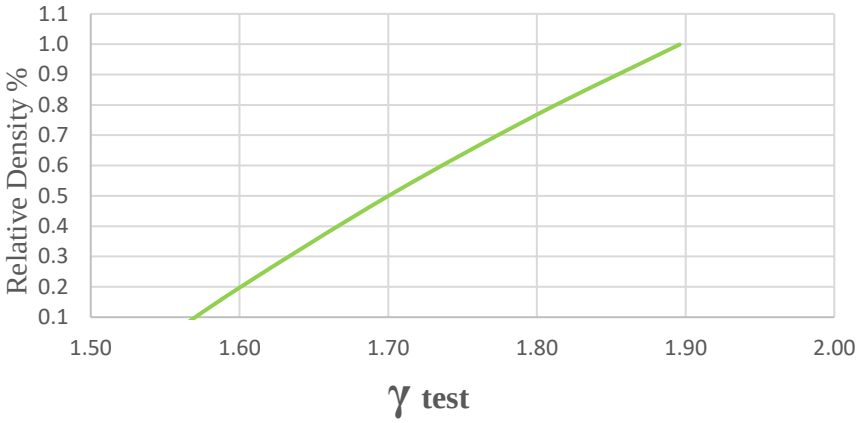

Figure (8): Relative density, Density calibration curve

5. Results and Discussion

After conducting many experiments to find the ideal method for fixing the density and reaching the relative density of 70%, the ideal way to determine the required density was to use an electric vibrator for 60 seconds with a wooden plate to prevent the sand particles from breaking.

6. Conclusions:

1. The direct soil filling method gives an impression of the density of loose soil.
2. Soil density statistics depend on the free fall distance, the Diameter of the sand spill hole, and the sand gradation
3. That the vibration method is optimal for this type of soil.

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