Soft soil Settlement Improvement Using Stone columns

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Abstract:

The current study is focused on determining the evaluation of settlement enhancement rate (Sr=treated or untreated) using constrained compression tests on a permeating stone pillar in soft soil. The study was conducted using standard testing of a stone pillar within a container with measurements of 300 millimeters by 300 millimeters and heights of 350 millimeters, and the stone pillars were used to enhance the soil. The soil produced in the box had an undrained shear strength ranging from 5 kPa to 25 kPa. The findings found that values important for settlement improvement percentage, Sr, completed by soil that has an undrained shear strength of 25 kap with different diameters (27, 33, and 42), were (0.9, 0.8, and o.6), respectively.

INTRODUCTION

It has been shown that using stone columns to amend soft soils is efficient, affordable, and environmentally beneficial [1, 2]. They may improve slope stability, lower the risk of liquefaction, minimize final and variational settlement, speed soil consolidation, and raise bearing capacity [3–5]. This method has been widely utilized worldwide since it was first noted in Bayonne, France, in 1839 [6–8]. The improved engineering qualities of soils that are soft by stone columns have been the subject of several trainings, particularly in recent years. Based on Terzaghi's limited (1D) consolidation theory and Barron's ideal drain well solution, several analysis and semi-analytical solutions for clay that is soft with stone pillars have been discovered. The majority of them created consolidation equations that took into consideration pore water pressure and the passage of time while considering diverse geology stages and boundary conditions. It is feasible to predict the average consolidation degree using the answers [9–15]. The pressure distribution on a loaded compound basis was explored, and the weight transport method coming into the reinforced soil was elucidated. It also proposed key formulae for evaluating pressures on the pillar and surrounds, as well as the settlement improvement proportion (Sr) [16].

Ref [17], [18]. They looked at how the stone pillar and the soil around it were affected by pressure, as well as the concentration of stress rate n and settlements enhancement rate (Sr) under various soil properties.

Ref [19], used a specifically designed triaxial cell to perform Triaxial stress experiments were performed on compound soil samples. The results of a laboratory research are summarized in this report. into the effect of a number of influences arranged the settlement reaction of soft footing base supported through a stone pillar**.**

Ref [20], The researcher concentrated on determining the settlement improvement ratio (Sr=Streated/Suntreated) using limited compression experiments on a stone column penetrated in soft soil. The values for settlement improvement ratio, Sr, crushed stone +50% sand, crushed stone +5% dry lime, crushed stone +0% dry lime, crushed stone +2.5% cement, crushed stone +5% cement that was 0.23, 0.22, 0.16, 0.15, and 0.09, sequentially.

The current research investigates the performance of stone pillars in constrained pressure, with the primary goal of determining the settlement enhancement ratio Sr.

TOOLS AND PROCEDURES TO BE TESTED

This study took place in an experiment container that was the size of 300 mm by 300 mm by 350 mm. The stone pillars were made of stone. Load tests were performed using digital load cells (1,000 kg) and the multi-speed framework of an unconfined test machine. Offset adapter (50 mm). Load tests were performed on single stone pillars of different diameters (27 mm, 33 mm, and 42 mm). Shear values ranging from 5 kPa to 25 kPa were used in the trials, which were conducted on soft clay soil. On top of the column, 100-mm steel foundations plates were loaded during the weight test.

SOIL USED

At the site of Babylon in Iraq, clay soil samples were taken from the ground surface at depths ranging from 0.5 m to 6 m. To determine the properties of the soil, routine laboratory tests were performed on it. These tests consist of:

1- The liquid and plastic Atterberg limits in accordance with ASTM D423 and D424 requirements [21].

2- ASTM D422 requirements for grain size distribution (sieve testing and hydrometer testing) [22].

based on test findings, the soil is made up of 17% sand, 53 % silt, and 30 % clay. The unified soil classifying system states that, the soil selected as (ML). Table (1) the soil's physical characteristics are shown.

Table 1: Physical properties

Property	Value
Liquid limit (LL)	35
Plastic limit (PL)	25.4
Plasticity index (PI)	9.6
Specific gravity (GS)	2.67
Sand content	17
Silt content	53
Clay content < 0.005 mm	30
Symbol according to Unified Soil Classification System	ML

THE SOIL FOR THE LAYER HAS BEEN PREPARED.

The soil utilized for the experiment had been mixed with water, and the undrained shear strength ranged from 5 to 25 kPa. The soil had been set up in the layer to obtain the ideal shear. The earth was finely compacted into layers about 50 mm thick. After installing each layer, it is gently squeezed to expel the trapped air with a full thickness of 300 mm, and the component foundation is prepared so that the middle of the base and the hydraulic center lifting device meet. Loads were then useful as an increment of load through a loading disc, with each increment of load lasting 4 minutes. At the conclusion of each loading period, contact scale values are recorded. Measurements were taken for each increment of the load. For comparison, load reductions continued until total settlement reached 20 mm. Loading experiments were carried out in containers filled with untreated and treated soil.

STONE PILLAR INSTALLATION

The center of the test mold (container) was accurately marked to indicate the location of the stone pillar. The cylindrical tube was added at the bottom of the model, and then the soil was arranged in a hollow PVC pipe in three diverse diameters (27 mm, 33 mm, and 42 mm). The tube was progressively withdrawn and twisted throughout the raising operation. Crushed stone was used to fill a hole, which was subsequently compressed to give it a density of around 17 kN/m3.

PRESENTATION AND DISCUSSION

Table No. 1 of the leveling improvement percentage The results showed a 20-cm-long stone column with different diameters (27, 33, and 42). The stability improvement ratio is (Sr = treated/untreated). It can be summarized in Table No. 1. Where we conclude that the stability ratio increases with an increase in shear strength. The Sr proportion found (0.6, 0.45, and 0.38) for soils with an undrained shear strength of 5 kap, from figure (1); the Sr ratio was (0.8, 0.69, and 0.5) in soils with an undrained shear strength of 10 kap, from figure (2); and the soils had a resistivity of Shear 15 kap, which was the result of Sr (0.72, 0.6, and 0.45) from figure (3); and the Sr ratio was (0.7, 0.62, and 0.39) for soil having an undrained shear strength of 20 kap, from figure (4); and the results showed that the percentage of improvement in stability values, Sr, was achieved for soil with an unlearned shear strength of 25 caps of different diameters (27, 33, 42), which were (0.9, 0.8, and o.6) from figure (5), respectively.

Table (١): (Settlement treated /Settlement untreated) from various model tests (Sr).

	Stone column Ls = 20		
Shear strength	**Ds= 27 mm**	**Ds= 33 mm**	**Ds= 42 mm**
Cu = 5	**0.6**	**0.45**	**0.38**
Cu =10	**0.8**	**0.69**	**0.5**
Cu=15	**0.72**	**0.6**	**0.45**
Cu=20	**0.7**	**0.62**	**0.39**
Cu= 25	**0.9**	**0.8**	**0.6**

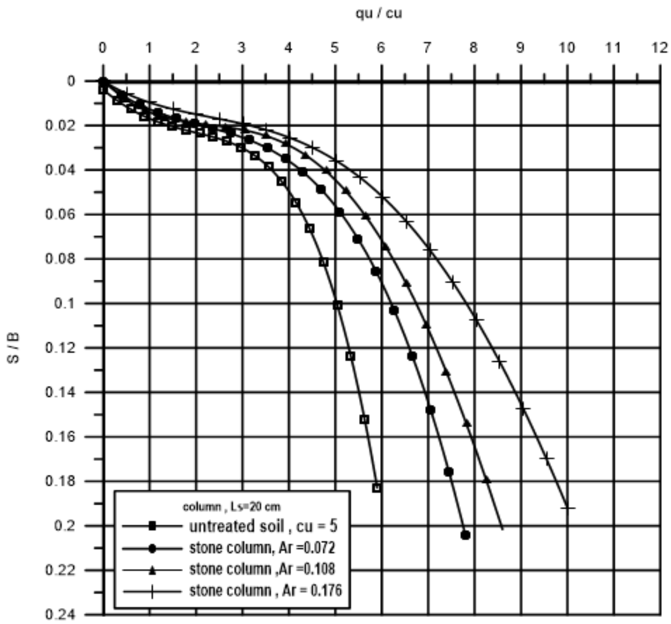

Figure (1): (q/cu) with S/B for soil treated with a column for stones, cu = 5 kPa, Ls=20 cm

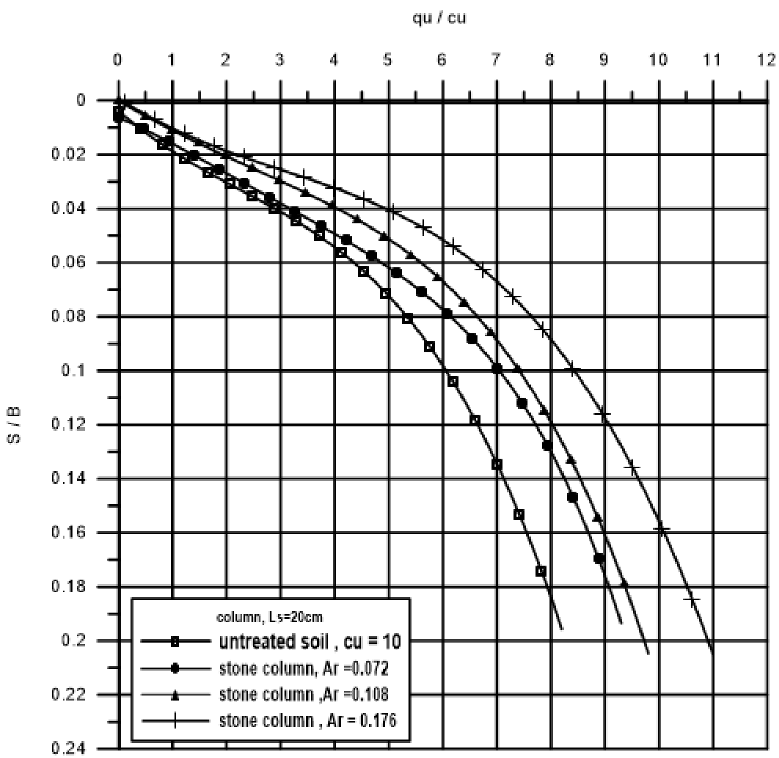

Figure (2): (q/cu) with S/B for stones column-treated soil, cu = 5 kPa, Ls=20 cm

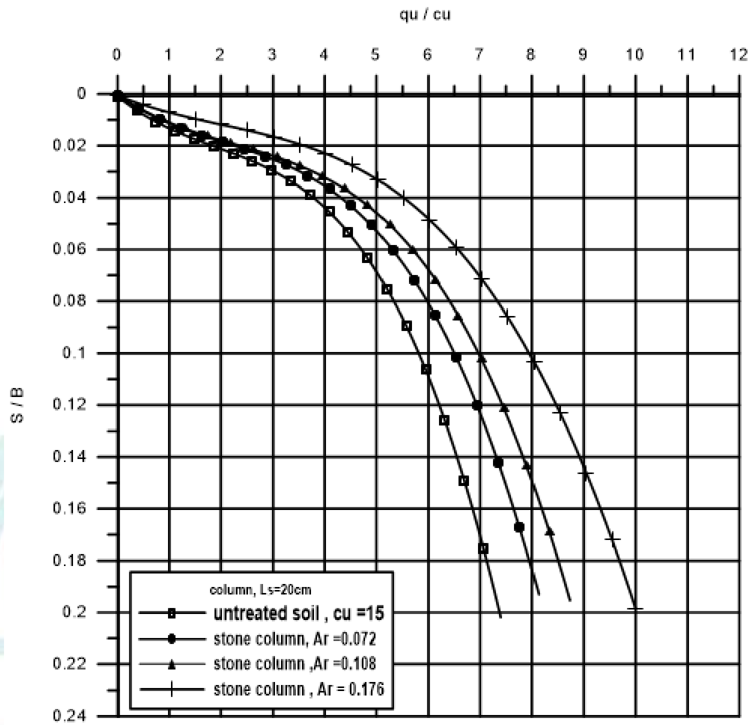

Figure (3): (q/cu) with S/B for stones column-treated soil, cu = 5 kPa, Ls=20 cm

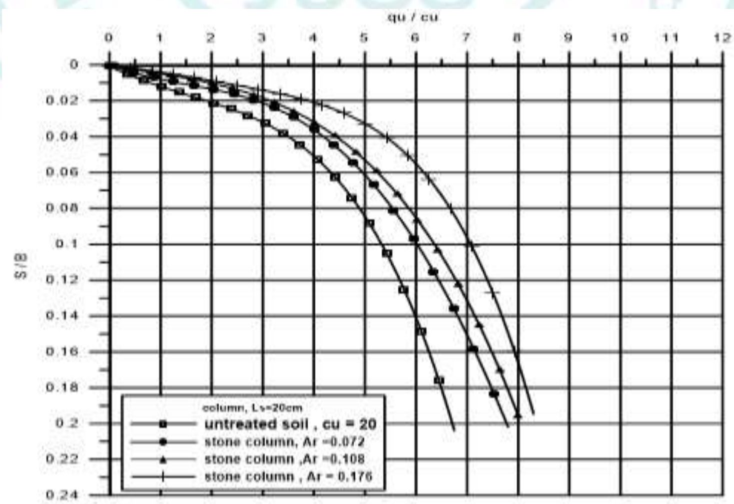

Figure (4): (q/cu) with S/B for stones column-treated soil, cu = 5 kPa, Ls=20 cm

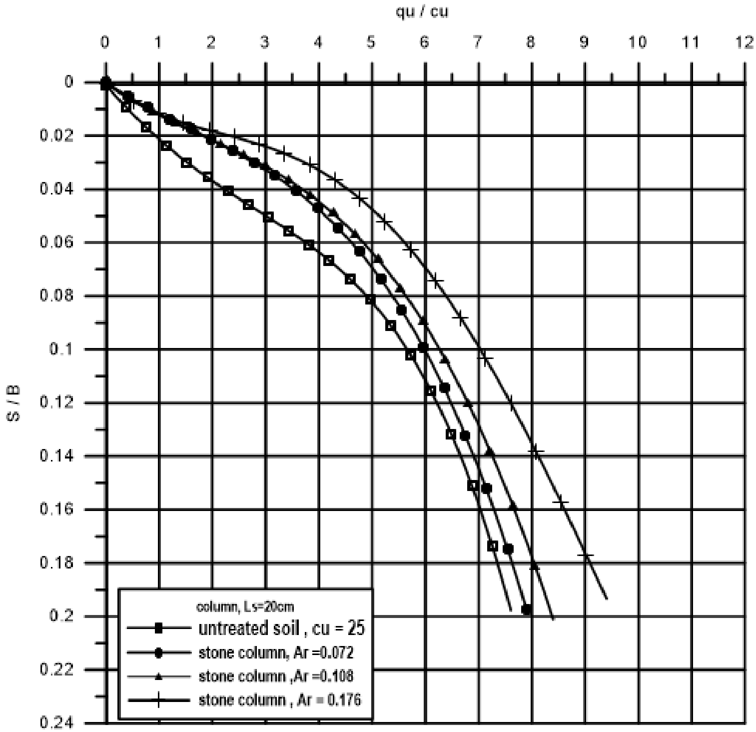

Figure (5): (q/cu) with S/B for stones column-treated soil, cu = 5 kPa, Ls=20 cm

CONCLUSIONS

Depending on the research results, a settlement enhancement rate, Sr, achieved by soil that has an undrained shear strength of 25 kap with different diameters (27, 33, and 42) was 0.9, 0.8, and o.6, respectively. It has been seen that the settlements decrease ratios grow as shear strength increased.

RECOMMENDATIONS

The following points can serve as a starting point for more detailed research:
1.Real-world field testing of models may validate the current work.
2.Convenient study of the result of stone column stabilization by other additions on the concentration of stress ratio
3. The use of a stone pillar in weak soil

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