RESEARCH ARTICLE

A comparative study of red brick powder and lime as soft soil stabilizer [version 1; peer review: 2 approved with reservations]

Aisyah Salimah ¹, Miftah Hazmi², Muhammad Fathur Rouf Hasan ¹, Putera Agung Maha Agung¹, . Yelvi ¹

¹Civil Engineering, Politeknik Negeri Jakarta, Depok, Jawa Barat, 16425, Indonesia

²Directorate General of Water Resources, Ministry of Public Works and Housing, Jakarta, DKI Jakarta, Indonesia

V1 First published: 09 Aug 2021, 10:777
<https://doi.org/10.12688/f1000research.27835.1>
 Latest published: 20 Jul 2022, 10:777
<https://doi.org/10.12688/f1000research.27835.2>

Abstract

Background: Soil has an important role to play in planning buildings because it supports the loads above it. Different types of soil with poor mechanical properties require more attention. Therefore, it is necessary to put in more effort to stabilize soil in order to improve its properties. This study aimed to compare the potential of lime and brick powder as stabilizers based on the values of California bearing ratio (CBR). Soil stabilization can be defined as the process of stabilizing soil properties by chemical or physical means to improve its engineering efficiency. The main objectives of stabilizing soil are to increase the bearing capacity of soil, to increase its resistance to weathering processes, and its permeability.

Methods: In this work laboratory tests were done with disturbed and undisturbed soil samples. The proportions of lime or red brick powder additives mixed together are 0%, 5%, 10%, and 15% of the original soil sample. From the results of the laboratory tests, the soil type obtained is MH soil based on the Unified Soil Classification System (USCS). The MH soil type is a low plasticity silt soil.

Results: The study's results showed that with the addition of lime and brick powder, the soil could be stabilized. In both soaked and unsoaked CBR tests, there was an increase in the CBR value for each proportion of the mixed additives. However, red brick powder had a significant increase of 15%.

Conclusions: This study found a very large range of variations because of the many material requirements for each test. We suggest other researchers perform the CBR test by reducing the range of variations in the additives to get firm data and using our experimental procedure in this study for further research.

Keywords

Soft soil, lime, brick powder, CBR, hambalang

Open Peer Review

Approval Status ? ✓

	1	2
version 2 (revision) 20 Jul 2022		✓ view
version 1 09 Aug 2021	? view	? view

1. **A. U. Ravi Shankar**, National Institute of Technology Karnataka, Mangalore, India

2. **Reginald B. Kogbara** , Texas A&M University at Qatar, Doha, Qatar
 İzmir Institute of Technology, İzmir, Turkey

Any reports and responses or comments on the article can be found at the end of the article.

This article is included in the **Research Synergy**
Foundation gateway.

Corresponding author: Aisyah Salimah (aisyah.salimah@sipil.pnj.ac.id)

Author roles: **Salimah A:** Conceptualization, Data Curation, Formal Analysis, Funding Acquisition, Investigation, Methodology, Validation, Writing – Original Draft Preparation, Writing – Review & Editing; **Hazmi M:** Resources, Software; **Fathur Rouf Hasan M:** Supervision, Validation; **Agung PAM:** Supervision, Validation; **Yelvi :** Validation

Competing interests: No competing interests were disclosed.

Grant information: This research was supported by UP2M Politeknik Negeri Jakarta through the PNJ DIPA funding [184/PL3.18/SPK/2021]. The funders had no role in study design, data collection, and analysis, decision to publish, or preparation of the manuscript.

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Copyright: © 2021 Salimah A *et al.* This is an open access article distributed under the terms of the **Creative Commons Attribution License**, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

How to cite this article: Salimah A, Hazmi M, Fathur Rouf Hasan M *et al.* **A comparative study of red brick powder and lime as soft soil stabilizer [version 1; peer review: 2 approved with reservations]** F1000Research 2021, **10**:777 <https://doi.org/10.12688/f1000research.27835.1>

First published: 09 Aug 2021, **10**:777 <https://doi.org/10.12688/f1000research.27835.1>

Introduction

Soil is considered to be a three-phase system consisting of soil particles, pores (air) between its particles, and liquid (water) which varying degrees, fills and flows through the pores.¹ Based on the particle size of soil, there are several types of soil, namely gravel, sand, silt, clay.² The large content of silt and clay in soil affects its geotechnical characteristics that can vary: shrink when dry, and expand when wet; in the presence of water, they swell and become plastic.³ Constructions such as buildings, highways, bridges, tunnels, dams, and towers are established on the ground that functions to support the loads above it.⁴ Engineers often have problems using soft soil, which has weak mechanical properties. Soft soil is a cohesive soil consisting of very small grains, characterized by low shear strength and high compressibility, which does not possess sufficient strength to support loads. It is necessary to treat these soils to provide a stable subgrade and avoid excessive land subsidence. A soil is categorized as soft soil if its shear strength value is 12 – 25 kPa.⁵

For these reasons, soft soils need treatment before they can be used as a material subgrade by enhancing their engineering properties. Soil stabilization aims at improving soil properties and increases its resistance to softening by water. In principle, it means rearranging soil grains for them to be very tight and interlocked together.^{6,7} The stabilization process, which is mixing soil with additives, can change the texture or plasticity of soil, its gradation, or act as a binder for soil cementation.⁸

In recent years, a considerable number of field and laboratory experiments have been carried out using various additives, such as lime,^{9–11} silica fume,¹² and fly ash.^{13,14} However, not much research has been done on soil stabilization using red brick powder as a soil stabilizer.^{15,16} Moreover, every red brick manufacturer knows its history, which does not always have the same characteristics. This could indicate differences in the test results at every location.¹⁷ Therefore, it is necessary to do more research on the effect of red brick powder on soil stability. Also, lime and red brick powder are compared in this work. The impact of lime and red brick powder on the geotechnical qualities of soft soil was examined by conducting the CBR test. The CBR values for the soil mixture progressively increased.^{18,19} The CBR value increased because the soil structure changed from being dispersed to flocculated. Thus, in this study, lime and brick powder were used as stabilizers on soft soils.

The study aims to compare the potential of lime and brick powder in stabilizing soft soil. Soil stabilization parameters were measured based on their effect on the CBR values of soaked and unsoaked soil samples. This test is a penetration test which entails inserting an object into the test object. Through this way, the strength of the base or other materials used to make the pavement can be assessed. As soil is not always in a dry condition, it would not be enough to do the CBR test with unsoaked soil samples; it must be done also with soaked soil. Soaking simulates adverse moisture conditions such as those caused by possible rain or flooding, and it is used in most CBR test. The difference between the soaked and unsoaked CBR testing procedure is that in the soaked CBR, the soil sample that has been molded is first soaked for 4 days (96 hours) by placing a standard load of 10 lb above the mold and then penetration test is carried out afterward. The mixed proportions of lime or red brick (additives) powder are 0%, 5%, 10%, and 15% of the original soil. In this study, the index and engineering properties of the original soil and mixed soil were tested. Index properties test includes testing moisture content, specific gravity, Atterberg limit, and grain size analysis. While testing the original soil with a variation of the mixture of lime or red brick powder, the standard compaction test and CBR analysis are carried out.

Literature review

Lime is commonly used as additional material for soil stabilization especially for the construction of highways. Lime reacts with soil and changes its mineral properties. This is due to its reaction with calcium ions, which leads to the formation of cementitious holding capacity of soil (decreases moisture content), reduction of swelling, and improvement of soil stability.²⁰ Previous studies^{21,22} revealed that the stabilization of subgrades by lime could significantly improve their engineering properties. Using lime for soil stabilization gives a significant level of long-term strength gain, which is developed through a long-term pozzolanic reaction.²³

Red brick is made of clay, which is burned at a high temperature until a reddish color is obtained. It cannot be broken down when immersed in water. Red brick has refractory properties and can withstand compressive loads.²⁴ There are scanty research works that have used red brick powder as a stabilizer because it is not commonly used. Each area has different red brick characteristics. Previous researches works have found that in CBR results, the primary strength parameters of soil were substantially improved by the use of brick powder.²⁵

Methods

Material and sampling

The type of soil used in this research is soft soil located in *Hambalang, Bogor*. The rock that makes up the area at the top is in the form of Quaternary volcanic breccia; it is less compacted, with its surface utterly weathered into sandy clay. Its

colour is gray-brown, it is soft and 0.30-1.50 meters thick. In the breccia unit, the localities have lenses or inserts that are flaky, swollen, stiff, partially scraped, and soft when exposed on the surface. Their colour is gray to brownish-gray. Figure 1 shows a systematic geological map of Bogor, Indonesia.²⁶ The green area is the sampling location used in this study where the surficial deposits show clay shale.

Experimental technique

The method used in this research is a descriptive method, with tests conducted in the laboratory. Soil samples were taken in October during rainy season near the project site of the homestead of Athlete Hambalang, Bogor, Indonesia. Its geographical coordinates are 6°33'14.5"S and 106°53'22.1"E. Soil sampling was taken from a depth of 1 m to approximately 200 kilograms. Soil materials used for the test were disturbed and undisturbed soil samples. The undisturbed soil sample was used for dry density and engineering properties testing. The test was applied to identify the existing soil. Also, several stages of the laboratory tests were carried out with the disturbed samples. The laboratory test included (i) index properties of soil test, (ii) standard proctor compaction test, and (iii) California Bearing Ratio test (CBR) soaked and unsoaked test. Index properties of soil test included specific gravity, sieve analysis, hydrometer test, and atterberg limit used to determine the classification of soil. Before the compaction and CBR test was started, the soil sample was dried and filtered with sieve number 4 (smaller than 4.75 mm). Also, lime and brick powder were filtered with sieve number 40 (smaller than 0.475 mm). Lime and brick powder were obtained from Bogor, West Java. The additives were mixed as a percentage of 0%, 5%, 10%, and 15% of soft soil ratio by weight. In the Standard Proctor test, each mixture of the additives required 6 samples with the composition of each sample being 2 kg of soil mixed with either lime or brick powder, based on the percentage determined by each sample. Each percentage of the mixture has 6 samples where the total sample is 48 for lime and brick powder. Furthermore, the Standard Proctor test was carried out to obtain optimum moisture content (Wopt) and maximum dry density (γ_d max) for each mixed sample of the various proportions of lime and brick powder. The CBR test compares the resistance to penetration of the test specimen to that of a standard sample of well-graded crushed stone material using a standard-sized piston in a simple empirical approach. CBR test is one of the ways used to measure the bearing capacity of subgrades.²⁷ Based on the optimum moisture content (Wopt) obtained from the standard Proctor test, we could use the optimum moisture content for the next stage, that is, to conduct the soaked and unsoaked CBR test with various mixtures of the additives. Each mixture of the additives required 2 samples with the

Figure 1. Systematic geological map of Hambalang, Bogor, Indonesia.²⁶ Reproduced with permission from the Head of the Geological Survey Institute of Indonesia.

composition of each sample being 5 kg of soil mixed with lime or brick powder, based on the percentage determined by each sample. So for each soaked and unsoaked CBR test, 8 samples are needed. CBR tests were carried to study the behavior and bearing capacity of the soil when mixed with the additives (lime and brick powder). After molding the soil shape, each of the soil sample used for the soaked CBR test was soaked in water for 4 days (96 hours), before the penetration test. While in the unsoaked CBR test, no soaking was carried out, but a direct penetration test. The sample was left in the mold to be used for penetration test. The piston was placed on the sample with the perforated plate and the necessary surcharge weights were put in place on the soil. Loading began at a rate of 0.05 in (12.7 mm) per minute. Test loads were recorded at eleven predefined depths of up to 0.500in as the piston entered the soil (13 mm). All these tests are also referred to as ASTM standards.^{28–33} Manufacturers of the dial gauge equipment used Mitutoyo analog type.

Statistical analysis

Statistical analysis using 2nd order polynomial regression was done. The software used was Microsoft Excel 2019. Polynomial relation regression results show quadratic regression function and coefficient of determination (R^2). The coefficient of determination is a statistical measurement that shows how much ability the independent variable has in explaining the dependent variable. A value close to 1.0 indicates a regression function that explains a lot of the function variable. This makes it a very reliable model for forecasting the future. While a value close to 0.0 indicates that the calculation fails to simulate the data accurately.

Results and discussion

The physical and mechanical properties of the original soil can be seen in Table 1.³⁶ The soil samples contained more than 95% fine-grains, with size smaller than 0.075 mm. Based on the results, *Hambalang* soils can be classified as soft soils with high plasticity (symbol MH based on the Unified Soil Classification System) due to their undrained shear strength of >25 kPa. Also, in a previous report, the Department of Settlements and Regional Infrastructure classifies *Hambalang* soil as fat clay because it has a high swelling potential.

Table 1. Properties of original soil.

Parameters	Unit	Value
A. Index properties		
Moisture Content	%	33.58
Specific Gravity (Gs)	%	2.67
Liquid Limit	%	58.31
Plastic Limit	%	41.78
Plasticity Index	%	16.53
Dry density	kN/m ³	1.58
B. Grain size distribution		
% Gravel	%	0
% Sand	%	4.55%
% Silt and Clay	%	95.45%
C. Engineering properties		
Triaxial UU		
Q	-	12.47
Undrained shear strength	kPa	17.9
E. Classification		
USCS	-	MH
F. Bearing capacity		
CBR Soaked at (MDD)	%	3.51
CBR Unsoaked at (MDD)	%	15.70

Triaxial UU = unconsolidated undrained test is compression test, in which the soil specimen is subjected under isotropic all-round pressure in the triaxial cell before failure is brought about by increasing the major principal stress. MDD = maximum dry density.

Figure 2. Moisture content vs dry density stabilized with lime.

Figure 3. Moisture content vs dry density stabilized with brick powder.

Figures 2 and 3 show the relations between moisture content against the dry density for the various proportions of lime and brick powder obtained from the compaction test. The figures also show the influence of lime and brick powder on the optimum moisture content of the soil.

Lime and brick powder have high effect on the soil's maximum dry density (MDD) in all the mixed samples. The highest is observed in the samples with 15% additive, where the value increased from 1.58 for the soil not mixed to 1.7 for the soil mixed with 15% lime and 1.68 for the soil mixed with 15% brick powder. These were obtained at optimum moisture content of 21.115% for brick powder and 21.06% for lime. Optimum moisture in the compaction test was used as a mixture in the CBR test. The MDD of the soil samples increased because lime and brick powder have relatively higher specific gravities than soil. When the proportion of lime and brick powder increases, the maximum dry density of the soil increases compared to the original soil. The increase in water content at MDD conditions can be seen in Figures 2 and 3. This can occur because of the pozzolanic reaction which causes the maximum density conditions to require a little more water.

As seen in Figure 4, the maximum dry density of the mixture of lime and brick powder is at the 15% additive level. The increase in dry bulk density (γ_d) was due to additional material filling the cavities in the original soil decreasing the pore number. A decrease in the incidence of an increase in soil density leads to an increase in dry density.

The CBR soaked and CBR unsoaked tests were carried out with the original soil from lime and red brick powder at predetermined levels (5%, 10%, and 15%) by observing any changes in the CBR value at the top and bottom. The relationship between the addition of lime and red brick powder to the original soil on the CBR values of soaked and unsoaked is shown in Figure 5.

The results of the test data on the discovery of CBR values that were soaked and soil that were not soaked increased with the addition of lime or red brick powder. This is because the original soil grains and additives react with one another in a process known as pozzolanization reaction. In mixed soil samples, the strength generated is determined by the strength of the brick grain and the friction between the grains, because the soil and brick grains are non-cohesive. So, the strength of the mixed soil is not due to cohesion but due to friction between grains. This finding agrees with another finding, which explained the strength of mixed soils in different cases.³⁴

Figure 4. The dry density of the original soil with different additive levels.

Figure 5. Percentage values of CBR soaked and unsoaked mixed sample.

The highest CBR value of lime and red brick powder is found in the 15% mixture. The CBR-soaked result for lime has a higher value (7.58%) than that of brick powder (4.55%). While the CBR unsoaked result of red brick powder has the highest CBR value (19.2%) compared to lime (16.91%).

The CBR soaked value is smaller than the CBR unsoaked value because, at the time of immersion, the water initially fills the pore cavities. Over time, the size of the soil grains expands to their maximum when the water is saturated. In these conditions, the bonds between the soil grains become weak so that the bearing capacity of the soil decreases. This result is similar to another finding which showed that the more saturated the soil is, the less its bearing capacity.³⁵

The increase in CBR value is due to the cementation process, which makes the soil clump, thus increasing the binding power between the grains. This makes the pore cavity to be surrounded by a more rigid cementation material, which results in the grains becoming strong and not easily destroyed.²¹

Conclusions

The MDD of the soil sample increases when mixed in various proportions of lime and brick powder. The soil sample mixed with 15% of additives had the highest maximum dry density. The soaked and unsoaked CBR values increased with the variation of lime and red brick powder. The highest CBR soaked value is obtained from a lime mixture of 15%. The highest unsoaked CBR value can be obtained from a combination of red brick powder by 15%. However, this study has a very large range of variations because of the many material requirements for each test. We suggest other researchers perform the CBR test by reducing the range of variations in the additives to get firm data and using our experimental procedure in this study for further research.

Data availability

Underlying data

Zenodo: A comparative study of red brick powder and lime as soft soil stabilizer (Dataset). <https://doi.org/10.5281/zenodo.5028251>.³⁶

This project contains the following underlying data:

- CBR soaked and unsoaked 10(percent) Mixed with Lime.xlsx
- CBR soaked and unsoaked 15(percent) Mixed with Lime.xlsx
- CBR soaked and unsoaked 5(percent) Mixed with Lime.xlsx
- CBR soaked and unsoaked resume value mixed percentage.xlsx
- CBR soaked and unsoaked soil.xlsx

Data are available under the terms of the [Creative Commons Attribution 4.0 International license](#) (CC-BY 4.0).

Competing interests

No competing interests were disclosed.

Grant information

This research was supported by UP2M Politeknik Negeri Jakarta through the PNJ DIPA funding [184/PL3.18/SPK/2021]. The funders had no role in study design, data collection, and analysis, decision to publish, or preparation of the manuscript.

Acknowledgments

The authors would like to sincerely appreciate the Head of *UP2M Politeknik Negeri Jakarta* for providing support. The authors also acknowledge the Head of Laboratory of the Civil Engineering Department of *PNJ* for granting permission to use laboratory facilities.

References

1. Shillito R, Fenstermaker L: **Soil Stabilization Methods with Potential for Application at the Nevada National Security Site: A Literature Review**. 2014; no. 45255.
[Publisher Full Text](#)
2. Woollorton FLD: **Soil Mechanics in Foundation Engineering**. 1973; 7(2).
3. Negi AS, Faizan M, Siddharth DP: **Soil stabilization using lime**. 2013; 2(2): 448–453.
4. Roy S, Kumar Bhalla S: **Role of Geotechnical Properties of Soil on Civil Engineering Structures**. *Resour. Environ.* 2017; 7(4): 103–109.
[Publisher Full Text](#)
5. Wesley LD: *Geotechnical Engineering in Residual Soils*. Wiley; 2010.
6. Sherwood PT: *Soil stabilization with cement and lime*. London: HMSO; 1993.
7. Amu OO, Adetuberu AA: **Characteristics of bamboo leaf ash stabilization on lateritic soil in highway construction**. *Int. J. Eng. Technol.* 2010; 2(4): 212–219.
8. Dang LC, Hasan H, Fatahi B, *et al.*: **Enhancing the engineering properties of expansive soil using bagasse ash and hydrated lime**. *Int. J. GEOMATE*. 2016; 11(3): 2447–2454.
9. Kumar A, Kumar A, Prakash V: **Stabilization of Expansive Soil with Lime and Brick Dust**. *Int. J. All Res. Educ. Sci. Methods*. 2016; 4(9): 2455–6211.
10. Khazaei J, Moayedi H: **Soft Expansive Soil Improvement by Eco-Friendly Waste and Quick Lime**. *Arab. J. Sci. Eng.* 2019; 44(10): 8337–8346.
[Publisher Full Text](#)
11. Al-Swaidani A, Hammoud I, Meziab A: **Effect of adding natural pozzolana on geotechnical properties of lime-stabilized clayey soil**. *J. Rock Mech. Geotech. Eng.* 2016; 8(5): 714–725.
[Publisher Full Text](#)
12. Alrubaye AJ, Hasan M, Fattah MY: **Stabilization of soft kaolin clay with silica fume and lime**. *Int. J. Geotech. Eng.* 2017; 11(1): 90–96.
[Publisher Full Text](#)
13. Phetchuay C, Horpibulsuk S, Arulrajah A, *et al.*: **Strength development in soft marine clay stabilized by fly ash and calcium carbide residue based geopolymer**. *Appl. Clay Sci.* 2016; 127–128: 134–142.
[Publisher Full Text](#)
14. Wang FH, Zhang F, Chen YJ, *et al.*: **A comparative study on the heavy metal solidification/stabilization performance of four chemical solidifying agents in municipal solid waste incineration fly ash**. *J. Hazard. Mater.* 2015; 300: 451–458.
[Publisher Full Text](#)
15. B SN: **Effect of Burnt Brick Dust on Engineering Properties on Expansive Soil**. *Int. J. Res. Eng. Technol.* 2014; 03(04): 433–441.
[Publisher Full Text](#)
16. Khan R, Sonthwal VK: **Soil stabilization using brick kiln dust and waste coir fibre**. *Int. J. Recent Technol. Eng.* 2019; 8(2): 2574–2578.
17. Tang Xu Y, *et al.*: **Investigation of the medium calcium based non-burnt brick made by red mud and fly ash: durability and hydration characteristics**. *Int. J. Miner. Metall. Mater.* 2019; 26(8):

- 983–991.
[Publisher Full Text](#)
18. Kumar KSR, Thyagaraj T: **Comparison of lime treatment techniques for deep stabilization of expansive soils.** *Int. J. Geotech. Eng.* 2020; **00**(00): 1–19.
[Publisher Full Text](#)
 19. Pancar EB, Akpınar MV: **Comparison of Effects of Using Geosynthetics and Lime Stabilization to Increase Bearing Capacity of Unpaved Road Subgrade.** *Adv. Mater. Sci. Eng.* 2016; 2016.
[Publisher Full Text](#)
 20. Chemedda YC, Deneele D, Christidis GE, *et al.*: **Influence of hydrated lime on the surface properties and interaction of kaolinite particles.** *Appl. Clay Sci.* 2015; vol. **107**, no. February 2019: 1–13.
[Publisher Full Text](#)
 21. Andavan S, Pagadala VK: **A study on soil stabilization by addition of fly ash and lime.** *Mater. Today Proc.* 2020; vol. **22**, no. xxxx: 1125–1129.
[Publisher Full Text](#)
 22. Asgari MR, Baghebanzadeh Dezfūli A, Bayat M: **Experimental study on stabilization of a low plasticity clayey soil with cement/lime.** *Arab. J. Geosci.* 2015; **8**(3): 1439–1452.
[Publisher Full Text](#)
 23. Sharma LK, Sirdesai NN, Sharma KM, *et al.*: **Experimental study to examine the independent roles of lime and cement on the stabilization of a mountain soil: A comparative study.** *Appl. Clay Sci.* 2018; **152**(June): 183–195.
[Publisher Full Text](#)
 24. Lourenço PB, Fernandes FM, Castro F: **Handmade clay bricks: Chemical, physical and mechanical properties.** *Int. J. Archit. Herit.* 2010; **4**(1): 38–58.
[Publisher Full Text](#)
 25. Akshatha M, Bharath M: **Improvement in CBR of Black Cotton Soil Using Brick Powder (Demolition Brick Masonry Waste) and Lime.** *Int. J. Innov. Res. Sci. Eng. Technol.* 2016; **5**(9): 16848–16855.
[Publisher Full Text](#)
 26. Effendi B, Kusnana AC, Hermanto: **Geological Map of The Bogor Quadrangle West Java.** 1998; vol. Second Edi.
 27. Li T, Kong L, Liu B: **The California bearing ratio and pore structure characteristics of weakly expansive soil in frozen areas.** *Appl. Sci.* 2020; **10**(21): 1–22.
[Publisher Full Text](#)
 28. American Standard Testing and Material (ASTM) D 4318-00: *Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.* American Standard Testing and Material (ASTM); 2000; **8**.
 29. ASTM D1883-16: **Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils.** West Conshohocken: ASTM International; 2016.
 30. **ASTM D698-12e2, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³)).** West Conshohocken, PA: ASTM International; 2012.
 31. **ASTM D4531-15, Standard Test Methods for Bulk and Dry Density of Peat and Peat Products.** West Conshohocken, PA: ASTM International; 2015.
 32. **ASTM D4318-17e1, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.** West Conshohocken, PA: ASTM International; 2017.
 33. **ASTM D7928-17, Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis.** West Conshohocken, PA: ASTM International; 2017.
 34. Raheem AA, Bello OA, Makinde OA: **A Comparative Study of Cement and Lime Stabilized Lateritic Interlocking Blocks.** *Pacific. J. Sci. Technol.* 2010; **2**: 11.
 35. Ige JA: **International Journal of Engineering Technology Research & Management Comparative Analysis of Selected Stabilization Agents for Subgrade Soil.** no. **02**, pp. 73–91.
 36. Salimah A, Miftah H: **A comparative study of red brick powder and lime as soft soil stabilizer (Dataset) (Version 1) [Data set].** *Zenodo.* 2021.
[Publisher Full Text](#)

Open Peer Review

Current Peer Review Status: ? ?

Version 1

Reviewer Report 22 June 2022

<https://doi.org/10.5256/f1000research.30780.r138934>

© 2022 Kogbara R. This is an open access peer review report distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Reginald B. Kogbara

¹ Mechanical Engineering Program, Texas A&M University at Qatar, Doha, Qatar

² Department of Environmental Engineering, İzmir Institute of Technology, İzmir, Turkey

The paper concisely describes experiments aimed at investigating the effect of lime and red brick powder on soft soil stabilization. Specifically, its use of red brick powder for soil stabilization allows for beneficial reuse of what might otherwise be a waste material for soil stabilization. Hence, the work is scientifically valid and contributes to knowledge in the area of soil stabilization. The experimental design is appropriate and the work is technically sound with sufficient details that allow replication of the work by others, and the conclusions made are supported by the results of the study.

Major Points:

- The authors should better put the work into context by citing current literature that deal with similar investigations and highlighting the contribution of this work that is different from what was done in similar studies. For example, see Blayi *et al.*, (2020)¹; Srikanth Reddy *et al.*, (2018)²; and Bhavsar *et al.*, (2014)³
- Could the authors please state the sources of the lime and red brick powder used for the soil stabilization?

Minor Points:

- It would have been more helpful if compressive strength data was included to facilitate comparison with data in other studies related to the use of lime and waste brick powder for soil stabilization.
- The authors should explain clearly the expression “Statistical analysis using 2nd order polynomial regression was done”, stating the specific dataset the polynomial regression was applied on. For example, was the polynomial regression done on the moisture content – dry density data?

References

1. Blayi R, Sherwani A, Ibrahim H, Abdullah S: Stabilization of high-plasticity silt using waste brick powder. *SN Applied Sciences*. 2020; **2** (12). [Publisher Full Text](#)
2. Srikanth Reddy S, Prasad A, Vamsi Krishna N: Lime-Stabilized Black Cotton Soil and Brick Powder Mixture as Subbase Material. *Advances in Civil Engineering*. 2018; **2018**: 1-5 [Publisher Full Text](#)
3. Bhavsar SN, Joshi HB, Shrof PK, Patel AJ: EFFECT OF BURNT BRICK DUST ON ENGINEERING PROPERTIES ON EXPANSIVE SOIL. *IJRET*. 2014; **3** (4). [Reference Source](#)

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Stabilization/solidification of problematic soils and wastes, subgrade soil stabilization using polymers, characterization, and utilization of cement-based materials.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 10 November 2021

<https://doi.org/10.5256/f1000research.30780.r91503>

© 2021 Shankar A. This is an open access peer review report distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

A. U. Ravi Shankar

Department of Civil Engineering, National Institute of Technology Karnataka, Mangalore,

Karnataka, India

The authors have conducted laboratory investigation to improve CBR of silty soil by using red brick powder and lime. The authors stabilized fine grain soil with and brick powder. The CBR values improved up 15 % addition of red brick powder. They could satisfy their objective. Not much information is generated. The reason for improvement in strength. The chemical composition of Brick Powder, Gradation etc. are missing. If it is only for pavement then only CBR improvement may not be sufficient as per new codes. Within the presented data the following pros and cons are observed. The suggested modification along with grammar check may help in improving the quality of paper.

The Text should be written in third person - 'I' and 'we' should not be there.

Abstract:

Statement: Soil has an important role to play in planning buildings because it supports the loads above it.

- Comment: May be corrected as 'Role of soil in building construction...'.

Statement: Soil stabilization can be defined as the process of stabilizing soil properties by chemical or physical means to improve its engineering efficiency.

- Comment: Can be corrected as 'process of modifying the soil properties....'.

Introduction:

Statement: Therefore, it is necessary to do more research on the effect of red brick powder on soil stability. Also, lime and red brick powder are compared in this work. The impact of lime and red brick powder on the geotechnical qualities of soft soil was examined by conducting the CBR test.

- Comment: Modify the sentences as 'Also, the stabilizing effect of lime and red brick powder are compared in this work. The influence of lime and red brick powder on the geotechnical qualities of soft soil was examined by conducting the CBR test'.

Statement: The CBR value increased because the soil structure changed from being dispersed to flocculated. Thus, in this study, lime and brick powder were used as stabilizers on soft soils.

- Comment: Remove the above statements.

Statement: In this study, the index and engineering properties of the original soil and mixed soil were tested.

- Comment: Remove the term 'original' and may be replaced with term either 'soil or silty soil or untreated soil' wherever applicable in the manuscript.

Statement: Literature review

- Comment: Literature review can be combined with introduction part.

Methods:

Statement: The proportions of lime or red brick powder additives mixed together are 0%, 5%, 10%, and 15% of the original soil sample.

- Comment: Can be corrected as 'The proportions of lime or red brick powder additives mixed are 0%, 5%, 10%, and 15% with the soil'.

Statement: From the results of the laboratory tests, the soil type obtained is MH soil based on the Unified Soil Classification System (USCS). The MH soil type is a low plasticity silt soil.

- Comment: Can be corrected as 'The soil type obtained is MH (low plasticity silt) as per the Unified Soil Classification System (USCS)'.

Material and sampling:

- Comment: Properly described.

Experimental technique:

Statement: proctor, atterberg

- Comment: Capitalize first letter as 'Proctor', 'Atterberg'

Statement: CBR, and other abbreviations

- Comment: All abbreviations are to be used at the first appearance throughout the manuscript.

Results and discussion:

Statement: However, red brick powder had a significant increase of 15%.

- Comment: Can be corrected as 'However, red brick powder addition has contributed to a significant increase in CBR value (15%)'.

Statement: Table 1

- Comment: Atterberg limits, CBR need to be indicated without decimals. Moisture contentment can be represented with 1 decimal. For Parameter % sand, unit %, value 4.55%, include correction as - Parameter sand, unit %, value 4.55. Make corrections wherever applicable in the manuscript.

Statement: Figure 2, 3 and 4

- Comment: Check x and y axes titles and units and incorporate correction (uniform writing style and standard units are to be used).

Statement: Lime and brick powder have high effect on the soil's maximum dry density (MDD) in all the mixed samples.

- Comment: Instead of term 'high effect' use 'significant' or 'notable effect'.

Statement: Figure 5

- Comment: Correction to be incorporated for CBR values.

Statement: Description of Results and discussion.

- Comment: Description has grammatical errors. It could be improved. Needs modification.

Conclusions:

Statement: This study found a very large range of variations because of the many material requirements for each test. We suggest other researchers perform the CBR test by reducing the range of variations in the additives to get firm data and using our experimental procedure in this study for further research.

- Comment: Authors need to draw conclusions on your work. Suggestions are not needed. Rewrite conclusions.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Pavement Materials, Concrete Pavement

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

The benefits of publishing with F1000Research:

- Your article is published within days, with no editorial bias
- You can publish traditional articles, null/negative results, case reports, data notes and more
- The peer review process is transparent and collaborative
- Your article is indexed in PubMed after passing peer review
- Dedicated customer support at every stage

For pre-submission enquiries, contact research@f1000.com

F1000Research