STUDY OF ENGINEERING PROPERTY OF BLACK COTTON SOIL AND STABILIZATION USING BRICK POWDER

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Abstract - Black cotton soils are able to absorb a lot of water, experience significant volume fluctuations, and experience seasonal expansion and contraction depending on the water availability. Structures built on such soils frequently suffer from this and fail. To address the swelling aspects related to these soils, techniques like preloading, moisture control, replacement of impacted soil, and additives have been employed. Various Researchers conducted research to alter the brick powder and other industrial wastes, in this examination, the soil's engineering qualities alone are studied, they correspond to the features of black cotton combined 5% 10% and 15% by weight of brick powder. The geotechnical characteristics dealt with in this study include plasticity, compaction, and swelling shrinking of that black cotton soil in terms of free swell index value

Keywords- Stabilizing black cotton, brick powder plasticity, compaction, behaviors of soil

1. INTRODUCTION

1.1 GENERAL

Black cotton soil shrinks and swells in response to variations in moisture content. This variance in the soil causes significant soil disturbance, which is followed by harm to the structures above. During times of greater precipitation, such as the monsoon, these soils absorb water and swell; as a result, they become spongy and lose some of their ability to hold water. Conversely, during the summer, these soils lose they had absorbed while evaporation, making them strong. The Indian subcontinent's Deccan trap (Deccan lava tract), which encompasses, Gujarat, Madhya Pradesh, and a few remote areas of Odisha, is where black cotton soils are most commonly found. The valleys of the Narmada, Godavari, and Krishna rivers may also include these soils. These are the soils that remain at a disaster site after various decomposition agents have chemically broken-down rocks like basalt [1]. Clay-sized particles make up a large majority as black cotton soils. The majority particles are clay-sized, and it ranges in color from black to reddish brown. Expansive

soils have a tremendous ability to retain moisture, which makes them perfect for dry farming and the growth of crops like cotton. Ionic exchange, or soil stabilisation, works to stop soil from swelling and moving beneath the foundation of your house or place of business. There are various methods available on the market today, many of which reinforce the soil by adding stuff to it. But the most effective method is chemical soil stabilisation[2]**.** The application of chemical soil stabilisation is a practical and affordable way to enhance the characteristics of the soil.

1.2 NEED OF STABILIZATION

1. Sometimes the locally available soil lacks the properties necessary to satisfy design requirements, and it is not cost-effective toimport suitable soil from elsewhere [4].
2. The only option accessible to the civil engineer is to adjust the soil's qualities using the necessary processes.
3. Soil stabilization is also used for military andother emergency demands to quickly make a location passable.
4. Soil stabilization is occasionally utilized to increase the noise absorption of city and suburban streets.
5. The methods for improving the soil shouldbe both useful and economical.

1.3 STABILIZATION METHOD

The methods described below are only a few that canbe used to alter a soil's characteristics.

- Compaction and structural stability
- Stabilization through chemical methodsdrainage methods
- Consolidation techniques
- The use of vibration
- Soil fortification
- Heat treatment
- Electro-osmosis
- Vibration approach

1.4 SOIL STABILIZATION APPLICATION

The following conditions benefit from soil stabilization:

1. Roadway development.
2. Wetland regions
3. The foundations for large projects are embankments.
4. Bridge abutments and retaining walls
5. Locations with constrained space and right of way

1.5 HEAT TREATMENT

Using heat to stabilize soil is a method for enhancing the surface. Discussions are made regarding the idea, process, and applications of soil thermal stabilisation [17]. It has been noted that soil qualities vary noticeably when heated or cooled**.**

1.6 BENEFITS OF SOIL STABILIZATION

Stabilized soil can be used to build steep slopes in embankments, reducing the amount of filling material needed and increasing the covered area of the embankment [6].

1. It increases the level of safety against sloping.

2. The carrying capacity of the soil is greatly increased through soil stabilization.
3. It increases the soil's binding power, making it possible to use it to build inclined structures and on the sides of bridges. It is therefore advantageous in areas with a high population density [7].
4. Soil stabilization is a practical method for enhancing soil qualities because it merely makes use of inexpensive waste and raw materials.
5. Soil stabilization provides a sturdy base. There is no settlement in the case of gravity walls or R.C. cantilever walls. As a result, construction is feasible even in poor soils.
6. Utilizing waste materials to stabilize soil is environmentally friendly.

1.7 OBJECTIVE OF WORK

My research aims to examine the qualities of black cotton soil had been examined by mixtures of black cotton soil at 5%, 10%, and 15% by weight brick powder.

1. The black cotton soil's swelling features.
2. The flexibility of black cotton soil is studied there.

2. MATERIAL AND PROCEDURE

2.1 BLACK COTTON SOIL (BCS)

Black cotton soil is expansive soil type utilized for experiments for this study, vast A sample of the black cotton soil is obtained. location JAM NAGAR GUJRAT IN plastic sacks, the lab received the black cotton soil.

TABLE 1 Black cotton soil characteristics

S.NO	PROPERTIES	TEST VALUE
1.	SPECIFIC GRAVITY	2.5
2.	LIQUID LIMIT (%)	64%
3.	PLASTIC LIMIT (%)	22%
4.	PLASTICITY INDEX	42%
5.	OMD (%)	23%
6.	MDD (g/cm^3)	1.46

2.2 BRICK DUST

Large amounts of brick dust are created as a waste product in brick kilns, tile industries, and old brick structures. It is fine in nature. The study looks at how black cotton soil's engineering qualities are affected by brick dust and black cotton soil together [3].

2.2 ADOPTED METHODOLOGY

In a series of tests, brick dust that ranged from 5% to 15% by weight of the total amount obtained was added to expansive soils to see how it affected the soil's ability to stabilize. The following test was carried out according to Indian Standard codes:

1. IS: 2720 - 1980 SPT
2. IS 2720 - 1977 – Free swell index test
3. IS 2720 - 1985 Atterberge Limit test forliquid and plastic limit

TEST PROCEDURE

1. STANDARD PROCTOR TEST

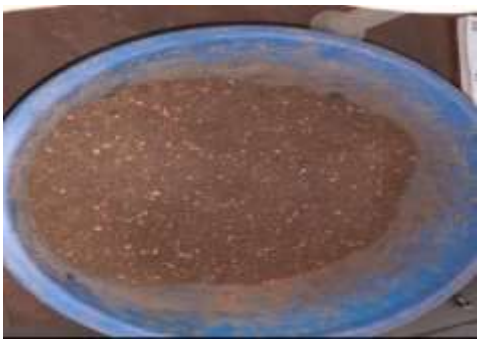

FIG-1-SOIL SAMPLE

FIG-2 -SAMPLE WEIGHT + MOULD

2. FREE SWELL INDEX

FIG-3-INDEX SAMPLE

2. ATTERBERGE LIMITS

FIG-4-LIQUID LIMIT SAMPLE FIG-5- PLASTIC LIMIT SAMPLE

FIG-6 FIG-7

3.DATA ANALYSIS

This chapter presents the effects of the tests performed for this investigation. The behavior combination on black cotton and brick dust was examined using the free swell test, S.P.T, and Atterberg limit. Investigated were the effects of compaction, water content, and for different percentages brick dust. From 5% to 10% of the mixture contains brick dust. The Galgotias University civil engineering department's soil mechanics laboratory served as the site for all laboratory investigations.

STANDARD PROCTOR TEST

S.P.T for black cotton soil only
Soil sample taken (passes 4.75 mm sieve)
Volume of mould = 943 cm^3

MOIST UNIT WEIGHT (g/cm^3) = $\frac{WEIGHT\ OF\ MOIST\ SOIL(g)}{VOLUME\ OF\ MOULD(cm3)}$

DRY UNIT WEIGHT (g/cm3) = $\frac{MOIST\ UNIT\ WEIGHT(\frac{g}{cm3})}{1+WATER\ CONTENT}$

WATER CONTENT (%) = $\frac{WEIGHT\ OF\ WATER}{WEIGHT\ OF\ SOLID} \times 100$

TABLE 2-STANDARD PROCTOR TEST

SAMPLE DESCRIPTION	MDD (g/cm^3)	OMC (%)
BLACK SOIL	1.46	23
BLACK SOIL + 5% BRICK POWDER	1.47	21.6
BLACK SOIL + 10% BRICK POWDER	1.59	18.6
BLACK SOIL + 15% BRICK POWDER	1.60	18

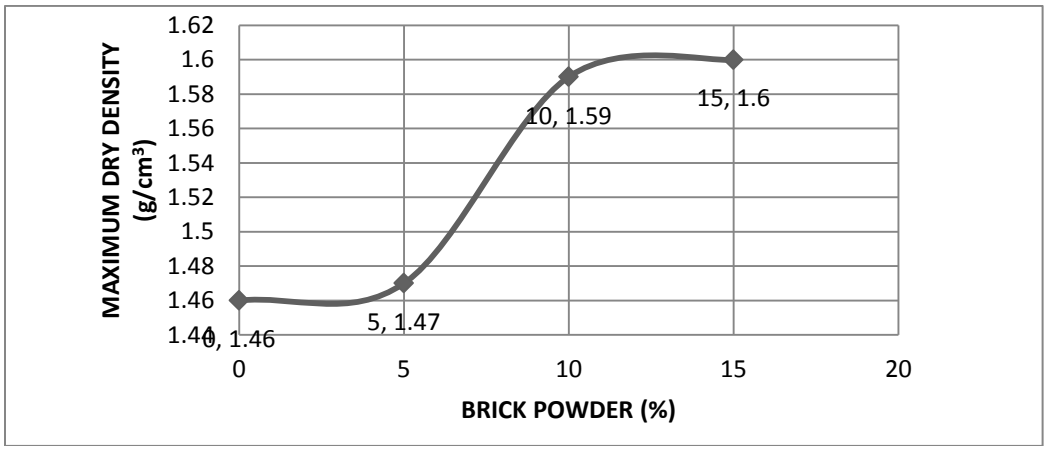

FIG- 6-VARIATION OF MDD WITH BRICK POWDER

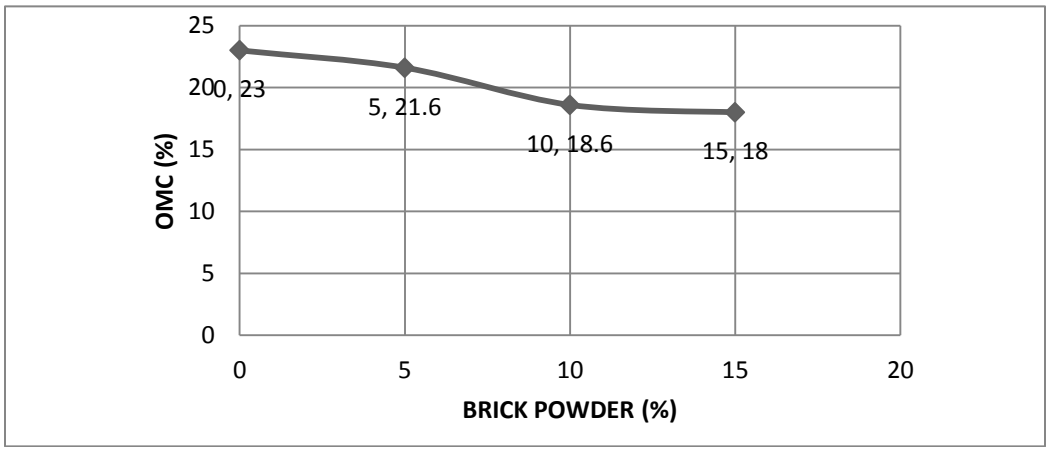

FIG-7- VARIATION OF OMC WITH BRICK POWDER

TABLE-3-FREE SWELL INDEX

Sr.no	**Description**	**Free swellindex (%)**
1.	Black cotton soil only	42
2.	Black soil +5% brick dust	39
3.	Black soils +10% brick dust	35
4	Black soils +15% brick dust	34

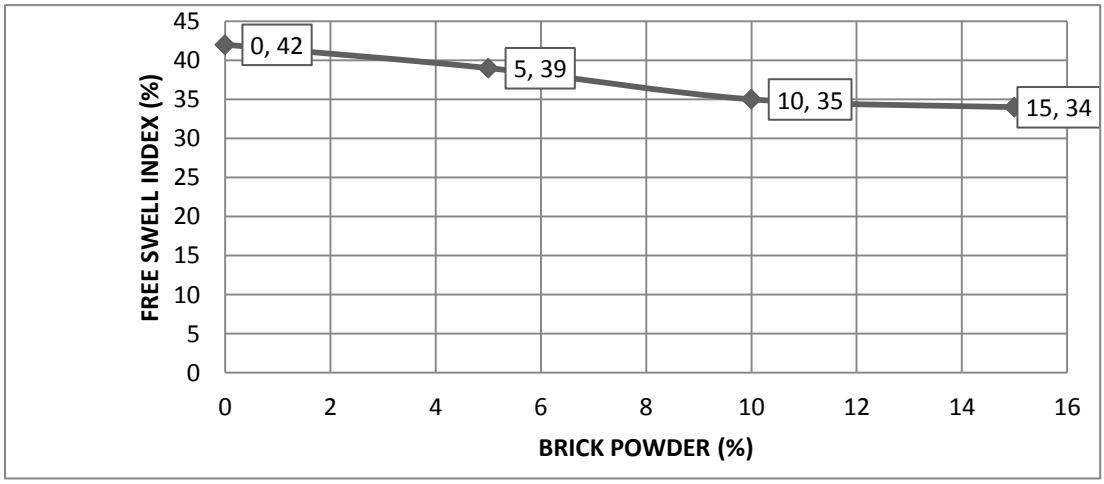

FIG 8 - VARIATION OF FSI WITH BRICK POWDER

TABLE 4-ATTERBERGE LIMIT

Description	**Black cotton soil only**	**Black cotton soil + 5% brick powder**	**Black cotton soil + 10% brick powder**	**Black cotton soil + 15% brick powder**
Liquid limit (%)	64	48	42	37
Plastic limit(%)	22	19	15	13
Plasticity index (%)	42	29	27	24

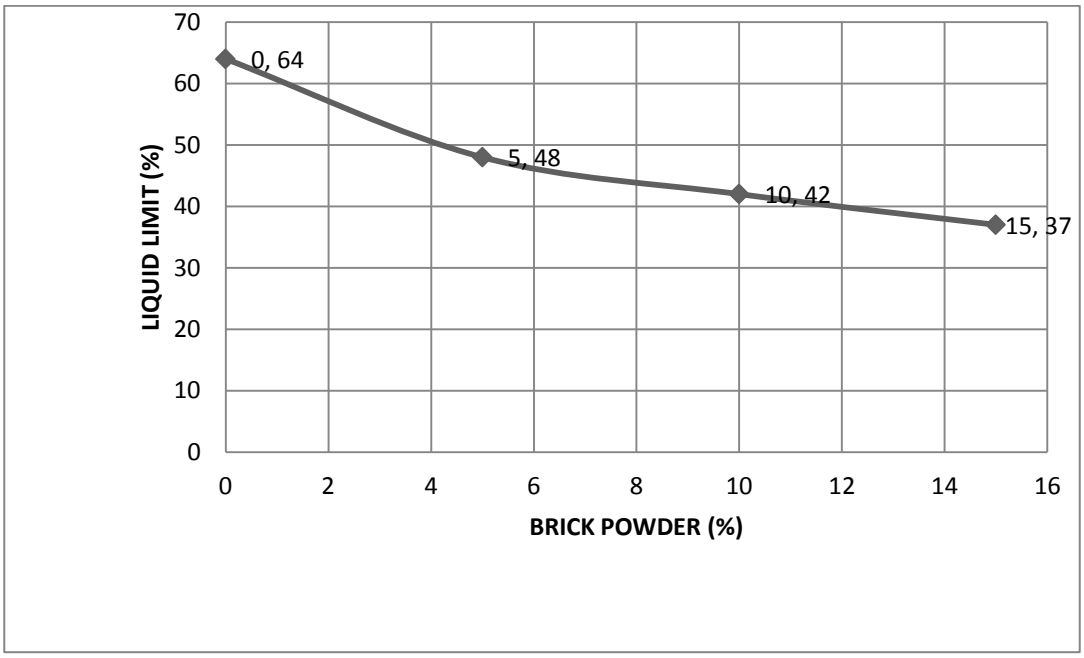

FIG 9 - VARIATION OF LL WITH BRICK POWDER

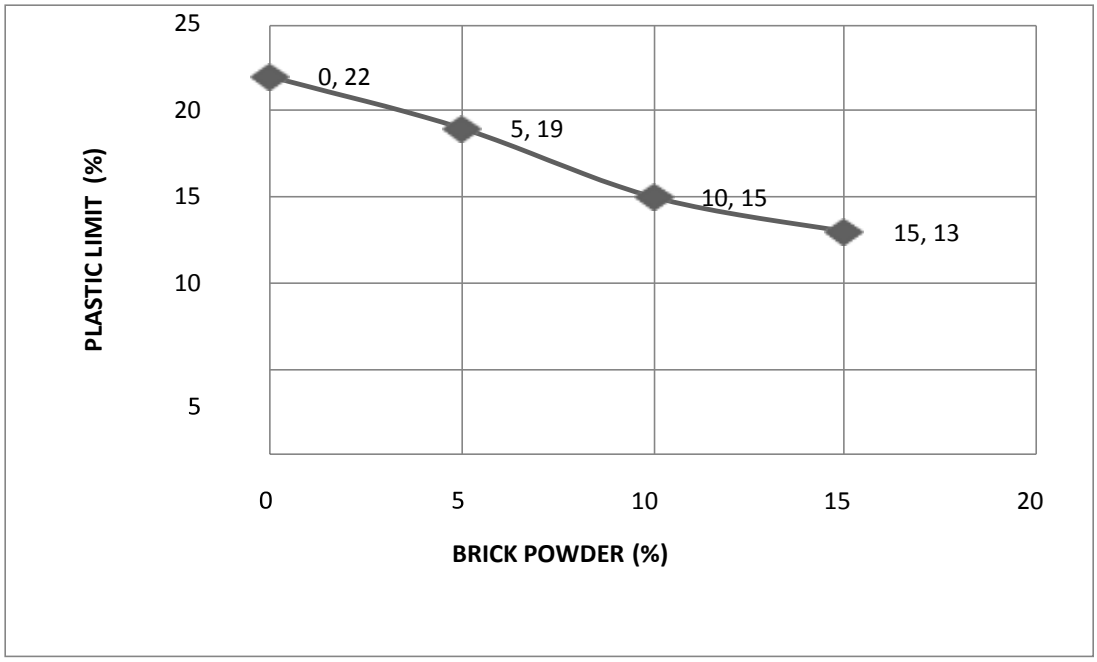

FIG 10 -VARIATION OF PL WITH BRICK POWDER

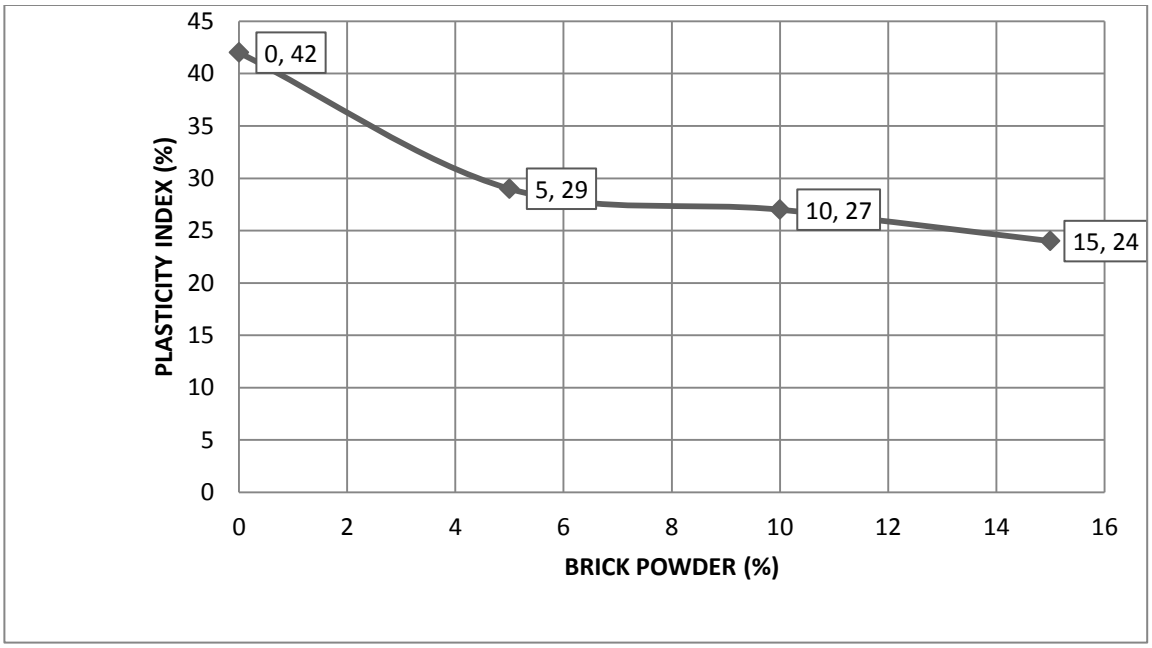

FIG 11-VARIATION OF PI WITH BRICK POWDER

4.RESULTS

- study the behaviour of black cotton soil brick powder with the soil is multiple 5% by weight
- The MDD of black cotton increase when we add brick powder in black cotton soil and OMC decreases.
- The LL and PL of black cotton decreases whenever brick powder are mixed with black cotton soils.

5.CONCLUSIONS

1) MDD
   - With MDD increased when we increases percentage of brick powder
   - after 10% of brick powder mixture with black cotton soil the MDD is almost as almost constant
   - maximum dry density at 15% mixture of brick powder with black cotton soil is 1.60g/cm^3

2) OPTIMUM MOISTURE CONTENT
   - The ideal moisture level of the soil slowly decreases as the amount of brick powder in black cotton soil rises.
   - OMC at 15% brick dust mix with black cotton soil is 18%
3) ATTERBERGE LIMIT

- By increasing brick dust percentage in the black cotton soil, notified that the LL and PL both are decreases However, because the decline in the liquid limit is higher the decline plastic limit, the PI also falls.
- At 15% mixture of brick powder with black cotton soil liquid limit is 37% plastic limit is 13% and plasticity index is 24%

4) FREE SWELL INDEX

- Experimental study concluded that Increased brick dust content in black cotton soil reduces soil swelling.

5.REFRENCES

[1] Lakshman Teja, D. N., and Kumar Shraavan. "Stabilization of expansive soil using brick dust." *Int. J. Pure Appl. Math* 17 (2018): 903-910.

[2] Bhavsar, Sachin N., et al. "Effect of burnt brick dust on engineering properties on expansive soil." *international Journal of Research in Engineering and Technology* 3.4 (2014): 433-441.

[3] Neha, Pundir, and M. K. Trivedi. "Improvement of pavement soil subgrade by using Burnt Brick Dust." *International Journal for Research in Applied Science and Engineering Technology* 5.5 (2017): 218-221.

[4] Akshatha, R., and H. M. Bharath. "Improvement in CBR of Black Cotton Soil Using Brick Powder (Demolition Brick Masonry Waste) and Lime." *International Journal of Innovative Research in Science, Engineering and Technology* 5.9 (2016).

[5] Sudheer Kumar, J., and Upma Janewoo. "Stabilization of expansive soil with cement kiln dust and RBI grade 81 at subgrade level." *Geotechnical and Geological Engineering* 34 (2016): 1037-1046.

[6] Venkateswarlu, H., D. S. V. Prasad, and GVR Prasada Raju. "Study on Geotechnical Properties of Stabilized Expansive Soil-Quarry Dust Mixes."

[7] Manjularani, P., W. Channabasavaraj, and MdKhajaMoniuddin MdKhajaMoniuddin. "Augmenting the properties of black cotton soil using additives." *International Journal of New Technology and Research* 1.3 (2015): 263690.Kumar Sharma, Anil, and P. V. Sivapullaiah. "Improvement of strength of expansive soil with waste granulated blast furnace slag." *GeoCongress 2012: State of the Art and Practice in Geotechnical Engineering*. 2012. 3920-3928.

[8] Buwa, Varun, and A. S. Wayal. "Use of fly ash and lime for stabilization of soft soil." *Electron. J. Geotech. Eng* 21 (2016): 6235-6246.

[9] Gupta, Chayan, and Ravi Kumar Sharma. "Influence of micro silica fume on sub grade characteristics of expansive soil." *International Journal of Civil Engineering Research* 5.1 (2014): 77-82.

[10] Shaka, Abhijeet, et al. "STABILIZATION OF COHESIVE SOIL USING COCONUT SHELL AND FLYASH AS ADMIXTURE."

[11] Bhavsar, Sachin N., and Ankit J. Patel. "Effect of waste material on swelling and shrinkage properties of clayey soil." *International Journal of application or innovation in Engineering & Management (IJAIEM)* 3.11 (2014): 200-206.

[12] Thakur, Rabindra Nath, et al. "A durability study of jute geotextile treated with bitumen emulsion." *Journal of Natural Fibers* 18.3 (2021): 400-418.

[13] Kumar, R., V. K. Kanaujia, and D. Chandra. "Engineering behaviour of fibre-reinforced pond ash and silty sand." *Geosynthetics International* 6.6 (1999): 509-518.

[14] Srikanth Reddy, S., A. C. S. V. Prasad, and N. Vamsi Krishna. "Lime-stabilized black cotton soil and

brick powder mixture as subbase material." *Advances in Civil Engineering* 2018 (2018).

[15] Krishna, Tulasi Sai, Noorbasha Sanil Basha, and Karri Shyam Chamberlin. "Experimental study on black cotton soil to be used as filling material by strenghtning with baggasse ash and brick dust." *International Conference on Advances in Civil Engineering (ICACE-2019)*. Vol. 21. 2019.

[16] Mai-Bade, Umar Yerima, et al. "Stabilization of Black Cotton Soil Using Various Admixtures: A Review." *Composite Materials* 5.2 (2021): 37-45.

[17] Randhawa, Karanbir Singh, Rajiv Chauhan, and Raman Kumar. "An investigation on the effect of lime addition on UCS of Indian black cotton soil." *Materials Today: Proceedings* 50 (2022): 797-803.

[18] Oneka, Lit Jolly. *Effects of partial replacement of lime with burnt clay brick powder on physical and mechanical properties of black cotton soil*. Diss. Makerere University, 2022.

[19] Mohan, Shalini. "CHARACTERISTICS STUDY ON BLACK COTTON SOIL ADMIXED WITH BRICK DUST AND RICE HUSK ASH." (2018).

[20] Vyas, Neha M., and Shashikant A. Deshmukh. "Effect of Marble Dust and Burnt Brick Dust on Characteristics of Black Cotton Soil."

[21] Malode, Prachi, et al. "Impact Of Soil Stabilization By Using Lime And Brick Powder." *Int. J. of Aquatic Science* 13.1 (2022): 151-156.

[22] Rahman, Shafi Kamal, Mantu Kumar Das, and Joutish Deka. "A Study on the Improvement of Engineering Properties of Locally Available Soil of Kokrajhar by Using Burnt Brick Dust." *Proceedings of the 7th Indian Young Geotechnical Engineers Conference: 7IYGEC-2019*. Singapore: Springer Singapore, 2022.

[23] Blayi, Rizgar A., et al. "Stabilization of high-plasticity silt using waste brick powder." *SN Applied Sciences* 2 (2020): 1-12.

[24] Kumrawat, Neeraj, and S. K. Ahirwar. "Performance analysis of black cotton soil treated with calcium carbide residue and stone dust." *Int. J. Eng. Res. Sci. Technol* 3.4 (2014): 202-209.

[25] Jain, Gaurav, and Anupma Agarwal. "Improvement in engineering properties of locally available black soil by fly ash and brick waste." (2021).