



Soil Stabilization Using Lime and Brick Dust

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ABSTRACT

The soil can be altered and improved by improving its chemical and physical properties, which is also called as soil stabilization. The main objectives of this project or research work are to do soil stabilization by using lime and brick dust in order to increase the strength of the soil, its resistance to weathering process and soil permeability. Since less work found to be done in this regard therefore the authors have taken up this work. And also its performance can be increased by additives like brick dust and lime stone. The long-term performance of any construction project depends on the soundness of the underlying soils. Unstable soils can create significant problems for pavements or structures, Therefore soil stabilization techniques are necessary to ensure the good stability of soil so that it can successfully sustain the load of the superstructure especially in case of soil which are highly active, also it saves a lot of time and millions of money when compared to the method of cutting out and replacing the unstable soil. This paper deals with the complete analysis of the improvement of soil properties and its stabilization using lime and brick dust. Over here exiting and positive results are obtained which is giving additive strength to soil properties.

KEYWORDS

Stabilization, black cotton soil , lime , brick dust , permeability.

INTRODUCTION

Soil stabilization can be defined as improving the soil properties. Soils containing significant levels of silt or clay, have changing geotechnical characteristics: they swell and become plastic in the presence of water, shrink when dry, and expand when exposed to frost. Site traffic is always a delicate and difficult issue when projects are carried out on such soils. In other words, the re-use of these materials is often difficult, if not impossible. Once they have been treated with lime, such soil can be used to create embankments or subgrade of structures, thus avoiding expensive excavation works and transport. Use of lime significantly changes the characteristics of a soil to produce long-term permanent strength and stability, particularly with respect to the action of water and frost. The mineralogical properties of the soils will determine their degree of reactivity with lime and the ultimate strength that the stabilized layers will be considered to be good candidates for stabilization². Soils containing significant amounts of organic material (greater than about 1 percent) or sulfates (greater than 0.3 percent) may require additional lime or special construction procedures.³

CHEMISTRY OF LIME TREATMENT

Drying: If quicklime is used, it immediately hydrates (i.e., chemically combines with water) and releases heat. Soils are dried, because water present in the soil participates in this reaction, and because the heat generated can evaporate additional moisture. The hydrated lime produced by these initial reactions will subsequently react with clay particles (discussed below). These subsequent reactions will slowly produce additional drying because they reduce the soil's moisture holding

capacity. If hydrated lime or hydrated lime slurry is used instead of quicklime, drying occurs only through the chemical changes in the soil that reduce its capacity to hold water and increase its stability. In fig.1 water content W_n is reduced to $W'n$ after treatment with lime.

Modification: After initial mixing, the calcium ions (Ca^{++}) from hydrated lime migrate to the surface of the clay particles and displace water and other ions. The soil becomes friable and granular, making it easier to work and compact. At this stage the Plasticity Index of the soil as shown in fig. 1 decreases dramatically, as does its tendency to swell and shrink. The process, which is called "flocculation and agglomeration," generally occurs in a matter of hours.

Brick Dust is a waste product obtained from different brick kilns and tile factories. There are numerous brick kiln which have grown over the decades in an unplanned way in different part of the country. Tons of waste products like brick dust or broken pieces or flakes of bricks (brickbat) come out from these kilns and factories. So far, such materials have been used just for filling low lying areas or are dumped as waste material.

IMMEDIATE EFFECT: SOIL IMPROVEMENT

- A reduction in the plasticity index: The soil suddenly switches from being plastic (yielding and sticky) to being crumbly (stiff and grainy). In the latter condition it is easier to excavate, load, discharge, compact and level.
- An improvement in the compaction properties of the soil: The maximum dry density drops, while the optimal

water content rises, so that the soil moves into a humidity range that can be easily compacted. This effect is clearly advantageous when used on soils with a high water content. A treatment with quicklime therefore makes it possible to transform a sticky plastic soil, which is difficult to compact, into a stiff, easily handled material. After compacting, the soil has excellent load-bearing properties.

- Improvement of bearing capacity: In most cases, two hours after treatment, the CBR (California Bearing Ratio) of a treated soil is between 4 and 10 times higher than that of an untreated soil. This reaction greatly relieves on-site

MATERIALS AND PROPERTIES

The properties of the Black Cotton soil and Lime are presented in Table 1 & 2

Table 1 Properties of soil

LL (%)	66.3%
PL (%)	31.56%
PI	34.7%

Table 2 Chemical Properties of Lime

Calcium Oxide, CaO (%)	73.22
Phosphorus Oxide, P2O5 (%)	0.08
Calcium Sulphate, CaSO4 (%)	0.12
Ferric Oxide, Fe2O3 (%)	0.17
Aluminium Oxide, (%)	0.11
Magnesium Oxide, MgO (%)	0.74
Loss on Ignition, LOI (%)	24.35

MEDIUM TERM EFFECT : SOIL STABILIZATION

When lime comes into contact with a substance containing soluble silicates and aluminates (such as clay and silt), it forms hydrated calcium aluminates and calcium silicates. As with cement, this gives rise to a true bond upon crystallization. Called a pozzolanic reaction, this bonding process brings about improved resistance to frost and a distinct increase in the soil's compressive strength and CBR. In general, in non-winter conditions, the soil develops sufficient strength after three to six months. A slow curing process during road construction is a marked advantage, as it allows greater flexibility when working with the treated soil. The long-term hardening facilitates the design of foundations for industrial platforms. The stabilizing effect gives load-bearing qualities to the treated soil.

NUMEROUS ADVANTAGES IN BROAD RANGE OF APPLICATION

In the time of a few hours, an unconditional soil is transformed by lime + brickdust into a stabilized soil which can carry the traffic load sufficiently. An added bonus is that the soil becomes less sensitive to moisture. This immediate and spectacular effect makes it possible to build job site roads that can be used regardless of weather condition.

The technique makes it possible to retain high quality raw materials for quality applications. The building of embankments using moist plastic soils treated with lime can result in considerable savings on materials brought in from elsewhere, often at great cost, and the inevitably high costs of waste soil disposal.

Lime and brick dust treatment makes it possible to construct good quality capping layers and beds for roads, railway tracks, and runways. The stiffening/curing of the structure means that the slopes of the structure have greater stability.

EXPERIMENTAL SETUP

In this present paper we are performing atterberg's limits test, linear shrinkage test, free swell index, and modified proctor test for determination of dry density and moisture content on black cotton soil and the mix proportions of black cotton soil

and brunt brick dust with lime as 20%BD+10%lime, 25%BD+5% lime& 35% BD + 5% lime replacement of soil by its dry weight.

Table 2: Tests and IS code determination

Atterberg's Limits	IS 2720 (Part V) 1985
Modified Proctor Test	IS: 2720 (Part VIII) 1983
Free Swell	IS 2720 (Part 40)-1977

Atterberg's Limits IS 2720 (Part V) 1985

Liquid Limit:

1. The liquid limit device shall be inspected to determine that it is clean , dry and in good working order, that the cup falls freely and it does not have too much side play at its hinge. The grooving tool shall also be inspected to determine that it is clean and dry.
2. About 120 gm of the soil sample passing 425-micron sieve shall be mixed thoroughly with distilled water in the evaporating dish or on the flat glass plate to form a uniform paste. The paste shall have a consistency that will require 30 to 35 drops of the cup to cause the consistency closure of the standard groove. In case of clayey soil , the soil paste shall be left for a sufficient time (24 hours) so as to ensure uniform distribution of moisture throughout the soil mass.
3. Take a portion of the paste in the spatula and place it in the centre of the cup so that it is almost half filled. Level off the cup surface of the wet soil with the spatula , so that it is parallel to the rubber base and maximum depth of the soil is 1 cm.
4. Cut a groove in the wet soil in the cup by using appropriate grooving tool.
5. Turn the handle of the apparatus at the rate of 2 revolutions per seconds until the two parts of the soil come in contact with bottom of the groove along the distance 10 mm. record the numbers of blows required to cause the groove close to 10 mm.
6. Collect the representative slice of soil from cup and put it in a airtight container, determine water content of the sample.
7. Remove the soil from the cup and mix it with the soil left earlier on the glass plate. Change the consistency of the mix by adding more water or leaving the soil paste dry. repeat the above steps 3,4,5, & 6. Note the numbers of blows to close the groove and keep the soil for water content determination.

Plastic Limit

1. Take about 120 gm of dry soil passing through the 425 micron IS sieve.
2. Mix the soil with distilled water on a glass plate to make it plastic enough to shape into a small ball.
3. Leave the plastic soil mass for some time for maturing.
4. Take about 8 gm of the plastic soil, and roll it with fingers on a glass plate, when a diameter of the thread has decreased 3mm, the specimen is kneaded together and rolled out again. Continue the process until thread just crumbles at 3 mm dia.
5. Collect the piece of crumbled soil thread in a moisture content container for water content determination.
6. Repeat the procedure at least the twice more with fresh sample of plastic soil.
7. The average water content of three soil sample will give plastic limit.

Modified Proctor Test IS: 2720 (Part 8) 1983

1. 5 kg of sample is taken
2. Thoroughly mix it with mixing tools.
3. Fill the mixed soil sample into the standard proctor mould into 5 layers with 25 blows per layer.
4. Unmould the soil specimen.
5. Take out very small amount of sample from the centre of the specimen and weight it. Put it into the oven for 24 hours for drying.
6. After completion of time period again weight the sample and note the difference in weight.

7. Repeat whole process until value increase again.
8. Plot the values and get OMC & MDD.

RESULTS AND DISCUSSION

Atterberg's Limits

Table 3: Atterbg's limit values for mix proportions of soil & brick dust with lime

DISCRIPTION	black cotton soil	20% BD + 10% lime	25% BD + 5%lime	35% BD+ 5% lime
Liquid Limit (%)	66.3%	44.56%	42.39%	40.02%
Plastic Limit (%)	31.56%	25.82%	23.24%	18.6%
Plasticity Index (%)	34.7%	18.74%	19.15%	21.42%

By the replacement of black cotton soil from the burnt brick dust with lime it is identified that the values of atterberg's limits are decreasing with increasing the stabilizing content. As same reduction is identified liquid limit, plastic limit and plasticity index. Reduction in liquid limit value for 20%BD+10%lime, 25%BD+ 5% lime& 35% BD + 5% lime are respectively 44.56, 42.39, & 40.02 %. Plastic limit values are as for 30, 40, 50 % burnt brick dust are respectively 25.82, 23.24, and 18.6%.

Modified Proctor Test

Table 4: Modified proctor test values for mix proportions of soil & brick dust with lime

CONTENT	black cotton soil	20%BD + 10%lime	25% BD+5%lime	35% BD+ 5% lime
MDD (g/cc)	1.42	1.63	1.66	1.68
OMC (%)	25.33	21.3%	19.3%	18.2%

The above figure is showing the impact of brick dust with lime on maximum dry density and optimum moisture content. Form the figure it is concluded that with the increasing amount of brick dust and lime by percentage weight of black cotton soil dry density is increasing and optimum moisture content is decreasing.

CONCLUSIONS

From the results it is concluded that the impact of brick dust and lime on black cotton soil is positive. By replacing soil by 35% of brick dust and 5% of lime of its dry weight it gives maximum improvement in the engineering properties of black cotton soil. So use of brick dust and lime is preferable for stabilization because it gives positive results as stabilizer and also it is a waste utilization.

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