Influence of Lime and Brick Dust on Compaction and Strength Properties of Clay Soil When Mixed With Ldpe

Sameer Khaliq, Mohammad Irshad Malik, Jagdeep Singh

Abstract: Soil is an essential part of construction and forms a base for all the essential activities of construction. Soil is not same at all places and sometimes lacks in various properties. So, to improve its various qualities and to meet the engineering requirements like quality, durability, etc., we can achieve it by adding suitable admixtures such as, lime, cement, fly ash, plastic, gypsum etc. This not only improves the properties of soil but also reduces the quantities of waste in the environment. The aim of this study is to experimentally investigate the effects of adding Lime, Brick dust and Plastic and low density polyethylene to Clayey Soil. The low density polyethylene is a vital environmental pollutant and its biodegradation is the focus of the present study. The clay soil used was taken near Baddi, Himachal Pradesh. The optimum contents of Lime, Brick dust and LDPE in the Clay soil was found by Standard Proctor Test and CBR test, and the results showed by adding 20% lime , 8% Brick dust and 1.5% LDPE in the Clay soil, we get the maximum Bearing Capacity of the mixture.

Keywords: Clayey soil, low density polyethylene, lime, brick-dust, soil compaction, California bearing ratio

I. INTRODUCTION

The effect of various materials added to clay soil has been experimentally studied in this venture work by utilizing lime and brick dust and LDPE. Clays are important to any foundation because the structures frequently rest upon clayey formations. So to enhance its engineering property many admixtures can be added to it. In this present investigation lime, brick dust and LDPE were used.Once treated with lime, such soil can be used to create embankments or sub grade of structures, thus avoiding expensive excavation works and transport. Lime is already known for its binding property it is widely used as a stabilizer. By using lime in soil, it significantly improves the characteristics of soil and produce long-term stability and permanent strength.

We also added brick dust with it to make it economical since brick dust is locally available waste material and its disposal is a challenge to the environment and lessen the cost of maintenance. Along with Lime and Brick dust different proportions of LDPE (Low Density Polyethylene) which is also a waste material was added to the mixture and investigation is done to find out its effect on the engineering property of clay soil. Ldpe particles increase soil reinforcement as well as utilization of waste.

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Less study is available on the combined use of lime brick dust stabilized soil. Hence in the present experiment, an attempt is made to study combined effect of lime, brick dust and plastic waste on the properties of clayey soil, with an aim of obtaining a cost-effective mixture as well as the utilization of waste plastic that will be used as sub base material for various purposes. From the test results, they have concluded that the proposed methodology is very effective for improving the engineering properties the clayey soil. The use of by-product materials to improve the soil properties varies with economic, environmental and technical points.

II. MATERIALS USED

1. CLAY SOIL

Clay is a finely grained natural rock or soil that consists of one or more clay minerals with fragments of metal oxides, quartz, and organic matter. Clays being plastic in nature become hard upon drying and when fired in a kiln .This plasticity in clay soil is because of its particle size ,geometry as well as water content. These changes transform the clay into a ceramic material. Due to these properties of clay soil is pottery, bricks, wall and floor tiles are made of it. Vast quantities of earth materials containing clays are used in embankments and linings. In this experimental study the clay soil investigated was taken from Baddi District, Himachal Pradesh.

2. LIME

The word “lime” refers to products obtained from heating or calcining limestone. Lime is a resourceful mineral with many uses. It is been used as a principle binder for mortars and plasters. Consisting of calcium, carbonates, oxides and hydroxides, lime is used in construction, environmental, metallurgical, industrial and chemicals applications. Lime is typically derived from rocks and minerals of limestone or chalk, composed primarily of calcium carbonate. Limestone is found in abundant quantity in sedimentary rocks. So, Lime is produced by extracting limestone from quarries and mines. In this experimental work, the lime was purchased from local market for the intended purpose.

3. BRICK DUST

Brick dust is a waste material generated in tons of amount in brick kilns. It is red in color and is fine in nature. It has tremendous ability to reduce swelling potential of the soil. Brick dust is mixed with lime to study their combined effect on engineering properties of clayey soil. The brick dust used in this investigation is brought from brick kiln near Gharaun, Mohali.

4. LDPE(Low Density Polyethylene)

LDPE, Low Density Polyethylene is a thermoplastic made from the monomer ethylene. It is a tough flexible material which is easy to process, and has excellent impact resistance, chemical resistance and insulation proportion. Ldpe is easily available and products like Carry bags, sacks, milk pouches, bin lining, cosmetic and detergent bottles are made from it. In this experiment, ldpe bags were collected from surroundings and cut into strips and rounded particles as shown in the figure.

III. EXPERIMENTAL SETUP

The experiment is carried out on clayey soil by addition of Lime, Brick dust and LDPE in different proportions and tests are conducted for studying the variation of different Geotechnical Parameters like optimum moisture content, maximum dry density and California bearing ratio.

A. TESTS CONDUCTED

Following tests were conducted in this experimental work:

i. Liquid Limit Test
ii. Plastic Limit Test
iii. Standard Proctor test
iv. California Bearing Ratio

The series of Tests conducted for determination of Compaction Characteristics (Optimum Moisture Content & Maximum Dry Density) and California Bearing Ratio for different proportions of Lime, Brick dust and LDPE mixed with soil as given below:

Soil Only
Soil + 5% Lime
Soil + 10% Lime
Soil + 20% Lime (taken as optimum content)
Soil + 25% Lime

Soil + 20% Lime + 2% Brick dust
Soil + 20% Lime + 4% Brick dust
Soil + 20% Lime +6% Brick dust
Soil + 20% Lime + 8% Brick dust (taken as optimum content)
Soil + 20% Lime + 10% Brick dust

Soil + 20% Lime + 8% Brick dust + 0.5%LDPE
Soil + 20% Lime + 8% Brick dust + 1%LDPE
Soil + 20% Lime + 8% Brick dust + 1.5%LDPE
Soil + 20% Lime + 8% Brick dust + 2%LDPE
Soil + 20% Lime + 8% Brick dust + 2.5%LDPE

All the tests are conducted as per the relevant IS Codes of Procedures. Brief descriptions of the test procedures are given below.

B. TEST PROCEDURES

All the tests are conducted as per the relevant IS Codes of Procedures. Brief descriptions of the test procedures are given below:

i. Liquid Limit Test

The liquid limit test on soil is done to determine the moisture content of the soil, and is defined as the percentage of moisture content required to close a distance of 0.5 inches along the bottom of a groove after 25-30 blows in a liquid limit device. The apparatus used for liquid limit test is known as Casagrande Apparatus.

ii. Plastic Limit Test

The plastic limit of a soil is the empirically created moisture content at which the soil turns so dry that it behaves as a plastic material and can be rolled into threads 3.2mm(about 1/8 inch) in diameter before the soil breaks into pieces. A soil which does not breaks into pieces at 3.2 mm diameter is termed as non-plastic. The Plastic limit threads of soil are performed on flat and non-porous surface.

iii. Standard Proctor Test

The standard proctor test is a laboratory geotechnical testing method of soil for determining its compaction properties especiallyto find the optimum water content at which the soil reaches its maximum dry density. The dry density is maximum at the optimum water content. The proctor test consists of following equipments

- Compaction mould
- Rammer
- Base Plate
- Collar
- 4.75 mm IS Sieve
- Mixing tools, trowels, etc.

About 2.5 kg of oven dried soil passing 4.75mm IS Sieve is taken and placed in the mould in 3 layers and all the three layers are uniformly compacted by giving 25 blows of rammer in three successive steps. Then we weigh the mould and determine its bulk density ,dry density and the moisture content. Similarly the test is performed on this soil again and again by increasing the water percentage till a stage reaches

when the dry density of the soil starts to decrease.

iv. California Bearing Ratio Test

The CBR tests were conducted in the CRR mould. The sample sizes were of 152mm diameter and 126mm length. The tests were performed at the OMC and maximum dry unit weight values of the natural soil. The load is applied by loading frame through a plunger of 50 mm diameter on the specimen in the mould compacted to Maximum Dry Density and Optimum Moisture content. Dial gauges are used for the measurements of the expansion of specimen on soaking and for measurement of penetration.

IV. RESULTS AND DISCUSSION

1. Atterberg's Limits

The Clay Soil was tested in the lab and plastic limit and liquid limit were found .The Liquid limit of the clay was found as 61.10% and the Plastic limit as 26.18% as shown in the table.

Table1.Atterberg'sLimits of Clay Soil

Liquid Limit	61.10%
Plastic Limit	26.18%
Plasticity Index	34.92%

2. Standard Proctor Test

The optimum moisture content and the maximum dry unit weight of the clay soil were 17% and 1.69gm/cc respectively. From table 4, the maximum dry density of Clay soil with Lime was found highest at 20% Lime content. So it was taken as optimum content.

Table 2.Standard Proctor Test result for Percentages of Lime with Clay

Percentages of Brick dust +20%Lime with Clay Soil	Maximum Dry Density (g/cm^3)	Optimum Moisture Content (%)
Clay Soil	1.69	17
Clay Soil + 20% Lime + 2% BD	1.81	14
Clay Soil + 20% Lime + 4% BD	1.80	14
Clay Soil + 20% Lime + 6% BD	1.82	14
Clay Soil + 20% Lime + 8% BD	1.83	14
Clay Soil + 20% Lime + 10% BD	1.73	14

The optimum moisture content and the maximum dry unit weight of the clay soil were 17% and 1.69gm/cc respectively. From table 4, the maximum dry density of Clay soil with Lime was found highest at 20% Lime content. So it was taken as optimum content.

Table 3 .Standard Proctor Test result for 20% Lime and percentages of Brick dust with Clay soil

Percentages of Lime with Clay Soil	Maximum Dry Density (g/cm^3)	Optimum Moisture Content (%)
Clay Soil + 0% Lime	1.69	17
Clay Soil + 5% Lime	1.78	14
Clay Soil +10% Lime	1.77	14
Clay Soil + 15% Lime	1.74	14
Clay Soil + 20% Lime	1.8	14
Clay Soil +25% Lime	1.77	14

The maximum dry density for clay+20% Lime was found at 8% Brick dust i.e,1.83 g/cm3 as well as CBR results also showed maximum bearing capacity of Clay soil with 20% Lime at 8%Brick dust i.e. 17.20 as shown in table below. So, it was taken as Optimum content.

Table 4. Standard Proctor Test result for 20% Lime + 8% Brick dust +Percentages of Ldpe with Clay soil

Percentages of LDPE+20%LIME+8%BD with Clay soil	Maximum Dry Density (g/cm^3)	Optimum Moisture Content (%)
Clay Soil	1.69	17
Clay Soil + 20% Lime + 8% BD + 0.5% LDPE	1.71	17
Clay Soil + 20% Lime + 8% BD + 1% LDPE	1.68	14
Clay Soil + 20% Lime + 8% BD + 1.5% LDPE	1.66	14
Clay Soil + 20% Lime + 8% BD + 2% LDPE	1.62	11
Clay Soil + 20% Lime + 8% BD + 2.5% LDPE	1.61	11

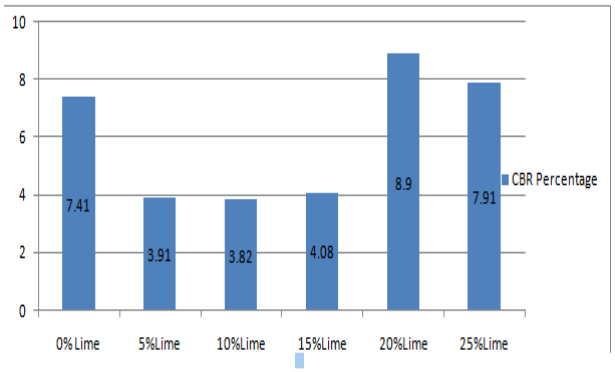
In the above experiment, various percentages of LDPE waste i.e., 0.5%,1.0%,1.5%,2.0% and 2.5% were added to the above optimum content of Clay with Lime and Brick Dust and it was found that the maximum dry density increases till 1.5% LDPE content and then decreases as we increase LDPE content.

3. California Bearing Ratio Test

Table 5.CBR Test result for various percentages of Lime with Clay

Percentages of Lime with Clay Soil	CBR Values (%)
Clay Soil	7.41
Clay Soil + 5% Lime	3.91
Clay Soil +10% Lime	3.82
Clay Soil + 15% Lime	4.08
Clay Soil + 20% Lime	8.90
Clay Soil +25% Lime	7.91

It can be clearly seen that the CBR Value decreases sharply with the addition of Lime, then the maximum bearing capacity of Clay soil with lime increases till 20% Lime content and then again decreases at 25% Lime as shown in the table. So, Clay with 20% Lime was taken as Optimum content.

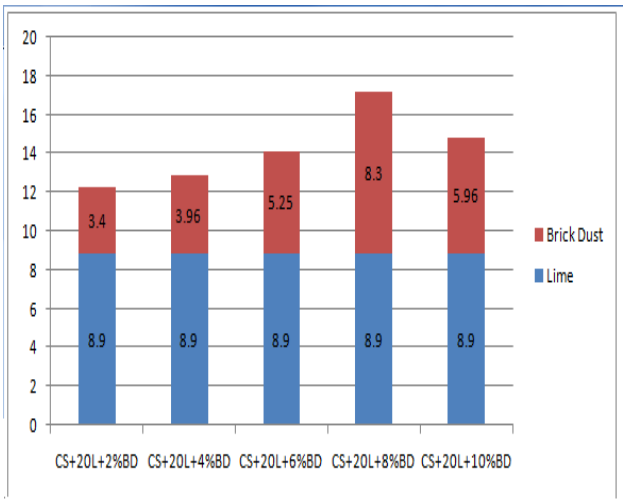


Graph 1,showing increase in the CBR value with variations in the percentages of Lime

Table 6. CBR Test result for 20% Lime and percentages of Brick dust with Clay soil

Percentages of Brick dust +20%Lime with Clay Soil	CBR Values(%)
Clay Soil	**7.41**
Clay Soil + 20% Lime + 2% BD	**12.3**
Clay Soil + 20% Lime + 4% BD	**12.86**
Clay Soil + 20% Lime + 6% BD	**14.15**
Clay Soil + 20% Lime + 8% BD	**17.2**
Clay Soil + 20% Lime + 10% BD	**14.86**

When different percentages of Brick dust were added to Clay with 20% Lime with, the CBR results showed that first maximum bearing capacity of the mixture increases up to certain percentages of brick dust i.e., 8%, and then decreases as shown in the figure. So CBR value was highest at 8% Brick dust.

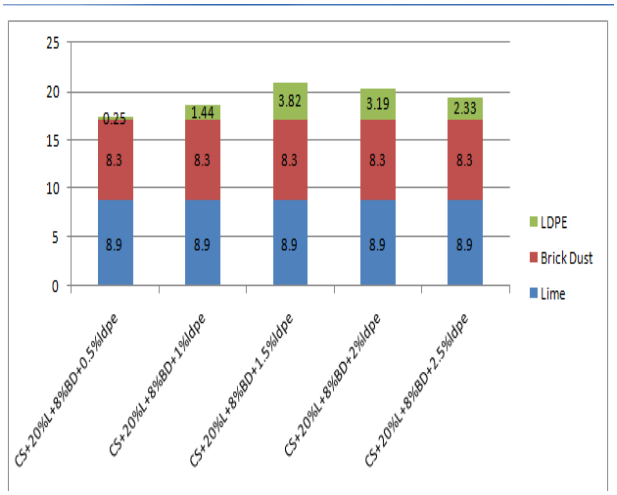


Graph 2, showing increase in the CBR value with variations in the percentages of Brick Dust

Table 7. CBR Test result for 20% Lime + 8% Brick dust +Various Percentages of Ldpe with Clay soil

Percentages of LDPE+20%LIME+8%BD with Clay soil	CBR Values
Clay Soil	7.41
Clay Soil + 20% Lime + 8% BD + 0.5% LDPE	17.45
Clay Soil + 20% Lime + 8% BD + 1% LDPE	18.64
Clay Soil + 20% Lime + 8% BD + 1.5% LDPE	21.02
Clay Soil + 20% Lime + 8% BD + 2% LDPE	20.39
Clay Soil + 20% Lime + 8% BD + 2.5% LDPE	19.53

Waste LDPE product was mixed at different percentages of dry weight of the soil (0.5, 1, 1.5, 2and 2.5 %) to the optimum lime brick dust content and the samples were tested for cbr values. The results revealed that the CBR of 0.5% to 2.5% LDPE-treated samples increased from 17.45% to 21.02% and then decreased to 19.53% . So the maximum bearing capacity of the mixture was found at 1.5% of LDPE.



Graph 3,showing increase in the CBR value with variations in the percentages of LDPE

V.CONCLUSION

The feasibility of adding particles of reclaimed LDPE to the mixture of Lime and Brick dust with clay soil was studied in this experiment. Small round particles of LDPE were mixed with soil along with lime and local brick dust and tested to determine Optimum Moisture content, Maximum dry density and CBR values. The tests show that there is an overall increase in the OMC and MDD while addition of LDPE increases the CBR values at least three times as that of clay soil.

Based on the results, the following conclusions can be drawn:

1. On the basis of experimental investigations it was observed that the CBR value of the Clay soil improved with the addition lime, brick dust and waste plastic in it.
2. The addition of Lime and brick dust increases the OMC and MDD of the clay soil.
3. The addition of LDPE particles, a waste material, with Clay incorporated with Lime and Brick dust increases the CBR value.
4. The maximum improvement in CBR is obtained when the mixture contains 20% Lime + 8% Brick dust 1.5% ldpe content.
5. The maximum CBR value of a reinforced system is approximately 3 times that of an unreinforced system.
6. The CBR percentage increased up to 1.5% plastic content in the soil and there after it decreased with the increase in plastic content. Hence, we conclude that 1.5% plastic content is the optimum content of plastic waste in the soil.
7. Also, it was found that the maximum dry density decreases with the increase in plastic content.

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