

Effect Of Lime And Brick Dust On Compaction And Swelling Property Of Black Cotton Soil

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Abstract - The black cotton soil also known as expansive soil due to its property of swelling and shrinking with change in moisture content, this property makes the black cotton soil counterproductive for the construction of roads, designing of flexible pavements and embankments. Many researchers found that change in properties is due to reaction with water that leads to reduction in strength. To improve the behaviour and engineering properties of black cotton soil, it needs to be stabilized using suitable stabilizers. So in this present investigation lime and brick dust are used at different proportions to stabilize the black cotton soil. The proportion used in this experiment is 2% lime with 10, 20, 30, and 40% brick dust in black cotton soil & another proportion used is 4% lime with 10, 20, 30 and 40% brick dust in black cotton soil. The test conducted are, compaction test, Atterberg's limit test and differential free swell index test. From the above test result we observed exceptionally great decrement in swelling and increment in maximum dry density of the soil.

Keywords - Soil stabilization, black cotton soil, brick dust, lime, swelling property

II INTRODUCTION

The black cotton soil is found in greater amount all over the world and is unsuitable for construction purpose. It contains montmorillonite mineral which has a tendency to expand and shrink due to this property they are named expansive soil. The engineering properties of fine grained soils depend on water content present in them. Plasticity index is the main parameter of classification of black cotton soil which depends on the liquid and plastic limit. Black cotton soils become very hard in their dry state and contain high bearing capacity. The swelling property generally increases with increase in plasticity index. So this parameter should be reduced to improve the black cotton soil's property. They are clayey soils and undergo volumetric change with effect of water content, this volumetric change leads to swelling and shrinking property in the soil, due to this, the structure built over it goes through many problems such as, undulation, uneven surfacing, cracks and settlement. They have less shearing resistance and are not appropriate for the construction. So to enhance its engineering property many admixtures can be added to it, in this present investigation lime and brick dust are used. Lime is already known for its binding property it is widely used as a stabilizer we used brick dust with it to lessen the cost of maintenance and make it economical as brick dust is locally available waste material, its disposal is a challenge to the environment so this investigation is done to find out its effect on the engineering property of black cotton soil. Earlier many researchers have worked on it and found that it is suitable for the stabilization of the black cotton soil.

III MATERIALS USED

1. Black cotton soil

It is also known as expansive soil due to its property of swelling it shows swelling and shrinking with change in water content. The soil used for the present experimental investigation is bought from Kunhadi region of Kota city of Rajasthan. The basic property of the soil are given in below table

Table 1 Properties of Black Cotton Soil

Property	Value
Water Content	17.5%
Maximum Dry Density	1.59g/Cc
Liquid Limit	43.07%
Plastic Limit	17.89%
Plasticity Index	25.18%
UCS	2.07kg/Cm ³
Soaked CBR	2.4

2. BRICK DUST

Brick dust is a waste material produced in tons of amount in brick kilns and tile processing plants. It is red in colour and is fine in nature. It has great ability to reduce swelling potential of black cotton soil. Brick dust is mixed with lime to study their combined effect on engineering properties of black cotton soil. The brick dust used in this investigation is brought from brick kiln near Taleda region of Kota city.

Table 2 Engineering Properties of Brick Dust

Engineering Property	Value
Grain Size Analysis 1.Gravel Size	0

2.Sand Size	86
3. Fines	14
Plasticity Characteristics	NP
IS Classification	SM
MDD	1.36g/Cc
OMC	33%
Soaked CBR	21.17

3. QUICK LIME

It gives binding property to the soil and increases its bearing capacity as it reacts with clay and forms cementing agents such as calcium silicate and alumina Quick lime is the common name of calcium oxide it is a chemical compound often used as a stabilizing agent. It has many qualities such as bond strength, cohesion, adhesion, comprehensive strength etc so it is also used as a building material. Using lime as a stabilizer it improves engineering properties of soil such as strength, resistance to deformation, decrease in liquid and plastic limit hence plasticity index is also reduced, it increases maximum dry density and reduces moisture content but after attaining its peak value it might led to decrease in MDD. The stabilization is a process to increase and improve quality and strength of the weak soil such as black cotton soil for such stabilization stabilizer is needed such as lime, the lime is obtained from local market for the intended purpose.

IV TESTS PERFORMED AND RESULTS

1. Sieve Analysis

The wet sieve analysis of soil particles is done by using 75 microns sieve. from the result obtained the soil can be considered as fine grained soil as more than 50% of particles passed through sieve. Based on these results classification is done as per IS 1498(1970). The following table shows the result of wet sieve analysis.

Table 3 Sieve Analysis of BCS

IS SIEVE	PARTICAL SIZE (mm)	Wight Retained	%Wight Retained	Cumulative % Retained	Cumulative % finer
4.75	4.75	0	0	0	100
2	2	8.9	0.89	0.89	99.11
1	1	9.9	0.99	1.88	98.12
0.6	0.6	12.3	1.23	3.11	96.89
0.425	0.425	15.3	1.53	4.64	95.36
0.3	0.3	15.8	1.58	6.22	93.78
0.212	0.212	16.1	1.61	7.83	92.17
0.15	0.15	14.2	1.42	9.25	90.75
0.075	0.075	22.6	2.26	11.51	88.49
Pan		884.9	88.49	100.00	0.00
Total		1000	100		

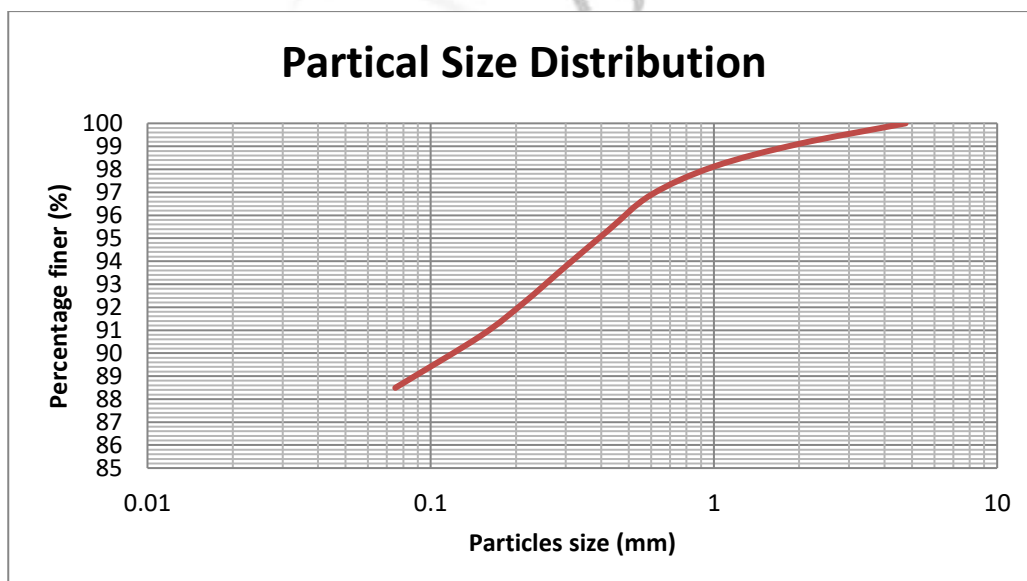


Figure 1 Particle Size Distribution Curve of BCS

2. STANDARD PROCTOR TEST

In standard proctor test soil sample is taken in a mould having 1000ml capacity and having internal diameter of 10cm. The soil is compacted in three layers with 25 blows per layer by a rammer of 2.6Kg falling from a height of 310mm. This process is repeated for different water content and a graph is plotted between dry density and water content to determine maximum dry density and optimum moisture content.

The results for 2% lime and brick dust is shown below

TABLE 4 STANDARD PROCTOR RESULT FOR BLACK COTTON SOIL WITH 2%LIME AND BRICK DUST

Percentages of lime and brick dust with black cotton soil.	Maximum dry density (g/cm ³)	Optimum moisture content
Black cotton soil	1.59	17.5
BCS+2%lime+10%BD	1.69	15.4
BCS+2%lime+20%BD	1.77	14.5
BCS+2%lime+30%BD	1.82	14.1
BCS+2%lime+40%BD	1.84	13.3

It can be seen that with increasing percentages of brick dust at 2% lime in black cotton soil the maximum dry density of the soil increases and the optimum moisture content gets decreased. Due to presence of lime and brick dust the weight of the soil specimen increases with increase in stabilization content. The maximum dry density increases up to 1.84 g/cc from 1.59 g/cc. The MDD value for 2% lime with 10, 20, 30 and 40% is 1.69, 1.72, 1.82 and 1.84 g/cc respectively. Similarly there is decrease in optimum moisture content with increasing percentage of brick dust the OMC of black cotton soil decreases to 13.3 from 17.5 the decrement in OMC for 2% lime with 10, 20, 30 and 40% brick dust is 15.4, 14.5, 14.1, and 13.3 respectively

The result for 4% lime with different percentages of brick dust in black cotton soil are as follows

TABLE 5 STANDARD PROCTOR RESULT FOR VIRGIN SOIL MIXED WITH 4% LIME AND BRICK DUST

Percentages Of Lime And Brick Dust With Black Cotton Soil.	Maximum Dry Density (g/cm ³)	Optimum Moisture Content
Black cotton soil	1.59	17.5
BCS+4%lime+10%BD	1.74	14.9
BCS+4%lime+20%BD	1.82	13.9
BCS+4%lime+30%BD	1.88	13.1
BCS+4%lime+40%BD	1.95	12.5

The above table shows the result of compaction test at 4% lime and different percentage of brick dust it can be conclude from above table that with increase in brick dust the MDD increases and OMC decreases. The decrease in OMC is up to 12.5 from 17.5. The decrease in OMC at 4% lime and 10, 20, 30 and 40% BD is 14.9, 13.9, 13.1, and 12.5 respectively. The increase in MDD value reaches up to 1.95 g/cc. The increase in MDD and decrease in OMC is due to change in size and behaviour of particles as clay size particles changes to silt due to presence of lime. Brick dust being a granular material increases the weight of the soil hence the MDD of specimen increases.

3 ATTERBERG'S LIMIT

The liquid limit and plastic limit test results are as follows

TABLE 4.4 ATTERBERG'S LIMITS FOR BCS MIXED WITH 2% LIME AND BRICK DUST

Percentages of lime and brick dust with black cotton soil.	Liquid limit	Plastic limit	Plasticity index
Black cotton soil	43.072	17.894	25.178
BCS+2%lime+10%BD	39.214	16.250	22.964
BCS+2%lime+20%BD	34.622	15.436	19.18
BCS+2%lime+30%BD	31.567	13.382	18.18
BCS+2%lime+40%BD	28.857	12.5	16.357

From the above figure and table it can be concluded that with increase in percentage of brick dust in 2% lime mixed with black cotton soil the liquid limit and plastic limit of the soil decreases and so does the plasticity index. This decrement in plasticity index, changes soil from CI to CL.

The decrement in liquid limit is up to 28.85 from 43.07%, the decrement in plastic limit is up to 12.5 from 17.89% and change in plasticity index with varying percentage of lime is 16.37 from 25.15. The values for liquid limit for 2% lime mixed with 10, 20, 30 and 40% brick dust with black cotton soil is 39.214, 34.622, 31.567 and 28.857 respectively. The change in plastic limit for 2% lime mixed with 10, 20, 30 and 40% brick dust with black cotton soil is 16.25, 15.436, 13.382 and 12.5 respectively.

Percentages Of Lime And Brick Dust With Black Cotton Soil.	Liquid Limit	Plastic Limit	Plasticity Index
Black cotton soil	43.072	17.894	25.178
BCS+4%lime+10%BD	35.36	14.062	21.298

BCS+4%lime+20%BD	32.116	12.328	19.878
BCS+4%lime+30%BD	28.361	10.309	18.052
BCS+4%lime+40%BD	24.55	9.090	15.46

TABLE 5 ATTERBERG LIMIT FOR BCS WITH 4% LIME AND BRICK DUST

The values for liquid limit for 4% lime mixed with 10, 20, 30 and 40% brick dust with black cotton soil is 35.36, 32.116, 28.361 and 24.55 respectively. The change in plastic limit for 2% lime mixed with 10, 20, 30 and 40% brick dust with black cotton soil is 14.062, 12.328, 10.309 and 9.09 respectively. The plasticity index reduced to 15.46 from 25.178. This decrement is due to the presence of brick dust and lime as it led to decrease in the diffused double layer thickness of the clay particles.

4 DIFFERENTIAL FREE SWELL INDEX TEST

The test results are

TABLE 6 DFS TEST RESULT FOR BCS WITH 2% LIME AND BRICK DUST

Percentages Of Black Cotton Soil With Lime And Brick Dust	Differential Free Swell Index	Degree Of Expansiveness	% Decrease In DFS
Black cotton soil	41.67	Very High	-
BCS+2%lime +10%BD	20.58	Moderate	50.61
BCS+2%lime +20%BD	10	Low	76.00
BCS+2%lime +30%BD	7.69	Low	81.54
BCS+2%lime +40%BD	2.5	Low	94.00

From the above table it can be concluded that with increase in percentage of brick dust the free swell index of the black cotton soil mixed with 2% lime is decreasing. The decrease in free swell index at 40% brick dust reaches to 94%. The value of free sell index reaches to 2.5% from 41.67%. Free swell index for the black cotton soil mixed with 2% lime and 10, 20, 0 and 40% brick dust is 20.58, 10, 7.69 and 2.5 respectively. This reduction in free swell index is due to replacement of clay particles with brick dust as clay content decreases the free swell index decreases.

TABLE 7 TEST RESULT FOR BCS WITH 4% LIME AND BRICK DUST

Percentages Of Black Cotton Soil With Lime And Brick Dust	Differential Free Swell Index	Degree Of Expansiveness	% Decrease In DFS
Black cotton soil	41.67	Very High	-
BCS+4%lime +10%BD	13.88	Moderate	66.69
BCS+4%lime +20%BD	7.31	Low	82.45
BCS+4%lime +30%BD	5.0	Low	88.00
BCS+4%lime +40%BD	0	Low	100.00

The above table shows the result obtained in differential free swell index test the differential free swell index becomes zero at addition of 40 %brick dust and 4% lime in black cotton soil. It can be concluded that with increasing percentage of brick dust the free swell index decreases and ultimately becomes zero. The value of free swell index of black cotton soil mixed with 4% lime and 10, 20, 30 and 40% brick dust is 13.88, 7.31, 5.0 and 0.00% respectively.

CONCLUSIONS

1. It can be concluded from the above results that with increase in percentages of brick dust at 2 and 4% of lime the MDD of soil increases and OMC of Soil decreases. We get greater values of MDD and less value of OMC at 4% lime then 2% lime.
2. The liquid limit and plastic limit gets reduce with increase in percentages of brick dust at 2% and 4% lime. The plasticity index also gets reduced with increment in percentage of brick dust.
3. The differential free swell index gets reduced by addition of lime and brick dust, it almost gets reduced to zero at 4% lime and 40% brick dust.
4. From the above observation it can be concluded that brick dust and lime can be used to improve the engineering property of black cotton soil.

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