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ANALYSIS OF ENGINEERING PROPERTIES OF BLACK COTTON SOIL AND STABILIZATION USING BRICK DUST

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Abstract -Black cotton soil absorb of water and go through a lot of volume changes, causing heave and shrinkage depending on water availability. Structures built on such soils are frequently disturbed and fail as a result of this .To deal with the swelling issues associated with these soils, methods such as preloading, moisture control, replacement of black soil, and additives have been utilized. The purpose of this study is to find a practical application of brick dust in black cotton soil. The geotechnical properties dealt in this study include plasticity, compaction characteristics, strength characteristics and swelling behavior of black cotton soil. A laboratory experiment is carried. Black cotton soil is mixed with different proportions of brick dust (%). The engineering properties of plain black cotton soil and soil mixed with different brick dust (%) is analyzed here. The percentage of brick dust is varied from 5% to 20%. From study it is concluded that engineering properties of black cotton soil is modified

Key Words: Unconfined compressive strength, soil stabilization, black cotton soil, brick dust, swelling and shrinkage behavior

1. INTRODUCTION

1.1 General

Soil stabilization is the process of altering or enhancing the physical, chemical, or mechanical properties of soil. Soil stabilization is a method for fine-tuning and improving soil engineering features. Mechanical strength, permeability, compressibility, durability, and plasticity are some of these qualities. Although physical and mechanical improvements are common, certain theoretical approaches prefer to refer to chemical changes in soil quality caused by the use of chemical admixtures as "stabilization."

1.2 ADVANTAGES OF SOIL STABILIZATION

1. It raises the safety factor against slope sliding.

2. Soil stabilization significantly improves the soil's bearing capacity.

3. It improves the soil's binding force, allowing it to be employed on bridge side slopes and in the construction of sloped buildings. As a result, it is advantageous in densely populated places.

4. Soil stabilization uses only low-cost raw and waste materials, making it a cost-effective strategy for improving soil properties.

5. Soil stabilization creates a solid foundation. In the case of gravity walls and R.C. cantilever walls, there is no settlement. As a result, even on bad soils, construction is possible.

1.3 OBJECTIVE OF WORK

The aim of my work is to made brick dust mixture with black cotton soil at different percentage of brick dust and study about

1The behavior of black cotton soil in terms of swelling and shrinking

2. The maximum dry density is studies as well as the optimal moisture content of black soil is also analyses

.3. To investigate the strength of black cotton soil.

4. test is conduct to reduce the plasticity of black cotton soil

2. MATERIALS AND METHODOLOGY

2.1 MATERIAL USED

BLACK COTTON SOIL –

Black cotton soil was used in this study. As part of this investigation, black cotton soil was collected from the location of Jam Nagar in Gujarat. The black soil was transported to the laboratory in plastic bags or polythene.

Fig 1: BLACK COTTON SOIL

The geotechnical properties of the plain black cotton soil are

Table -1: physical properties of black cotton soil

SI.NO	PROPERTIES	VALUE
1	SPECIFIC GRAVITY	2.3
2	LIQUID LIMIT (%)	56
3	PLASTIC LIMIT (%)	26
4	PLASTICITY INDEX (%)	30
5	OMC (%)	27.6
6	MDD (g/cm^3)	1.51
7	UCS (Kg/cm^2)	0.50
8	CBR VALUE(UN-SOAKED)	1.36%
9	FREE SWELL INDEX (%)	45

BRICK DUST - Brick dust is a waste product produced in large quantities in brick kilns, tile processing factories, and old brick buildings. It has a red color and is fine in nature. It has a strong ability to limit the propensity for black cotton soil to swell. The combined influence of brick dust and black cotton soil on engineering properties of black cotton soil is investigated in this study.

Fig 2-BRICK DUST

2.2 METHODOLOGY ADOPTED

A series of tests were conducted to examine the effect of brick dust as a stabilising additive in expansive soils, with the brick dust in the expansive soil varying from 5% to 20% by weight of the total quantity taken. During the studies, the Indian Standard codes were followed:

1. IS: 2720 (Part 7) – 1980 Standard proctor test

2. Unconfined compressive strength (UCS) test according to IS: 2720 (Part 10) – 1991

3. CBR (California Bearing Ratio) test (IS: 2720 (Part 16)) test (California Bearing Ratio) test (IS: 2720 (Part 16)) test (California Bearing Ratio)

4. Free swell index test – IS 2720 (Part 40) – 1977

5. AtterbergeLimit test for liquids and polymers, IS 2720 (Part 5) - 1985

6. IS 2720 (Part 3) - 1980 Pycnometer specific gravity test of soil

2.3 TEST PROCEDURES

2.3.1 STANDARD PROCTOR TEST

Fig 3- PROCTOR TEST

2.3.2 UNCONFINED COMPRESSIVE STRENGTH TEST

Fig 4-UCS APPARATUS

2.3.3 CALIFORNIA BEARING RATIO TEST

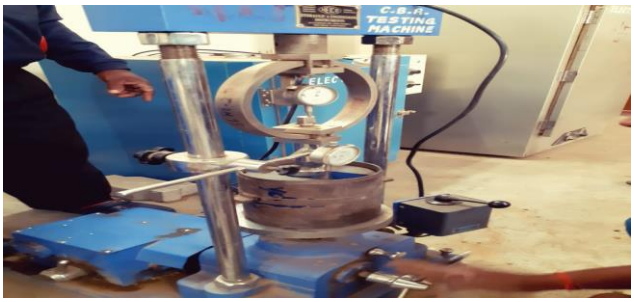

Fig 5-CBR APPARATUS

2.3.4 FREE SWELL TEST

2.3.5 ATTERBERGELIMIT TEST FOR LIQUIDS AND PLASTICS

2.3.5.1 LIQUID LIMIT

Fig 6- CASSAGRANDE APPARATUS

2.3.5.2 PLASTIC LIMIT

Fig 7-PLASTIC LIMIT SAMPLE

2.3.6 SPECIFIC GRAVITY TEST OF SOIL USING PYCNOMETER

Fig 8- PYCNOMETER APPARATUS

3. RESULTS AND DISCUSSION

The outcomes of the tests undertaken in this study are presented in this chapter. Free swell test, unconfined compression test, standard proctor test, and ATTERBERG limit test were used to investigate the behavior of black cotton soil and brick dust combination. The impact of compaction, water content, dry density, and optimal moisture for various percentages of brick dust were investigated. The proportion of brick dust in the mix varies from 5% to 15%. All laboratory experiments were carried out in the soil mechanics laboratory of B.I.T SINDRI civil engineering department.

3.1 STANDARD PROCTOR TEST

Table-2

SAMPLE DESCRIPTION	MDD (g/cm^2)	OMC (%)
BCS ONLY	1.51	27.6
BCS+5% BD	1.53	21.6
BCS+10% BD	1.61	18.60
BCS+15% BD	1.69	18
BCS+20% BD	1.59	17.6

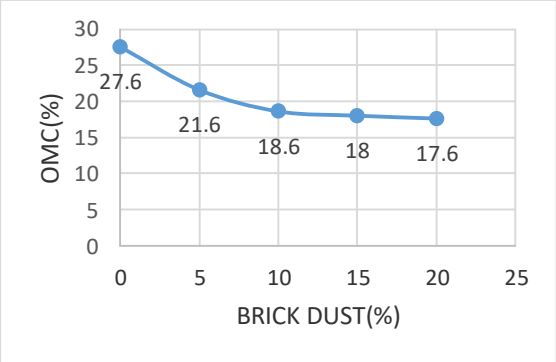

Fig 9-Variation of OMC(%) with BD(%)

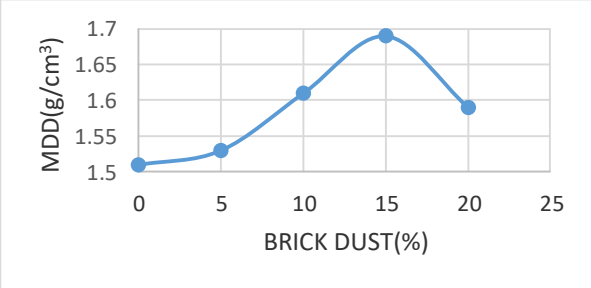

Fig 10- Variation of MDD with BD(%)

3.2 UNCONFINED COMPRESSIVE STRENGTH TEST

Table-3

SAMPLE DESCRIPTION	UCS(Kg/cm^2)
BCS ONLY	0.50
BCS+5% BD	1.10
BCS+10% BD	2.52
BCS+15% BD	2.80
BCS+20% BD	2.41

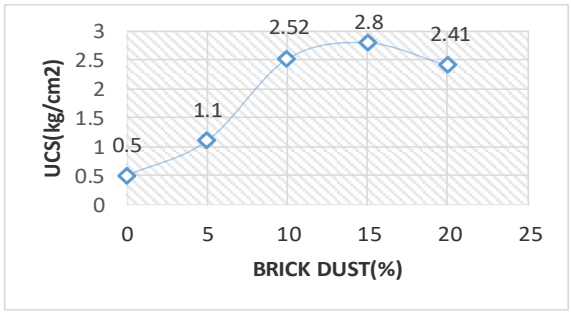

Fig 11- variation of UCS with BD (%)

3.3 UN-SOAKED CALIFORNIA BEARING RATIO TEST

Table-4

SAMPLE DESCRIPTION	CBR VALUE (%)
BCS ONLY	1.36
BCS+5% BD	2.29
BCS+10% BD	4.70
BCS+15% BD	7.65
BCS+20% BD	6.80

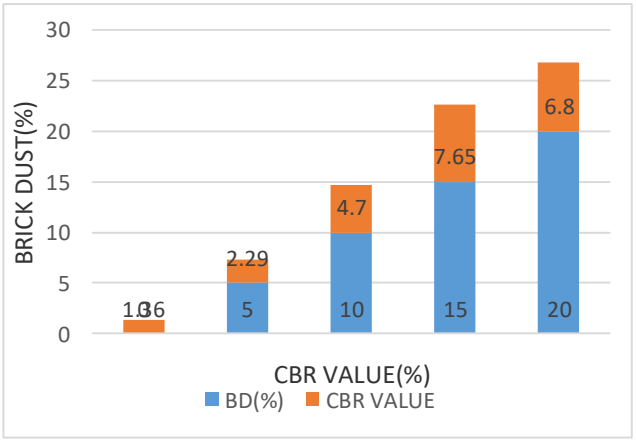

Fig 12-variation of UN-SOAKED CBR VALUE (%) with BD (%)

3.4 FREE SWELL INDEX

Table-5

SAMPLE DESCRIPTION	FREE SWELL INDEX (%)
BCS ONLY	45
BCS+5% BD	42
BCS+10% BD	39
BCS+15% BD	26
BCS+20% BD	21

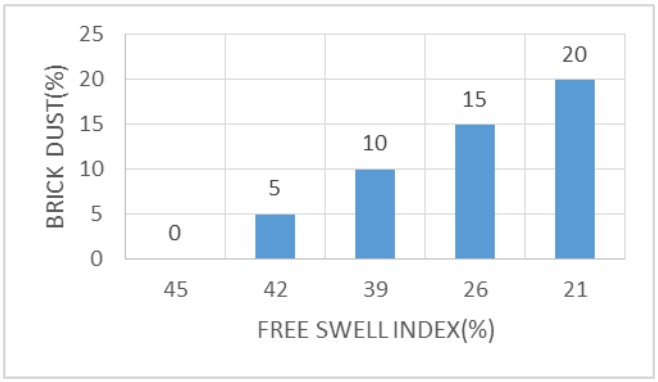

Fig 12-variation of FSI (%) with BD (%)

3.5 ATTERBER'G LIMITS

Table-6

SAMPLE DESCRIPTION	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)
BCS ONLY	56	26	30
BCS+5% BD	48	23	25
BCS+10% BD	42	19	23
BCS+15% BD	36	15	21
BCS+20% BD	30	11.6	18.4

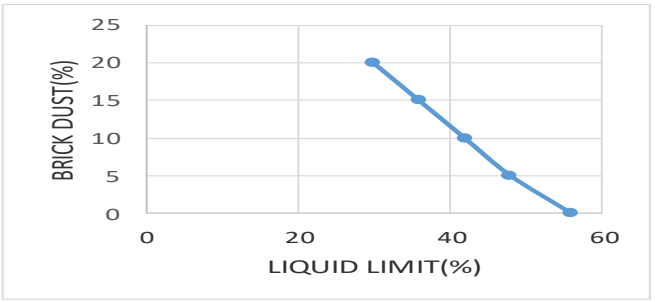

Fig 13- variation of LIQUID LIMIT (%) with BD (%)

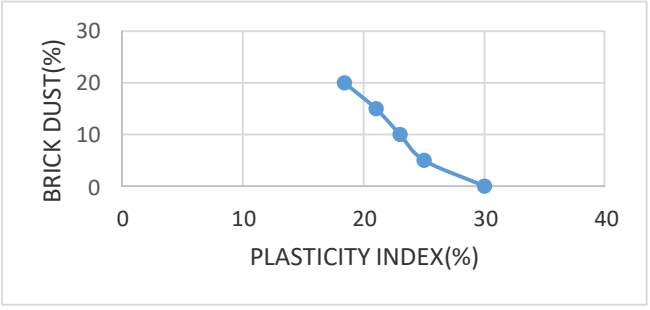

Fig 14- variation of PLASTICITY INDEX (%) with BD (%)

4. CONCLUSIONS

The conclusion of the experimental study are:

1. When black cotton soil is mixed with brick dust up to 15%, the maximum dry density increases, and the maximum dry density of black cotton soil at 15% brick dust mixing is 1.69 g/cc. The optimal moisture content of black cotton soil falls as the quantity of brick dust in the soil increases. OMC is 18% when 15 % brick dust is mixed with black cotton soil

2. Compressive strength of plain black cotton Soil is very low. UCS of plain black cotton soil is very less which are increases when brick dust (%) increases. The unconfined compressive strength at 15% brick dust mixture is 2.8kg/cm^2

3. The CBR test is carried out in a dry environment. The CBR value of plain black cotton is less and increased with mixture as the percentage of brick dust increases. CBR value at 15% mixture with brick dust is found to be 7.36%

4. Experimental study concluded that increase in percentage of brick dust in black cotton soil decreases the swelling of soil.

5. The Liquid limit and plastic limit both decreases but decrease in liquid limit is more as compare to plastic limit hence plasticity index also decrease.

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