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Effect of Burnt Brick Dust on Swelling and Shrinkage in Black Cotton Soil

Omkar U. Kumbhar

B.E Student, Department of Civil Engineering, AMGOI, Shivaji University, Kolhapur, India

Abstract: ***With rapid growth of populations, fast urbanization and more construction of buildings and other structures has resulted in reduction of good quality available land. There is no choice of people except to use soft and weak soils around for construction activities. Such soil possesses poor shear strength and high swelling and shrinkage. The mechanical behaviour of such nature of soil has to be improved by employing stabilization techniques to make it reliable for construction activities. The black cotton soil is one of the major issues in india. The black cotton soil has a properties of expansiveness, swelling and shrinkage. Due to this types of properties of soil the behaviour of black cotton soil changes drastically. When exposed to variation in moisture content they undergo high swelling and shrinkage making it more complicated from engineering point of view. Based on many research we can conclude that the changes in properties and behaviour are due to reaction with water that may reduce the strength and can damage the structure. In this project we have performed stabilization on black cotton soil with brick dust which is waste material and widely available in large quantity. To resolve the problem of swelling and shrinkage we have replaced soil by stabilizing agents of its varying percentage of dry weigth. For analysis of effect of stabilizer on soil. The comparison has done of properties of 100% black cotton soil and various combinations of black cotton soil and brick dust. The comparison includes total properties consideration carried out by compaction test, atterberg's limit test, linear shrinkage test and swelling test on both normal and stabilized soil.***

1. Introduction

Black cotton soil occupies about 3% of the world land area (i.e., about 340 million hectares). They are found mainly in Africa, in the Gezira cotton fields of the southern black cotton plains of Sudan, South Africa, Ethiopia and Tanzania. In Asia they are found extensively in the Indian Decca Plateau. They could also be found in Australia, West Indies and in vast areas of Russia. In India which occupy about 20% of its surface area. In India these, soils are predominant in the states of Gujarat, Maharashtra, Madhya Pradesh, Andhra Pradesh, Karnataka and Tamilnadu.

Expansive soils contain the clay mineral montmorillonite with claystones, sedimentary and residual soils are absorbing great amount of water and expand.

The expansive nature of the clay is less near the ground surface where the profile is subjected to seasonal and environment changes. Expansive soils also shrink when they dry out. Fissures in the soil can also develop. These fissures help water to penetrate to deeper layers when water is present. The more water they absorb the more their volume increases. This produces a cycle of shrinkage and swelling that causes the soil to undergo great amount of volume changes. This movement in the soil results in structural damages especially in lightweight structures such as sidewalks, driveways, basement floors, pipelines and foundations.

The effect of cyclic swell-shrink on the swelling behavior of natural soil is studied by many researchers (Popesco 1980; Chen and Ma 1987; Subba Rao and Satyadas 1987; Dif and Blumel 1991; Day 1994; Al Homoud et al 1995; Bilsel 2002; Tripathy 2002). Some investigators studied the swelling characteristics of expansive soils after repeatedly wetting-drying cycles. Chen et al (1985), Chen and Ma (1987), Subba Rao and Satyadas (1987), Dif and Bluemel (1991) concluded that when soils were subjected to full swell and allowed to shrink to their initial water content, they showed less expansion due to the fatigue of clay after Popesco (1980), Day (1994) and Guney (2007) concluded that swelling potential increased with the number of cycles. Al Homoud et al (1995) stated that cyclic wetting-drying resulted in particle aggregation. He supported his findings by the reduction in clay content and the plasticity index values of the soils after the increasing number of cycles. This inevitably caused reduction in the swelling characteristics (awfiq, 2009).

Black cotton soil is one of the major regional soil deposits in India, covering an area of about 3.0 lakh sq.km. The annual cost of damage to the civil engineering structures is estimated at £150 million in the UK, $1000 million in the USA and many billions of pounds worldwide.

In India, black cotton soils have liquid limit values ranging from 50 to 100%, plasticity index ranging from 20 to 65% and shrinkage limit from 9 to 14%.

The amount of swell generally increases with increase in the plasticity index. The swelling potential depends on the type of clay mineral, crystal lattice structure, cation exchange capacity, ability of water absorption, density and water content.

Almost 20% area of is occupied by black cotton soil. These soil are predominant in states of Andhra Pradesh, Western Madhya Pradesh, Gujrat, Maharashtra, Northern Karnataka, Tamil Nadu and some parts of Southern Uttar Pradesh (Bundelkhand area). They are mostly clay soils and form deep cracks during dry season. They are popularly known as "Black Cotton Soils" because of their dark brown color and suitability for growing cotton. They are black due to compounds of iron and aluminum. These soils are deficient in nitrogen, phosphoric acid and organic matter but rich in calcium potash and magnesium.

2. Literature Review

Analysis of clayey soil using waste material
Ankit J. Patel,Sachin N. Bhavsar
In this paper it is observed that by stabilization of black cotton soil for 30% replacement by marble powder and brick dust the properties related to soil are improved. For marble powder Liquid limit, Plastic limit, Plasticity index values are decreasing. As same we have found increment in maximum dry density and reduction in optimum moisture content. It is clearly identified from result that swelling and shrinkage behavior of soil is reduced after stabilization. For replacement of marble powder we get 0% of swelling in soil and also shrinkage is reduced by 17.7%. As same for brick dust swelling is only 0f 10% and shrinkage reduced by 14.3 %. Result great decrement in swelling and shrinkage behavior of soil which can be helpful to our future construction uses and waste of land can be reduced by using black cotton soil itself as a construction material or a base of any construction.

Analysis of Swelling and Shrinkage Properties of Expansive Soil Using Brick Dust as a Stabilizer
Ankit J. Patel ,Sachin N. Bhavsar
In this paper presents it is clearly identified that the engineering properties are improving after stabilizing it with Brick Dust by 50% of its dry weight. It has shown a great reduction in swelling and shrinkage behaviour of expansive soil.

Experimental investigation for stabilization of black cotton soil by using waste material - brick dust
Kunal R. Pokale , Yogesh R . Borkar, Rahul R. Jichkar
In this paper presents Combination of Black cotton soil+ brick dust. In this combination, black cotton soil is mixed by weight with brick dust on percentage basis i.e. 10%, 20%, and 30%. 4.75 mm IS sieving BCS 4.75 mm IS sieving brick dust used for the preparation of sample. There are Four samples for experimental test. (1) Plain black cotton soil (0%) ,(2) 10% brick dust + 90% black cotton soil (10%BD), (3) 20 % brick dust + 80 % black cotton soil (20%BD) , (4) 30 % brick dust + 70 % black cotton soil (30%BD). These Four samples considers for the experimental test for day1, day7 and day28 performance.

Swell-shrink behavior of expansive clays
Salma Tawfiq, Zalihe Nalbantoglu
In this paper study is to carry out an experimental work to investigate the effect of the weathering process caused by the wetting-drying cycles on the swelling behavior of an expansive soil. The paper describes the modified oedometer used and the different swell-shrink pattern (full swelling-full shrinkage and full swelling-partial shrinkage) adopted in this investigation. After each cycle, the expansion and shrinking characteristics of the soil were assessed. The experimental data indicated that wetting-drying cycles caused an increase in the swell potential of the soils which were subjected to full swell-full shrinkage cycles whereas a decrease in the swell potential of the soils was observed for the soils which were subjected to full swell-partial shrinkage cycles. The change in the vertical deformation values of the soils which were subjected to full swell-full shrinkage cycles was much higher than the soils which were subjected to full swell-partial shrinkage cycles.

3. Methodology and Materials

3.1 Methodology

a) Collection of sample
b) Establishing properties of soil
   i) Particle size distribution
   ii) Atterberg's limits **IS 2720 (Part V) 1985**
      - Plastic limit
      - Liquid limit
      - Plasticity index
   iii) Swelling index
   iv) Linear shrinkage
   v) Modified proctor test
      - Optimum moisture content
      - Maximum dry density
c) Re-establishing properties of soil after stabilization
d) Observations and interpretation
e) Conclusion

3.2 Material

Brick Dust
Burnt brick powder is a waste powder generated from the burning of bricks with the soil covered by surroundings. Due to burning of soil bricks it hardened and at the time of removal the set up we get the powder form of brick. It has red colour and fine in nature. It has great ability to reduce the swelling potential of black cotton soil.

Black Cotton Soil
The black cotton soil has been collected from the nearby area for the evaluation of soil properties.

4. Results and Analysis

4.1 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 brick powder with 10%, 20%, & 30% replacement of soil by its dry weight.

Table: Tests and IS code determination

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

4.2 Results and Discussion

Atterberg's Limits

Table: Atterberg's limit values for mix proportions of soil & brick dust

(%)	BC soil	10% BD	20% BD	30% BD
LL	42.50	38.7	33.9	30.54
PL	24.33	23.89	17.87	16.5
PI	18.17	14.81	16.03	13.96

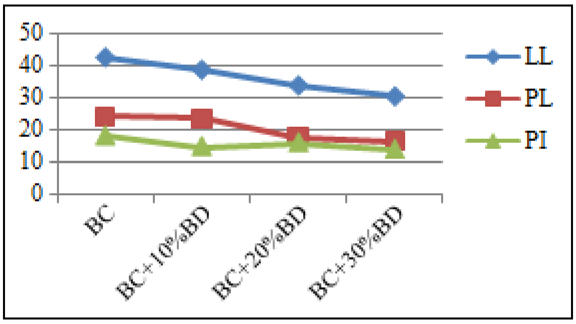

Chart: Atterberg's Limit Chart of Replacement of Brick Dust

By the replacement of black cotton soil from the burnt brick dust it is identified that the values of attereberg's limits are decreasing with increasing the stabilizing content.

Modified Proctor Test

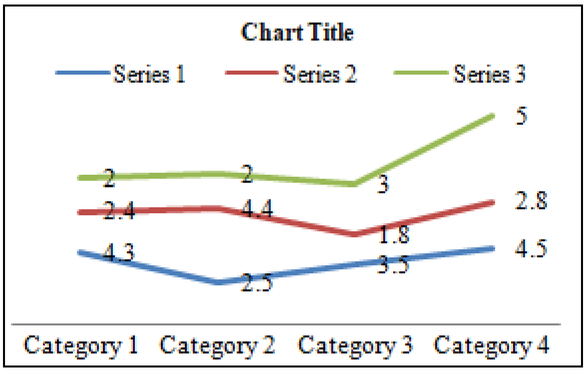

Chart: Maximum dry density for mix proportions soil & brick dust

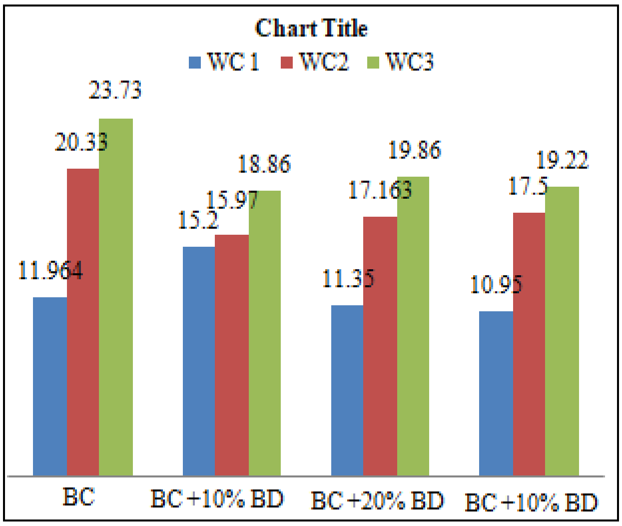

Chart: Optimum moisture content for mix proportions soil & brick dust

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

Free Swell Index

Table: Free swell index values for mix proportions of soil & brick dust

Mix Proportion	black cotton soil	BC + 10% BD	BC + 20% BD	BC + 30% BD
Free swell index	31.81	19.05	12.75	10.89

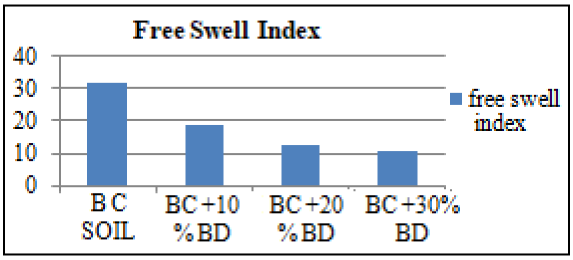

Chart: Free swell index chart for mix proportions soil & brick dust

With increasing the burnt brick dust content the swelling index is decreasing which shows reduction in swell index with increment in stabilizing content

Water Content and Specific Gravity

Table: Water content and specific gravity values for mix proportions of soil & brick dust

Mix Proportion	BC soil	BC + 10% BD	BC + 20% BD	BC + 30% BD
Specific Gravity	2.57	2.61	2.65	2.71
Water Content (%)	8.695	4.167	3.75	3.2

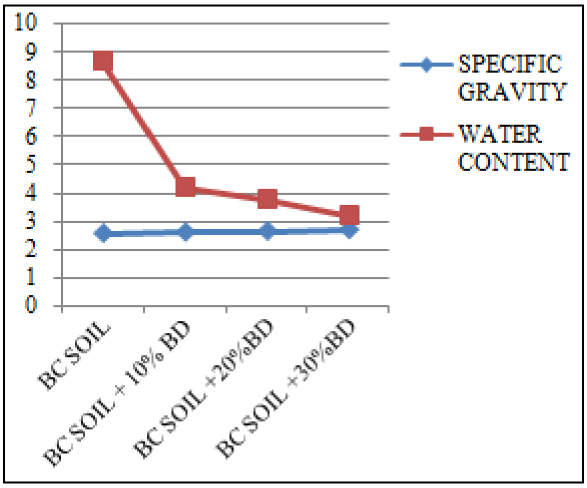

Figure: Water content and specific gravity values for mix proportions of soil & brick dust

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