Comparison of Geotechnical Engineering Properties of Black Cotton Soil by Adding Lime and Sugarcane Straw Ash

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Abstract

Black cotton soil or expansive soil covers almost more than 20% of Indian geographical area. Madhya Pradesh has approximately 44% area under this category. This soil has peculiarity of good fertility with respect to grains but poor for construction activities. In this study the results of laboratory investigation on the use of Lime and Sugarcane Straw Ash with this soil are compared for different engineering properties. Black cotton soil mixed with Lime and Sugarcane straw ash (SCSA) in different proportion and its effects are compared for different geotechnical properties. It is observed that when Lime is added to this soil, significant variation in Optimum Moisture Content (OMC) increased from 19.50% to 23.50% and Maximum Dry Density increased from 1.63g/cc to 1.80g/cc. The soaked CBR also increase from 2.22% to 9.72%. Also observed that in case of Sugarcane Straw Ash (SCSA) significant variation in Optimum Moisture Content (OMC) increased from 19.50% to 19.62% and Maximum Dry Density increased from 1.63g/cc to 1.82g/cc. The soaked CBR also increased from 2.22% to 4.90%.

Keywords: Lime, Sugarcane Straw Ash, Compaction, OMC, CBR

I. INTRODUCTION

Black cotton soil is an expansive soil that increase in volume or expand as they get wet and shrink as the water dry out. The compressive strength and stability of the soil can be considerably improved by the soil stabilization through controlled compaction and addition of suitable admixture in some proportion. Lime and Sugarcane Straw Ash are used as soil stabilization additives in this study. Lime is calcium oxide (Cao) or Hydroxide of Calcium and Magnesium and is made by calcining Limestone into either calcite lime (High in Calcium) or Dolomite lime (High in magnesium). The use of Lime in stabilization improves strength, resistance to fracture, fatigue and permanent deformation. Sugarcane Straw Ash is a pozzolanic material which is very rich in oxide of silica and aluminum and sometime calcium. Pozzolanic usually require the presence of water in order for silica to combine with calcium hydroxide to form stable calcium silicate which has Cementous properties. This research provides the effect the Lime and SCSA an engineering properties like Compaction characteristics of the Black cotton soil.

II. LITERATURE REVIEW

Engineering properties of expansive clay has been improved to make them suitable for construction using stabilization technique. This paper mainly emphasizes of expansive soil using locally available Lime and Sugarcane Straw Ash.

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III. METHODOLOGY

The Black cotton soil used in this study was mixed with the Lime and SCSA in the different proportion and a series of the laboratory test were conducted on all sample containing various percentage (3%,6%,9%,12%,15 %) and all test were conducted as per relevant IS CODE of practice. Following Experiment test are conducted on original soil and on different samples prepared by taking different proportions of lime and SCSA

- Grain size distribution
- Compaction characteristics (OMC & MDD)
- CBR (California bearing ratio test)

The physical characteristics of Black Cotton soil are presented in table -1

Table – 1
Physical Characteristics

S. No	*Properties*	*Test Value*
1	*Specific gravity g/cc*	*1.99*
2	*Liquid limit % (LL)*	*64.50*
3	*Plastic limit %(PL)*	*24.62*
4	*Plasticity index%(PI)*	*39.88*
5	*Differential Free Swell%(DFS)*	*43.00*
6	*Optimum Moisture Content %*	*19.50*
7	*Maximum dry density g/cc*	*1.63*
8	*California Bearing Ratio*	*2.22*

A. Test Results

Various tests conducted on BC Soil, Lime and SCSA mixed. the variation in various engineering properties of the BC soil are discussed below. In the use of Lime, the Proctor Compaction test result showed a increased in OMC from 19.50% to 23.35% and increased in MDD value from 1.63g/cc to 1.80 g/cc. The soaked CBR test result indicate that the value increased from 2.22 % to 9.72%. Now in the case of SCSA Compaction test result showed a increased in OMC from 19.50% to 19.62% and increased in MDD value from 1.63g/cc to 1.82 g/cc The soaked CBR test result indicate that the value increased from 2.22% to 4.90%. Various test were conducted on BC soil mixed with Lime and SCSA in different proportion as per relevant.

IS CODE of practice Test result are shown in Table 2

Table – 2
IS CODE of practice Test result

S. NO	*Type of soil*	*OMC%*	*MDD (g/cc)*	*CBR %*
1	*B.C. SOIL*	*19.50*	*1.63*	*2.22*
2	*B.C.SOIL +3% LIME*	*20.41*	*1.72*	*3.74*
3	*B.C.SOIL +6% LIME*	*20.95*	*1.74*	*7.09*
4	*B.C. SOIL +9% LIME*	*21.47*	*1.76*	*8.52*
5	*B.C. SOIL +12% LIME*	*22.54*	*1.78*	*9.04*
6	*B.C. SOIL +15% LIME*	*23.35*	*1.80*	*9.72*
7	*B.C. SOIL +3% SCSA*	*13.95*	*1.71*	*2.60*
8	*B.C. SOIL +6% SCSA*	*15.68*	*1.75*	*2.91*
9	*B.C. SOIL +9% SCSA*	*17.52*	*1.78*	*3.22*
10	*B.C. SOIL +12% SCSA*	*18.60*	*1.80*	*4.26*
11	*B.C. SOIL +15% SCSA*	*19.62*	*1.82*	*4.90*

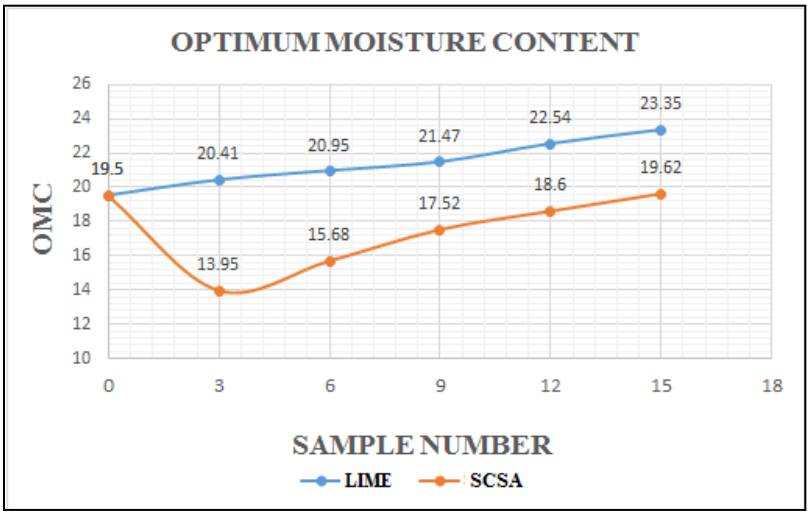

Fig. 1: Variation of OMC with Lime and SCSA

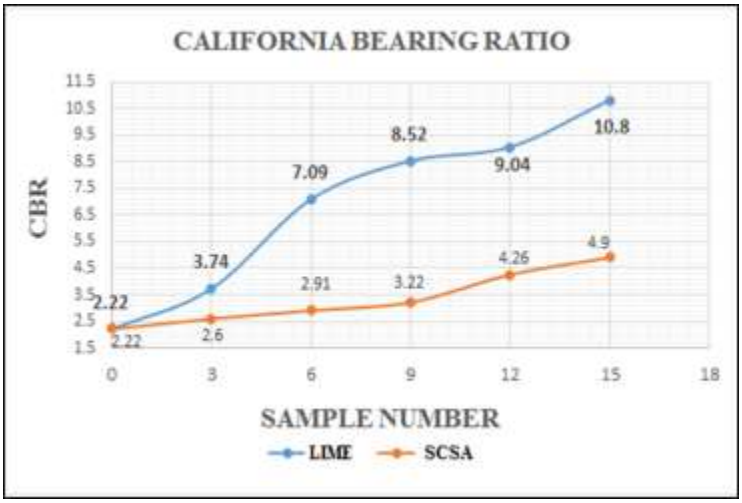

Fig. 2: Variation of MDD with Lime and SCSA

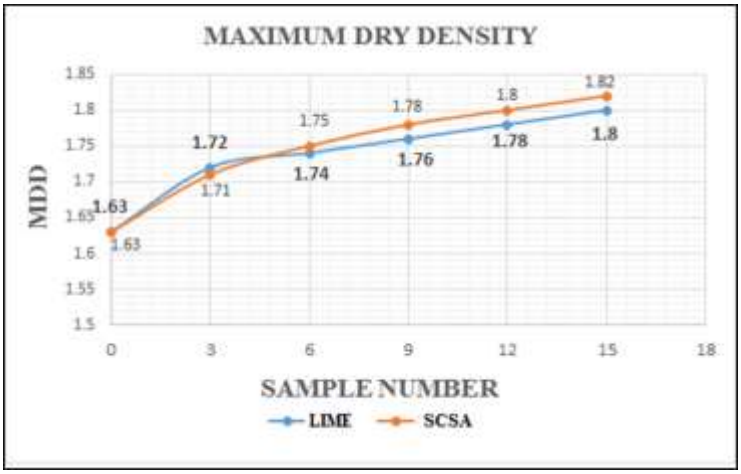

Fig. 3: Variation of CBR with Lime and SCSA

IV. CONCLUSION

Based on the above Laboratory investigation conducted on Black Cotton soil mixed with Lime and SCSA. The following conclusion can be drawn

1) For the use of lime added in the BC soil it has been found that OMC of BC soil has increased and MDD also increased. Same as material used of SCSA in the BC soil also found that OMC and MDD increased.
2) Soaked CBR value have also increased with the addition of both lime as well as SCSA. For lime CBR value increased from 2.22% to 9.72%. Also for SCSA soaked CBR value increased from 2.22% to 4.90%.

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