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The Behavior of Expansive Soil on The Addition of Kota Stone Slurry and Cement

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Abstract. Kota stone slurry powder is a good inert filler material and a good stabilizing material which improves the pore structure and enhance the resistance of the concrete to various harmful actions and the mortar with pozzolanic and non-pozzolanic material. Kota stone slurry powder enhances durability properties. Investigations were carried out related to the usefulness of kota stone slurry powder as filler material or as a stabilizing material in other fields of constructions so that the damage caused due to its disposal in environment can be reduced. In the present investigation kota stone slurry powder was mixed with the black cotton soil in the constant proportion such as soil: slurry powder:: 60:40. The soil content was replaced by the cement with 1, 2, 3 & 4 % of the weight of the sample. The mix proportions were prepared as follow – soil: slurry powder: cement :: (59 : 40 : 1), (58 : 40 : 2), (57 : 40 : 3), (56 : 40 : 4). The effects of kota stone slurry powder and cement on the engineering properties of black cotton soil i.e. Atterberg's limit, differential free swelling, standard proctor and California bearing ratio were studied and improvement in following properties is discussed.

Keywords: Black cotton soil, Kota Stone Slurry, Cement Stabilization.

1 Introduction

Expansive soil (Black cotton soil) is one of significant soil deposits of India. Black cotton soil exhibits major swelling and shrinkage when it is exposed to the atmosphere where the moisture content is variable hence have been found to be most dangerous and troublesome from engineering consideration. The presence of montmorillonite is more in black cotton soil which causes expansiveness hence crack occurs in soil without any warning which is dangerous for construction.

The waste generated from the industries cause environmental problems. Hence the consumption of that waste material can be emphasized. Stone cutting industry is a classic example of unscientific mixing and improper waste disposal regardless of aesthetic senses and proper land use practices. Kota stone industry is also one of them. It has been reported that about 23 million tons of Kota stone waste in powder or slurry forms are being thrown over waste land in Rajasthan every year. Dumping of

the waste has many negative impacts on the environment. It leads to air, water and land pollution.
On studying the above problems, it becomes extremely important to utilize this kind of waste in other industrial activities or to convert them into value added products.
Cement is a binding material and if it is added in the soil then it will give strength to soil. So, in this experimental study cement is added in the black cotton soil along with the Kota Stone Slurry powder to utilize the waste material and to provide some extra binding and strength to expansive soil.
In this investigation Kota Stone Slurry powder is mixed with black cotton soil and cement at various proportions and the effect of Kota Stone Slurry waste and Cement on the engineering properties of the black cotton soil is recorded.

2 Literature Review

Tak et al (2019) presented performance evaluation of waste kota stone slurry powder mixed with black cotton soil. Black cotton soil was tested by mixing the kota stone slurry powder from 4% to 24% at the interval of 4%.
Likhita H. et al (2018) investigated the improvements in the properties of expansive soil by adding cement and M sand. Various laboratory tests were performed on the mix of expansive soil, cement and M sand while cement percentage is kept constant.
Malik and Priyadarshee (2017) presented the work based on compaction and swelling behavior of black cotton soil mixed with non- cementitious materials. The effect of compaction and swelling behavior is analyzed by performing the proctor test and one dimensional free swell test.
Babu et al (2016) carried out a study on black cotton soil with M sand and cement to improve the engineering properties of soil. The quantity of cement was used 2% and sand was used 10% to 30%.
Gupta and Sharma (2014) evaluated the influence of marble dust, fly ash and beas sand on subgrade characteristics of expansive soil. This study concluded that 15% marble dust was enough to increase the value of CBR soaked up to 200%.

3 Methodology

In this experimental program results are recorded for different mixes. The proportion of Kota stone slurry powder in the sample is kept constant (i.e. 40) in all the mixes and the cement content is added in various proportions as explained below. Aim of this study was to utilize the maximum amount of the kota stone slurry powder as a base admixture and to study its behavior with different proportion of cement. so the proportion of kota stone slurry powder was kept high (i.e. 40%) to get the better results. If this proportion was further increased then it could not remain admixture, so to use kota stone slurry powder as a admixture in maximum amount, its proportion is kept below and near to 50%. Hence a common proportion of kota stone slurry powder is constant (40) and there are 4 different mixes with varying percentage of cement. The soil content was replaced by the cement with 1, 2, 3 & 4 % of the weight of the

sample. All the mixes are shown in their respective proportion as (soil : slurry powder : cement)
Mix-1 (59:40:1)
Mix-2 (58:40:2)
Mix-3 (57:40:3)
Mix-4 (56:40:4)

4 Properties of Expansive Soil And Kota Stone Slurry Powder

Black cotton soil used in this study was collected from Baran Road, Kota. The index properties and engineering properties of soil are tabulated in Table 1.

Table 1. Properties of Expansive soil

S. No.	Property	Value
1	Fines (<75μ)	80.23%
2	Liquid Limit (L.L.)	41.12%
3	Plastic Limit (P.L.)	20.99%
4	Plasticity index (P.I.)	20.13%
5	Soil Classification	CI
6	Specific gravity (G)	2.65
7	Max. Dry Density (Υ_d)	1.68 g/cm3
8	O.M.C.	17.5%
9	Free Swell Index	56.25%

Table 2. Properties of Kota stone slurry powder

Sr. No.	Properties	Value
1	Dry density (Kg/m^3)	1.67
2	O.M.C (%)	17.08
3	Fineness modulus (cm^2/gm)	3900-4123
4	Water absorption (%)	2-4
5	Specific gravity	2.58-2.65
6	Max particle size (mm)	.2
7	Colour	Grey-white

5 Results and Discussion

5.1 Particle size distribution curve

Wet sieve analysis is a process used to evaluate particle size distribution or gradation of a granular soil. It's also used to prepare a granular material for particle size analysis by removing fines that may cause trouble in the separation process. In Wet sieve analysis, the soil type defines by percentage of retaining of soil particles on 75 microns sieve. If soil particles are retained on 75 microns sieve more than to 50% than soil is known as coarse grain soil otherwise soil is known as fine grained soil. The test was conducted as per the guidelines of IS 2720 –IV (1985).

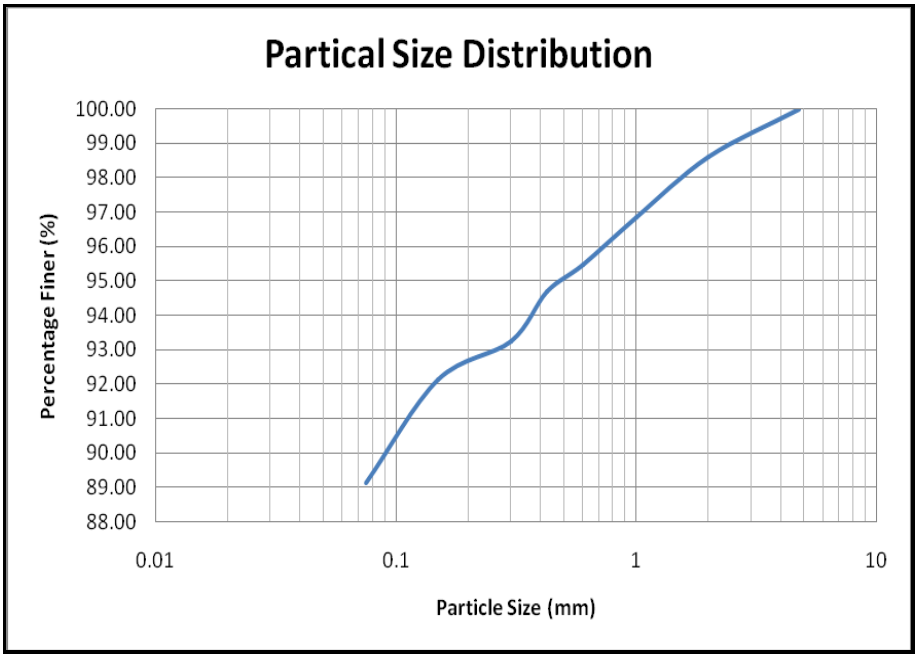

Fig. 1. Partcle Size Distribution Curve of Black Cotton Soil

5.2 Differential free swell

The object of test is to find out the free swell index of soil which helps to identify the potential of a soil to swell. Test was conducted on various mixes of soil. The proportion of Kota stone slurry powder is 40 in all mixes and cement is also mixed in the proportions of 1,2,3,4 respectively of total sample (by weight). The results are shown in table 3.

Table 3. Results of differential free swell for various mixes

Test Specimens (soil: slurry powder: cement)	Degree of Expansion (%)	Classification of Soil Based on Swelling
100 : 0 : 0	56.25	Very high
60 : 40 : 0	6.25	Low
59 : 40 : 1	0	Nil
58 : 40 : 2	0	Nil
57 : 40 : 3	0	Nil
56 : 40 : 4	0	Nil

5.3 Consistency limits

The consistency of a fine-grained soil is the physical state in which it exists. The soil was also tested for its liquid limit and plastic limit. The results obtained are shown in Table 4. Based on these results, the soil is classified as "medium plastic clay" [CI]. The test was conducted as per the guidelines of IS 2720 –V (1985).

Table 4. Result Obtained for Liquid Limit, Plastic Limit and Plasticity Index of Mix Specimen

Test speci-men (Soil : Slurry : Cement)	Liquid limit W_L (%)	Plastic limit W_P (%)	Plasticity index P.I. (%)	Specimen Classification
100 : 0 : 0	41.12	20.99	20.13	CI
0 : 100 : 0	10.41	Non plastic	0	Non plastic
60 : 40 : 0	28.21	12.99	12.08	CL
59 : 40 : 1	32.04	21.45	10.59	CL
58 : 40 : 2	35.26	22.82	12.44	CI
57 : 40 : 3	37.62	24.45	13.17	CI
56 : 40 : 4	39.73	25.44	14.29	CI

5.4 Compaction behavior

It was observed that the maximum dry density of soil is 1.68kg/cm^3. By adding the Kota stone slurry powder in proportion of 40 in the black cotton soil, the maximum dry density was increased 4.76% and optimum moisture content was decreased by 10% by adding Kota stone slurry powder in the clay. When the cement was added to

the mix in varying proportion (1 to 4), with fix proportion of Kota stone slurry powder (i.e.40), the MDD was increasing and OMC was decreasing by increasing the proportion of cement up to 4 of the total sample. The max dry density 1.93 kg/cm^3 can be achieved at proportion of cement content 4 and the OMC is decreased up to 8.95% at the proportion of cement content 4.

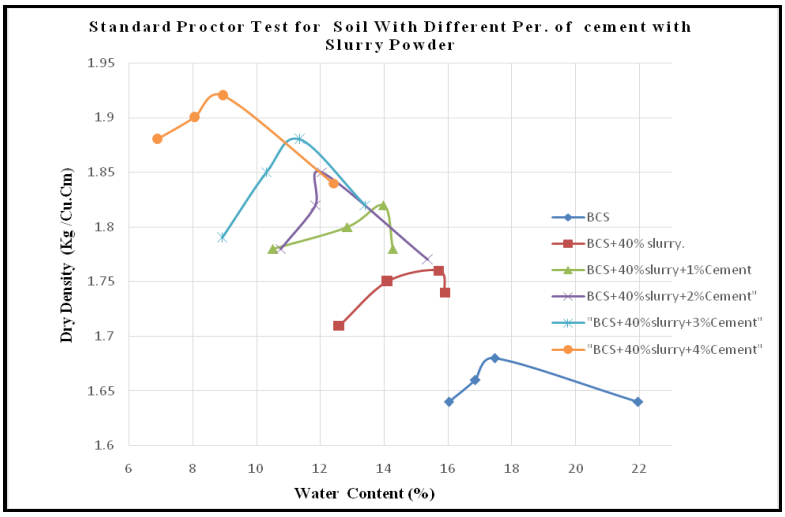

Fig. 2. Variation of Water Content with Dry Density for Diff. Mix Specimen

5.5 California bearing ratio

California bearing ratio test was conducted in laboratory in soaked condition. The specimen was soaked for 3 days in water. It is observed that the value of CBR for clay specimen is 2.20%. When the proportion of Kota stone slurry powder was mixed with clay in the proportion of 40, the value of CBR was found to be 5.77% and percentage increase was 61.87%. Further by replacing the soil with the proportion of cement from 1 to 4, the CBR value increases up to 13.28

Table 5. Results Obtained for California Bearing Ratio Test (Soaked)

Test Specimen	CBR value (%)	% Increase
100 : 0 : 0	2.20	-
60 : 40 : 0	5.77	61.87
59 : 40 : 1	7.30	69.86
58 : 40 : 2	9.42	76.64
57 : 40 : 3	11.17	80.30
56 : 40 : 4	13.28	83.43

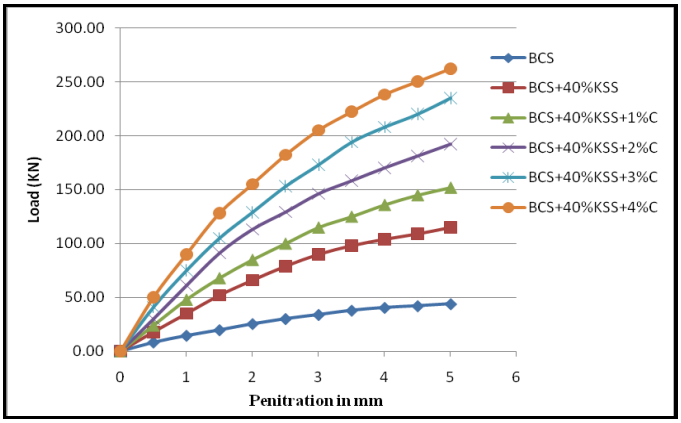

Fig. 3. Variation of CBR Test results for BCS with Mix Specimen

6 Conclusions

1. The differential free swell nature of clay was reduced to zero with increasing proportion of cement with constant proportion of Kota stone slurry powder in mixture.
2. The maximum dry density of clay was increased with increasing the proportion of cement with constant proportion of Kota stone slurry powder. There is 14.88% increase in MDD with increasing the cement content up to proportion 4.
3. There was 48% decrease in OMC by increasing the proportion of cement content up to proportion 4 with constant proportion of Kota stone slurry powder.
4. The CBR value of clay is increasing with increasing the proportion of cement content in the mix. There is 83.43% increase in CBR value with adding of cement 1 to 4 %.

References

1. Dayanand Tak, Dr. J K Sharma, Dr K S Grover, “performance evaluation of waste kota stone slurry powder mixed with black cotton soil” International Journal for Research in Applied Science & Engineering Technology, ISSN: 2321-9653, Volume 7, Issue XII, Dec 2019.
2. Likhita H, Raghavendra H N, Rakesh K P, Uday Shrihari P, “Stabilization of Subgrade Black Cotton Soil Using Cement and M Sand” International journal of Engineering technology Science and Research, ISSN 2394-3386, Volume 5, Issue1, January 2018.
3. Vikash Malik, A Priyadarshee, “Effect of Rice Husk Ash Stone Dust on Compaction and Swell Effect of Expansive Soil”, International Journal of Geotechnical Engineering (IJGE), DOI: org/10. 1080/19386362.2017. 1288355, ISSN: 1938-6362.
4. V Ramesh Babu, K Niveditha, Dr B Ramesh Babu, “Stabilization of Black Cotton Soil with Sand and Cement as A Subgrade Pavement” International Journal of Civil Engineering and Technology (IJCIET), Volume 7, Issue 2, March-April 2016, pp 341-351.
5. Gupta C, Sharma R. K., “Influence of Marble Dust, Fly Ash and Beas Sand on Subgrade Characteristics of Expansive Soil”, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), e-ISSN: 2278-1684, p-ISSN: 2320-334X, PP 13-18.