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STABILIZATION OF BLACK COTTON SOIL BY 15% KOTA STONE SLURRY WITH RECRON 3S FIBRE

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ABSTRACT

Black Cotton soil is expansive soil which expand when it contacts with water. this is the major reason of failure of black cotton soil strata and soil strata is improved by different types of fibres. The different areas having different types of black cotton soil and it is engineering properties. In this research paper, the engineering properties of black cotton soil is tried to improve by using Recron 3s fibre with 15% Kota stone slurry. Most of the times, the black cotton soil is stabilized by polypropylene fibre. The polypropylene, polyester is synthetic and jute is natural fibre. Sometimes soil is stabilized by using Kota stone slurry but this research paper is based on stabilization of black cotton soil by 15% Kota stone slurry with Recron 3s fibre. In this research, the 15% Kota stone slurry is mixed with different percentage of Recron 3s fibre in black cotton soil. The engineering parameters are also determined by conducting tests for 15% Kota stone slurry with black cotton soil mix specimen. For stabilization of black cotton soil with 15% of Kota stone slurry, the Atterberg's limits (Liquid Limit, Plastic Limit, Plasticity Index), differential free swelling index, swelling pressure and wet sieve analysis tests are conducted but with different percentage of fibre, standard proctor test and unconfined compressive strength test also conducted.

Keywords: Recron 3s Fibre, Maximum Dry Density, Optimum Moisture Content, UCS of Recron 3s Fibre, 15% Kota stone slurry with Recron 3s Fibre.

I. INTRODUCTION

Expansive soil is one among the problematic soils that has a high potential for shrinkage or swelling due to change of moisture content. Black cotton soil is cohesive soil. The black cotton soil is mostly found in the central and western parts and cover approximately 20% of total area of India. The concept of reinforcing soil masses by including some kind of fibre was practiced by early civilizations which used soil mixed with straw or other available fibre to improve durability and strength of the dried brick used as building materials. From previous years, the amount of stone slurry waste has been generated in stone production plants with significant environmental impacts. This waste is used with different percentage of Recron 3s fibre. The percentage of Recron 3s may vary from 0.5% to 2.5%. The laboratory tests are conducted for determining the engineering

properties of black cotton soil with fibre and Kota stone slurry. The main objective of this work is to investigate the possibility of improving engineering properties of black cotton soil by using Kota stone slurry.

II. LITERATURE REVIEW

For the stabilization of black cotton soil, many researchers did work on the black cotton soil with different materials. In the past many researchers have carried out their research work for stabilizing of black cotton soil using different types of admixture, stone dust and fibre. Some detailed literatures have been reviewed on this topic i.e. related to stabilization of black cotton soil and some of the reviewed of the reviewed literatures are presented in proceeding paragraphs.

P. Sowmya Ratna et. al. (2016) studied the performance of Recron 3s fibre with lie in expansive soil stabilization. They used lime content from 0% to 13% with black cotton soil and for the results of compaction with addition of 5% or more lime content to clays. They also reported an increase in the optimum moisture content till 3% lime content and decreased with the increase in lime content with Recron 3s fibre. From the results, it has observed that black cotton soil with lime and Recron 3s fibre the strength parameters can be improved and the main disadvantage of lime is brittle nature which is overcome by the inclusion of fibre which gives ductility to the soil. **Muhammad Nawazish Husain et. al. (2015)** studied Recron 3s fibre which is polypropylene fibre is used as a stabilizer to improve the CBR and UCS value of the local soil of Kurukshetra. The Recron 3s fibre is used 0.15%, 0.30%, 0.45% and 0.60% by weight of dry soil. The results show, when fibre increases, the dry density decreases due to packing becomes loose of soil – fibre. The value of CBR test increases 3.5% to 20.2% with addition of 0.15% Recron 3s fibre. The value of UCS increases with increases the percentage of the Recron 3s fibre.

III. EXPERIMENTAL INVESTIGATIONS

Various such as Atterberg's limit (liquid limit and plastic limit), OMC and MDD, UCS, etc tests have been performed to find out the engineering properties of black cotton soil as well as soil with 15% Kota stone slurry and varied percentage of Recron 3s fibre. The percentage of Kota stone slurry is 15% and fibre may have varied from 0.5% to 2.5% at 0.5% interval.

3.1 Material Used

- **Black Cotton Soil –** About 100 kg of soil sample for the present work was collected from the Borkheda, Kota.
- **Kota Stone Slurry –** Kota stone slurry for the present work was obtained from Kota stone slurry industry, Anantpura, Kota.
- **Recron 3s Fibre –** Recron 3s fibre is purchased from the market. The length of fibre is 6 mm.

3.2 Engineering Properties of Soil, Kota Stone Slurry and Mix Specimen

The following engineering properties are determined by the laboratory experiments as shown in Table

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3.1. Table 3.1 Engineering Properties of Black Cotton Soil and Kota Stone Slurry

Parameters	Black Cotton Soil	Kota Stone Slurry
Specific Gravity	2.44	2.35
Liquid Limit (%)	41.41	34.28
Plastic Limit (%)	18.46	21.77
MDD (kg/cm^3)	1.755	1.635
OMC (%)	17.4	17.1
Colour	Red – Brown	Grey Dirty White
IS Classification	CI	CL

The Kota stone slurry is mixed at 15% by weight of black cotton soil. The liquid limit and plastic limit for this mix specimen is 34.56% and 14.09% respectively determined, which is less than to black cotton soil values.

3.3 Standard Proctor Test

The object of testing is to find out the maximum dry density and optimum moisture content of mix specimen. The mix specimen is prepared by different percentage of Recron 3s fibre with 15% Kota stone slurry in black cotton soil. The test results of mix specimen are showing in Table 3.2.

Table 3.2 MDD and OMC for Fibre Mix Specimen

Test Specimen	MDD (kg/cm^3)	OMC (%)
Black Cotton Soil (BCS)	1.725	17.4
BCS + 15% KSS	1.755	15.2
BCS + 15% KSS + 0.5% Fibre	1.700	18.2
BCS + 15% KSS + 1.0% Fibre	1.650	18..8
BCS + 15% KSS + 1.5% Fibre	1.645	19.2
BCS + 15% KSS + 2.0% Fibre	1.655	18.0
BCS + 15% KSS + 2.5% Fibre	1.650	17.0

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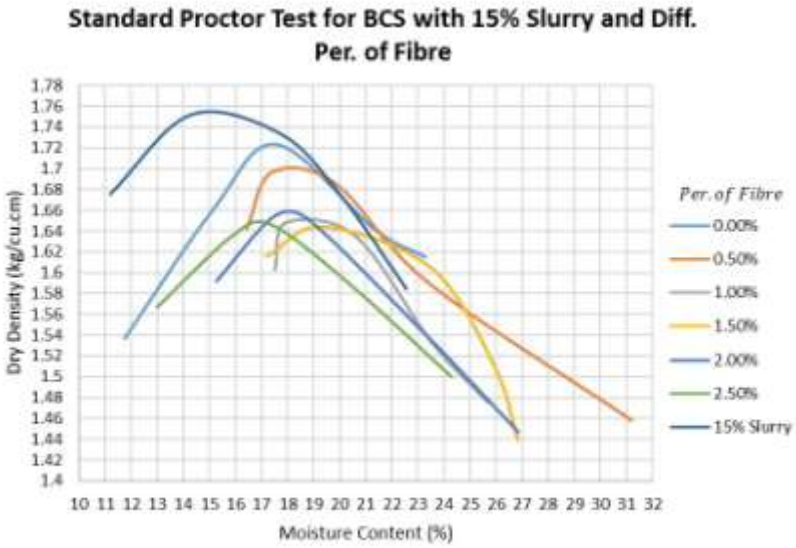

Fig. 3.1 Standard proctor test results of black cotton soil with 15% KSS and varied percentage of fibre

From fig. 3.1, it shows that the blue curve is having MDD and OMC, 1.755 kg/cm^3 and 15.2% respectively for 15% Kota stone slurry with black cotton soil mix specimen. When 0.5% to 1.5% fibre is added in black cotton soil and 15% Kota stone slurry mix specimen, the maximum dry density decreases from 1.700 kg/cm^3 to 1.645 kg/cm^3 but when the amount of fibre increases from 1.5% to till 2.5%, the MDD increases 1.655 kg/cm^3 for 2.0% fibre mix but for 2.5% fibre mix specimen, the MDD again decreases 1.650 kg/cm^3. Same as in case of OMC, the OMC increases with increasing the percentage of fibre in mix specimen from 18.2% to 19.2% but after 1.5% fibre mix, the value of OMC continuously decreases with increasing the percentage of fibre in mix specimen.

3.4 Unconfined Compressive Strength

The object of testing is to determine the shear strength parameter of clay and 15% Kota stone slurry with varied percentage of fibre by loading axially cylindrical specimen. the observation and calculation of UCS test is shown in Table 3.3.

Table 3.3 – UCS Test for Fibre Mix Specimen

Test Specimen	UCS, q_u (N/cm^2)	Shear Strength C_u (N/cm^2)	Percentage Variation in C_u
Black Cotton Soil (BCS)	15.967	07.983	-
BCS + 15% KSS	21.465	10.732	34.43
BCS + 15% KSS + 0.5% Fibre	17.929	08.964	- 16.47
BCS + 15% KSS + 1.0% Fibre	21.629	10.814	00.76
BCS + 15% KSS + 1.5% Fibre	27.078	13.539	26.15
BCS + 15% KSS + 2.0% Fibre	18.832	09.416	- 12.27
BCS + 15% KSS + 2.5% Fibre	19.166	09.583	- 10.71

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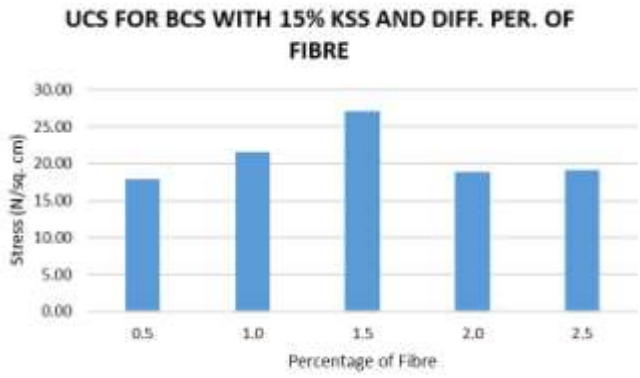

Fig. 3.5 – UCS for black cotton soil and with diff. per. of KSS

From Table 3.3, it is shown that when 15% Kota stone slurry is added in black cotton soil, the shear strength is increased 34.43% to shear strength of the black cotton soil but when 0.5% fibre is added in black cotton soil with 15% Kota stone slurry mix specimen, the shear strength 16.47% decreases from 15% Kota stone slurry mix specimen. When 1.5% fibre is added in 15% Kota stone slurry mix specimen, the shear strength 26.15% increases. After 1.5% fibre mix specimen, the value of shear strength continuously decreases with increasing the percentage of Recron 3s fibre.

IV. DISCUSSIONS ON TEST RESULTS

The black cotton soil changes it is behaviour due to Kota stone slurry and Recron 3s fibre. The Kota stone slurry is low plasticity material and black cotton soil is inorganic clay of medium plasticity. The plasticity of black cotton soil decreases with increasing the amount of Kota stone slurry. The maximum dry density and optimum moisture content is 1.755 kg/cm3 and 15.2% determined for 15% Kota stone slurry mix specimen but when Recron 3s fibre is added in mix specimen of 15% KSS and BCS, the maximum dry density and optimum moisture content is varied with increasing the percentage of fibre and the obtained values are less than to 15% KSS mix specimen which is not acceptable for Borkheda soil. The shear strength is also varied with increasing the percentage of Recron 3s fibre in 15% KSS and black cotton soil mix specimen. The maximum shear strength is observed for black cotton soil with 15% Kota stone slurry and 1.5% fibre mix specimen, which is 13.539 N/cm^2. When 1.5% fibre is added in 15% KSS with black cotton soil mix specimen, the value is 26.15% increased form black cotton soil with 15% Kota stone slurry mix specimen. The 1.5% fibre with black cotton soil and 15% Kota stone slurry may be used to increase the shear strength of black cotton soil.

V. CONCLUSIONS

The black cotton soil is inorganic clay of medium plasticity soil. With 15% percentage of Kota stone slurry, the black cotton soil changes its behaviour from inorganic clay of medium plasticity to inorganic clay of low plasticity (CI to CL) and the plasticity index of black cotton soil decreases 10.81%. The maximum dry density of black cotton soil is 1.725 kg/cm^3 determined but when fibre is mixed in 15% Kota stone slurry with black cotton soil mix specimen the maximum dry density is less than to 1.725 kg/cm^3. Hence, the density may not be

improved by the mixing of Recron 3s fibre. Recron 3s fibre can be used to improve the shear strength of black cotton soil. The black cotton soil is having 07.983 N/cm^2 shearing strength, but this strength is improved by adding 15% Kota stone slurry in black cotton soil. The mix specimen 15% Kota stone slurry with black cotton soil is having 10.732 N/cm^2 shear strength which is 34.43% more than to shear strength of the black cotton soil. Same as when 1.5% fibre is added in 15% Kota stone slurry with black cotton soil mix specimen, the shear strength is 26.15% is increased from 15% Kota stone slurry mix specimen. Hence, it is also cleared that the 1.5% fibre may be used to improve the shear strength parameter of black cotton soil with 15% Kota stone slurry.

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