iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** II **Month of publication:** February

DOI: http://doi.org/10.22214/ijraset.2019.2162

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 7 Issue II, Feb 2019- Available at www.ijraset.com

Stabilization of Black Cotton Soil using Surkhi and Polypropylene Fiber Material

Rachit Mishra[1], Mohit Verma[2]
[1]*M.E. scholar Geotechnical Engineering Jabalpur Engineering College (JEC), Jabalpur (M.P)*
[2]*Assistant Professor Jabalpur Engineering College (JEC), Jabalpur (M.P)*

Abstract: ***In India, a major portion of total land area is covered by clayey soil. Of this, a large proportion is expansive soil. Structures constructed over this expansive soil may be severely damaged due to its high swell-shrinkage behavior. So such soils need to be stabilized to increase its strength, durability and to prevent erosion. Various studies have been carried out on expansive soils to improve its properties. Soil stabilization is one of the promising techniques used to improve the geotechnical properties of soil and has become the major practice in construction engineering. This project aims to conduct a study to check the improvements in properties of clayey soil analysing physical properties of soil stabilized with surkhi and polypropylene such as Atterberg Limits, Compaction Curve (O.M.C. and M.D.D.),California bearing ratio, unconfined compression strength test.The tests were conducted in three phases.In first phase, the physical properties of pure soil were determined. In the second phase, various tests were performed on the soil with varying percentage of surkhi .In third phase varying percentage of polypropylene fiber was added to the optimum value of surkhi and soil mix determined in second phase.***
Keywords: Black Cotton Soil, surkhi, polypropylene fiber,standard proctor test, CBR.

I. INTRODUCTION

Soil stabilization is an effective and reliable technique for altering important soil properties. Several reinforcement methods are available for stabilizing expansive soils such as stabilization with chemical additives, rewetting, soil replacement, compaction control, moisture control, surcharge loading and thermal methods . These techniques have wide application in areas like construction of road, slope stabilization, railway embankments, and so on. Soils are generally stabilized to increase their strength and durability or to prevent erosion and dust formation in soils. The properties of soil vary a great deal at different places.This study deals with the stabilization of locally available expansive soil in the region of Jabalpur, Madhya Pradesh with varying percentages of surkhi and polypropylene fiber to determine the optimum percentage of above mentioned materials required to suitably strengthen the soil.

II. MATERIALS USED

A. Black cotton soil

Black cotton soil (BC soil) is a highly clayey soil. They are of variable thickness, underlain by black sticky material known as “Black soil”. BC soil when comes in contact with water it either swells or shrinks and resulting in moments to the structure which are generally not related to direct effect of loading. On account of its high volumetric changes it is not suitable for construction. It swells and shrinks excessively due to present of fine clay particles. Hence black cotton soil must be treated by using suitable admixtures to stabilize it. The soil used was locally collected from Panagar region in Jabalpur, Madhya Pradesh. As per the test conducted over the soil following properties were obtained:

Table -1**:** Basic properties of soil

S.No.	Properties	Values
1	Liquid Limit (LL)	63%
2	Plastic Limit (PL)	30%
3	Plasticity Index (Ip)	33%
4	Specific Gravity (Gs)	2.58
5	Differential Free Swell (DFS)	70%
6	Optimum Moisture Content (OMC)	16.20%
7	Maximum Dry Density (MDD)	1.41
8	California Bearing Ratio (CBR)	7.11
9	Unconfined compression strength (UCS)	102.2 Kpa
10	Soil classification	CH

B. Surkhi / Brick powder(BP)

Brick dust with its component 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 color and fine in nature. it has great ability to reduce the swelling potential of black cotton soil. Brick 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 color and fine in nature. it has great ability to reduce the swelling potential of black cotton soil.

C. Polypropylene Fiber (PP)

Table -2: Physical and chemical properties of fibre:

S.No.	Properties	Values
1	Fiber type	Single fibre
2	Unit weight	0.91 gm/cm3
3	Average diameter	0.034 mm
4	Average length	12 mm
5	Breaking tensile strength	350 MPa
6	Modulus of elasticity	3500 MPa
7	Fusion point	165°c
8	Fusion point	590°c
9	Acid and alkali	Very good
10	Dispersibility	Excellent

III. EXPERIMENTAL WORK

A. Preparation of Sample

The soil sample should be oven dried at approximately 105°C and then sieved.

The different values adopted. For the percentage of Surkhi are 0%, 0.5%, 1% and 1.5%. The adopted content of Surkhi was first mixed into the air-dried soil sample in small increments by hand, making sure that all the material was mixed thoroughly, so that a fairly homogenous mixture is obtained, and then the required water was added. The Optimum Surkhi percentage was determined. Polypropylene fibers were added to different proportion (0.35%,0.40% and 0.45%) to the sample having optimum surkhi content.

B. Standard proctor test

The standard proctor test was performed as per IS 2720 (Part VII) 1980. The compaction tests were done on soil and surkhi blends and the optimum quantity of surkhi was obtained.Further to this optimum quantity of surkhi and soil mix polypropylene fibers were added in different proportions.The appropriate quantity of water was added to the mix and the wet specimen was compacted in mould in three layers utilizing standard proctor rammer of 2.6kg.The MDD and OMC for various samples were determined from this test.

C. California Bearing Ratio Test

The CBR tests were executed as per IS 2720 (part-16) 1987.The test was conducted on three samples.

1) Sample 1 : pure black cotton soil
2) Sample 2: 60% soil + 40% BP
3) Sample 3 :60% soil + 40% BP + 0.35% PP

The samples were prepared in a cylindrical mould of 150mm diameter and 175mm height by compaction of the mixture. The samples were experimented for each variable proportion and the samples were soaked in water for 96 hours before test was conducted. All the experiments were executed at a penetration rate of 1.25mm/min until a penetration of 12.5mm was obtained. CBR values were calculated and the Load-Penetration curve was plotted for all the specimens.

IV. RESULTS AND DISCUSSIONS

According to experimental program, numerous tests were executed on soil with various percentages of surkhi and polypropylene fiber. The effects of surkhi and polypropylene fiber inclusion on OMC-MDD relationship, and CBR values were considered.

A. Standard Proctor Test

It is observed in Table-3 and Figure(a) that with the inclusion of surkhi, the MDD increased up to 40% surkhi addition and then decreased. On inclusion of 40% surkhi with soil, the optimum value of MDD was obtained. On addition of coir waste(0.30%,0.35% and 0.40%)to this optimum percentage of surkhi it was observed that the MDD increased for the sample containing 0.35% polypropylene fiber and 40% surkhi while it decreased for the sample containing 5% coir waste and 20% fly ash. The maximum value of MDD was obtained for a soil sample containing 20% fly ash and 2.5% coir waste by dry weight of the soil sample.

Table 3: OMC,MDD for soil samples containing varying percentages of surkhi (BP)and polypropylene fiber (PP)

Sample No.	Soil%+BP%+PP%	M.D.D. (g/cc)	O.M.C. (%)
1	100%+0%+0%	1.41	16.2
2	65%+35%+0%	1.53	11.12
3	60%+40%+0%	1.64	13.93
4	55%+45%+0%	1.56	14.48
5	50%+50%+0%	1.54	16.2
6	60%+40%+0.3%	1.69	14.11
7	60%+40%+0.35%	1.78	14.5
8	60%+40%+0.40%	1.64	14.9

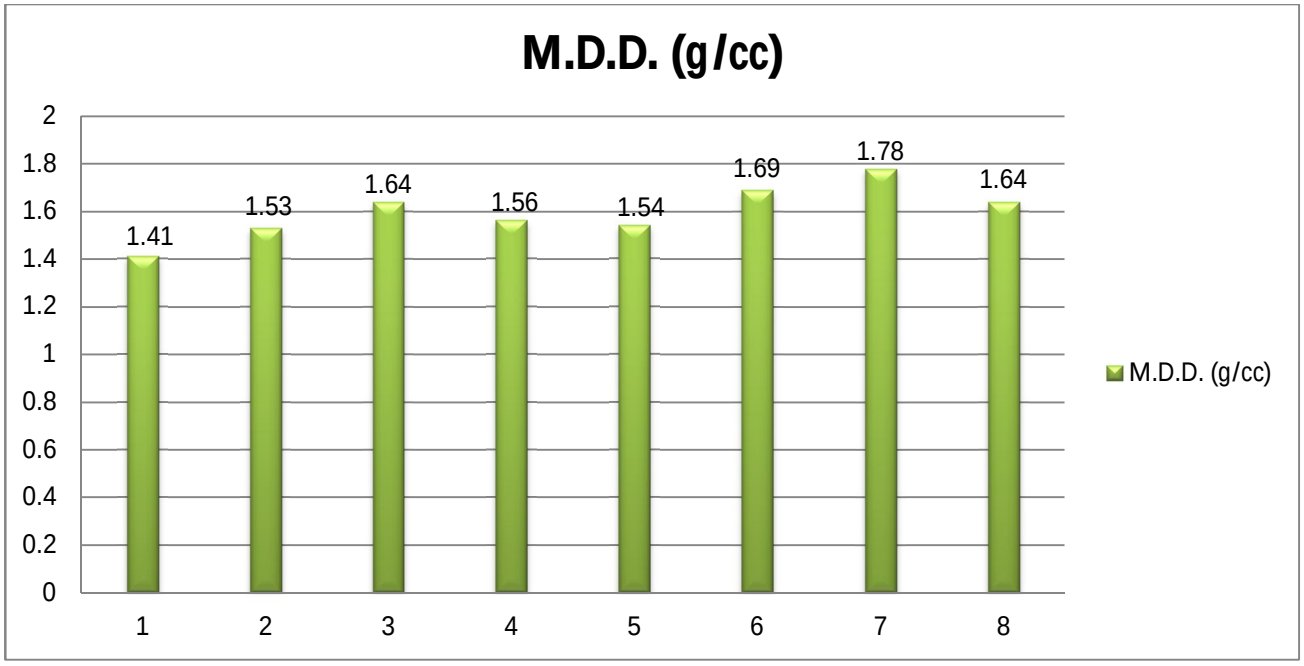

Figure (a) : MDD for soil samples containing varying percentages of surkhi(BP)and polypropylene fiber(PP)

B. California Bearing Ration Test

The outcomes of soaked CBR test from Table 4 and Figure(b) indicated that the CBR value increased upon inclusion of surkhi .Further polypropylene fiber was added to the soil sample containing 40% surkhi and 60% soil. The CBR value increased with addition of 0.35% polypropylene fiber and 40% surkhi to 60% soil. The maximum value of CBR was obtained for a soil sample containing 60% soil+40% surkhi+0.35% polypropylene fiber.

Table 4 : C.B.R. Value for soil samples containing varying percentages of surkhi(BP)and polypropylene fiber(PP)

Sample no.	SOIL%+BP%+PP%	CBR VALUE
1	100%+0%+0%	3.15
2	60%+40%+0%	7.11
3	60%+40%+0.35%	8.45

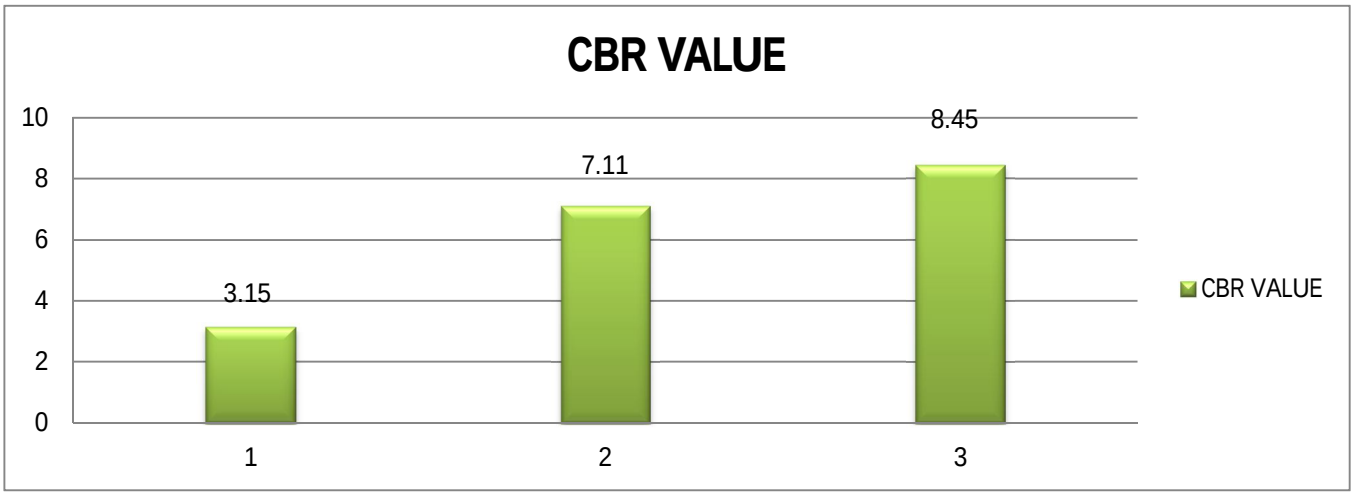

Figure (b): C.B.R. Value for soil samples containing varying percentages of surkhi (BP) and polypropylene fiber (PP)

V. CONCLUSION

For the stabilization of black cotton soil, the optimum quantity of surkhi and polypropylene fiber was found to be 40% and 0.35% for 60% soil.The two materials were mixed in the above proportion in the black cotton soil. The proctor density was increased from 1.41 g/cc to 1.78 g/cc. The CBR value increased from 3.11% to 8.45%.

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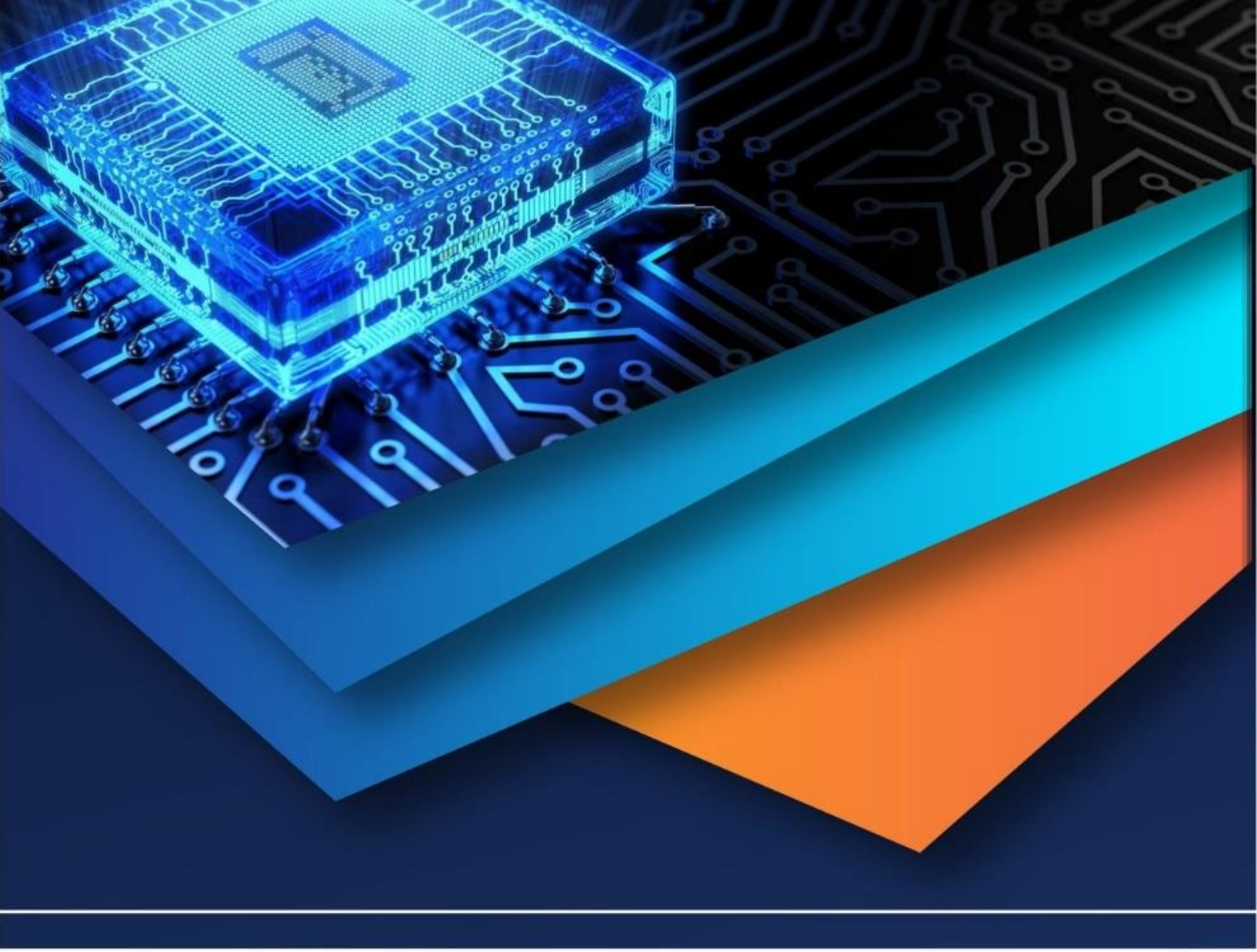

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