iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** XI **Month of publication:** November 2021

DOI: https://doi.org/10.22214/ijraset.2021.39086

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue XI Nov 2021- Available at www.ijraset.com

Black Cotton Soil Stabilization by Using Fly Ash - Kota Stone Slurry Mix

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Abstract: ***The usage of waste material for stabilizing black cotton soil has been a sustainable interest. Kota stone slurry is a waste from kota stone and fly ash is a waste from industries containing high amount of sodium and magnesium, was used as a soil stabilizer for blac cotton soil improvement in this study. This research investigated the effects of sizes and percentages of kota stone slurry mix and fly ash on the physical and strength properties, which included particle size distribution, Atterberg limits, compaction, and unconfined compressive strength (UCS) of blac cotton soil. Micro structural characterization, including the scanning electron microscopic, energy dispersive X-ray spectroscopy, and X-ray diffraction was conducted on both untreated and treated black cotton soil samples to examine the mechanism of strength development. The addition of kota stone slurry and fly ash reduced the water holding capacity, which then caused the reduction in soil plasticity (from 18 to 11%) and optimum water content (from 20 to 16%) along with the increase in peak dry density (from 1.66 to 1.74 Mg/m3). The strength of black cotton soil may increased from 50 to almost 220 kPa. The optimum kota stone slurry and fly ash contents, providing the highest UCS, were at 20 and 30% for 0.063 mm kota stone slurry and fly ash and 0.15 mm kota stone slurry and fly ash, respectively. The UCS improvement of treated marine clay is attributed to the formation of cementation compounds, mainly aluminum magnesium silicate hydrate (A–M–S–H). The outcome of this research will allow the use of RBT as a low-carbon soil stabilizer across civil engineering applications.***

Keywords: Stablization, Fly ash, kota stone slurry, Atterberg limits, Compaction, and unconfined compressive strength

I. INTRODUCTION

Soil is the last goal of any structure on which the heap of structure rests. In this manner quality of soil is vital. What's more, is general, soil quality relies on thickness, dampness content and the surface of soil. Increment in thickness is typically joined by increment in quality, whereas increment in dampness content is generally joined by decline in soil quality. The motivation behind an asphalt is to give a cover surface up which the vehicles may go under every single climatic condition. Thusly, the execution of asphalt is influenced by the attributes of the sub review. Alluring properties which the sub review ought to have incorporate trength, drainage, ease of compaction, permanency of strength, since sub review shifts extensively.

It is important to make through investigation of the dirt set up for asphalt configuration purposes. Soil is profoundly factor material. The bury relationship of density, moisture substance, and quality are unpredictable, and specifically, conduct under rehashed stack is hard to assess. As a result of the multifaceted nature, it is absurd to expect to set down tenets which will be appropriate for all cases. The issue which we constantly confronting is that managing strategies and systems by which inadmissible soils might be enhanced by adjustment. Sub level soils that are unsuitable in their normal state can be adjusted by admixtures, by the expansion of total or by the correct compaction and this made appropriate for interstate sub level development.

Adaptable asphalt determines their heap supporting limits not from the bowing activity of the chunk but rather by appropriating the heap down through a limited thickness of asphalt, with the goal that weight on the sub review won't be exceeded. Adjustment for this kind of asphalt ought to coherently grant extra solidarity to the sub level soil, accessibility of material and economy in development.

These strategies are being used for common sense purposes be that as it may, the best and monetary one is to balance out the dirt by locally accessible material. Coal based warm stations (Kota warm power plant) created fly fiery remains as a loss by item. It makes soil contamination, water contamination, and air contamination prompting antagonistic effect on harvest generation and human wellbeing. Kota stone slurry is accessible in immense sum in regions close Jhalawar and Kota. In the present investigation an endeavour has been made of utilization their locally accessible fly fiery remains (Kota warm power plant) and Kota stone slurry to settle sub level soil for street development, subsequent to looking at the properties of soil, fly powder, Kota stone slurry and their blends at various proportions

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II. METHODOLOGY CONSIDERED

Atterberg limits tests were conducted on both untreated and treated marine clay in accordance with BSI 1377: Part 2 (1990). Marine clay samples were first air-dried and sieved through a 0.425 mm mesh to make them suitable for liquid limit and plastic limit tests. The sieved sample was then mixed with various mix designs (10, 20, 30 and 40%) of 0.063 and 0.15 mm RBT. After being mixed with water, marine clay-RBT mixtures were kept inside air-tight plastic containers for at least 24 h before testing.

Untreated and treated marine clay samples with 10, 20, 30 and 40% of 0.063 and 0.15 mmRBT underwent the standard compaction tests as per the guidelines specified by the BSI 1377: Part 4 (1990). The 2 mm mesh sieved clay was mixed by hand as well as palette knives with dry RBT at different RBT contents (before compaction) until homogeneity was observed. After being mixed with water, samples were kept for at least24 h for proper moisture distribution. Next, the maximum dry density (MDD) and optimum moisture content (OMC) for both untreated marine clay and marine clay-RBT mixtures were determined. Using the predetermined MDD and OMC for treated and untreated samples, UCS samples were. prepared inside a cylindrical mold of 80 mm height and 38 mm internal diameter (Latifi et al. 2015). The determined proportions of RBT were evaluated on the basis of dry mass of untreated marine clay. The soil- RBT mixtures were then placed inside the mold in three equal layers. Each layer, which was approximately 25.3 mm in diameter, was compacted 27 blows using a stainless steel tamper with a circular face diameter of 37.5 mm to attain the desired dry unit weight (Ahmed 2015; Yilmaz 2015). Upon compaction, the UCS samples were extruded using a stainless steel plunger. Next, the samples were trimmed and wrapped using several layers of cling film before being placed in air-tight plastic bottles. These samples were stored inside the humidity chamber (27 ± 2 _C and humidity of 97 ± 2%) for 7, 14 and 28 days. The reported results were the average of at least three specimens in order to safeguard their reliability. Under the same testing conditions, most cases were reproducible with a low standard deviation, SD (SD=_x\10%, where _x denotes the mean strength value). The axial deformation and applied load were recorded automatically using a data acquisition unit (DAU). The maximum axial strain was set at 20%, and the UCS was obtained with reference to its peak axial stress at failure (BSI 1377: Part 7, 1990). If each test sample's difference in UCS was found to be greater than 10%, the test was repeated. Subsequently, the average UCS value of three samples was reported. Microstructural tests included X-ray diffraction (XRD), energy dispersive X-ray spectroscopy (EDS) and scanning electron microscopic (SEM). They were carried out to assess the mineralogical changes at the surface of treated samples as a result of adding RBT and investigate the formation of new crystalline.

A. Test Preparation

The Atterberg imit tests is conducted on Casagrande Appaatus,Plastic Limit test Appaatus CBR test is conducted on CBR apparatus. Standard Proctor compaction tests were carried out to determine the optimum moisture content and maximumdry density of all fly ash-soilmixtures according to ASTM D698-12e2 [22]. Cylindrical samples having a diameter of 38mmand height of 76 mm, used in the UCS test, were prepared at their corresponding optimum moisture content and maximum dry density by static compaction. For curing, the samples were closely wrapped in a polythene bag and placed above water in a desiccator kept in a room. The unconfined compressive strength of the samples was assessed according to ASTM D5102-09 [23]. The index properties of the organic soil and fly ash treated soil were determined according to ASTM D2976-15[24].

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Test of Liquid Limit, Plastic limit and CBR

B. Test Results

Varieties of different properties of soil on expansion of Fly Ash

Plastic limit	Liquid limit	Plasticity index	OMC	Dry density	CBR
Kota stone + 18% fly powder + 3% Kota stone slurry	28.81	39.5	10.69	17.85	1.79
Kota stone + 18% fly powder + 6% Kota stone slurry	31.25	38.8	7.55	18.40	1.780
Kota stone + 18% fly fiery remains + 9% Kota stone slurry	31.81	38.40	6.59	18.97	1.775
Kota stone + 18% fly fiery remains + 12% Kota stone slurry	30.23	36.80	6.57	19.64	1.770
Kota stone + 18% fly fiery remains + 15% Kota stone slurry	29.26	35.49	6.23	20.54	1.765
Kota stone + 18% fly cinder + 18% Kota stone slurry	29.41	36.16	6.75	22.414	1.760
Kota stone + 18% fly cinder + 21% Kota stone slurry	28.57	35.81	7.24	22.95	1.741

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Variations of different properties of soil on expansion of ideal Fly Ash and Kota stone slurry.

Plastic limit	Liquid limit	Plasticity file	OMC	Dry density	CBR
Kota soil	16.75	40.75	24.00	12.69	1.855
Kota soil	16.75	40.75	24.00	12.69	1.855
Fly ash	N.A.	N.A.	N.A.	N.A.	N.A.
Kota soil+3% fly ash	17.142	39.93	22.788	12.80	1.803
Kota soil+3% fly ash	17.142	39.93	22.788	12.80	1.803
Kota soil+6% fly ash	17.74	39.26	21.52	14.49	1.751
Kota soil+9% fly ash	18.75	39.25	20.50	16.07	1.740
Kota stone + 12% fly ash	20.27	36.85	16.58	16.36	1.722
Kota stone +15% fly ash	22.414	37.20	14.786	16.47	1.695
Kota stone + 18% fly ash	23.61	35.95	12.34	16.49	1.684
Kota stone + 21% fly ash	21.42	38.20	16.78	16.51	1.681

III. CONCLUSION AND DISCUSSION

In light of exploratory examination, the accompanying conclusion can be drawn.

1) Soil in Kota is dark cotton soil. This dirt kind isn't best for roadway development because of its pliancy attributes.

2) Fly fiery debris is accessible in huge sum in Kota as a waste item from warm power plants. It makes contamination and transfer issue.

3) Fly fiery debris Kota stone slurry adjustment procedure is likewise savvy when contrasted with other ground enhancement systems like utilization of chose soil, concrete adjustment, lime adjustment, grouting and so forth. In addition, required asphalt thickness on sweeping soil can be extensive decreased by selection of this method, which results in by and large sparing in development cost.

4) Experimental research facility deal with soil adjustment has exhibited variation in building properties of far-reaching virgin soil which generally unacceptable/less reasonable for use in street development. Impeding impacts of such soil can significantly be decreased with utilization of Fly Ash and Kota stone slurry in soil adjustment procedure in street development.

5) These territories, which have just been relinquished by aggregate misuse of Fly Ash and Kota stone slurry can be revived by utilizing the loss as a stabilizer for street development.

6) Waste dumps, which by and by give a betrayed look, when completely created will give a lovely stylish look. Land involved by waste dumps can be utilized for any human advantages or different exercises. Land being a rounded-out zone will offer better seepage for transfer of wastewater and along these lines give progressively clean-living conditions.

7) The examination shows that rate substitution of soil by fly cinder require improvement. The examination results demonstrate that substitution of soil by fly fiery remains up to 18% and with expansion of 3% to 9% Kota stone slurry to ideal fly slag can enhance the designing properties of soil extensively and further substitution does not show increasingly great outcomes.

8) Maintenance expense of the street developed on sweeping dark cotton soil is regularly high to substantial pain of the asphalt after storm. Utilization of fly fiery remains adjustment strategy can diminish consequent support cost of the street.

9) Experimental research facility contemplates on adjustment of soil with Fly Ash and Kota stone slurry has demonstrated that there is an enhancement in versatility and quality properties. Hence, the designing properties of sub review soil can be moved forward.

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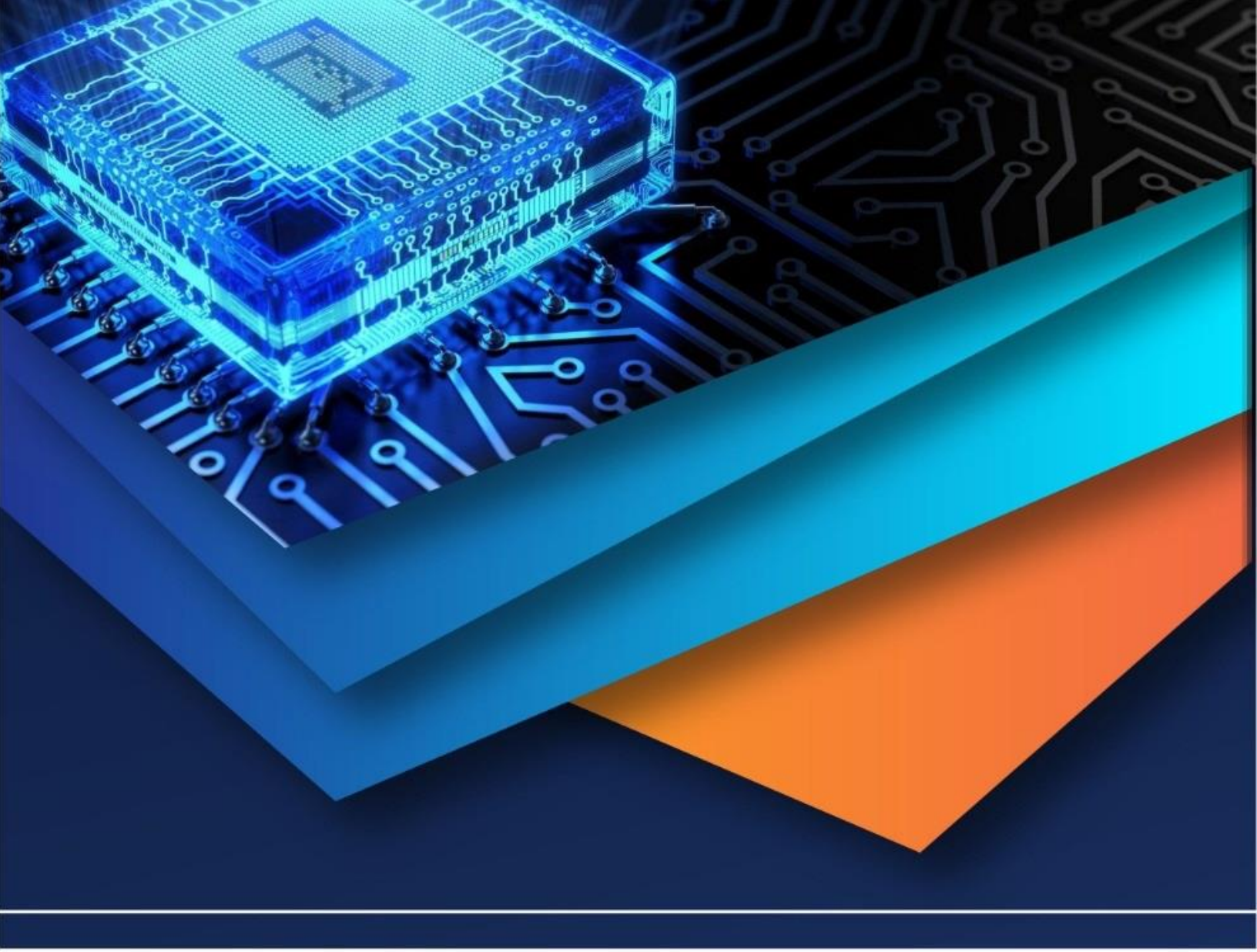

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