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Stabilization of Black Cotton Soil Using Lime and Rice Husk Ash

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Abstract:
For any land-based structure, the foundation is very important and has to be strong to support the entire structure. In order for the foundation to be strong, the soil around it plays a very critical role. So, to work with soils, we need to have proper knowledge about their properties and factors which affect their behaviour. The process of soil stabilization helps to achieve the required properties in a soil needed for the construction work.
This work is an attempt to increase the behaviour of black cotton soil by stabilizing it using Lime and Rice husk ash. Black cotton soil is known as expansive soil. It has unfavourable behaviours like low bearing capacity and very high compressibility. Several methods have been adopted so far in the construction industry to enhance the mechanical properties and behaviours of black cotton soil. The methods adopted are not environmental friendly as they need an irreversible material, which leads to find a way to utilize lime and rice husk ash for the stabilization to improve its behaviour. This paper will present the effectiveness of using rice husk ash and lime as stabilizer material by mixing 70% rice husk ash and 30% lime and then added to concrete by 3,5,8 and 10 % and check its behaviour of stabililization and by test results obtained from Specific gravity, un-confined compression test (UCC), Standard Proctor Test, pH level, Liquid limit, Plastic limit test it was seen that 8% of stabilizer will give good improvement in strength.

Keywords*: black cotton soil, Stabilization, Bearing capacity*

1. Introduction

Black cotton soils are problematic in nature due to its swelling, shrinkage property posing damaging effects on the structure constructed. We need to improve the overall performance of the soils by some means. In the present paper an attempt is made to improve the engineering properties of soil by using rice husk ash in combination with Lime.Vidarbha is a major rice producing region of Maharashtra and hence ash of the same is opted for the proposed work and lime is also easily available in the market.

From the beginning of construction work, the necessity of enhancing soil properties has come to the light. Ancient civilizations of the Chinese, Romans and Incas utilized various methods to improve soil strength etc., some of these methods were so effective that their buildings and roads still do exist. In India, the modern era of soil stabilization began in early 1970's, with a general shortage of petroleum and aggregates, it became necessary for the engineers to look at means to improve soil other than replacing the poor soil at the building site.

Soil stabilization was used but due to the use of obsolete methods and also due to the absence of proper techniques, soil stabilization lost its favor in enhancing the properties of peat soil. In recent times, with the increase in the demand for infrastructure, raw materials and fuel, soil stabilization has started to take a new shape. With the availability of better research, materials and equipment, it is emerging as a popular and cost-effective method for soil improvement.

Soil improvement plays a vital role in geotechnical engineering because it is the only way to stabilize and enhance the properties of soils. If structures are placed without any proper ground improvement to provide adequate stability to the ground, failure of structures may happen and this will cause death, loss of money and energy. Hence, a proper ground improvement work is essential before starting construction works over peat. Since peat is extremely soft soil and is unable to reach the required specification at construction sites due to its properties of low shear strength or low bearing capacity and high compressibility. The main aim of soil stabilization is to attain the below mentioned parameters like higher density shear strength, reduce the compressibility and permeability to control ground water flow or to increase the rate of consolidation to reduce consolidation time.

The effect of marble dust with RHA in a mix with expansive soil has been studied by Sabat and Nanda (1). It has been seen that with addition of RHA and marble dust with soil, the MDD decreases and OMC increases. Also the CBR and UCS values increase substantially due to adding these two with the natural soil. In 2008, Musa Alhassan (2) conducted an study on Potentials of Rice Husk Ash for Soil Stabilization.from the result of his study he concluded that treatment with RHA showed a general decrease in the MDD and increase in OMC with increase in the RHA content.Also in 2009 robert (3) performed a study on soil stabilization

with flyash and rice husk ash. He recommended that Stress strain behaviour of unconfined compressive strength showed that failure stress and strains increased by 106% and 50% respectively when the flyash content was increased from 0 to 25%. When the RHA content was increased from 0 to 12%, Unconfined Compressive Stress increased by 97% while CBR improved by 47%. Therefore, an RHA content of 12% and a flyash content of 25% are recommended for strengthening the expansive subgrade soil. A flyash content of 15% is recommended for blending into RHA for forming a swell reduction layer because of its satisfactory performance in the laboratory tests. In 2012 Sabyasachi etal (4)performed a study on Utilization Of Rice Husk Ash With Lime In Subgrade Soil For Rural Road Result showed that only use of RHA decreases the strength whereas in addition of RHA with soil, a very little amount of lime improves the soil property to a great extent. The study of Yulianto etal shows the effectiveness of using rice husk ash (RHA) and lime as a pozolanic material with natural soil. The results showed good improvement on its physical and engineering behaviour of the stabilized peat soil(5).

2. Methodology

The physical properties of black cotton soil are found out using the standard tests like moisture content, Specific gravity, un-confined compression test (UCC), Standard Proctor Test, pH level, Liquid limit, Plastic limit, Voids ratio, and then stabilizer (lime and rice husk ash) is added to the black cotton soil by 3%, 5%, 8% and 10% by weight and the optimum stabilizer content is found by all the test results. Since curing has an impact on the specific gravity, water content, organic content and acidity level, a study is made for curing period as 1day.The following tests were conducted to see the strength of soil such as UCC(unconfined compression test)was carried to find the strength of the soil .For UCC test cylindrical samples of 3.8mm diameter and 8.5 length were cast and Comparison of the nominal soil samples with that of the additive enriched samples are done similarly for direct shear with sample of size 60 x 60 x 50mm.

3. Results

For all the different test conducted on black cotton soil and stabilized soil for different percentages of stabilizer and test results are compared in the Table 1. Comparing all the results it is seen that the increase in specific gravity was about 22.5%, UCC 53%, Direct shear test C value of 64%, Maximum dry density 25% for very less water content of 12%, liquid limit 40%, plastic limit 18% and CBR 38% for 8% stabilizer than for 3%,5%,10% and it is seen that 8% of stabilizer can be considered as optimum dosage.

Sl. no	Tests conducted	Results for black cotton soil	stabilized soil with different % of stabilizer			
			3	5	8	10
1.	Specific gravity	2.17	2.208	2.26	2.66	1.99
2.	Unconfined compression test	29.1 KPa	33.6KPa	38.78	44.6	108.5
3.	Direct shear test	C=0.251 Φ =2.061	C = 0.02 Φ=10.67	C = 0.66 Φ=0.103	C = 0.24 Φ=2.061	C = 0.009 Φ =11.3
4.	Standard Proctor Test OMC MDD	17.02% 1.34g/cc	20% 1.458g/cm	22% 1.58g/cm	12% 1.68g/cm	22% 1.53g/cm
5.	Liquid limit	39.95	53.5	55.5	56	56
6.	Plastic limit	36.66	38.95	43.28	44	28.85
7.	CBR	5.47	5.67	6.88	7.6	4.87

Table 1: Comparison of test results for black cotton soil with and without stabilizer

4. Conclusion

- Specific gravity of stabilized soil was increased marginally for 3 %and 5 % but drastically for 8% and further started decreasing
- Unconfined compressive strength was increased by 15.4% for 3% stabilizer, 33% for 5% stabilizer 53% for 8% of stabilizer and 4 times increased for 10% stabilizer
- Standard proctor results shows that maximum dry density of soil was obtained for 8% stabilizer
- Liquid Limit and Plastic Limit of stabilized siol is found to be more than than of normal soil .
- CBR(california bearing ratio) was maximum for 8% stabilizer of almost 39% than plain soil
- The use of 8% stabilizer (30% lime + 70% rice husk ash) is able to improve physical and engineering characteristics of black cotton soil, those are: specific gravity; water content and void ratio decrease, soil shear strength increases and its compression decreases for one day curing.

5. References

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