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A Review on Expansive Properties of Dark Cotton Soil

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Abstract: ***Rapid increase in population and limitation of available land, construction of buildings and other civil engineering structures have to be done on soft soil. The properties of soil remarkably impact the constancy of the design laid on it. Dark Cotton Soil (Expansive soils) have the property of volumetric change when presented to variation in moisture conditions. It is having a swelling and impervious nature with good geotechnical sub grade characteristics. This irregular conduct is basically due the presence of Soil mineral montmorillonite. Physical and geotechnical properties of the soil samples will be studied in the laboratory. The tests such as standard Proctor compaction, specific gravity, grain size analysis direct shear test and consolidation test will be conducted on black cotton soil and sandy soil of the study area. Obtained results will be compared with the Indian standard code (IS).***

Keywords: Expansion soil, IS code, Black Cotton Soil, Montmorillonite

1. Introduction

The soils prone to expansion or shrinkage due to the variation of moisture content present in it are known as Expansive soil. “Montmorillonite” which is a clay mineral is mainly responsible for the expansive behaviour of the soil. The expansive soils are also known as swelling soils or black cotton soils. These soils are generally residual soils left at the place of their formation after chemical decomposition of the rocks such as basalt and trap. Expansive soils are generally dry because the water table there is quite deep. During rainy season, they become wet. The soils expand as the water content is increased. Severe movements of the soil mass may occur and the structures built on such soils may experience cracking and damage due to differential heave. A large part of the central India and a part of the south India is covered with expansive soils. Although these soils are good for growing cotton, they are treacherous for foundation of structures. Severe damages may occur to buildings, roads, runways, pipe lines and other structures built on such soils if proper preventive measures are not adopted. The damages can be restrained by a large extent if the characteristic of the expansive soil is properly assessed and suitable measures are taken in the design, construction and maintenance of structures built on expansive soil. When the water content of the expansive soil is increased, it expands. When the water content is reduced, it shrinks and cracks develop, which may travel deep into the ground. The maximum width of the shrinkage cracks is usually limited to 20mm. The depth of the expansive soil in which periodic changes of moistures content occur to cause swelling and shrinkage is known as the active zone. The soil below the active zone is not affected. The depth of the active zone at various locations is different. In most of the cases, the depth of the active zone is limited to 3 to 4 metres.

2. Literature Review

According to **Kunal Anand, Awanish Kumar Shukla, Sidharth Sharma (2013)** Comparative Study between Black Cotton Soil and Alluvial Soil for Economical Pavement Design by Lime & Fly - Ash Stabilization by analyzing the characteristics of soil collected from Pune and fly ash collected from Nasik Thermal Power Station. After mixing fly ash and lime with soil in different percentage the change in properties of soil were observed.

N. Kumrawat, &, S. K. Ahirwar (2014) concluded that the combination of the same amount of stone dust and CCR is more effective, (10%) than adding stone powder and CCR individually to the black cotton soil for controlling swelling behaviour.

Quarry waste is what occurs in large quantities. In each crusher unit, around 20 - 25% of the production is eliminated as waste material stone dust. In bulk, the use of quarry dust is possible through geotechnical applications such as filler material, substructure material. It is a by - product in the manufacture of Acetylene Gas. By CCR stabilization, chemical changes in unstable clay soils with long - term effects, experiments with stone dust and CCR in combination with different percentages mixed with expansive soil. Test results such as the standard Proctors test, the relationship Californiaload bearing and unrestricted compressive strength were observed on black cotton soil.

H. N. Ramesh, L. Manjesh, H. A. Vijaya Kumar (2014) conducted Unconfined Compression Test (UCC) & California Bearing Ratio (CBR) test to determine optimum fiber content as a reinforcing material in black cotton soil and gain in strength achieved by black cotton soil with the use of coir fiber as a reinforcing material with their optimum fiber content (OFC).

Golakiya, H. D., & Savani, C. D. (2015) Evaluated the effect of adding waste to black cotton soil to improve geosynthetic properties by performing various tests in the laboratory and varying the ratio of industrial waste for finding the optimum mixture to use in geotechnical construction work.

Vinayak Kaushal (April 2015) Collected & investigated the samples of black cotton soil from IndraSagar Rockfill Dam, Polavaram, Andhra Pradesh (India) at a depth of 1m, 1.2 m and 1.5 meters. The Physical and geotechnical properties of the soil specimen were studied in the laboratory. The tests performed were grain size analysis, Atterberg's limits, specific gravity, standard Proctor compaction, consolidation and direct sheartest. Results obtained by the tests were compared with the Indian standard code.

A. Jain, & R. K. Yadav (2016) The experimental work has been carried out by to check the improvement in the index properties and swelling property of expansive soil with lime in varying percentages. Lime was added in 2%, 4%, 6%, 8%, and 10% by weight of dry soil and the change in index properties and swelling property examined. Test results indicated that liquid limit, plasticity index and DFS of expansive soil decreased with increase in lime percentage. The optimum quantity of lime was found as 8% by weight of dry soil.

Maha Devi & Devarajan, (2017) This research was done to stabilize the soil using fly ash and lime. Experimental work was done with 10, 20 and 30% fly ash and 5%, 10% and 15% lime content. The experimental work was based upon variation in percentage content of the fly ash and lime the soil. Atterberg Limit, CBR Test, Unconfined Compression Test and Standard Proctor Test were conducted to record the change in engineering properties of black cotton soil.

Ajay Kumar Pandagre (2017) conducted various laboratory tests on black cotton soil mixed with different proportion of terrasili. e.0.03%, 0.05%, 0.07%, 0.09% by weight of dry soil, then in next stage in addition to variation of terrasil (%), lime is also added about 2% by weight of dry soil. The tests conducted on black cotton soil having soil mixed with terrasil, and by combining soil+terrasil+lime as per relevant IS codes of practice.

Hebi Madona (2018) Conducted experiments to improve the geotechnical properties of the subgrade of a flexible pavement by using stabilizers. Metakaolin and ceramic powder were used as a stabilizer for reducing uneven settlement in the pavement. Various laboratory experiments were performed to know the influence of stabilizers used and obtaining optimum mix.

Tulasi Sai Krishna, Noorbasha Sanil Basha, Karri Shyam Chamberlin (2019) Conducted experiment with Bagasse Ash (BA) and Brick Dust (BD) for overcoming the volumetric change property of soil. The experiment was focused on physical properties of soil, compressive test, Shear Strength tests, and Swell Pressure test.

3. Conclusion

It is clear that the soil which is blackish colour having high swelling potential and classified as inorganic clay of high plasticity in comparison with the sandy soil, the black soil is giving low bearing capacity, low CBR and low UCS value confirming it as an expansive soil. During wet season, moisture penetrates into these soils, because of which they swell. In addition to this, those soils have very bad bearing capacity, starting from five $T/m^2$to ten T/m^2. If there's a danger for water to come in contact with foundation, then the load should be constrained to 4.9 $tonnes/m^2$. We should have to be very careful while designing foundation on such soils. Taking mitigative measures such as stabilizing the layer of expansive soil with different stabilizers or removing the layer completely if possible before working on these types of soils can be marked as a good practice for avoiding foundation failures causing due to volumetric change of black cotton soil.

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