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Stabilization Of Black Cotton Soil By Using Iron Dust

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Abstract-The recent development in the use of advanced composites in the improvement of soil is increasing on the basis of specific requirements and national needs. The need of efficient and strengthening techniques of existing soil has resulted in research and development of newer materials for improvement. Particularly for black cotton soil which have high swelling and shrinkage tendencies, demands great deal of attention for stabilization. Various techniques are available for stabilization of black cotton soil. Here as a further steps toward the innovative material to be used for stabilization, this study endeavor to use industrial waste material like Electric Arc Furnace Dust (EAFD)iron dust and dolime fine for the soil improvement.

1. INTRODUCTION

The term 'soil' has various meanings, depending upon general professional field in which it is being considered. To an agriculturist, soil is the substance existing on the earth's surface, which grows and develops plant life. To the geologist also, soil is the material in the relatively thin surface zone within which roots occur, and all the rest of the crust is grouped under the term rock irrespective of its hardness. To an engineer, soil is the unaggregated or uncemented deposits of minerals and organic particles or fragments covering large portion of the earth's crust. It includes widely different materials like boulders, sands, gravels,clays and silts , and the range in the particle sizes in a soil may extend from grains only a fraction of micron (10^{-4} cm) in diameter up to large size boulders.

Soil is considered by the engineer as a complex material produced by the weathering of the solid rock. The formation of the soil is as a result of the geologic cycle continually taking place on the face of the earth. The cycle consist of weathering or denudation, transportation, deposition and upheaval, again followed by weathering, and so on. Weathering is caused by the physical agencies such as a periodical temperature changes, impact and splitting action of flowing water, ice and wind and splitting actions of ice, plants and animals. Cohesion less soils are formed due to physical disintegration of rocks.

Soils transported by gravitational forces are termed colluvial soils, such as talus. The accumulation of decaying and chemically deposited vegetable matter under conditions of excessive moisture results in the formation of cumulus soils, such as peat and muck.

For any land- based structure, the foundation is

very important and hence 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 a proper knowledge about their properties and factors which affect their behavior. The process of soil stabilization is to achieve the required properties in a soil needed for the construction work. From the beginning of construction work, the necessity of enhancing soil properties has come to the light. Ancient civilization of the Indians utilized various method to improve the soil strength etc., some of these methods were so effective that their building and roads still exists.

Objective of the study

Soil is an important construction material vastly used in every type of construction. All types of structures are constructed on foundation which is ultimately rested on soil. Remember, foundation does not carry the load it simply transfer the load to the soil. Entire load is to be taken up by soil only. If the soil is not capable of bearing the load, there will be no use of heavily deigned, heavily reinforced foundation.

Black cotton soil is an expensive soil which undergoes swelling and shrinkage on addition and removal of

water content. It may cause danger to any structure constructed on such type of soil. Such soil must be stabilized before used as foundation or construction material. The study area in the present work consist of black cotton soil, so efforts have been made to improve the geotechnical properties of soil in cost effective way. So the main objective is to stabilize the soil and improve its geotechnical properties in order to make use of the soil in the study area for construction purpose.

Soil stabilization

Definition

"Soil stabilization is the process of altering some soil properties by different methods, mechanical or chemical in order to produce an improved soil material which has all the desired engineering properties."

Soils are generally stabilized to increase their strength and durability or to prevent erosion and dust formation in soils. The main is the creation of a soil material or system that will hold under the design use condition and for the designed life of the engineering project. The properties of soil vary a great deal at different places or in certain cases even at one place; the success of soil stabilization depend on testing. Various methods are employed to stabilize the soil and the method should be verified in the lab with the soil material before applying it on the field.

Expansivesoils are considered problematic in construction since they undergo large volumetric changes due to seasonal variations in moisture.These soils are found in many regions of the world, especially in arid and semi-arid regions. Vast areas in Africa, Asia, and America are covered with expansive soils. Due to their vast availability & easy accessibility, these soils proved to be economical and so they are widely being used in construction of road embankments, airports, pavements, and other engineering structures. On the other hand, seasonal variations in moisture have surfaced the swelling and shrinkage ability of these soils. Soil stabilization is proved as aneffective technique to address this problem. Stabilization of expansive soil has been done by addition of different types of materials like Cement , Lime, and Bitumen . Nowadays, the usage of waste materials for soil stabilization has become popular by considering environment and economy. Waste materials like Wood Ash, Steel Slag, rice husk ash], Silica Fume , Quarry Dust , Fly Ash have been used to improve the properties of expansive soils. Iron is the second most metallic element in the earth's crust and accounts for 5.6% of the lithosphere. The level of per capita consumption of Iron is treated as an important index of the level of socioeconomic development and living standards of the people in any country. The usage of large quantities of iron in the present days is resulting in the generation of large amount of Iron waste. Few attempts were made in the past to stabilize the expansive soils using Iron powder.In the present study, the expansive soil is replaced with different proportions of Waste Iron Powder and various tests are carried out tofind the Atterberg limits, maximum dry density and California bearing ratio Values.

Principles of soil stabilization

1) Evaluating the properties of the given soil
2) Deciding the method of supplementing the lacking property by the effective and economical method of stabilization
3) Designing the stabilized soil mix for desired stability values
4) Considering the construction procedure by adequate compaction of stabilized layer soil stabilization may result in any one or more of the following change:

i. Increase the drain ability of the soil
ii. Increase stability
iii. Reduce volume changes
iv. Control the undesirable effects associated with clay
v. Reduce settlement
vi. Increases shearing resistance
vii. Increases the bearing capacity of soil
viii. Improving the local soil

Needs and Advantages:

Soil properties vary a great deal and construction of structure depends a lot on the bearing capacity of the soil, hence, we need to stabilized the soil which make it easier to predict the load bearing capacity of the soil. The gradation of the soil is also a very important property to keep in mind while working with soils.The soil may be well graded which is desirable as it has less number of voids or uniformly graded which though sounds stable but has more voids. Thus, it is better to mi different types of soil together to improve the soil strength properties. It is very expensive to

replace the inferior soil entirely and hence, soil stabilization is the thing to look for in this case.

1. It improves the strength of the soil, thus, increasing the soil bearing capacity.
2. It is more economical in both terms of cost and energy to increase the bearing capacity of the soil rather than going for deep foundation
3. It also provides more stability to the soil in slopes or other such places
4. Sometimes soil stabilization is also used to prevent soil erosion or formation of dust, which I very useful especially in dry and arid weather
5. Stabilization is also done for soil water proofing; this prevent water from entering into the soil and hence helps the soil from losing its strength
6. It helps in reducing the soil volume change in temperature or moisture content
7. Stabilization improves the workability and the *durability* of the soil

Methods of stabilization:

Mechanical method of stabilization :

In this procedure, soil of different gradation are mixed together to obtain the desired property in the soil. This may be done at the site or at some other place from where it can be transported easily. The final mixture is then compacted by the usual methods to get the required density.

Additive method of stabilization :

It refers to the addition of manufactured products into the soil, which in proper quantities enhances the quality of the soil. Materials such as cement, lime, bitumen, fly ash etc. are used as chemical additives. Sometimes different fibers are also used as reinforcement in the soil.

Available material for soil stabilization

Soil strength depends on the contact between soil particles and it can be improved at microscopic andmacroscopic scales. At the microscopic scale, resistance is increased by creating link between the particleswhich can be done by soil stabilization methods. At the macroscopic scale, the link between particles isreinforced using certain equipment and this method is usually referred to as soil reinforcement. There are bothphysical and chemical stabilizers. Chemical stabilizers stabilize and strengthen soils by creating reactions andtransforming the structure and link between soil particles. Through these reactions, soil particles form a newmaterial with new characteristics. Lime and cement are two of these stabilizers. Physical stabilizers such aspolymeric materials and ionic stabilizers usually increase the cohesion between particles and thus increase soilstrength. Different admixtures can be used in soil stabilization, the commonest of which are

• Lime

• Cement

• Fly ash

• Lime-fly ash mix

• Chlorides and salts

• Mixture of lime and polymer fibers

• Waste materials

The type of stabilization depends on the geotechnical characteristics of the soil and how much they need to be improved. These characteristics may include strength, plasticity, permeability, durability, stability, fatigue, etc. Nowadays, one of the common and acceptable methods of soil improvement is to use waste materials, for they are not only economical, but also help in protecting the environment. Waste materials such as fly ash, glass, plastics, blast furnace slag, rice husk ash, scrap tire rubber, waste iron powder, egg shells, and other pozzolanic materials have been used to improve the geotechnical characteristics of soils.

Iron is the second most metallic element in the earth's crust and accounts for 5.6% of the lithosphere . The level of per capitaconsumption of Iron is treated as an important index of the level of socioeconomic development and living standards of the people inany country. The usage of large quantities of iron in the present days is resulting in the generation of large amount of Iron waste.

2. LITERATURE REVIEW

E.A. Meshidaet. al,(May-2013 2242 ISSN 2229-5518)

They studied the effect of the strength characteristics of tropical black cotton clay soil steel mill dust. Tropical Black Cotton clay soils were mixed with steel mill dust at 5%, 10%, 15%, 20%and 30% steel mill dust content (by dry weight of soil) in order to establish the soil stabilizing potentials. The Unconfined compressive strength and CBR tests on the soil-steel mill dust mixtures yielded peak values at 30% mill scale content.

From the tests and results obtained, they concluded that:

The addition of steel mill dust increased the Maximum Dry Density, MDD, of tropical black cotton soil by about 28%. The MDD increased from 1639Kg/m^3 t0 2094Kg/m^3 which is considered satisfactory to excellent.The Optimum Moisture Content, OMC, of the tropical black cotton soil was lowered by about 45% by the addition of steel mill dust.The addition of steel mill dust increased the Un-soaked CBR of the tropical black cotton soil by about 90% at 30% steel mill dust content. A peak un-soaked CBR value of 58.8% was obtained using the WAS compactiveeffortwhich is above the minimum CBR value of 40% required for sub base of lightly trafficked roads**Gray and Al-Refeai (1986 *)***

They are conducted a series triaxial compression teston dry sand reinforced with continuous, oriented fabric layers and alsowith randomly distributed discrete fibres. Test results shows that bothtypes of reinforcement systems increased strength and modified thestress-deformation behavior of sand in a significant manner.

Thefollowing main conclusions emerged from the study . (i)continuous,oriented fabric inclusions markedly increased the ultimate strength,increased the axial strain at failure, and in most cases limited reductions in post-peak loss of strength. (ii) Discrete, randomlydistributedfibres increased both the ultimate strength and thestiffness of reinforced sand. (iii) At the same aspect ratio, confiningstress and weight fraction, rougher (not stiffer)fibres tended to bemore effective in increasing strength.

Lindh and Eriksson (1990)

They are conducted field experiments to study thesuitability of fibres for road construction.They constructed teststretches of 20 m and 40 m road by incorporating plastic fibresinsand and compared the performance with unreinforced stretch ofroad. The effect of plastic fibres on the stability of the sand wasobserved to be good. After about two years use by traffic, the teststretches were reported to have performed well, with no rutting ofthe road surface.

M Rupas Kumar et.al (July-August, 2015ISSN 2091-2730)

They studied the effect of iron powder on Atterberg's limit of soil, compaction tests & CBR test by using different percentage of iron powder (0 %,2 %,4 %,6 %,8 %). They got following results.The liquid limit values are decreasing with the percentage increase of Iron Powder in the soil, while the Plastic limit remained constant. The Plasticity Index (P.I) decreased with increase in percentage of Iron Powder in Soil. The Maximum dry density increased upto 6% replacementof Iron Powder and decreased further. It was also observed that increase in the percentage of Iron powder in soil is resulting in higher CBR values. By the comparison of the tests conducted (Atterberg's Tests, Compaction Tests and CBR Tests), it is recommended to replace 6% of Iron Powder in Soil to get maximum drydensity, higher CBR Values which are the indicators of Strength of a Soil.

3 Methodlogy

MATERIALS AND METHODS

Materials

a) Specification of soil*:*

Nearly black highly plastic silty clayey soil was used in this study, collected from At. Otur , Tal-junnar, Dist- pune, Maharashtra India. The collected soil was loose, wet and it was pulverized manually by hammer. Then the soil was screened through the sieve of 4.75 mm aperture before preparing the specimens for testing. and also oven dried the soil at 110 c for 24 hours before using specimen.

Test conducted

Specific gravity of soil by Density bottle

Determination Liquid Limit

Determination of Plastic Limit:

Determination of Shrinkage Limit:

Optimum moisture content

CBR test

Results:

Replacement of Iron dust(%)	Atterberg Limits		Compaction Test		CBR(%)
	LL	PI(%)	OMC(%	MDD(gm/cc)	
0	48	26	23.08	1.545	0.69
2	47	25	21.07	1.519	1.99
4	45	23	20	1.61	2.832
6	42	20	22	1.74	3.93
8	41	19	15.4	1.637	4.27

Conclusion

Thus we conclude that we increase the stability of black cotton soil using iron dust.We improve the shear strength of black cotton soil,plasticityindex.We can reduce theswelling property of black soil.We can increase drainability of black cotton soil. In geotechnical construction work

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