Soil Stabilization by using Fly Ash and Ferric Chloride

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Abstract: This paper mainly includes the stabilization of soil with the admixtures of fly ash and ferric chloride. The performance of pavement is very tractable to the characteristics of the soil subgrade. For that reason, weak subgrade is enhanced by adopting the most efficient stabilization technique. Based on the literature review, stabilization with fly ash activated subgrade found to be an effective option for improvement of soil properties. Stabilization of soil is mostly undertaken in soft soils such as organic soil, clayey peat, silt to achieve desirable engineering properties of soil. Some of the waste materials used are fly ash, marble dust, foundry sand, rice husk ash etc. These materials not only provide an alternative to the usage of conventional materials, but are also helpful in controlling the environmental pollution. At most of the places these waste materials are dumped into the open area which causes a lot of problem to the people around that area as well as to the workers working at these places. Utilizing these waste materials will not only reduce the pollution but will also reduce the human dependability on the natural resources, thus leading to a more sustainable approach of construction. From the literature it was found that the optimum dosage of fly ash and ferric chloride revealed in significant improvement in strength and durability and reduction in swelling and plasticity properties of the soil. Based on the results, it is recommended that fly ash and ferric chloride admixture be considered a viable option for the stabilization of expansive subgrades.

Keywords: Soil stabilization, fly ash, ferric chloride, material properties.

1. Introduction

Fly ash is a byproduct of the powdered coal ignition process generally associated with electric force creating plants. Fly ash is a fine residue which is pozzolanic in nature and made out of alumina, silica and different alkalies and oxides. It delivered cementitious product subsequent to responding with hydrated lime. (Braja M. Das). Type C fly ash is acquired from the ignition of coal preliminary. It contains a lot of free lime with the expansion of water that will respond with other fly ash mixes to frame cementitious products. This may dispense with the need to include produced lime (Braja M. Das). The soil stabilization is the alteration of soil properties to amend the designing execution of soils. The properties regularly changed are water content, density strength and plasticity. Change of soil properties is the transitory upgrade of sub level dependability to speed up development. Fly ash can be a fastener for settling soils for highway bases. Notwithstanding, restricted data opposes on the reuse of high carbon fly ash in development of thruway asphalts. This is especially significant when high carbon fly debris is calcium-rich and non-cementitious activators are required to create pozzolanic responses. In this manner, there is a need to assess the firmness and quality of base layers balanced out with high carbon fly ash.

Fly ash can be utilized to balance out the subgrades and furthermore to settle inlay to limit the horizontal earth pressures. Fly ash can likewise be utilized to settle banks to meliorate slope stability. Fly ash has been utilized effectively in numerous tasks to correct the quality attributes of soils. Typical stabilized soil depths are 15 to 46 centimeters (6 to 18 inches). The principle reason of fly ash is utilized in soil adjustment applications is to improve the compressive and shearing quality of soils. For the adjustment of fly ash the choice of a blend of fly ash, soil and water content normally relies upon which one would offer the proposed geotechnical properties on a momentary premise. The long haul execution of fly debris settled is to progressive distinctive climate cycles, for example, freeze-defrost or wet-dry cycles are regularly disregarded. The enduring cycles impact on common soils and soils balanced out with other settling materials, for example, lime and additionally concrete presume that the enduring activity may markedly affect the long haul execution of fly ash settled soils. The general quality and execution of asphalt is needy not just upon its plan (counting both basic structure and blend structure) yet in addition on the heap bearing limit of the subgrade soil. Along these lines, the methods that should be possible to expand the heap bearing limit (or auxiliary help) of the subgrade soil will in all likelihood correct the asphalt load-bearing limit and asphalt execution and quality. The more noteworthy subgrade basic limit can bring about more slender and progressively conservative asphalt structures. At last, the completed subgrade layer should meet evaluations, heights and inclines determined in the agreement base. This subsection covers:

1.1 Increasing subgrade support-compaction

The subgrade soil must be compacted to a sufficient thickness to offer the maximum structural support (as estimated by MR, CBR or R-Value). On the off chance that it isn't compacted, at that point the subgrade will keep on distorting or dissolve and pack after development, causing asphalt disfigurement and splits. For the most part, the thickness of soil is indicated as a relative thickness for the best 150 mm (6 inches) of subgrade of at the very least 95% of greatest thickness determined in the lab. In the event that the infill zone is compacted to 90% relative thickness, at that point the subgrade beneath the best 150 mm (6 inches) is frequently viewed as satisfactory. So as to acquire these densities the subgrade must be at or approach its ideal dampness content (the dampness content at which most extreme thickness can be gotten). Normally compaction of fill subgrade or in situ will bring about sufficient structural support.

1.2 Increasing subgrade support-alternative means

If the structural support offered by the in situ compacted subgrade is assessed to be insufficient, there are three choices to increase the structural support (any one or mix of the three can be utilized).

1.2.1 Stabilization

The binding characteristics of the materials for the most part increase subgrade load-bearing capacity. Normally, cement is utilized with less plastic soils (plasticity index less than 10), lime is utilized with highly plastic soils (versatility list more noteworthy than 10) and emulsified black-top can be utilized with sandy soils. For adaptable asphalts, a prime coat isn't successful on residue dirt or mud soils in light of the fact that the material can't be ingested into such a fine soil.

1.2.2 Over-excavation

The general standard is to supplant poor load-bearing in situ subgrade soil with better burden bearing fill. Normally, 0.3-0.6 m (1 – 2 ft.) of poor soil might be unearthed and supplanted with better load-bearing fill, for example, rock gets.

1.3 Subgrade elevation

The subgrade elevation ought to for the most part modify near the development plan subgrade height after definite evaluating (frequently called fine-grading). Huge elevation disparity ought not be compensated for by fluctuating asphalt or base thickness on the grounds that on account of HMA asphalts, HMA compacts differentially and HMA, PCC and total are more costly than subgrade soil. Thicker regions minimal more than more slender territories which will result in the subgrade elevation disparities influencing final pavement smoothness.

1.4 Needs and advantages of soilstabilization

Soil properties vary from place to place depending upon the climatic and geographical conditions of that area. They are not suitable for construction always and need to be modified sothattheydonotcauseanydamagetothestructurebuiltonthem.Themainneedofstabilizing the soil is to improve the bearing capacity so that they are able to withstand the load applied on them. The advantages of soil stabilization are:

- If during the development stage frail soil strata are experienced, the typical practice followed is supplanting the powerless soil with some other great quality soil. With the use of soil adjustment system, the properties of the locally accessible (soil accessible at the site) can be upgraded and can be utilized adequately as the subgrade material without supplanting it.
- The cost of setting up the subgrade by supplanting the frail soil with a decent quality soil is higher than that of setting up the subgrade by balancing out the locally accessible soil utilizing diverse adjustment methods.
- The quality giving parameters of the soil can be successfully expanded to a necessary sum by adjustment.
- It improves the quality of the soil, in this way, expanding the soil bearing limit.
- It is progressively conservative both as far as cost and vitality to expand the bearing limit of the soil instead of diving for deep establishment or pontoon establishment.
- It is additionally used to give greater solidness to the dirt in slants or other such places.
- Sometimes soil adjustment is likewise used to forestall soil disintegration or development of residue, which is exceptionally helpful particularly in dry and parched climate.
- Stabilization is additionally accomplished for soil water-sealing; this keeps water from going into the soil and henceforth helps the dirt from losing its quality.
- It helps in decreasing the soil volume change because of progress in temperature or dampness content.

1.5 Scope of soilstabilization

Soil engineering has immense application in the development of different structural designing structures. A portion of the different significant applications are as under:

i. Foundation: In the field of construction structure, whether it is bridge, building, or dam is foundedonorbelowthesurfaceoftheearth.Foundationisrequiredtotransmittheloadof the structure to soil safely and efficiently. Foundation engineering is an important branch of soil engineering. Foundation are of differenttypes:
    - Shallow Foundation: Foundation is term shallow establishment when the heap transmits to upper strata of earth.
    - Deep Foundation: Foundation is called profound establishment when the heap transmitted to impressively far beneath ground.
    - Pile Foundation: Pile establishment is a profound establishment's type.

ii. Retaining structure: A structure is required to hold the soil when adequate space isn't accessible for a mass of soil to spread and structure a sheltered slant. The holding structure might be an inflexible holding divider or a sheet heap bulkhead which is generally adaptable.

iii. Underground structure: The plan and development of underground structure are passage and conductor. Passages are built beneath the ground surface while conductors are laid underneath the ground surface.
Earth Dam: Earth Dam is colossal structure it requires short information on soil. Soil is gives as development materials in earth dam are worked for making water stores. Along these lines, disappointment of an earth dam may make savage aggravation condition, subsequently; outrageous consideration is taken in its structure and development.

2. Material Properties

2.1 Soil properties

To understand the properties of soils drainage and nutrients holding capacity the particle size of soils have a lot to do. To all the more likely see how this enormous three soil, we can envision that on the off chance that molecules of sand were the size of b-ball, at that point the sediment would be the size of a baseball, and earth would be the size of a golf ball. Line them up, and we can perceive how these molecule think about in size. One methodology is to utilize fly debris to settle the delicate sugared. The quality estimations of the dirt fly debris blends were assessed to describe the presentation of balanced out soil as a street sub-base. California bearing ratio (CBR) and unconfined compression strength tests were executed to determine the optimum mixture contents and strength properties of the soil-fly ash mixtures for construction. The properties of unmodified soil are listed in Table 1.

Table 1 Geotechnical properties of unmodified soil

Sl. No	Property	Value
1	Gravel	1.5%
2	Sand	32.5%
3	Fines	66.3%
4	Bulk Density	2.3g/cc
5	Specific gravity	2.66
6	Plastic limit	22.3%
7	Liquid limit	35.8%
8	Plasticity index	13.5%
9	Optimum moisture content	10.6%
10	Maximum dry density	19.3 kN/m^3

2.2 Additives

Added substances when added to the soil in the best possible amounts it fabricated commercial products that improve pliancy (Gordon R. Sullivian, 1994) and some building trademark. Added substances tended to right now constrained and only focus on the fly debris and ferric chloride.

2.3 Fly ash

Fly ash is a non-crystalline pozzolanic and slightly cementitious material. It is an environmentally risky solid waste that created for the most part from the burning of coal in thermal power plants. Presently, in India alone, the creation of fly ash has come to around 95 million tons for every year with the charging of super power plants roughly 1000-2000 MW and expanding utilization of coal. This stunning increment and alarmingly low level of usage up to 7.5% in India in 1998 represents a potential risk to condition and economy. Based on its cementitious properties (Nayak et al., 1988; Mittal, 1998) it was unmistakable to attempt it as an admixture with soil utilized right now. The fly ash was collected from a nearby thermal power station. Fly ash is the finely isolated mineral leftover portion coming about because of the consuming of ground or powdered coal in electric generating plant.

Fly ash comprises basically of oxides of silicon, calcium and aluminum iron while magnesium, potassium, sodium, titanium, and sulfur are additionally present to a lesser degree. At the point when fly ash utilized as a mineral admixture in concrete the fly ash is named either Class C or Class F fly ash dependent on its substance arrangements. Fineness of fly ash is most about identified with the working state of the coal trounces and the travail capacity of the coal itself. A coarser degree can bring about less receptive debris and could oppose higher carbon substance. Points of confinement on fineness are tended to by ASTM and state transportation office particulars. The physical properties and substance structures of run of the mill fly ash are given in Table 2 and Table 3.

Table: 2 Physical properties of fly ash

Colour	Dark grey
Specific gravity	2.74
Liquid limit	27%
Plastic limit	Non plastic
Maximum dry density	1.1g/cc
Optimum moisture content	32%
Swelling pressure	0.124kg/cm2

Table: 3 Chemical composition of fly ash

Sl. No.	Chemical component	Chemical content by wt.%	
		Class C	Class F
1	Silica(SiO_2)	40	55
2	Alumina(Al_2O_3)	16.5	26
3	Ferric Oxide(Fe_2O_3)	6.5	7
4	Calcium Oxide(CaO)	24	9
5	Magnesium Oxide(MgO)	2.3	2
6	Sulfate Oxide(SO_3)	3	1
7	Loss of Ignition(LOI)	6	6

2.4 Ferric chloride

Ferric chloride is an orange to dark colored dark strong. Ferric chloride is totally dissolvable in water. Ferric chloride is noncombustible. Ferric chloride is destructive to Aluminum and most metals when it is wet. Get and expel spilled strong before including water. From prior investigations it was discovered that FeCl3 was very compelling in limiting growing of broad soils. The properties of ferric chloride are recorded in Table 4.

Table 4 Properties of ferric chloride

Molecular formula	$FeCl_3$	Density	2.898 g/cm^3(anhydrous) 1.82 g/cm^3(hex hydrate)
Molar mass	162.2 g/mole (anhydrous) 270.3 g/mole (hex hydrate)	Melting point	306^{o}C (anhydrous) 37^{o}C (hex hydrate)
Appearance	Green-black by reflected light; Purple-red by transmitted light;	Boiling point	315^{o}C (anhydrous, decomp) 280^{o}C (hex hydrate, decomp) (Partial decomposition to $FeCl_2 + Cl_2$)
Odour	Slight HCl	Viscosity	40% solution: 12cP
Solubility in water	74.4 g/100 mL (anhydrous, 0^{o}C) 92 g/100 mL (hex hydrate, 20^{o}C)	Solubility in acetone Methanol Ethanol Diethyl ether	63 g/100 mL (18^{o}C) Highly soluble 83 g/100 mL Highly soluble
Crystal structure	Hexagonal	GHS hazard statements	H290, H302, H314, H318
Other anions	Iron (III) fluoride Iron (III) bromide	Other cations	Iron (II) chloride Manganese (II) chloride Cobalt (II) chloride Ruthenium (III) chloride
Related coagulants	Iron (II) sulphate Poly aluminium chloride	-	-

3. Literature Review

Joel H. Beeghly, 2003, concluded that Pavement engineers have since quite a while ago perceived long haul advantages of expanding the quality and toughness of pavement subgrade soil by blending in a cementitious fastener during remaking or new development. Government and state expressway engineers have a reestablished enthusiasm for "unending asphalt" which will profit by "never-ending establishments". For a low strong, silty soil or for recovering full profundity black-top asphalt late examinations and some ongoing practice has demonstrated that lime and Class F fly ash adjustment can be financially designed for long haul execution. For suitable soils, LFA can offer cost reserve funds by decreasing material expense by up to 50% when contrasted with Portland cement adjustment. David J. White, 2013, investigated that the subgrade soils rate generally from fair to poor with the majority of soils classifying as AASHTO A-4 to A-7-6, these soils can exhibit low bearing strength, high volumetric instability, and freeze/ thaw durability problems. Stabilization offers opportunities to improve these soil conditions. ASTM class C self-cementing FA has been used on a limited scale in Iowa to treat or stabilize unstable/wet subgrade. Primarily, stabilization serves the purpose of creating a construction platform in wet soils for embankment fill construction, soft subgrades, or temporary roadway foundations. The FA stabilization isn't utilized as of now to improve the quality/firmness of pavement establishments, this examination set out to research its application for asphalt thickness plan advancement. This examination required contemplating the in situ designing properties over an all-encompassing length with uncommon focus on freeze/defrost execution. David J. White, Dale Harrington, and Zach Thomas, 2005, presumed that the soil treated with self-establishing fly ash is progressively being utilized in Iowa to balance out fine-grained pavement subgrades, however without a total comprehension of the short-and long haul conduct. To build up a more extensive comprehension of fly ash designing properties, blends of five diverse soil types, going from ML to CH, and a few distinctive fly ash sources (counting hydrated and molded fly remains) were assessed. Results show that soil compaction attributes, compressive quality, wet/dry toughness, freeze/defrost solidness, hydration qualities, pace of solidarity increase, and versatility qualities are totally influenced by the expansion of fly ash. In particular, Iowa self-establishing fly cinders are powerful at balancing out fine-grained Iowa soils for earthwork and clearing tasks; fly ash increments compacted dry thickness and diminishes the ideal dampness content; quality increase in soil-fly ash blends relies upon fix time and temperature, compaction vitality, and compaction delay; sulfur substance can shape sweeping minerals in soil–fly ash blends, which seriously lessens the long haul quality and solidness; fly ash builds the California bearing proportion of fine-grained soil–fly ash viably dries wet soils and gives an underlying quick quality increase; fly ash diminishes swell capability of extensive soils; soil-fly ash blends relieved underneath frigid temperatures and afterward absorbed water are profoundly defenseless to slaking and quality misfortune; soil settled with fly ash displays expanded freeze-defrost sturdiness; soil quality can be expanded with the expansion of hydrated fly ash and molded fly ash, however at higher rates and not as successfully as self-solidifying fly ash.S. Siva Gowri Prasad, Suresh Kumar .Ch, Ramesh Surisetty, 2014, demonstrated that the presentation of a pavement is receptive to the attributes of the soil subgrade, which gives base to the entire pavement structure. Therefore of most extreme essentialness the exhibition of pavement is improved by receiving legitimate structure and development plans. Million tons of fly ash created from different thermal power plants is low unit weight, non-plastic, exceptionally fine and arranged in slurry structure into lakes covering immense territory. The debris procured from lakes gets legitimately air-borne and along these lines comprises a genuine contamination danger to the general public. These materials have a low burden conveying limit, debased settlement peculiarity and their usage in structural building works is an intense task. Right now, of fly ash compacted to its greatest dry thickness at the best dampness content is sorted out without and with Geotextile layers in the CBR form. Geotextile sheets equivalent to the arrangement measurements of CBR form is put in particular arrangements of first , second , third and fourth layers at various areas (for example at various installation proportion, z/d) in the CBR shape. Consequent to every course of action of Geotextile, the CBR (California Bearing Ratio) values are assessed in the research facility and contrasted and the aftereffects of CBR esteems sooner than including geotextiles. In view of the tests led and conversation the creators inferred that by expansion of fly ash, the CBR esteem is expanded by 27% when contrasted with unmodified soil. The CBR esteem is expanded by 28.4% where the geotextile is put at first layer when contrasted with other three layers. The CBR esteem is expanded by 64% where the geotextile is put at second and fourth layers when contrasted with first and third layers. The CBR esteem is expanded by 58.0% by setting the geotextile at all four layers contrasted with the unmodified soil and by putting the geotextile in the middle of the subgrade layers, the properties of the soil can be expanded and at last decreases the subgrade layer thickness, indicating cost- effective pavement. Louisiana standard specification (2006): Various states established their own criteria for modification and stabilization. The LADOTD recommends the criteria for the selection of the stabilizer based on the soil characteristic. Furthermore, the Texas DOT has a wide range of selection of stabilizers for subgrade and sub-base soils, which describes the selection of various stabilizers based on the properties of the subgrade soils. Fly ash delivered by power plants occasionally contains critical measures of unburned carbon because of normal utilization of low nitrogen-oxide and Sulfur-oxide burners as of late. This ash can't be reused in solid creation because of its reactivity with air entrainment admixtures and is being land filled everywhere rates. An investigation was directed to settle low firmness street surface material with high carbon fly ash. The non-cementitious fly ash was enacted with another reused material, lime Kiln dust (LKD). California bearing ratio (CBR) and versatile modulus tests were directed to decide the quality and firmness, individually, of the balanced out materials. Expansion of LKD and relieving of examples by and large expanded CBR and synopsis flexible modulus (SMR), and brought down plastic strains, CBR expanded with expanding CaO content just as with CaO/SiO_2 and $CaO/(SiO_2 + Al_2O_3)$ proportion of the blends; be that as it may, these parameters couldn't be connected with the SMR. The unpaved street materials balanced out with LKD and fly ash are relied upon to lose 31–67% of their underlying moduli after 12 patterns of freezing and defrosting. Lower base thicknesses and decrease in development expenses can be normal by settling street surface materials with high carbon fly ash. Cetin Bora et al. (2010): Roadways are one of the biggest development fields, and reuse of reasonable waste materials in their development can give noteworthy cost reserve funds while meeting the destinations of the United States Federal Highway Administration Green Highways Partnerships activity. A research facility study was led to examine the achievability of reusing artificially settled street surface material in development of thruway bases. Non-cementitious off-spec high carbon fly ash was initiated with lime furnace residue and used to settle an unpaved road material (URM) gathered from Maryland. The impacts of lime kiln dust (LKD) and fly debris expansion, and restoring time on quality and firmness of roadway bases were contemplated. The impacts of winter conditions on firmness were analyzed by performing versatile modulus tests on the examples after a progression of freeze–defrost cycles. The base thicknesses were determined for all blend structures by utilizing their CBR and summary resilient modulus (SMR) values. S. Kolias (2004): The viability of utilizing high calcium fly debris and concrete in balancing out fine-grained clayey soils (CL, CH) was researched in the lab. Quality tests in uniaxial pressure, in backhanded (parting) strain and flexure were completed on tests to which different rates of fly ash and cement had been included. Modulus of flexibility was resolved at 90 days with various sorts of burden application and 90-day drenched CBR esteems are likewise detailed. Pavement structures consolidating subgrades improved by in situ adjustment with fly ash and cement were investigated for development traffic and for working traffic. These pavements are contrasted and traditional adaptable pavements without improved subgrades and the outcomes obviously show the specialized advantages of settling clayey soils with fly ash and cement. What's more TG–SDTA and XRD tests were completed on specific examples so as to contemplate the hydraulic compounds, which were shaped. This work shows that the potential advantage of balancing out clayey soils with high calcium fly ash however this relies upon the kind of soil, the measure of settling specialist and the age. The investigation of the development of the hydraulic products during the restoring of mud containing as a balancing out operator high calcium fly ash shows that a lot of bermorite is shaped prompting a denser and progressively stable structure of the examples. A further expansion of cement gives better setting and solidifying and the mix of these two folios can build the ahead of schedule also the last quality of the balanced out material. The free CaO of fly ash responds with the earth constituents (SiO_2 and the other aluminum silicates) prompting the development of bermorite and calcium aluminum silicate hydrates too. Misra Anil (2004): Self-establishing class C fly ash is by and large progressively utilized for soil adjustment of road bases and in other common developments. Due to their self-establishing ability within the sight of water, they can be utilized for earth subgrade improvement as cement surrogates, or as street subgrade material. In any case, for productive and monetary usage of self-establishing class C fly debris, the physico-mechanical qualities of these remains must be resolved broadly. This paper centers upon the research center assessment of the (1) adjustment attributes of earth soils mixed with self-establishing class C fly ash, and (2) leftover self-cementation abilities of ponded class C fly ash. Testing completed by the creators and different specialists have shown that restoring time, relieving condition, mud mineralogy, measure of fly ash and expanding potential in the soil fly ash blend are the significant factors that control adjustment attributes. Right now, adjustment attributes were assessed as far as the addition in the uniaxial compressive quality and firmness, and growing potential. To analyze these impacts, 12 arrangements of blends of perfect mud soils with known rates of kaolinite and montmorillonite, self-solidifying class C fly ash and suitable measure of water were compacted and relieved. In the blended examples, measure of montmorillonite fluctuated from 0, 2, 4 and 6%, and the measure of self-establishing class C fly ash differed from 5, 10 and 20%. To examine the impact of relieving condition, three restoring situations were utilized. For growing test, the relieved examples were immersed and permitted to expand at the seating weight of around 2 KPa applied by the heaviness of the top permeable stone and burden plate utilizing the one dimensional odometer mechanical assembly. Notwithstanding the adjustment qualities of mud soils-fly ash mix, the leftover self-cementation abilities of ponded class C fly ash were additionally examined regarding unconfined pressure and CBR tests performed at 7 and 14 days of restoring. Results got from these test were empowering and contrasted well and the ordinary subgrade materials.

4. Conclusions

From the above literature, the following conclusion drawn:

i. It was seen that OMC increments and MOD reductions with expanded level of fly ash blended in with silty sand. The ideal estimation of fly ash blend was acquired to be approximately 30%.

ii. The variety of unconfined compressive strength (UCS) with variation of fly ash blend indicates that UCS increments up to 30% of fly ash blend and afterward it diminishes.

iii. When the variation of fly ash expanded then the liquid limit increased and plastic limit diminished.

iv. The addition of fly ash more prominent than 20%, plasticity index of the soil is additionally decreased.

v. With the addition of ferric chloride more prominent than 2 %, the plasticity index of the soil is additionally reduced.

vi. The variation of fly ash more prominent than 20%, the ideal dampness substance of the black cotton soil is expanded while the greatest dry density of the soil diminished.

vii. The addition of 20% of fly-ash, the unconfined compressive strength (UCS) of the stabilised subgrade soil is expanded when compared with the subgrade soil.

viii. The addition of 1.5 % of ferric chloride, the unconfined compressive strength (UCS) of the stabilised subgrade soil is expanded when contrasted with the subgrade soil.

ix. With the variation of ferric chloride more than 1.5%, optimum moisture content of the black cotton soil is expanded while the most extreme dry density of soil reduced.

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