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Stone Stabilization of Black Cotton Soil Of Sub grade in Saline Condition using Lime And Fly Ash As a Case Study: Bhavnagar-Dholera State Highway No- 6

Abhijitsinh Parmar[1], Sandeep Khorasiya[2], Mr Vismay J shah[3]

Ahmedabad Irrigation Division, Narmada Water Resources and Kalpsar Department Ahmedabad,India
S.V.B.I.T, Gandhinagar,India
J M Sambva Institute of Technology, Botad,India

ABSTARCT

The Aim of this paper to define improvement in Geotechnical properties using different stabilizers in black cotton soil having high salinity.

Black cotton soil is very problematic during wet condition. It works like stone when it is dry but loses its strength when it getting wet. So it is required to improve its geotechnical properties. In this case study area black cotton soil have high swelling as well as high salinity. In this research paper we will describe our improvement in different geotechnical properties using lime and fly Ash

Key words: California Bearing Ratio ,Optimum Moisture Content, Maximum dry Density, Soil Salinity , Free Swell Index, Fly Ash , Lime

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INTRODUCTION

In country like India traffic on National or State Highway is Near to 4500 CVD, hence m.s.a is near to 150 m.s.a. If those Highways are constructed in Black cotton soil it become problematic due to its characteristics. Black cotton soil having tremendous strength when it is dry but after getting wet it loses its strength of subgrade. BC soils shrink in volume and develop cracks during summer. They are characterized by extreme hardness and cracks when dry. The stability and performance of the pavements are greatly influenced by the sub grade and embankment as they serve as foundations for pavements.

On such soils suitable construction practices and sophisticated methods of design are to be adopted. In the present paper, reasons for poor condition of roads in B.C soils and measures to be taken for construction and improvement of roads on BC soils are presented.

Expansive soil is one among the problematic soils that has a high potential for shrinking or swelling due to change of moisture content. Expansive soils can be found on almost all the continents on the Earth. Destructive results caused by this type of soils have been reported in many countries.

A. IMPORTANCE OF STUDY AREA

- Connecting road of National Highway – 8 E at Bhavnagar.
- The Ahmedabad-Dholera industrial region lies within 100 km from the Dedicated Freight Corridor (DFC) in Central Gujarat
- Traffic to Alang braking ship yard which is Asia's largest ship yard is connected to this Highway.
- Pipavav port is connected with this Highway.
- For the Military and Navy purpose this Coastal Highway is very important.
- Connecting road to Kalpsar Project for sweet water.

B. PROBLEM DEFINATION

In India, large tracts are covered by expansive soils known as black cotton soils. The major area of their occurrence is the south Vindhyachal range covering almost the entire Deccan Plateau. These soils cover an area of about 200,000 square miles and thus form about 20% of the total area of India.

Deccan lava in majorparts of Maharashtra, western MadhyaPrades (Hoshangabad, Narsinghpur, Damoh, Jabalpur, Raisen and Shahdol districts), Gujarat (Bhavnagar,Surat, Bharuch, Vadodara Kheda, Sabarkantha and Dang districts), Andhra Pradesh (Adilabad, Warangal, Khammam, Mahbubnagar, Kurnool, Guntur and Karimnagar districts), Karnataka (Bijapur, Dharwar, Gulbarga, Bidar, Belgaum, Raichur, Bellari and Chitradurga districts), Rajasthan (Kota, Bundi, Sawai Madhopur, Bharatpur and Banswara districts), Tamil Nadu (Ramnathpuram, Tirunelvelli, Coimbatore, Madurai and South Arcot districts) and Uttar Pradesh (Jalaun, Hamirpur, Banda and Jhansi districts).
The primary problem that arises with regard to expansive soils is that deformations are significantly greater than the elastic deformations and they cannot be predicted by the classical elastic or plastic theory.

- ❖ Movement is usually in an uneven pattern and of such a magnitude to cause extensive damage to the structures resting on them. Proper remedial measures are to be adopted to modify the soil or to reduce its detrimental effects if expansive soils are indentified in a project.
- ❖ The remedial measures can be different for planning and designing stages and post construction stages.
- ❖ Many stabilization techniques are in practice for improving the expansive soils in which the characteristics of the soils are altered or the problematic soils are removed and replaced which can be used alone or in conjunction with specific design alternatives. Additives such as lime, cement, calcium chloride, rice husk, fly ahs etc. are also used to alter the characteristics of the expansive soils.

The characteristics that are of concern to the design engineers are permeability, compressibility and durability. The effect of the additives and the optimum amount of additives to be used are dependent mainly on the mineralogical composition of the soils

Roads on Expansive soils are much problematic than problem's in other types of soil and in addition it affects more when roads were constructed in Expansive soil as well as in saline region, Saline soil may also create much problem in Sub Grade of Roads.[2]

In this case study Area region is highly affected with salinity and soil type is expansive soil.

- Swelling of soil in subgrade in expansive type of soil
- Shrinkage creates crakes in subgrade in dry session.
- Consolidation creates uneven pavement in dry session.
- Salt can cause spalling of steel reinforced concrete by accelerating steel corrosion if cracks allow chloride ions access to the reinforcing steel.
- Heavy traffic of Multi Axle vehicles due to pipavav port,Alang Ship Yard, Connecting road to NH-8 E at Bhavnagar, Short Route for Ahmedabad , Proposed Kalpsar Project and Dahej Ferry Service.
- For the purpose of Navy and military it may not allowed to close this highway for a single day also.

MATERIALS AND METHODS

40 to 60% of the Black cotton soil (BC soil) has a size less than 0.001 mm. At the liquid limit, the volume change is of the order of 200 to 300% and results in swelling pressure as high as 8 kg/cm2/ to 10 kg/cm2. As such Black cotton soil (BC soil) has very low bearing capacity and high swelling and shrinkage characteristics. Due to its peculiar characteristics, it forms a very poor foundation material for road construction. Soaked laboratory CBR values of Black Cotton soils are generally found in the range of 2 to 4%. Due to very low CBR values of Black cotton soil (BC soil), excessive pavement thickness is required for designing for flexible pavement. Research & Development (R&D) efforts have been made to improve the strength characteristics of Black cotton soil (BC soil) with new technologies.[3]

A) STABILIZATION WITH FLY ASH [4]

Fly ash by itself has little cementatious value but in the presence of moisture it reacts chemically and forms cementatious compounds and attributes to the improvement of strength and compressibility characteristics of soils. It has a long history of use as an engineering material and has been successfully employed in geotechnical applications.

ERDAL COKCA (2001):

Effect of Flyash on expansive soil was studied by Erdal Cokca, Flyash consists of often hollow spheres of silicon, aluminium and iron oxides and unoxidized carbon. There are two major classes of flyash, class C and class F. The former is produced from burning anthracite or bituminous coal and the latter is produced from burning lignite and sub bituminous coal. Both the classes of fly ash are puzzolans, which are defined as siliceous and aluminous materials. Thus Fly ash can provide an array of divalent and trivalent cations (Ca2+,Al3+,Fe3+etc) under ionized conditions that can promote flocculation of dispersed clay particles. Thus expansive soils can be potentially stabilized effectively by cation exchange using flyash. He carried out investigations using Soma Flyash and Tuncbilek flyash and added it to expansive soil at 0-25%. Specimens with flyash were cured for 7days and 28 days after which they were subjected to Oedometer free swell tests. And his experimental findings confirmed that the plasticity index, activity and swelling potential of the samples decreased with increasing percent stabilizer and

curing time and the optimum content of flyash in decreasing the swell potential was found to be 20%. The changes in the physical properties and swelling potential is a result of additional silt size particles to some extent and due to chemical reactions that cause immediate flocculation of clay particles and the time dependent puzzolanic and self hardening properties of flyash and he concluded that both high calcium and low calcium class C fly ashes can be recommended as effective stabilizing agents for improvement for improvement of expansive soils.

PHANIKUMAR AND SHARMA (2004):

A similar study was carried out by Phanikumar and Sharma and the effect of fly ash on engineering properties of expansive soil through an experimental programme. The effect on parameters like free swell index (FSI), swell potential, swelling pressure, plasticity, compaction, strength and hydraulic conductivity of expansive soil was studied. The ash blended expansive soil with flyash contents of 0, 5, 10,15 and 20% on a dry weight basis and they inferred that increase in flyash content reduces plasticity characteristics and the FSI was reduced by about 50% by the addition of 20% fly ash. The hydraulic conductivity of expansive soils mixed with flyash decreases with an increase in flyash content, due to the increase in maximum dry unit weight with an increase in flyash content. When the flyash content increases there is a decrease in the optimum moisture content and the maximum dry unit weight increases. The effect of fly ash is akin to the increased compactive effort. Hence the expansive soil is rendered more stable. The undrained shear strength of the expansive soil blended with flyash increases with the increase in the ash content.

B) STABILIZATION OF EXPANSIVE SOILS USING FLYASH [5]

In this paper description about a study carried out to check the improvements in the properties of expansive soil with fly ash in varying percentages. Both laboratory trials and field tests have been carried out and results are reported in this paper. One of the major difficulties in field application is thorough mixing of the two materials (expansive soil and fly ash) in required proportion to form a homogeneous mass. The paper describes a method adopted for placing these materials in layers of required thickness and operating a “Disc Harrow”. A trial embankment of 30m length by 6m width by 0.6m high was successfully constructed and the in-situ tests carried out proved its suitability for construction of embankment, ash dykes, filling low-laying areas, etc.

C) EFFECT OF LIME STABILIZATION ON PROPERTIES OF BLACK COTTON SOIL [6]

In this paper detail study on behavior of lime on stabilization of black cotton soil Stabilization occurs when lime is added to black cotton soil and a pozzolanic reaction takes place. The hydrated lime reacts with the clay particles and permanently transforms them into a strong cementitious matrix. Black cotton soil showing low to medium swelling potential from Latur, Maharashtra was used for determining the basic properties of the soil. Changes in various soil properties such as Liquid limit, Plastic Limit, Maximum Dry Density, Optimum Moisture Content, Differential Free Swell, Swelling Pressure and California Bearing Ratio were studied specified,

LABORATORY SETUP

Experimental setup has done in three step

i) Collection of Test sample

ii) Establish in soil properties
iii) Results and Interpretation

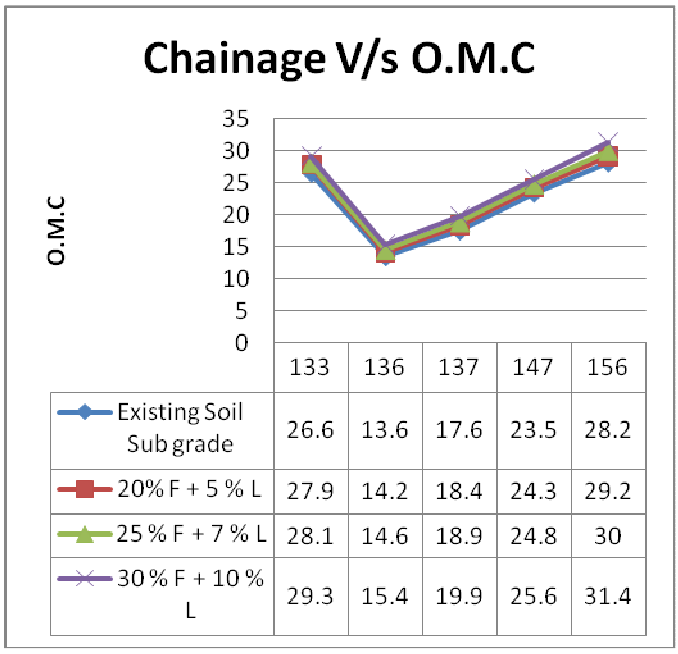
In Laboratory test was carried out for Existing Subgrade and After adding Lime and Fly Ash as a stabilizer with different percentages.

Below mentioned test was carried out in laboratory as per Indian Standards. (IS 2720) for weakest section of Case Study Area.

I. Modified Proctor Test
II. Free Swell Index
III. Soil Salinity Test

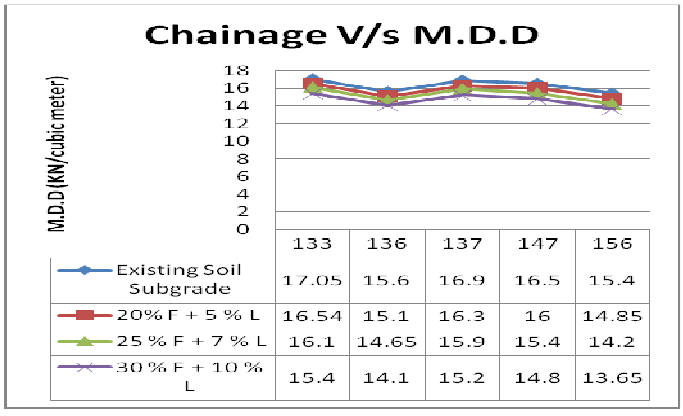
A) Analysis of Test Result For Modified Proctor Test

Optimum Moisture Content



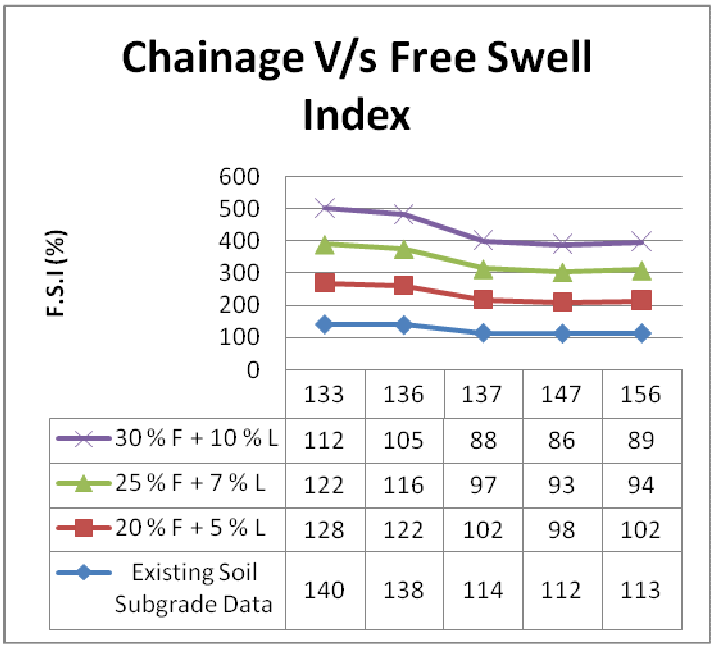
	133	136	137	147	156
Existing Soil Sub grade	26.6	13.6	17.6	23.5	28.2
20% F + 5 % L	27.9	14.2	18.4	24.3	29.2
25 % F + 7 % L	28.1	14.6	18.9	24.8	30
30 % F + 10 % L	29.3	15.4	19.9	25.6	31.4

Maximum Dry Density



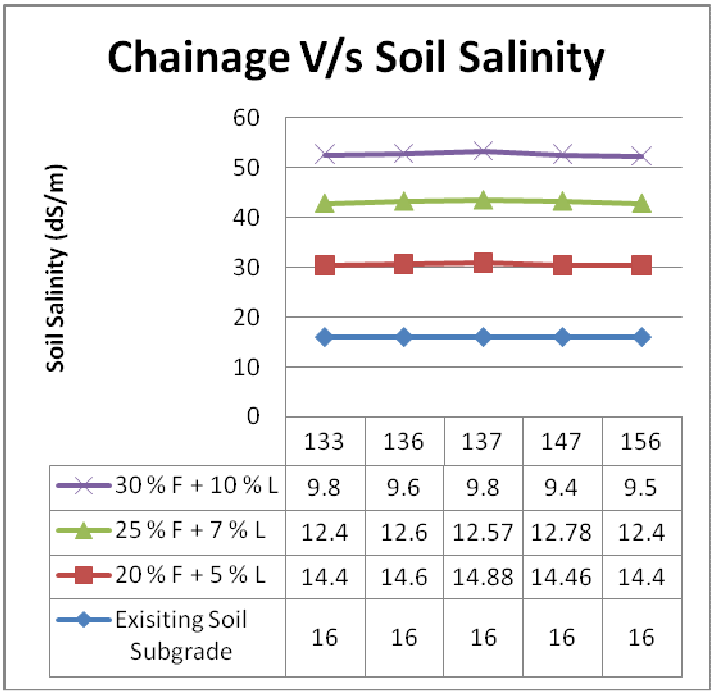
	133	136	137	147	156
Existing Soil Subgrade	17.05	15.6	16.9	16.5	15.4
20% F + 5 % L	16.54	15.1	16.3	16	14.85
25 % F + 7 % L	16.1	14.65	15.9	15.4	14.2
30 % F + 10 % L	15.4	14.1	15.2	14.8	13.65

B) Free Swell Index test result Analysis



	133	136	137	147	156
30 % F + 10 % L	112	105	88	86	89
25 % F + 7 % L	122	116	97	93	94
20 % F + 5 % L	128	122	102	98	102
Existing Soil Subgrade Data	140	138	114	112	113

C) Soil Salinity Test result Analysis



	133	136	137	147	156
30 % F + 10 % L	9.8	9.6	9.8	9.4	9.5
25 % F + 7 % L	12.4	12.6	12.57	12.78	12.4
20 % F + 5 % L	14.4	14.6	14.88	14.46	14.4
Exisiting Soil Subgrade	16	16	16	16	16

CONCLUSION

In present Case study area geotechnical properties were improved by below mentioned result.

- Optimum Moisture Content was improved by 11.1 %
- Maximum Dry Density was Improved by 10.74 %
- Free Swell Index was Improved by 13.74 %
- Soil Salinity which is major devil in present study area was improved by 16.66 %.

FUTURE SCOPE

Hence result of O.M.C and M.D.D was not improved in major terms so need to improve with another material or addition with this materials like stone dust, Fibers or granular material.

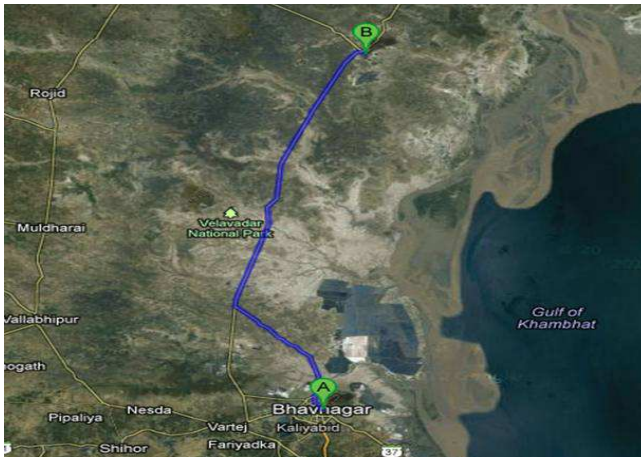


Fig – 1 Study Area- Bhavnagar-Dholera Highway (SH – 06)

Fig – 2 High Shrinkage in Case Study Area

Fig – 3 Failure of Recently constructed Pavement after Monsoon due to High Swelling

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