

# Improvement of C.B.R in Black cotton Soil having high Salinity using different Materials

As a Case Study: Bhavnagar-Dholera State Highway No- 6

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**Abstract**— The Aim of this paper to define improvement of California Bearing Ratio of Sub grade in saline condition in black cotton soil. Expansive soil have tremendous strength but it become very soft when it getting wet, It expands/swell due to its mineralogical composition during its wet condition, It creates cracks or consolidated when it is dry. The stability and performance of the pavements are greatly influenced by the sub grade. Design of Flexible Pavement according to Indian Road Congress ( IRC) is highly dependent on California Bearing Ratio of Soil. In Black Cotton Soil it lies between 1-2.5 % which is very low. Low bearing ratio required high Pavement thickness which become very uneconomical so improvement is necessary. In this paper C.B.R is between 2.0 – 2.5 % which is improved up to 7.8 % in case Study Area. The Saline soils have excessive concentration of natural soluble salts, mainly of chlorides, sulphates and carbonates of calcium, magnesium and sodium. The magnesium in magnesium chloride may react with the cement paste in concrete, weakening the pavement structure. Rutting or Pot holing in granular Pavement & Differential shape resulting in rough pavement. Both Expansion and Salinity influences pavement failure due to failure in sub grade so it is required to detail study on stabilization of black cotton soil.

**Index Terms**—California Bearing Ratio , Fly Ash , Stone Dust Powder , Polypropylene fiber , Lime

## I. 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. If C.B.R value is between 2% to 3 % .Design of flexible pavement according to IRC 37-2011. Which requires C.B.R value and Traffic load in m.s.a, If value of C.B.R is near to 2 % than thickness of layer required 830 mm which is very uneconomical.[1]

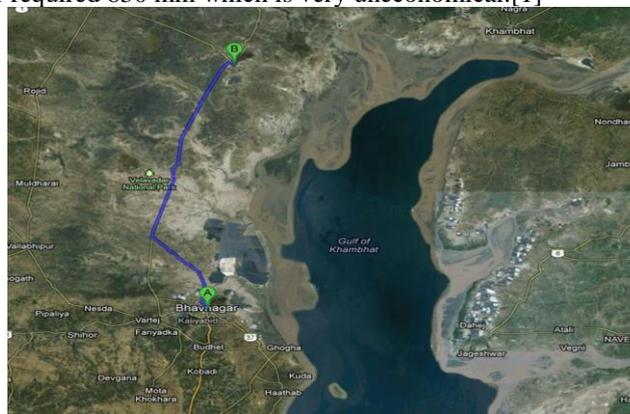


Fig 1 Study Area- Bhavnagar-Dholera Highway (SH – 06)

### 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.

Alang is a census town in Bhavnagar district in the Indian state of Gujarat. In the past three decades, its beaches have become a major worldwide centre for ship breaking.

### Marine Salvage Industry

The shipyards at Alang recycle approximately half of all ships salvaged around the world. The yards are located on the Gulf of Khambhat, 50 kilometres southeast of Bhavnagar.

#### **Future**

Japan and the Gujarat government have joined hands to upgrade the existing Alang shipyard. The two parties have signed a Memorandum of Understanding, which focuses on technology transfer and financial assistance from Japan to assist in the upgrading of operations at Alang to meet international standards. This is a part of the Delhi Mumbai Industrial Corridor, a larger partnership between the Japanese and Gujarati governments. Under this plan, Japan will address the environmental implications of ship breaking in Alang, as well as devising a marketing strategy. The project is to be carried out as a public-private partnership. The project's aim is to make this shipyard the largest International Maritime Organization-compliant ship recycling yard in the world.

#### **Pipavav Port**

Port Pipavav, India's first port in the private sector, is a port on the West Coast of India for containers, bulk and liquid cargo. Its lead promoter is APM Terminals, one of the largest container terminal operators in the world. The services include pilotage/towage, cargo handling and logistics support. Port Pipavav is located in Saurashtra, Gujarat, at a distance of 90 km South of Amreli, 15 km South of Rajula and 140 km South West of Bhavnagar. The port handles both bulk, container and liquid cargo. The northwest market generates 60 % market of India and Gujarat itself major cargo generating state.

#### **Dholera**

Dholera is a town in Gujarat, India. Dholera is an ancient port-city in Gulf of Khambhat, 30 km. from Dhandhuka village of Ahmedabad district. One of the original six temples built by Swaminarayan is located here. Dholera Metro City Dholera is in proximity with the coastal line. It is covered by water faces on three sides, namely, on the east face by Gulf of Khambhat, on the north side by Bavaliari creek and on southern side by Sonaria creek Proximity to Ahmedabad has provided Dholera a strong locational advantage with a vibrant manufacturing base and investment scenario. Strategically located, the Ahmedabad-Dholera industrial region lies within 100 km from the Dedicated Freight Corridor (DFC) in Central Gujarat National Highway 8 connects the Dholera Special Investment Region with Ahmedabad, Bhavnagar and Mumbai. Dholera itself has good connectivity with National Highway (NH) 8 (Anand) and 8A (Bagodra), augmenting Bagodra -Bhavnagar, Bagodra- Surendranagar- Radhanpur.

#### **B. Problem Definition**

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 cracks 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 closing this highway for a single day also.

## **II. REVIEW OF LITERATURE**

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/cm<sup>2</sup>/ to 10 kg/cm<sup>2</sup>. 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 Of Expansive Soils Using Flyash [4]**

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.

#### **B) Effect Of Lime Stabilization On Properties Of Black Cotton Soil [5]**

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.

### III. LABORATORY SETUP

Experimental setup has done in three steps

- i) Collection of Test sample
- ii) Establish in soil properties
- iii) Results and Interpretation

Following laboratory tests have been carried out as per IS: 2720. CBR value of the soil is determined according to IS 2720 (Part 16) – 1987 The tests were carried out on [6]



Fig 2

The test of CBR for soil-consolid is mix on CBR testing machine. The CBR test is performed at a constant penetration rate of 1.2 mm per minute. The test readings are noted for penetration of plunger at 0.2, 0.4, 0.6, 0.8, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10.0, and 12.5 mm. The CBR values are usually calculated for penetrations of 2.5 and 5.0 mm.

As per indian standard laboratory test was carried out in a laboratory below result i got between most sensitive section on dholera bhavnagar highway between chainage 133/00 to 160/00

TABLE -1 LABORATORY TEST RESULT DATA

Sr No	Chainage Location (km)	Existing C.B.R (%)	20% Fly Ash + 7 % Lime	20% Fly Ash + 7 % Lime + 25 % Stone Dust	20% Fly Ash + 7 % Lime + 25 % Stone Dust + 2% P.P.F
1	133	2	3.2	6.1	6.75
2	136	2	3.1	5.9	6.5
3	137	2.2	3.5	6.7	7.5
4	147	2.5	3.7	6.9	7.3
5	156	2.5	3.7	6.75	7.8

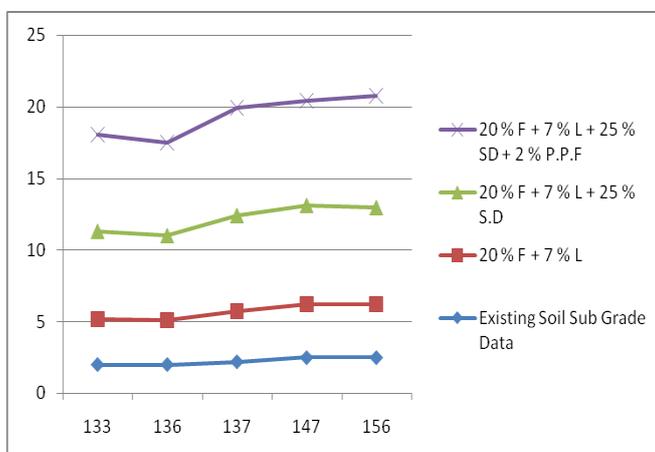


Fig 3 Chainage v/s C.B.R value

#### IV. CONCLUSION

1. In first proportion C.B.R value is improved by 160 % as from existing condition.
2. In second proportion C.B.R value is improved by 276% as from existing condition.
3. In third proportion C.B.R value is improved by 312 % as from existing condition

#### FUTURE SCOPE

Study area is very important for security reason, freight purpose and as a State Highway. After every monsoon competent authority waste lots of money behind this Highway. In Gujrat there are less study have been carried out in past on coastal way having high saline and high swelling soil. Kutch, Certain region of Saurashtra is also affected with the same problem, Government resurfaces those pavements every year and at the end of monsoon it becomes very crucial. So in future study behind these type of highway is much needed in below mentioned field.

- 1 Re pavement Design using improved C.B.R value
- 2 Feasibility of Rigid Pavement in Coastal highway using hybrid Concrete
- 3 Design Superior performance pavement after improvement in Sub grade
- 4 Design Flexible pavement with AASHTO method.

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