

# Requirement to Improve C.B.R value in Black Cotton Soil in Saline Condition: A case study of Bhavnagar-Dholera Highway in Gujarat, India

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**Abstract**-The Aim of this paper to define need to improve C.B.R value of subgrade 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 and embankment as they serve as foundations for pavements. 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. 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. Flexible Pavement design is based on C.B.R value and m.s.a value. If value of C.B.R is low than thickness of material is going to increase hence for economical thickness need to improve C.B.R value where it is low.

but after getting wet it losses its strength of subgrade.C.B.R value is between 2% to 3 % .Design of flexible pavement in India is from IRC 37-2011.Which need C.B.R value and Traffic load in m.s.a, If value of C.B.R is low than thickness of layer required 830 mm which is very uneconomical. Hence we need to improve value of C.B.R in that type of area.[1]

## 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.

## 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.

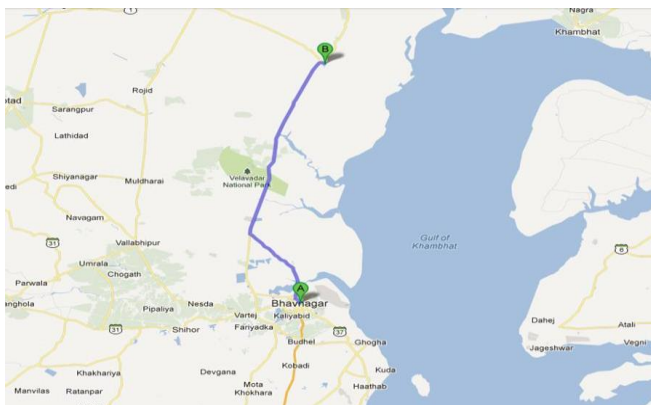


Fig. 1. Highway on the map

Black cotton soil having tremendous strength when it is dry

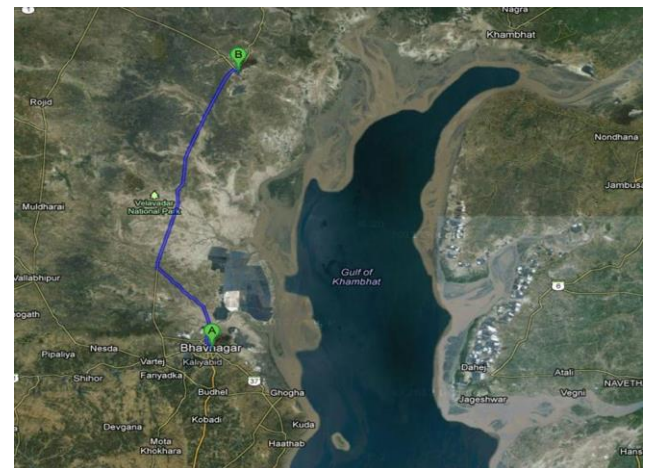


Fig. 2. Internet view of Highway

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

## a) 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.

b) *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.

c) *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 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]

In India, CBR method developed in USA is generally used for the design of crust thickness. This method stipulates that while determining the CBR values in the laboratory and in the field, a surcharge weight of 15 kg and 5 kg per 62 mm and 25 mm thickness respectively should be used to counteract the swelling pressure of Black cotton soils (BC soils). BC soils produce swelling pressure in the range of 20-80 tons/m<sup>2</sup> and swelling in the range of 10-20%. Therefore, CBR values obtained are not rational and scientific modification is required for determining CBR values of expansive soil.

Having heavy-duty traffic of 4500 commercial vehicles per day and m.s.a 150 as generally found on our National Highways and taking CBR value of 2%, total crust thickness of flexible pavement works out to 830 mm which is practically an impossible preposition. It is felt that CBR design curves require modification for expansive soil.

Assuming heavy traffic intensity of 4500 commercial vehicles per day and m.s.a 150, crust thickness of rigid pavement works out approximately 300-320 mm, which is about one third of thickness needed for flexible pavement. Therefore, it sounds reasonable to adopt cement concrete pavement in Black cotton soil areas. This type of pavement may save the engineers from day to day maintenance problems.

Another approach to the problem can be in having semi rigid sub-bases. It is suggested that the CBR value of the BC soil be improved by giving a suitable treatment with the appropriate technology and then work out the crust thickness. This will substantially reduce the required crust thickness.[4]

## III. REVIEW OF LITERATURE

Experimental setup has done in three steps,

1) Collection of Test sample	7	139	7.53	51	25	CH
2) Establish in soil properties	8	140	13.6	56	31	CH
3) Results and Interpretation	9	141	13.6	59	30	CH
Following laboratory tests have been carried out as per IS: 2720. The tests were carried out both on [5]	10	142	6.69	22	13	SC
1) Grain Size Analysis	11	143	13.6	53	26	CH
2) Atterberg Limit Test	12	144	8.69	55	28	CH
3) California Bearing Ratio Test	13	145	13.6	53	28	CH
1) Grain Size Analysis	14	146	16.3	59	31	CH
As per IS 1498-1970 soil divides in three major groups.	15	147	23.5	54	28	CH
i) Major groups	16	148	21.9	53	27	CH
ii) Coarse Groups	17	149	16.3	58	31	CH
iii) Organic Soil	18	150	12.4	26	17	SC
Coarse grained soils are those with more than 50% of the material larger than 0.075mm size. Coarse grained soils are further classified into gravels (G) and sands (S). The gravels and sands are further divided into four categories according to gradation, silt or clay content.	19	151	11.11	55	28	CH
Fine grained soils are those for which more than 50% of soil finer than 0.075 mm sieve size. They are divided into three sub-divisions as silt (M), clay ©, and organic salts and clays (O). based on their plasticity nature they are added with L, M and H symbol to indicate low plastic, medium plastic and high plastic respectively. [6]	20	152	25	54	26	CH
Examples:	21	153	8.7	58	32	CH
GW – well graded gravel	22	154	16.3	55	29	CH
GP – poorly graded gravel	23	155	25.6	54	28	CH
GM – silty gravel	24	156	28.2	59	31	CH
2) Atterberg's Limit	25	157	23.5	59	33	CH
As per IS 2720-part V 1985,	26	158	31.8	58	33	CH
3) C.B.R Test	27	159	17.6	52	24	CH
As per IS 2720 Part 31-1990,	28	160	22	58	29	CH

#### IV. REVIEW OF LITERATURE

As per Indian standard laboratory test was carried out in a laboratory below result I got between most sensitive sections on Dholera Bhavnagar highway from chainage 133/00 to 160/00.

Sr. No.	Location Km	Natural Moisture Content %	Consistency Limits		Soil Classification
			Liquid Limit %	Plastic Limit %	
1	133	26.6	58	31	CH
2	134	26.6	55	26	CH
3	135	35.1	56	27	CH
4	136	13.6	57	31	CH
5	137	17.6	52	25	CH
6	138	15	53	26	CH

Table.1. Lab. Test results for soil classification

#### C.B.R. Test Result

Sr. No.	Location Km	CBR Value %	Sr. No.	Location Km	CBR Value %
2	134	3.2	16	148	3.8
3	135	4	17	149	4
4	136	2	18	150	2.8
5	137	2.2	19	151	3.8
6	138	2.9	20	152	2.9
7	139	3.9	21	153	3.2
8	140	2.9	22	154	3.9
9	141	3.4	23	155	2.5
10	142	2.6	24	156	2.5
11	143	3.4	25	157	3.4

12	144	3.8	26	158	3.1
13	145	2.6	27	159	2.8
14	146	3.5	28	160	3.1

Table.2. Results for C.B.R. Test

As we can see lowest value of C.B.R is 2% at chainage 133/00 and 136/00

According to IRC-37-2001 (page no 29)

At 2% C.B.R and Load (In m.s.a) is between 10-150 required thickness of layer is 950mm ,In case study area traffic is around 100 m.s.a(Source by Road and Building Department, Bhavnagar) [7]

## V. CONCLUSION

From laboratory test results we get value of C.B.R at different chainage. for design of flexible pavement as per I.R.C 37-2001,value of C.B.R & Traffic load is required in this case study area traffic is heavy and value of C.B.R is very poor Hence it is required to improve C.B.R value for economical purpose as well as stabilization purpose.

## VI. FUTURE SCOPE

From test result we conclude that in case study area need to improve C.B.R value of sub grade.

Modify that soil using fly ash, Lime or Polypropylene fiber which may increase geo technical properties.

In Laboratory need to do tests using those material and check effect on soil properties.

## REFERENCES

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- [6] Traffic survey Report by Road and Building Department, Bhavnagar, Gujarat, India