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Stabilization & Reconstruction of Roads in BC Soil Area of SH-150

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Abstract **- All economies are impacted by the long-term durability of roads and bridges. In certain regions, BC soils are referred to as Regur soils. All of these states have soils rich in black cotton. Likewise, the Narmada, Tapi, Krishna, and Godavari do the same. Northwest India contains a significant amount of black cotton soil. Black cotton soils are formed as a consequence of the weathering or chemical decomposition of volcanic rocks, most notably Deccan trap or Basalt. BC These soils encompass almost one-fifth of India's total area, with the majority of it concentrated on the Deccan plateau. Roads and bridges account for more than 20% of the country's total land area, with the majority concentrated in Maharashtra, Gujarat, Karnataka, and central India. Nonetheless, trouble-free and cost-effective foundations in these soils remain a stumbling block. Shearing soils are susceptible to failure. The soils are soft and have a limited bearing capacity. It's difficult to work in dirt. Expansive soil is wet and exhibits minimal shrinking. It is a moisture-susceptible subgrade material. It becomes brittle when exposed to dampness or other physical disorders. Settlement and cracking of black cotton soil are caused by moisture in the subgrade layer. The majority of buildings and roads are degraded by black cotton soil. Due to the soil characteristics of flyash, it is unsuited for embankment building and stability. In principle, we might use polluted British Columbia soil to construct highways and bridges. BC Soil Removal has always been more expensive. By conserving natural resources, we can benefit the environment.**

Index Terms **- BC soil, SH-150, highway construction, stabilization, pavement.**

I.INTRODUCTION

1.1 GENERAL

Roads and bridges' long-term functioning have become critical to the economy of all countries. In certain regions of the globe, black cotton soils are referred to as Regur soils. Black cotton soils were widespread in Andhra Pradesh, Madhya Pradesh, Gujarat, & Maharashtra, and in certain areas of Orissa. They are also found in the Narmada, Tapi, Krishna, and Godavari River basins. Black cotton soil is abundant in depth in northwestern India. Black cotton soils are generated as a result of weathering or chemical breakdown of the rock, mainly Deccan trap or Basalt, that was left behind when the volcanic rock was formed. BC In India, about one-fifth of the land surface is surrounded by these soils, which are mostly found in and around the Deccan plateau. Approximately 20% of the country's total land area is used as a basis (Natural ground or Natural stratum) for highway and bridge building, mostly in Maharashtra, Gujarat, Karnataka, and certain parts of central India. Civil engineers continue to face difficulties in designing trouble-free and cost-effective foundation in such soil. Soils have a very low shear strength. The soils are very compressible and possess a negligible bearing capability. Working with such dirt is quite tough.

II. LITERATURE REVIEW

S. SINGH, "A Study of The Black Cotton Soils with Special Reference to Their Coloration"
The cause of the deeper tint in tropics and subtropics topsoil was indeed a subject of concern throughout the disagreement. The colour was initially ascribed to plant substances, because when the evidence revealed that even this soil had hardly any plant substances, other answer was required. According to Del Villar, the bulk of something like the dark colour is caused by ang kanilang (Fe?). According to Retargeting and colleagues, the black is not caused by biological factors. After being treated using H,O, specimens containing shadowy dirt gathered by the researcher in

Algeria's Blida region and Israel's Mountain of Jezreel remained midnight but gained pigmentation and became red when burned at 400-oo0 C. Oxidation using H,O was used to explore the deep coloration of certain Indian sandy loam. Carbonaceous soils with trace quantities of MnO collect H,O and retain their primary colors; nevertheless, following pretreatment with weak sodium hydroxide to dissolve the bicarbonate, the basic black areas of these grounds are entirely removed by washing by H,O. Its brown color from oxidised organic molecules has been studied. While it appears that organic carbon in alluvial soil is more resistant to H,O decomposition than in surrounding red soils, this has been established that this apparent susceptibility is attributable to Ca saturation. Clay components which are very similar in colour to their native soils have less resistance to H202 then their neighbouring red counterparts. All of these soils have a high proportion of ga nai, a chemical that is extremely resistant towards this chemical.

III. IDENTIFICATION AND CLASSIFICATION OF BC SOIL

3.1 Identification of BC Soil

The soil of British Columbia is mostly clayey and expansive in character. It is so difficult to pulverise so the clods could be readily treated for use in building. This creates significant challenges for the road's or structure's later performance. BC Soil may be readily characterised in labs by its expansion/swelling capacity and in the fields by its own black or greyish black hue.

Capacity of swell is depends upon type and amount of clay minerals and their exchangeable bases. The only Montmorillionite clay mineral is swelling due to water bond between the particles of soil and has expansible lattice structure. Thus, the soil containing excess amount of montmorillionite clay minerals exhibit high swelling and shrinkage and this characteristic depends upon the kind and amount of exchangeable actions.

3.2 Identification Criteria for BC Soil: (IS 1498-1970)

Identification criteria give the specification requirement or limits of index properties to decide whether the soil is BC soil or not. The criteria for major index properties are as below:

Table 1: Index Properties of BC Soil (Originally extracted Table -8 of IS 1498)

Colloid Content (< 0.001 mm)	LL (%)	PI (%)	Shrinkage Index (%)	FSI (%)	Degree of Expansion	Degree of Severity
<15	20-35	<12	<15	<50	Low	Non Critical
13-23	35-50	12-23	15-30	50-100	Medium	Marginal
20-31	50-70	23-32	30-60	100-200	High	Critical
>28	70-90	>32	>60	>200	Very High	Severe

In addition to above as mentioned in MORTH 5^{th} edition, Expansive soil exhibiting the marked swell and shrinkage properties, free swell index more than 50% when tested as per IS 2720-Part 40 is considered as expansive soil.

Most BC Soil show the FSI is 50% to 200% depends upon the colloid content.

IV. PROBLEMS ASSOCIATED TO BC SOIL

4.1 Problems associated with BC Soil

Expansive soil has a lower shrinking limit and a high moisture content at its optimum. It is very sensitive to variations in moisture content and is an extremely compressible subgrade substance. It has a low shear strength, which decreases further upon wetness or other physical disruptions. The wet and dry of a subgrade layer of black cotton soil leads in the settling and cracking of pavements. Black cotton soil is among the most common causes of structural and road deterioration. The following damage occurs as a result of volume changes in black cotton soil.

1. Significant structural damage;
2. Pipeline and sewage system disruptions.
3. Road and highway constructions heaving,
4. Buildings are demolished.
5. Pavements, sidewalks, and basement flooring that are cracked.
6. As a result, prior to constructing a road on a subgrade, it is necessary to either remove current soil and replaced it with a non-expanding soil or to stabilise the current soil to enhance its engineering features.

There are several practical issues linked with Owing to the increase expansion and shrinkage features of the Dark Thread soils, construction engineers have had trouble building across BC Soils areas, particularly in Northern and Southwestern India (BC soils). While drying, soft cotton grounds are durable, although when wet, they lose all of their strength.

CBR values for laboratory-soaked Blacks Cloth sands are generally or less 2%.

There is no layout sheet in IRC37-2012 with such a CBR compared with fewer than 3%. Because Polycotton soil (BC soil) has extremely low Compressive strengths, a larger sidewalk is required when designing a geopolymer concrete in compliance with IRC 37-2012. Innovative technologies have been used in research & innovation (R&D) to improve the strength attributes of Expansive soil (BC soil).

4.2 Problems Arising out of Water Saturation

Water is a very well adversary of road pavements, and this is especially true in large soil areas. Water to enter the road asphalt from three different directions capillary forces: the top area, the sides berms, and the under grade. As a consequence, road regulations across broad soil areas must take these factors into account. To avoid water due partly, the asphalt pavement must be impervious, the lateral dirt mounds must always be paved, as well as the subsoil must be meticulously maintained.

In general, road construction authorities pay little attention to side berm building and upkeep. It is emphasised that a road's pavement and retaining walls must be viewed as a united entity. Unsurfaced berms are by far the most troublesome in large soil areas because they become mushy following rainfall and are by far the most neglected. Figure 2 depicts the growth of crocodile cracks, broad bouts of depression, and upheavals on bitumen surfaces in Thick cotton soil areas (BC soil).

Figure 1: Crack in BC Soil

V. RECONSTRUCTION IN BC SOIL @ SH-150

5.1 Pavement on Black Cotton Soils

5.1.1 New pavement Construction on BC Soil

For new construction on BC soil, the subgrade and the top 500 mm of the embankment immediately below the subgrade should be non-expanding in character and have the required CBR and degree of compaction in the design and specification. This may be accomplished in one of two ways:

1. Through the complete replacement of BC soil with acceptable borrow area soil, or 2. Through the enhancement of BC soil's engineering qualities.

A recommendation for black cotton soil improvement must be made if the free swelling index (FSI) exceeds 50%, the liquid limit (LL) exceeds 70, the plasticity index (PI) exceeds 45, and the CBR is less than 5%.

Following the identification of the portions that need reinforcing, the improper Soft cotton dirt (BC soil) must be eliminated to a thickness of 500 mm beneath normal ground surface (NGL).

Following excavation, demonstration spinning should always be undertaken to obtain a relative compacted of at minimum 90% compared to the highest experimental specific gravity (IS: 2720 part 8). If the thickness is almost than 90% of the Max. Dry Thickness (MDD), 225 mm of sand must be unfastened then s actually at Maximum Moisture (OMC) till it meets 90% of the MDD.

The embankment must be constructed in stages up to the bottom of the subgrade using stabilised BC soil or acceptable borrow area soil.

On top of the above-mentioned enhanced embankment layer, a subgrade should be erected using acceptable borrow area materials in accordance with the specification.

The Granular Sub-base layer must be extended the whole breadth of the formation.

Base (WMM) widths must be 150mm to 200mm wider than BT surface widths on each side to minimise water collection under BT surfacing and to protect BT edges.

5.1.2 Widening on BC soil

The techniques for embankment, subgrade, and pavement construction are identical to those for new pavement construction.

The width of the excavation for widening should be sufficient to accommodate roller operation.

When widening an existing embankment or subgrade with slopes more than 1 vertical to 4 horizontals, continuous horizontal benches each at least 300 mm broad should be cut into the previous slope to provide proper bonding with the new embankment/subgrade material.

Drainage arrangements similar to those specified in the process for new pavement construction should be provided in the event of widening as well.

5.1.3 Methodology of Reconstruction in BC Soil

This chapter of the seminar discusses the construction of a road embankment over BC soil using approved materials in accordance with the terms of the contract agreement and in strict compliance with the technical specifications; placement and compaction shall be carried out in accordance with specification clause 305.

Construction drawings indicating alignment, level, cross sections within individual lengths, and other survey details, as well as important technical standards, namely clause 305 of the technical specification, in accordance with required rules for assuring the quality of work. BC Soil is initially treated in accordance with MORTH CL 305, as detailed in the preceding chapter, and/or stabilised in accordance with IRC SP 89-2010.

Prior to the start of this activity, the materials for such embankment should be properly procured. Diverse sources must be designated for distinct lengths, taking into account the haulage load and, most crucially, the appropriateness and quantity of material available.

Generally, soil, moorum, gravel, a combination of these, or any other authorised material should be used to construct an embankment. In terms of material quality, such material should be devoid of logs, stumps, roots, and debris, as well as any other materials that might degrade or impair the embankment's stability. If deemed appropriate, the material excavated from the highway will also be utilised.

Figure 2: Removal of BC Soil at Vita Kokrud Section of SH 150

Figure 3: Prepared Bed with fresh material at Section of SH 150

Figure 4: Process of Blending at Plant-Mixing of Additives at Plant

Figure 5: Process of Site blending- Manual mixing of Additives at directly at site

VI. CASE STUDY AND CONCLUSION

6.1 Nagpur Ring Road Project

Soil property of Nagpur highway is also not suitable for embankment construction and stabilized by Flyash. Results of unmodified Soil and modified soils are as below:

Table 2: Soil Properties of Nagpur Ring Road

Parameter	Unit	As per MORTH	Existing BC soil	Sample properties
LL	%	<70%	73% to 105 %	68%
PI	%	<45	45 % To 58%	44.4%
FSI	%	<50	45% to 100%	60%
Shrinkage limit	%	<45	10% to 9%	
Swell pressure	Kg/cm2	<50	0.7	0.6
MDD	KN/cum	17		
CBR	%			5

Table 3: Modified Soil Properties of Nagpur Ring Road

Parameter	Unit	As per MORTH	Lab results 15% Fly ash	Lab results 20% Fly ash
LL	%	<70%	65.7%	61%
PI	%	<45	41.2%	36.5%
FSI	%		26%	26%
Shrinkage limit	%			
Swell pressure	Kg/cm2		0.3	0.25
MDD	KN/cum	17		
CBR	%		6.7	7.9

6.2 Conclusion

By analyzing above data we can conclude that we can use the BC Soil in highway construction or as a supporting ground to highway construction by modifying it. Removal of BC Soil always required extra money and space to dump it. Mean time we can save the environment by conserving or reusing natural resources.

A)Remove top 500 mm Soil and replace with acceptable soil- 20 lakh per Km

b) Do in situ stabilisation using lime/ fly ash admixture to Bring properties within acceptable limit - 8 Lakhs per Km

C) Put an impermeable layer of BC soil fly ash admixture

On existing ground with 1 m berm and deep drain - 3 lakh per KM

6.3 Amravati Jalgaon Gujarat Project-NH 6

Out of the total length of 500 kilometer nearly 250 kilometer passes through expansive soil zone .The properties of these soils as per DPR report. It can be seen them in major samples either of the three parameters

i.e. LL more than 75%, PI more than 50% or FSI exceeding 50% get violated .But in few samples all the three parameters get violate. The codal provisions are not clear whether the top 500 mm soil needs replacement even if one parameter i.e. LL, PI or FSI get violated

The swelling pressures as reported are very high and if the expansive pressure is to be counterbalanced by embankment dead weight, then the height of embankment will be more than 5 m.

Detailed analysis- Few sample have been tested and the embankment height is worked out based on free swelling pressure then the same is given in table below:

Table 4s: Soil Properties of Amravati Jalgaon Gujrat Project

Description of the Testing	LAB 1 Testing Results			LAB Testing Results		
	189+340 (LHS)	322+800 (LHS)	416+550 (LHS)	464+350 (LHS)	531+800 (LHS)	629+853 (LHS)
Free Swell Index (%)	54.50%	72.70%	63.60%	63.60%	36.40%	81.80%
LiquidLimit	60.70%	76.20%	75.20%	63.60%	46.10%	80.80%
OMC (%)	20%	23%	25%	23%	15%	29%
MDD(g/cm3)	1.73	1.63	1.59	1.61	1.97	1.53
Swelling Pressure at OMC(kg/cm2)	1.6	2.7	2.6	1.2	0.9	1.4

6.4 Conclusion

The engineering features of British Columbia soil are required for road building.

1. Because of the significant swelling qualities of Expansive soil, the dynamic asphalt pavements technique that includes the use of CBR should be changed (BC soil). In areas with Black cotton soil, prestressed concrete construction may be employed to optimize overall economic growth (BC soil).

2. The use of the lime soil stabilisation approach has great potential in areas with Expansive soil (BC soil). Because of its low cost, the moorum layer has been employed as a barrier between the sub - grade and the subbase layer in practice. Moorum with a lower PI has been demonstrated to be beneficial because it inhibits soft subgrade soil rise into the interlayer space of concrete aggregate and water penetration through it.

3. The use of a 225-millimeter-thick sands filter layer as a wall to protect subgrade soil reaching infiltrating the interstitial sites of the granular platform layer, functioning as a filtration system and supplying homogenous support on soft soils.

4. The use of geosynthetic cloth between both the sub - grade and subgrade soil layers is a new approach. It not only inhibits water seepage, but it also reduces thickness.

5. To prevent water penetration from the top surface, thick rubberized coating is necessary.

6. Berms beside highways need pucca preparation, which involves primer preparation and stone transplantation; a 1:36 camber is recommended.

7. A layer of 1000 mm in thickness compressed moorum shall be provided well above sands filter media, as indicated in (d.) above.

8. Compressed CNS soil with such a breadth of 3000 mm as well as a thickness of 2000 mm must be provided at the edges of the compaction sub layers to prohibit ground contaminants from reaching the factorization.

VII. CONCLUSION

By analyzing data, we can conclude that we can use the BC Soil in highway construction or as a supporting ground to highway construction by modifying it. Removal of BC Soil always required extra money and space to dump it. Mean time we can save the environment by conserving or reusing natural resources.

- Remove top 500 mm Soil and replace with acceptable soil- 20 lakh per Km
- Do in situ stabilisation using lime/ fly ash admixture to Bring properties within acceptable limit - 8 Lakhs per Km
- Put an impermeable layer of BC soil fly ash admixture
- On existing ground with 1 m berm and deep drain - 3 lakh per KM

There is a need for providing the engineering characteristics of B.C. soil for road construction.

- Because of the considerable swelling qualities of Expansive soil, a flexible asphalt pavement method that includes the use of CBR should be changed (BC soil). To maximize the overall economy in areas with Expansive soil (BC soil), stiff pavement design may be employed.
- The application of lime soil image stabilization technology has great potential in areas with Expansive soil (BC soil). The moorum level has been employed as a boundary between both the sub - grade as well as the subbase layer due to its low cost. Moorum with a low PI is shown to be effective in reducing soft granular soils elevation into the interlayer space of gravels and water penetration through them.
- On soft soils, a 225-millimeter-thick filtration system layer acts as a backfill material and provides constant support by preventing underlying soil reaching accessing the interstitial space of the grainy base/subbase layer.
- One novel solution is to use geotextile fabric here between subsoil & subgrade soil strata. Not only it inhibits water leakage, but it also reduces thicknesses. To avoid penetration of water from top surface, thick rubberized surfacings were necessary.
- Berms beside highways need pucca preparation, which involves primer preparation and stone grafts; a 1:36 camber is recommended.
- A layer of 1000 mm in thickness compressed moorum shall be provided above the sands filter layer, as indicated in (d.) above.
- At the edges of the compressed sub layers, a compressed CNS soil with a width of 3000 mm and just a depth of 2000 mm must be considered to prevent subterranean water entering your sub layers.

Future Scope

Soil plays a critical part in the design and building of any project, whether it be a road, a runway, or a railway track. This is because it works as a conduit for the efficient passage of load into the ground. This means that a weak soil basis will ultimately cause the building to sink, resulting in failure. rebalancing is the attempt to improve the soil physical properties prior to construction. Consolidation is often used to enhance the capacity of the material and shrink/halt its hydraulic conductivity, hence boosting the strength properties and overall quality from in sediments. The engineering properties of clay (BC soil) may well be considerably improved by limestone or concrete modification. This approach is frequently employed on a global basis and has been popular for several generations. Concrete or portland cement at a concentration of 3 to 5% enhances the engineering properties of Expansive soil considerably (BC soil).

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