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Construction of Roads on Consistency Limits of the Black Cotton Soil

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Abstract: ***Roads are a widespread and increasing feature of most landscapes. We reviewed the scientific literature on the ecological effects of roads and found support for the general conclusion that they are associated with negative effects on biotic integrity in both terrestrial and aquatic ecosystems. Roads of all kinds have seven general effects: mortality from road construction, mortality from collision with vehicles, modification of animal behavior, alteration of the physical environment, alteration of the chemical environment, spread of exotics, and increased use of areas by humans. Road construction kills sessile and slow-moving organisms, injures organisms adjacent to a road, and alters physical conditions beneath a road. Vehicle collisions affect the demography of many species, both vertebrates and invertebrates; mitigation measures to reduce roadkill have been only partly successful. Roads alter animal behavior by causing changes in home ranges, movement, reproductive success, escape response, and physiological state. Roads change soil density, temperature, soil water content, light levels, dust, surface waters, patterns of runoff, and sedimentation, as well as adding heavy metals (especially lead), salts, organic molecules, ozone, and nutrients to roadside environments. Roads promote the dispersal of exotic species by altering habitats, stressing native species, and providing movement corridors. Roads also promote increased hunting, fishing, passive harassment of animals, and landscape modifications. Not all species and ecosystems are equally affected by roads, but overall the presence of roads is highly correlated with changes in species composition, population sizes, and hydrologic and geomorphic processes that shape aquatic and riparian systems. More experimental research is needed to complement post-hoc correlative studies. Our review underscores the importance to conservation of avoiding construction of new roads in roadless or sparsely roaded areas and of removal or restoration of existing roads to benefit both terrestrial and aquatic biota.***

I. INTRODUCTION

Black cotton (BC) soil is a major soil group in India, covering about 200,000 square miles there. This paper discusses its geological, mineralogical, physical, and chemical properties in relation to the construction of road pavements and, more briefly, embankments. BC soil has high swelling and shrinkage properties; it is hard as long as it remains dry, but it loses its stability when wet. On drying, the soil shrinks and cracks very badly. The construction of roads in such soil areas has always presented serious problems, due to the extremely low bearing capacity of the subgrade when it is wet and extensive swelling during wetting. The Central Road Research Institute (CRRI) has conducted investigations for several years on the unsatisfactory performance of many road embankments built on BC soil foundations that have failed to varying degrees. It has been found essential to pulverise soil clods, place them in layers 20cm to 30cm thick, and compact the embankment properly. Methods for improving the bearing capacity of BC soil, to ensure pavement stability, include adequate compaction and use of a sand sub-base. The effects of moisture content have been studied. The paper also considers relevant Indian pavement standards, road berms as an essential pavement component, and the need for roadside drainage.

A. What is Black Cotton Soil?

Black soils are formed by lava basaltic rocks.Black cotton soil is one of major soil deposits of India.They exhibit heigh rate of swelling and shrinkage when exposed to changes in moisture content and hence have been found to be most troublosome from engineering consideration.

What we can grow in black soil? Black soil is rich in calcium, potassium and magnesium but has poor nitrogen content. Crops like cotton, tobacco, chilly, oil seeds, jowar, ragi and maize grow well in it. Sandy soil is low in nutrient content but is useful for growing trees such as coconut, cashew and casuarinas in areas with high rainfall.

B. What Are The Contents Of Black Soil?

Black soil in India is rich in metals such as Iron, Magnesium and Aluminum. However it is deficient in Nitrogen, Potassium, Phosphorous and Humus. Black soil is of red colour mainly due to its iron oxide content.

C. How black cotton soil is formed?

The black soil is formed by the weathering of lava (igneous rocks) and cooling of lava after a volcanic eruption. The soil in the Deccan Plateau consist of black basaltsoil, which is rich in humus, iron and also contain high quality of magnesia, lime and alumina.

D. Why The Colour Of Black Soil Is Black?

Black soil is dye to high content of organic matter or rich with iron and magnesium Minerals & Metals. It makes the color of soil dark and sometimes black. In India, black soil is due to weathering of basalt, Deccan traps.

E. Which Soil Is Known As Cotton Soil?

Black soils. These are mostly clay soils and form deep cracks during dry season. An accumulation of lime is generally noticed of varying depths. They are popularly known as “Black cotton soils” because of their dark brown colour and suitability for growing cotton

F. Why Black Soil Is Suitable For The Growth Of Cotton?

Black soils are highly argillaceous, very fine grained and dark, and contain a high proportion of calcium and magnesium carbonates. They are very tenacious of moisture and exceedingly sticky, when wet. ... Besides cotton, the soil is suitablefor the cultivation of crops like wheat, groundnut, chillies, tobacco and jowar

G. Which Is The Best Soil For Plant Growth?

The Ideal Soil Type: Loam. The type of soil that gardens and gardeners love is**loamy** soil. It contains a balance of all three soil materials—silt, sand and clay—plus humus. It has a higher pH and calcium levels because of its previous organic matter content.

H. Why Black Soil Is Called Black?

It is commonly known as "black cotton soil" as they are perfect for growing cotton. They develop deep cracks in extreme hot weather. Black soils or cottonsoils or regur soil represent same. However, the name "Regur" is derived from Latin word**.**

I. Technologies For Improving Cbr Of Black Cotton Soils

1) Materials for Soil Stabilization The materials for Black cotton soil (BC soil) stabilization shall comprise lime or Ordinary Portland Cement (OPC)43 grade, moorum of approved quality, sand and Cohesive Non swelling Soil (CNS) having properties given below: The Black cotton soil (BC soil) having characteristics as given in Table 1.

a) OPC 43 grade as per IS:8112- 1989.

b) Well graded granular moorum having minimum 4 day soaked CBR of 10% and maximum laboratory dry unit weight when tested as per IS:2720 (Part-8) shall not be less than 17.50 kN/m3.

c) The sand shall be as per IS:383-1970.

d) The material for CNS soil should be good quality soil having laboratory dry unit weight when tested as per IS:2720 (Part-8) not less than 16kN/m3.

J. Cement/ Lime-Soil Stabilization

The engineering properties of Black cotton soil (BC soil) can significantly be improved with lime or cement treatment. This technology has been very common at global level and is in vogue for the last several years. Cement or hydrated lime in the range of 3 to 5 per cent brings remarkable improvement in the engineering characteristics of Black cotton soil (BC soil). The test results of typical Black cotton soil (BC soil) samples are given in Table 2 to indicate the improvement in its characteristics Cement/ Lime–soil stabilization technology has been found useful cost-effective and suited to manual methods of construction. This technology has been found 20-30% cheaper than conventional WBM construction. The cement or lime treatment is being utilized for the following purposes:

1) To provide a pavement foundation of marginally weaker in strength than that of concrete pavement, but much improved strength than natural Black cotton soil (BC soil).

2) To consolidate subgrades and base courses for concrete pavement in order to make them resistant to volume changes and displacement or erosion in the presence of moisture even under the rocking action of curled slabs, if any.

3) To overcome the susceptibility of foundations to volume change and to increase their shearing resistance and bearing capacity.

K. Problems of Highway Construction in Black Cotton Soil Areas

Problems Arising out of Water Saturation

It is a well-known fact that water is the worst enemy of road pavement, particularly in expansive soil areas. Water penetrates into the road pavement from three sides viz. top surface, side berms and from sub grade due to capillary action. Therefore, road specifications in expansive soil areas must take these factors into consideration. The road surfacing must be impervious, side berms paved and sub grade well treated to check capillary rise of water.

It has been found during handling of various road investigation project assignments for assessing causes of road failures that water has got easy access into the pavement. It saturates the sub grade soil and thus lowers its bearing capacity, ultimately resulting in heavy depressions and settlement. In the base course layers comprising of Water Bound Macadam (WBM), water lubricates the binding material and makes the mechanical interlock unstable. In the top bituminous surfacing, raveling, stripping and cracking develop due to water stagnation and its seepage into these layers.

1) Material And Properties Black Cotton Soil: The soil sample is collected from Jabalpur in MadhyaPradesh. The properties of the soil sample collected from the site tabulated as such:

S no.	Particulars	Observation
1.	Specific Gravity	2.2
2.	Liquid Limit	51
3.	Plastic Limit	29.63
4.	Shrinkage limit	14.56
5.	Passing 75µ sieve	98 %

Table 1 Properties of Black cotton soil

2) Blast furnace Slag: The Blast furnace slag used in the study is collected from the disposal site of Bhilai Steel plant, Bhilai, Chattisgarh. It is a non- metallic by-product,produced in the iron making in a blast furnace consisting of silicates, alumino silicates and calcium alumina- silicates.

Table 2 Chemical Properties of BLACK COTTON SOIL.

S no.	Particulars	Percentage
1.	Calcium oxide	31%-40%
2.	Silicon Dioxide	29%-38%
3.	Aluminium Oxide	14%-22%
4.	Magnesium Oxide	7%-11%
5.	Ferrous Oxide	0.1%-1.9%
6.	Mangnese Oxide	0.01%-1.2%
7.	Sulphur	1.0%-1.9 %

Source-http://www.vebsar.com/blast_furnace_slag.html

Table 3 Physical Properties of B C SOIL

S no.	Particulars	Observation
1.	Specific Gravity	2.705
2.	Passing 12.5mm sieve (Gradation)	98 %
3.	Type	Granular

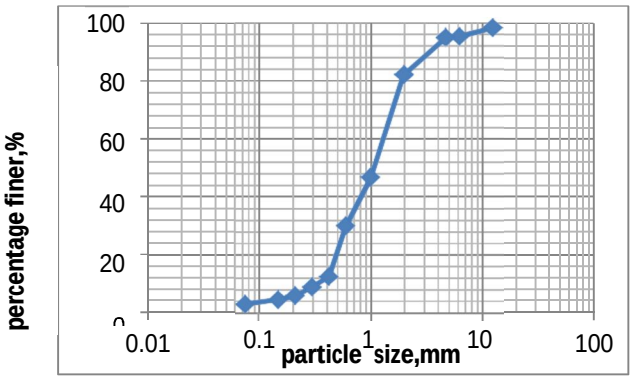

Figure 1 Particle size distribution of Blast furnace slag.

II. RESULTS ANDDISCUSSION

The laboratory tests are conducted in the Geotechnical laboratory, Jabalpur Engineering College, Jabalpur. The results of the index properties of the Black cotton soil treated with blast furnace slag are shown in table 4; it is observed that with the increase in the percentage of blast furnace slag there is a reduction in the Liquid limit, increase in shrinkage limit and Plasticity index is gradually decreased. (Figure 1,2,3,4)

1) Sample. I –Plain Black cotton soil.
2) Sample II –Black cotton soil with Stabilizer (5% lime)
3) Sample III –Black cotton soil with 5% blast furnace slag and Stabilizer
4) Sample. IV –Black cotton soil with 10% blast furnace slag and Stabilizer
5) Sample V –Black cotton soil with 15% blast furnace slag and Stabilizer.
6) Sample VI –Black cotton soil with 20% blast furnace slag and Stabilizer
7) Sample VII –Black cotton soil with 25% blast furnace slag and Stabilizer

Table 4 Resulting observations of Black cotton soil blended with Blast furnace slag.

Experiments	Results of the samples tested						
Sample no.	I	II	III	IV	V	VI	VII
Liquidlimit	51	49	44	42	43.5	41	39
Plastic limit	29.63	35.08	34.80	35.9	39.22	40.1	35.35
Plasticity Index	21.37	13.92	9.2	6.1	4.3	0.9	3.6
Shrinkage limit	14.56	25.73	26.08	26.17	30.13	29.6	28.5

The soil testing of index properties are done as per

I.S.2720 (part 5)-1985 and the results are plotted as such-

A. Liquid limit

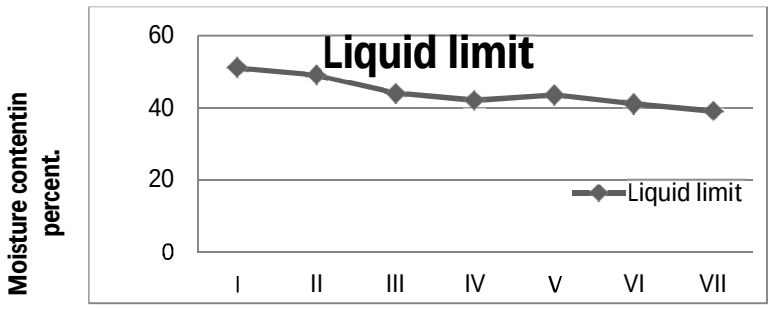

Figure 2 Variation in liquid limit. Plastic limi

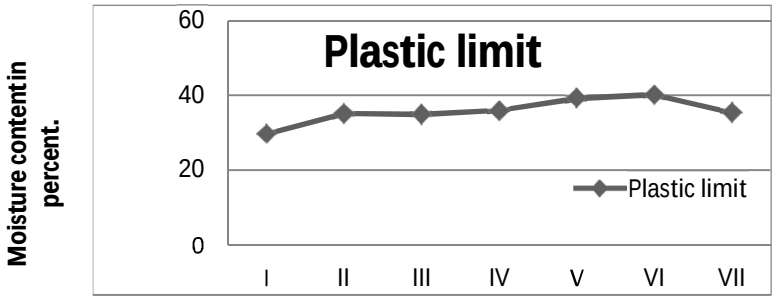

Figure 3 Variation in Plastic limit

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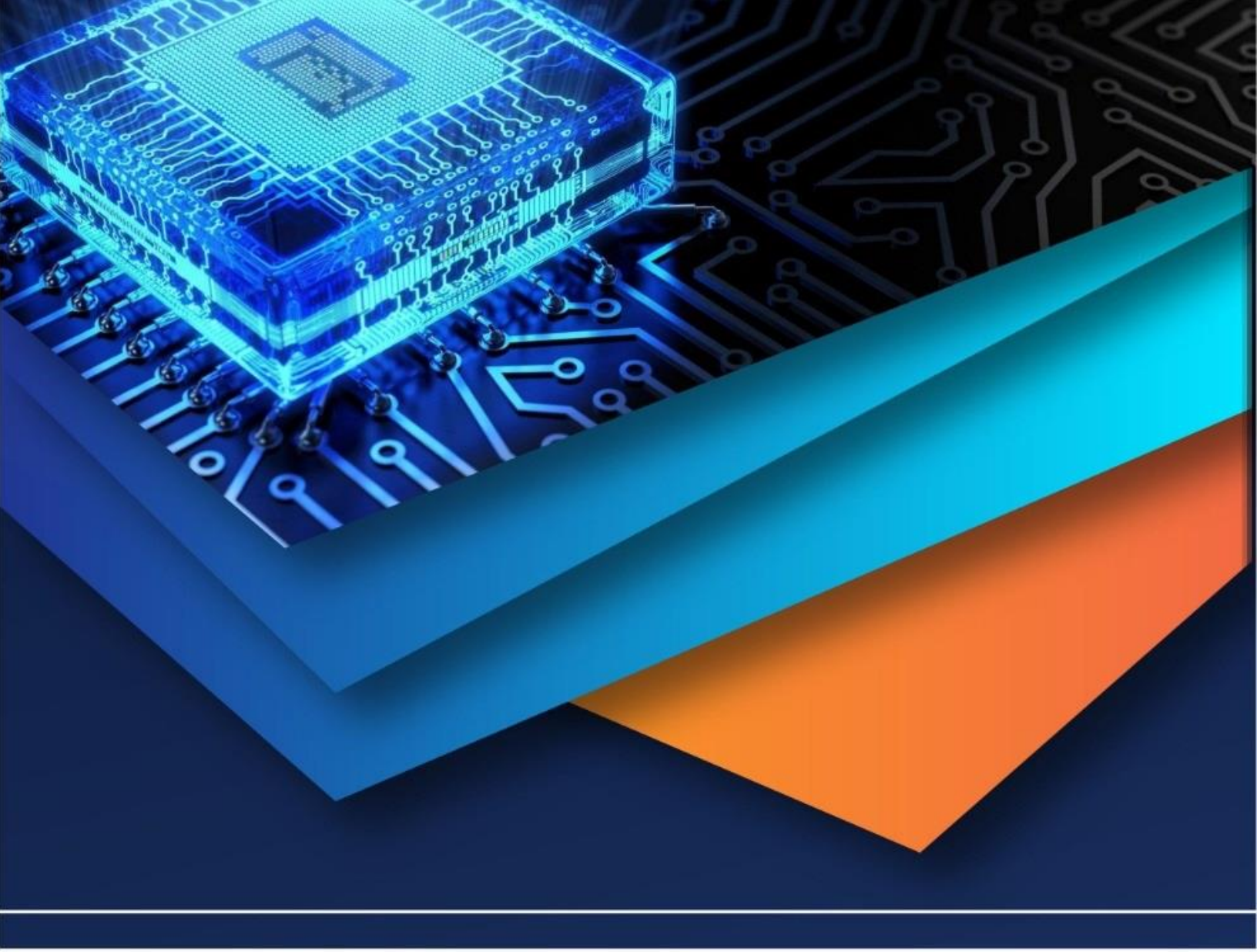

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