

Nominal Construction and Maintenance of Highway Roads by using FBF (Fly Ash-bc Soil-Foam) Method

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Abstract— Roads play a significant part in the development of nation. They are life saver giving a smooth stream of man and materials. With the expanding of populace and the lessening of accessible land, road developments and other structural building structures must be done on weak or delicate soil. Inferable from such soil of weak shear quality and high swelling and shrinkage, an extraordinary decent variety of ground change methods, for example, soil adjustment and reinforcement are utilized to enhance mechanical conduct of soil, in this way improving the dependability of development. This article covers roadway development in Black cotton soils (BC soils) and furthermore depicts a case history of interstate development in thruway development in Black cotton soils. The reason for this investigation is to decide the ideal dosage of the stabilizer, which enhances the quality which is appropriate for pavement structure. The outcome demonstrates that the utilization of sand in mix builds the California Bearing Ratio values(CBR).

Keywords— Black cotton soil, Fly ash, lime concrete, coarse aggregate, sand, CBR, density and stabilization.

I. INTRODUCTION

Urbanization and modern advancement in India needs to focus on development procedures of highways, railways, air terminals and private structures. For these developments should require great soil conditions for establishment sand dikes. The sweeping soils are hazardous soil for development and most generally accessible in significant places in India. Particularly far reaching soils are primarily under goes swelling and shrinkage issues when dampness content changes in that soil. Because of high swelling and shrinkage issues posture huge issues to the structures. Adjustment on sweeping soil utilizing admixtures is a decent answer for

the swelling and shrinkage issues. Adjustment controls the impacts on establishment and structures. Research centerwork conveyed by adding admixture to the sweeping soil at various extents for this test ponder. The shear quality of the soil has both inside grinding and union. Compaction offers quality to the soil expanding the heap bearing limit and soil ends up noticeably steady. Artificially adjusted the soil by including lime, cement, flyash and lime mixes were utilized adequately. Research center test was directed for street development with previously mentioned concrete mixes properties. The point of this paper, depends on our Indian economy and budgetary status we have to give the development strategy too.

Road construction method through geo-technology schedule with precautions:

1. Road construction/maintenance with the analysis of soil type and causes of the damage using with BC soil, fly ash and Lime concrete.
2. To increase the life time and strengthening of the road construction based on different BC soil land.
3. BC soil based concrete mix for support BC soil land and other soil lands.

II. DESIGN PROBLEMS IN BLACK COTTON SOILS

In India, CBR strategy created and commonly utilized for the outline of outside layer thickness. This strategy stipulates that while deciding the CBR values in the research facility and in the field, an additional charge weight of 15 kg and 5 kg for each 62 mm and 25 mm thickness separately ought to be utilized to neutralize the swelling weight of Black cotton soils (BC soils). BC soils deliver swelling weight in the scope of 20-80 tons/m² and swelling in the scope of 10-20%.Therefore, CBR values

acquired are not objective and logical adjustment is required for deciding CBR values of broad soil. Having substantial obligation movement of 4500 business vehicles for each day and 150 as by and large found on our National Highways and taking CBR values of 2%, add up to hull thickness of adaptable asphalt works out to 830 mm which is for all intents and purposes an incomprehensible relational word. It is felt that CBR values bends require adjustment for far reaching soils. Expecting overwhelming movement force of 4500 business vehicles for each day and msa 150, covering thickness of inflexible asphalt works out roughly 300-320 mm, which is around 33% of thickness required for adaptable asphalt. In this way, it sounds sensible to embrace cement concrete asphalt in Black cotton soil zones. This kind of asphalt may spare the architects from everyday upkeep issues moreover.

Characteristics of Black Cotton Soil

- Black cotton soil (BC soil) is a highly clayey soil.
- It is so hard that the clods cannot be easily pulverized for treatment for its use in road construction.
- The black colour in Black cotton soil (BC soil) is due to the presence of titanium oxide in small concentration.
- The physical properties of Black cotton soil (BC soil) vary from place to place.

III. REVIEW OF LITRATURE

Cokcaet et al. (2000) Utilized from high-calcium and low-calcium class C fly ashes for adjustment of a far reaching soil and assessment of the far reaching soil-lime, sweeping soil-cement and far reaching soil-fly powder frameworks. Lime, cement and fly ashes remains were added to the far reaching soil at various rates. The examples were subjected to substance creation, grain measure dissemination, consistency breaking points, and free swell tests. Additionally, the Specimens with fly ashes were cured and after that they were subjected to oedometer free swell tests. It can be reasoned that the expansive soil can be effectively settled by fly ashes. Moreover, plasticity index, action and swelling capability of the samples diminished with expanding level of stabilizer and curing time.

Bose et al. (2012) Utilized fly ash to balance out a very plastic earth. The geo-designing properties, for example, Waterberg limits, grain estimate appropriation, straight shrinkage, free swell list, welling pressure, compaction attributes, unconfined compressive quality and CBR value of virgin clay and balance out with fly ash were assessed. In this way expansion of fly ash remains expands its workability by colloidal response and changing its grain

measure. The free swell index value and swelling pressure of extensive mud blended with fly slag diminished with increment in fly ash content. Fly powder decreased the ideal dampness content however the dry thickness expanded and unconfined compressive quality of mud fly cinder blends is observed to be greatest. This finished up the fly ash has a decent potential for enhancing the designing properties of expansive soil.

Buhler and Cerato et al. (2013) Utilized lime and Class C fly ash debris to lessen the versatility of profoundly far reaching dirt. Soil tests with comparative arrangement were utilized to indicate shrinkage fluctuation with the expansion of lime and Class C fly fiery ash. The pliancy lessening was resolved with direct shrinkage test. The outcomes demonstrated that both lime and fly fiery remains lessened the direct shrinkage however the expansion of lime created additional reduction in straight shrinkage.

Prasad and Sharma et al. (2014) Assessed the effectiveness of clay soil mixed with sand and fly ash for soil adjustment by concentrate the subgrade qualities. The motivation behind this work is to discover an answer for legitimate transfer of fly ash and furthermore gives great subgrade material to pavement construction. The outcomes demonstrated that considerable change in compaction and California bearing proportion of composite containing clay, sand and fly fiery debris. The swelling of the mud likewise diminished after adjustment. The greatest dry thickness of dirt sand-fly fiery debris blend diminished with the expansion of fly cinder and ideal dampness content expanded. In this way the settled soil can be utilized for construction of adaptable pavements in low activity regions.

IV. ANALYSIS OF RESEARCH MATERIALS

Black cotton soils are inorganic clay of medium to high compressibility and frame a major soil portion in India. They are likewise clarified by high shrinkage in swelling property. This black cotton soils happen for the most part in the focal and western parts and cover roughly 20% of the aggregate zone of India. In light of its high swelling and shrinkage described, the black cotton soil has been a challenge to the highway engineers.

The proportions of **Fly Ash** used along with the soil in the study are 4%, 6%, 8%, 10% and 12%. The following tests were conducted on the soil samples mixed at different proportions of WPSA the liquid limit and plastic limit tests were conducted as per IS: 2720 (Part 5)- 1985. Heavy compaction test was carried out according to IS: 2720 (Part 8)-1983. Unconfined compressive strength tests were conducted at OMC and MDD as per IS: 2720 (Part 10)- 1991. The California Bearing Ratio tests were conducted as per IS: 2720 (Part 16)- 1987.

Soil stabilization with lime can be done by mixing dosage of unsoaked lime into damp soil creates both immediate and medium term effects. The supportive power of sub grade generally depends three properties of soil that are Shear strength, Bearing power and Penetration resistance of soil. Here we have selected BC soil land for research and with BC soil for admix. Some of immediate effects are discussed below:

Drying: On mixing, there is immediate exothermic hydration reaction. It reduces water content with further reduced by aeration of soil. Water – fall percentage varies by 2 to 3 % of added lime.

Flocculation: Mixing affects the ultrasonic field between clay particles which changes to granular structure.

Reduction in Plasticity Index (PI): It switches from being plastic to stiff and grainy.

Improvement in bearing capacity: After two hours of mixing, CBR of a treated soil is between 4 and 10 times higher than that of an untreated soil. The reaction greatly relieves on site transportation difficulties.

Table.1: Chemical composition of Indian Fly ash

Constituent	Percentage Range (%)
Silica (SiO ₂)	49-67
Alumina (Al ₂ O ₃)	16-29
Iron Oxide (Fe ₂ O ₃)	4-10
Calcium Oxide (CaO)	1-4
Magnesium Oxide (MgO)	0.2-2
Sulphur (SO ₃)	0.1-2
Loss on ignition	0.5-3

Table.2: Properties of BC Soil and Fly ash

Soil Type	Liquid Limit (Awl) %	Plastic Limit (Wp)	Plasticity Index Ip	Flow Index	Toughness IT	Liquidity Index IL	Consistency Index IC	Specific Gravity GS	Classification
Fly ash	NP	NP	NP	-		-		1.72	ML
BC Soil	43.5	25.0	18.5	4.75	3.8	-1.08	2.08	2.54	MH

Lime concrete: Lime concrete used to enhance certain properties of a characteristic soil to influence it to fill enough a planned designing need. The primary advantages of utilizing lime to balance out muds/BC Soil are enhanced workability, expanded quality and Hedge solidness. Workability is enhanced on the grounds that flocculation makes the mud more friable; this helps blend for successful blending and compaction. Lime expands the ideal water content for compaction, which is favourable position when managing wet soil. The compaction bend for lime-treated dirt is by and large compliment, which influences dampness to control less basic and decreases the inconstancy of the thickness created. In initial couple of hours in the wake of blending,

lime added substances cause a consistent increment in quality, yet at a slower rate than cement. Lime stabilization of earth soils is accomplished in the field by shallow/surface adjustment or profound adjustment techniques. Shallow adjustment utilizing lime is accomplished by mechanical blending of lime and black cotton soil, spreading the blend and after that compacting it. Profound adjustment includes the utilization of lime segments, lime heaps or lime infusion techniques. Blending spreading-compacting has the favorable position over the lime heap system that it guarantees proficient contact amongst lime and clay mineral particles of the soil.

Table.3: Improvement in BC soil characteristics with Lime

Property	Observed values of BC Soil	
	Without Lime Treatment	With Lime Treatment
Plasticity Index	45	15
Water absorption at OMC and MDD	29	5
Uncontained compressor strength(kg/cm)	1.3	3.0
CBR value at OMC&MDD	3	20

Table.4: Variation of Index Properties of Black Cotton Soil with Fly Ash Percentage

S. No.	Fly ash content (%)	Liquid Limit (WL)	Plastic Limit (WP)	Plasticity Index (IP)	Liquidity Index (IL)	Consistency Index (IC)	Specific Gravity (GS)
1.	0	43.5%	25.0%	18.5%	-1.081	2.081	2.540
2	10	36.0%	13.0%	23.0%	-0.356	1.356	2.465
3	20	34.25%	14.8%	19.45%	-0.534	1.534	2.403
4	30	33.8%	15.7%	18.1%	-0.618	1.618	2.350
5	40	34.25%	16.1%	18.15%	-0.644	1.644	2.305
6	50	33.0%	16.4%	16.6%	-0.735	1.735	2.266

V. MATERIALS FOR SOIL/ROAD 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 following properties,

- OPC 43 grade as per IS: 8112- 1989.
- 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.
- The sand shall be as per IS: 383-1970.
- 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.

Laboratory tests on soils, fly ash, foam and lime mixtures

In Experimental investigation the soil-Fly ash, form concrete and lime mixtures were prepared by mixing BC

Soil (10,20,30,40), fly ash (4%, 6%, 8%, 10% and 12%...), foam (10%,15%, 20%, 25%) and lime. All these mixtures were tested in the laboratory for their index properties, compaction characteristics. The test were carried out to determine the maximum dry density (MDD) and optimum moisture content (OMC) of soil mixtures using Heavy compaction (Modified Proctor Test) as per IS 2720-PartVII-1974. The mould used was 100 mm in diameter and 127.3 mm high. The samples were compacted in 5 layers by applying 25 blows to each layer with a free fall of 450 mm of 4.89 Kg weight.

CBR: The samples were prepared at OMC and compacted using Dynamic Compaction (Modified Proctor Test) as per IS: 2720-Part VII-1974. The mould used was 150 mm in diameter and 127.3 mm high. The samples were compacted in 5 layers by applying 56 blows to each layer with a free fall of 450 mm of 4.89 Kg weight. The penetration tests were carried out for samples soaked for 96 hours. The rate of penetration of the plunger was kept at 1.25 mm per minute.

Table.5: The most common desirable properties of soil/BC Soil as road material are listed below

Property	Sub base	Base course	Surface course
Liquid limit	20% Max.	25% Max.	35% Max
Plasticity Index	6% Max.	6% Max.	5 to 10% Max.

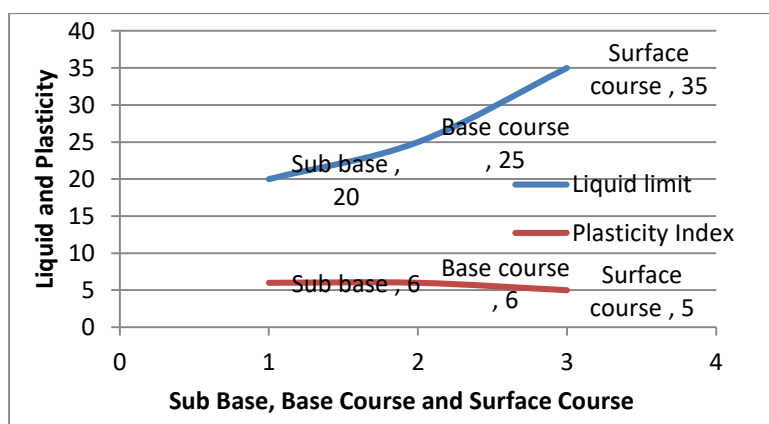


Fig.1: Desirable properties of soil/BC Soil

Consolidation of pavement takes much time, due to poor drainage capacity of soil. Shear strength of soil decreases with increase in moisture. Bearing capacity of soil is very low, resulting in extra thickness of pavement.

VI. RESULT DISCUSSION

The mix with perfect degree of (BC Soil + lime + fly ash stays) to soil and besides extent by weight of lime to fly powder should first be picked in the lab by experimentation. The same should be grasped in the field. The degrees of lime; fly blazing flotsam and jetsam and soil in the total mix conveyed in parts by dry weight.

Foamed concrete composition changes with the density that is request. For the most part, the foamed concrete that has densities lesser than 600kg/m³ will have cement, foam, water additionally some option of fly ash or lime stone tidy. To accomplish higher densities for frothed concrete, sand can be utilized. The base blend is 1:1 to 1:3 for heavier frothed concrete, which is filler to portland cement proportion. For more densities, say more greater than 1500kg/m³ more filler and medium sand is utilized. To diminish the thickness, the filler sum ought to be lessened. It is prescribed to dispose of the foam concrete with thickness lesser than 600kg/m³. Light weight filling material for street construction - Foam Technology: Foam concrete is a concrete blend that requires more prominent quality check to ensure the aggregate movement of its massiveness. The void rounding application has ended up being more obvious because of its related course of action of central focuses like warm security, its rigid nature, and controlled water ingestion properties. Ground feebleness issue is an problem generally went up against by old mines and sections. They have now used frothed concrete to fill the voids as a response for recoup quality in sewers, advantage trenches and various road structures like in cable cars and courses. Consequently the extent: L: FA is 1: 4: the task by parts may be,

Lime	3 parts
Fly Ash	12 parts
Soil	75 Parts
Foam Concrete	10 Parts
Total (Dry and Weight)	100

Experience recommends that lime-fly red hot flotsam and jetsam extents of 1:3 to 1:4 give perfect quality for various soil sorts sensible for lime-fly powder soil adjustment. Moreover increase in lime content does not demonstrate a proportionate augmentation in quality. Lime notwithstanding fly red hot flotsam and jetsam content going in the region of 10 and 30 for each penny by weight of the total dry mix has been seen to be sensible. Lime fly powder requirements, frankly, depend on the level of fines in the total mix. Fine solid residue requires a more elevated amount of (lime-f fly ash) appeared differently in relation to particularly explored soils. Quality advancement calls for sufficient system material (fines) to fill the voids in coarse materials.

The correct extents of the ingredients viz. lime fly fiery debris and soil, to be received at a specific area ought to be founded on the research facility blend configuration relying on the quality necessity. The base unconfined compressive quality and CBR values following 28 days curing and 4 days dousing ought to be 7.5 kg/cm² and 25 for each penny separately. As far as seven days curing and four days splashing, the base unconfined compressive quality and CBR esteems ought to be 3 kg/cm² and 10 for every penny individually. The curing might be done at a temperature extending from 30°C to 38°C. 5. Trial blends utilizing (lime-fly cinder) proportions of 1:2, 1:3, 1:4, are at first arranged. The accompanying general extents may as needs be utilized for setting up the mix for research facility tests:

Table.6: Lab Test Result

BC Soil + %5 Lime + 10% Fly Ash		BC Soil + %5 Lime + 20% Fly Ash		CBR -BC Soil + %5 Lime + 10% Fly Ash			CBR- BC Soil + %5 Lime + 20% Fly Ash		
Water Content	Dry Density	Water Content	Dry Density	Penetration	Load (Unsoaked)	Load (Soaked)	Penetration	Load (Unsoaked)	Load (Soaked)
19	1.625	18.34	1.63	0.5	20	12	0.5	24	15
23.61	1.657	21.25	1.685	5.0	116	84	5.0	132	96
28.57	1.69	25	1.75	10.0	132	96	10.0	152	115
33.33	1.63	29.165	1.68	15.0	140	102	15.0	158	120

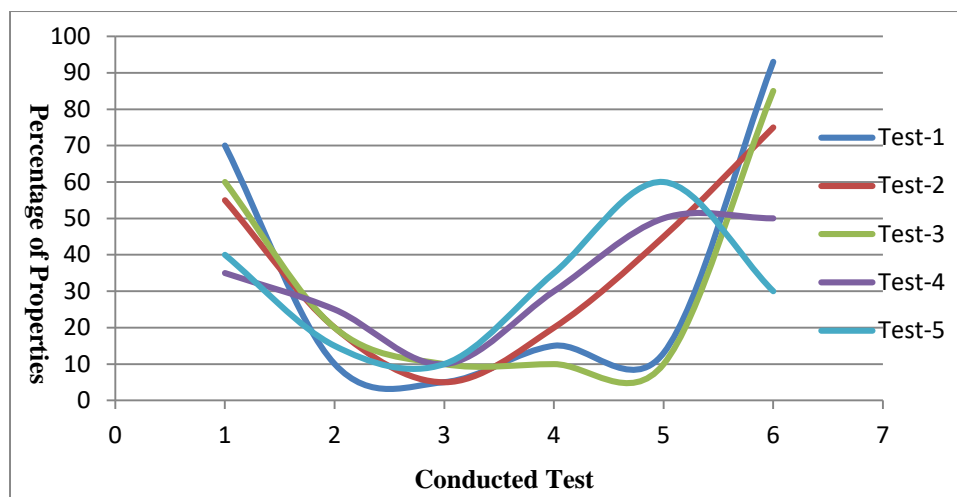


Fig.2: Lab test result of concrete

Index properties of soil have an essential part in choice of soil as a road construction material. Soils that experience huge volume changes with change in water substance might be troublesome if utilized for highway bases. The volume change can bring about knocks in road and break the structures, since the volume changes after some time may not and generally will not be equivalent. As far as possible, plastic breaking point might be utilized to foresee potential inconvenience in soil because of volume changes.

VII. CONCLUSION

The expansion in CBR (California Bearing Ratio) and dry density is most extreme for 20% fly ash mixture with black cotton soil, lime concrete, coarse, aggregates and sand. Black cotton soil of low or medium plasticity can be utilized for base courses by balancing out with fly ash, lime concrete, coarse, aggregates and sand because of change in its versatility attributes. So as level of Fly Ash is expanded the fluid furthest reaches of black cotton soil diminishes, bringing about lessened swelling of soil. There is a requirement for giving the designing attributes of B.C. soil for road construction. Flexible pavement design technique including utilization of CBR strategy needs change because of high swelling attributes of Black cotton soil (BC soil). Rigid pavement construction can be utilized to bring out general economy in Black cotton soil (BC soil) territories. Utilization of lime-soil adjustment innovation has an awesome potential in Black cotton soil (BC soil) zones. Some mechanical properties of clayey sands were explored and the conduct of these materials was communicated in a simple mathematical equations in view of test comes about on soil tests gave from the Peelamedu, Coimbatore, Tamilnadu, India. These capacities are pertinent for materials that have the same or close degrees to those, which were utilized as a part of

this investigation. As indicated by the results, it is noticeable that concrete mix was can use in wetland of BC soil land and for maintenance of road constructions.

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