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A Study of Enhancement of Expansive Soil Alone and by Adding Admixture Lime Powder and GGBS

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Abstract: **The swelling and shrinkage characteristic of black cotton soil causes many problems to the building which built on that. In order to increase the strength of these soils it is essential to stabilize it. In this present study the soil is brought from Toravi village, Bijapur district, and Karnataka state and stabilized by using various percentages of GGBS and with lime powder. Laboratory tests were performed with different percentages GGBS (4%, 8%, 12%, 16%) and lime powder (10%). The soil sample was prepared with definite percentages using modified proctor's test with optimum moisture content, later the shear parameters were calculated by conducting unconfined compression test. Also, California bearing ratio test were conducted to know the stability of subgrade under soaked and unsoaked condition. The test results from UCS test shows that increase in curing period may increases the strength up to maximum strength is achieved. CBR value is maximum at 10%LP+16% of GGBS. Hence economic stabilization of BC soil can be done using a mixture of 16% GGBS + 10%LP.**

Keywords: GGBS, Black Cotton (BC) Soil, Lime Powder (LP)

I. INTRODUCTION

Man started building huts for shelter from the ancient times and has been dealing with soils since then. Weathering is a process because of which soils are made mainly due to break down of rocks by weather. The process of weathering causes chemical and Physical changes leading to fine grained soils and coarse-grained soils. Majority of the clayey soils (fine grained) often cause a problem to a geotechnical engineer due to shrinkage and swelling while losing water and admitting water. Hence in the context of swelling and shrinkage aspects clayey soil is considered as soft soils or weak soils.

Highway engineers are regularly worried about the toughness of pavement structures particularly when BC soils are experienced which display high volumetric instability to subgrades. Expansive soils usually available in dry places which provides low strength pavement subgrade materials. Fine grained soil and mud soils are significantly named AASHTO A-7-6 soil. Essential qualities of such soils pocess low strength, reduced workability, high volumetric instability and poor durability. In for all intents and purposes each area where they are experienced, streets developed over BC soil subgrades poor performance, except if proper innovation is embraced to change them into successful development materials. Thusly, their quality is one of the critical elements that altogether sway expenses of street ventures.

Basic parts of a pavement structure in street development are firm subgrade and base layers. Overall performance and durability of the pavement have essentially affected from the soil parameters such as quality and consistent volume of subbase. During development of street the factor liable for the disappointment of asphalted path in the vast majority of the cases are because of unable response to applied loads.

So many stabilizing agents and additives are adopted to increase the physical behavior soil. The most cost-effective method is the usage of granulated material like Lime Powder (LP).

II. STATEMENT OF PROBLEM

Because of expanding cost of street development materials in India it is important to explore locally accessible materials and reusing of waste as development material. Then again, Steel processing plants exist on the planet that produces over a huge number and huge amounts of steel yearly for the development business. GGBS, the waste created from Steel creation is arranged in landfill as waste. It along these lines gives a decent choice to use in strengthening soils, subsequently diminishing expense and decreasing the issue of wastage in the space left can be used for farming. Additionally, Lime Powders are likewise discarded as it is additionally a waste item and it can make different unsafe effects on the earth.

III. LITERATURE REVIEW

[1]A.A.Amadiet al.,[2015], the unconfined pressure test esteems assessed tells that BC soil balanced out with consolidated Lime Powder and GGBS quality properties are affected by the time of curing. Soil blends was tried after 0, 7, 14, 21 and 28 days of curing and soil blend was compressed with British standard light (BSL) at ideal compaction boundaries. Starter tests did on the dirt blends demonstrated that there was decrease in LL, PI and dry unit weight, sporadic pattern in the variety of plastic cutoff and an expansion in OMC of soil blends. Further increment in GGBS and time for curing for soil blends builds UCS values. Consequences of UCS tests shows that there will be increment in values from 1.5 to multiple times more contrast with those tried following example arrangement. The outcomes show that the balanced-out soils with admixtures will build the quality extra with time for curing,

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the further quality will create with time. On these outcomes, further investigations thinking about longer time for curing occasions and perhaps higher GGBS substance are important. [2] Bshara et al., (2014) depicted that by including LP the CBR and MDD of low-quality soil can be enhanced and ideal dampness substance can be diminished. It likewise diminishes the plastic as far as possible, fluid cutoff, versatility list and expands helpfulness as parkway sub-grademateriał. [3] Jagamohana et al., (2014) depicted that the sweeping conduct of the Expansive Soil can be fundamentally diminished by addition of stone residue because of lessening of versatility list from 17.45% to 4.80% and diminish of fluid cutoff from 37% to 28% , if 0% to 30% rock dust and 5% lime from by weight of Black Cotton Soil is mixed with Black Cotton Soil from 57% to 28% as far as possible qualities decline with increment in the stone residue rate, from 37.2% to 3.7% pliancy list esteems decline, from 56.6% to 4.1% differential free swell diminished radically, with the expansion in rock dust the estimations of shrinkage limit increments from 8.15% to 18%. [6] Sabatet al., (2012) had explored that how lime impacts on far reaching soil balanced out with Quarry residue of 40% and 2 to 7% of lime with 1% increases. The properties like Atterberg's cutoff, (modified delegate test, shear quality boundaries were researched. Shear quality boundaries were additionally studied on 7 and 28 days of curing and concluded that wP, wS, C, Ø, OMC increments with increment in level of lime, the wL, and diminishes IP, MDD of the dirt Lime Powder. Despite the fact that MDD diminished however MDD of the virgin soil at 5% expansion of lime is short of what it. The toughness of soil-Lime Powder had made expanded by expansion of lime. Shear boundaries are likewise had constructive outcome because of curing. The most extreme estimation of shear boundaries is at 28 days to 30 days of curing by expansion of 5% lime. [7] Mehta (1993) In Modern method before the clinkering operation, water in the slurry must be evaporated subsequently so it is further energy proficient than the wet process. In dry- process kiln about 60% of energy is enough as compared to energy required in production of a large amount of cement in wet process. With the improvement in the machinery, rotary kilns are used and preheater system is used in the upstream of rotary kilns to combust fuel. Here the hot gas coming from the kiln disperses raw material powder in a stream. Initial heating of about 800ºC in preheater is generated as initial heat by using hot combustion gases from the fuel and limestone evolved carbon dioxide (CO2). Calcination requires much lower temperatures than required to fuse the minerals into clinker so lower grade fuels are used for calcination.

IV. SCOPE OF RESEARCH

This research would concentrate on improving the parameters of expansive soil for building and road construction by utilizing GGBS and Lime Powder (LP).

V. MATERIALS

Materials used during the conduction of experiments are: Black Cotton (BC)Soil, Lime powder (LP) and GGBS

1. *Black Cotton Soil: In this examination soil was taken from Toravi town, Bijapur area, Karnataka state, India. The area has short spells of wet climate.*

Table-1: Properties of BC Soil

S.No	Property	Value
1	Percentage of Gravel	4
2	Percentage of Sand	23
3	Percentage of Fines	73
4	Percentage of LL	71.22
5	Percentage of W_p	39.01
6	Percentage of I_p	32.21
7	IS-Classification	CH
8	Specific gravity	2.51
9	OMC (%)	23
10	MDD (g/cc)	1.83
11	UCS, (kN/m^2)	135
12	CBR (%)	1.6

1. *GGBS: GGBS is a derivative of iron (acquired from steel factory) slag collected from the blast. This unwanted matter is comfortably accessible and also cost friendly.*

Table-2: Properties of GGBS

S.No	Properties	Value
1	Percentage of Gravel (> 4.75mm)	3.0
2	Percentage of Sand (4.75-0.0 75mm)	5.32
3	Percentage of Fines (<0.075mm)	91.68
4	Percentage of LL	52.02
5	Percentage of PL	36.00
6	Plasticity index (%)	16.02
7	Specific gravity	2.60

2. *Lime Powder(LP): The Lime powder utilized in this investigation was taken from Gulbarga Industrial Area. Just the part going through IS strainer (4.75 mm) was utilized in the examination.*

Table-3: Properties of Lime Powder

S.No	Description	Value
1	Chemical Composition (%)	
	Calcium Oxide	83.3
	Magnesium Oxide	0.5
	Ferric Oxide (%)	2
	Aluminium Oxide (%)	1.5
	Silicon Dioxide (%)	2.5
	Sulfur Trioxide (%)	0.5
	Sodium Oxide (%)	0.4-0.5
	Carbon Dioxide (%)	5
	Calcium carbonate (%)	10
2	Specific Gravity	2.2

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IV. METHODOLOGY

The trial program included compaction test, Atterberg cutoff points, molecule size examination and toughness tests. California BR and CBR swell test methods were carried out as the two normalized lab tests for the appraisal of sturdiness of settled soil mixtures.

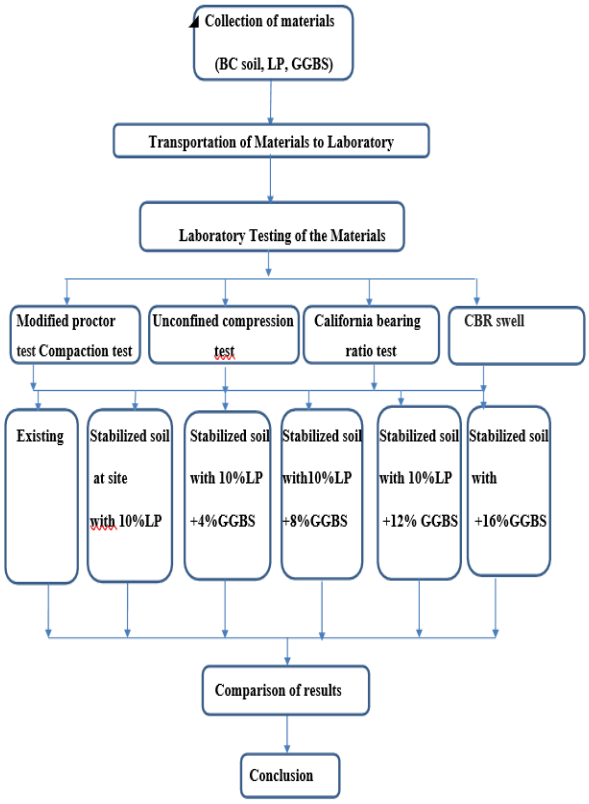

Fig 3.2: Plan of the test conducted

VI. RESULTS AND DISCUSSIONS

1. EFFECT OF GGBS AND LP ON CONSISTENCY (ATTERBERG LIMIT)

Table: Comparison of Consistency Limit Results of Expansive Soil Mixed With Lime Powder And GGBS.

Admixture	LL	PL	PI
Soil	71.22%	39.01 %	32.21%
Soil + 10% LP + 4% GGBS	63.2%	32.8%	30.4%
Soil + 10% LP + 8% GGBS	58.3%	31.2%	27.1%
Soil + 10% LP + 12% GGBS	52.46%	30.43%	22.03%
Soil + 10% LP + 16% GGBS	48.23%	28.1%	20.13%

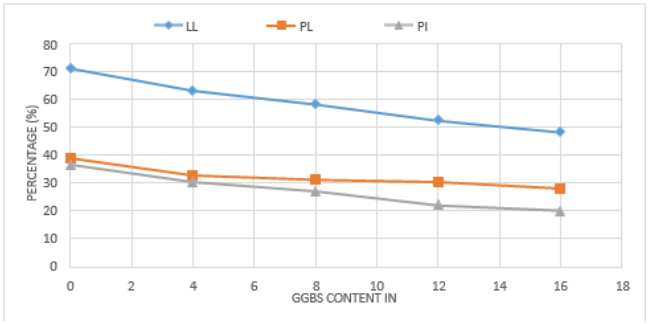

Fig: Comparison of Consistency limit results of Expansive soil mixed with Lime Powder and GGBS.

The liquid limit decreases by increase GGBS and LP up to 0% & 16% and afterward expanded somewhat with extra increment in the percentage of GGBS & LP. With the primary decrease in W_L. According to **(Talal and Awad 1998)** with the high percentage of calcium oxide in GGBS will aid to flocculation and aggregation of given soil sample.

2. EFFECT OF LP AND GGBS ON SPT CHARACTERISTICS OF EXPANSIVE SOIL

Table: SPT Parametrs Of Expansive Soil Mixed With Lime Powders And GGBS.

Admixture	Dry Density	Moisture Content
Soil	1.83	23.00
Soil + 10%LP	1.87	21.4
Soil + 10% LP + 4% GGBS	1.95	20.2
Soil + 10% LP + 8% GGBS	2.10	19.86
Soil + 10% LP + 12% GGBS	2.35	19.20
Soil + 10% LP + 16% GGBS	2.42	18.00

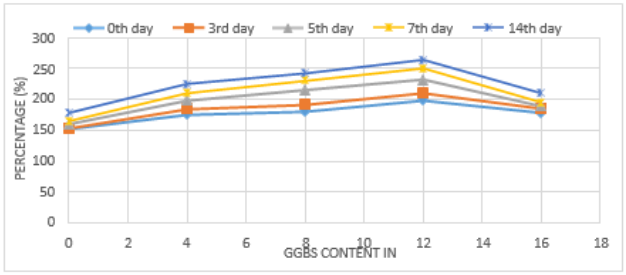

Fig: OMC Variation with Addition of GGBS and LP

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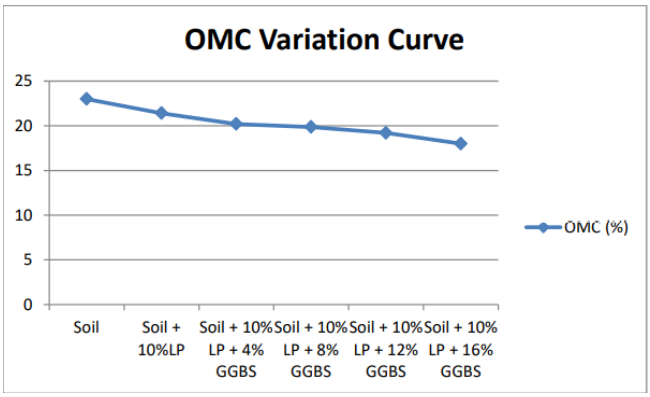
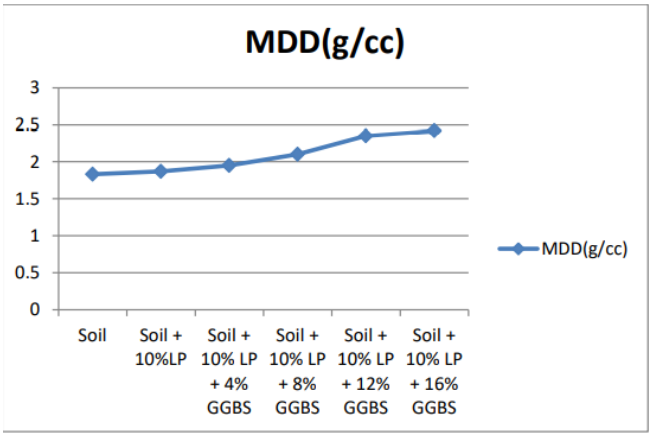


Fig 4.2.8 MDD Variation with Addition of GGBS and LP



3. EFFECT OF LP AND GGBS ON UNCONFINED COMPRESSION STRENGTH OF BC SOIL

Table: Change of Unconfined Compressive Strength value with addition of LP and GGBS from 0th day to 14th day

Admixture	UCS VALUE IN kN/m²				
	0 day	3rd day	5th day	7th day	14th day
Soil	149	152	156	162	170
Soil + 10%LP+ 0% GGBS	152	153	160	165	178
Soil + 10%LP + 4% GGBS	175	184	198	210	225
Soil + 10%LP + 8% GGBS	180	191	215	230	242
Soil + 10%LP + 12% GGBS	198	210	232	250	264
Soil + 10%LP + 16% GGBS	178	185	189	195	210

Fig: Change of Unconfined Compressive Strength value by adding of LP and GGBS from 0 to 16%

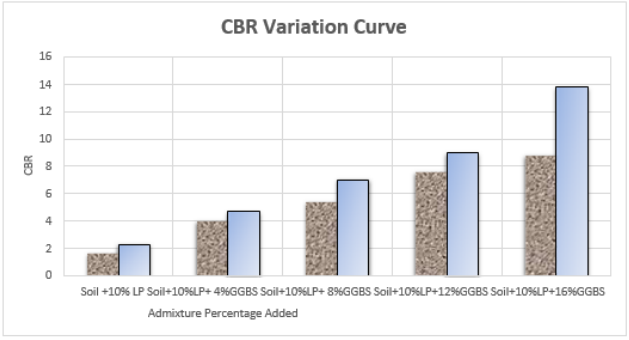
The time dependent responses that brought about increment in the content of the water which in the long run diminishes the γ_d of the rewarded soil. The impact of time required to on the quality advancement of soil blends was additionally shown by a variety investigation of the unconfined compressive quality (UCS) at various curing spans as shown in the figure. . The UCS at each time for curing has been standardized by the UCS at zero curing day. It very well may be seen that the course of events presents a moderate pace of increment in quality between the seventh day and fourteenth day. Additional result shows a general increment in UCS values with expanding GGBS content just as the time of curing for soil blends. Improvement in UCS values ran from 1.5 to multiple times higher than those tried following planning. The outcomes show that for 10% LP and somewhere in the range of 0% and 16% GGBS content, the UCS esteem expanded from 152 kN/m2 to 178 kN/m2. This is because of GGBS involving the void inside the dirt network. It might likewise be because of
the generally higher explicit gravity of GGBS (2.60) to that of the dirt.

4. INFLUENCE OF GGBS AND LP ON CALIFORNIA BEARING RATIO (CBR) TEST RESULTS OF BCSOIL

Table: Soaked and Unsaturated CBR Percentage for Soil Admixtures.

Admixture	CBR soaked(%)	CBR un-soaked(%)
Soil	1.6	2.3
Soil+10% LP	2.5	3.2
Soil+10% LP +4% GGBS	4.0	4.7
Soil+ 10% LP +8% GGBS	5.4	7.0
Soil+ 10% LP +12% GGBS	7.6	9.0
Soil+ 10% LP +16% GGBS	8.8	13.8

Fig: Comparison of Soaked and Un-soaked CBR v/s GGBS & LP content.



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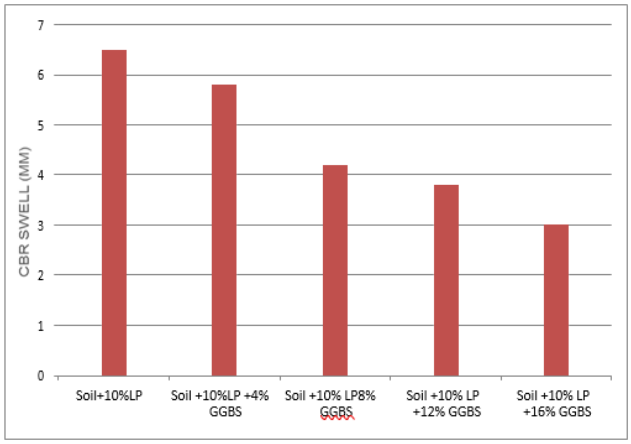
5. Influence of LP And GGBS On CBR Swell Test Results of BC soil.

Admixture(%)	CBR swell test(mm)
Soil+10% LP	6.5
Soil+10% LP +4% GGBS	5.8
Soil+ 10% LP +8% GGBS	4.2
Soil+ 10% LP +12% GGBS	3.8
Soil+ 10% LP +16% GGBS	3

Table: CBR swell test for Soil Mixtures.

Figure: CBR swell test with different admixture added



Illustrations of CBR v/s GGBS & LP content at OMC. Results of un-soaked samples are enhanced 16 to 138 by increasing the GGBS content about 0 to 16 percentage respectively. The expanding pattern in the estimations of CBR of soil blends because of use of GGBS. The California BR of the dirt added with 10 percent of LP with no GGBS, when only 10 percent of LP is mixed with soil gives low stability to the asphalted path that it cannot withstand heavy load. For instance, unsaturated California BR estimation of the dirt blended in with LP is 16. When GGBD substance of about 4% is added, the California BR is raised to 47. This is considered as better responsible upgrade. When the quantity of GGBS added is raised to 8 percent to 16 percent shows huge increase in California BR value, which satisfies the quality of good subgrade. Notwithstanding an expansion in the doused CBR, the uses of GGBS brought about the lessening of the swell capability of soil blends. The information shows that GGBS-rewarded examples done well particularly at higher focus levels as increment in volume of the dirt blends lowered in water was incredibly diminished. Swell worth acquired at 0% GGBS is around multiple times more prominent than that at 16% GGBS. When all is said in done, compound adjustment with GGBS boundlessly diminished the growing capability of the examples during submersion in to the water. In evaluating the strength of soil parameters utilizing the California BR and volume change estimations, an example can be seen as solid in case if the normal California BR esteem is greater than 15 percent without any distinct outcome less than 8 percent, and the swell is on normal 6.5 mm without any distinct outcome greater than 10 mm. By the assessments, soil blends having 0 and 4 percent GGBS failure occurred because of poor California BR and moderately raise in volume change estimation. As soil blends having 8, 12 and 16 percentages of GGBS crossed the California BR prerequisite of less than 15 percentages (accomplished 13–48 percent) and recorded less than 5 mm volume change (Table). Thus, the study gives us models which use these blends are tough enough to be regarded as reasonable substances for road development.

VII. CONCLUSION

Below conclusions are made depending up the laboratory report.

1. The addition of GGBS decreases the PL and LL properties of soil by rise in percentage of GGBS.
2. The plasticity properties of the dirt changes because of expansion of GGBS. The pliancy of the dirt was adequately diminishing by expansion of GGBS.
3. The UCS test results shows progressive increment in UCS esteem for relieving days from 0th day to fourteenth day. Indeed, even increment in relieving period may at present expands the quality up to most extreme quality is accomplished.
4. CBR value is enhanced by adding GGBS to the soil, maximum development obtained by almost 16% of GGBS. After treatment soil can be used base and sub base material
5. At given GGBS amount (0-16%) treating with the soil raises the MDD value from 1.83g/cc to 2.42g/cc. The OMC for the most part diminished with increment in GGBS content.
6. Models established resemble well with experimental results.
7. Economic stabilization of BC soil can be done using a mixture of 16% GGBS +10%LP

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