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IMPROVEMENT OF EXPANSIVE SOIL USING LIME & WASTE GLASS POWDER

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Abstract - *In Developing countries like India Civil engineers are frequently challenged to use land with expansive soil, which shows massive volume change against fluctuations of moisture content. Expansive soils, taken into consideration as tricky soils hence, their right identity and characterization turns into an absolute necessity in the attitude of the nowadays geotechnical engineering practice. This study presents an experimental investigation on the improvement of the geotechnical properties of expansive soil stabilized with waste glass powder and lime to find meaningful application of non-biodegradable waste glass powder that does not used in construction industry and to use lime as an optimal modifier of properties wherever required. In this research Waste glass powder and lime is added to soil in the proportions like 0%, 2%, 4%, 6%, 8%, 10% & 2% of constant lime to find the percentage at which the maximum strength is obtained. Several series of laboratory experiments are performed on untreated and treated expansive soil samples like Atterberg limit, free swell, standard proctor test and California bearing ratio test to find out the changed in the properties of this type of problematic soil.*

Key Words **: Black cotton Soil, *Swelling, Shrinkage,* CBR, Atterberg limit**

1.INTRODUCTION

In India Expansive soil occupies nearly 20% of the available land. Black cotton is one among the expansive soil available in India. Black cotton soil is an expansive soil that generally available within the tropical zones. Their Colour varies from black colour to brown colour. Expansive soil major portion generally found in central part and a some places in south India. Expansive soils known by black cotton soil are available within the Madhya Pradesh, Maharashtra, Gujarat, Andhra Pradesh state and in some parts of Odisha, in India. These soil show off excessive plasticity nature. The key clay mineral is montmorillonite.

Fig.1.1 Expansive soil

These clays shows more swelling and shrinkage characteristic due to montmorillonite group mineral. Expansive soils are difficult when they lose water content, and additionally the any other day in the event that they seize water they emerge as tender in nature.

In light weight structure it creates problem, under burden and by changing volumetrically alongside regular dampness variety. Subsequently, In Infrastructure the superstructures generally counter heavily settlement and different developments, bringing about harm to establishment frameworks, basic components and structural elements construction.

In general requirement is adequate strength. Within the case of a cohesion less soils is achieved by proper confinement or by mixing the cohesion lees soil with cohesion material. Here the cohesion material act sort of a cementing agent. In case of cohesive soil, we are able to improve the soil strength by drying process or make the soil water resistant, changing the soil electrolyte configuration by adding frictional properties. Stabilizing the soil is technique to increase strength and maintain atterberg limits within in the specified limit. By chemical alteration we are able to improve the engineering properties. Stabilization of soil can be used to treat extensive type of soil materials having poor engineering properties. Various forms of stabilization techniques are in use. Stabilization can be broadly classified into three type:

Mechanical Stabilization

In general, weak aggregates are preferred for mechanical stabilization. Mechanical stabilization include physically changing the property of soil by Dynamic compaction and vibro compaction. There two types of technique used for mechanical stabilization. In dynamic compaction the soil is compacted using heavy weight, while vibro Compactions the soil is compacted with the use of vibration. Mechanical stabilization is one of the oldest method for stabilizing the soil.

Chemical Stabilization

Chemical stabilization are the technique that depend on adding a material to the soil that will physically interact with it and changes its properties. Lime and cement are the oldest and commonly used materials for chemical

stabilization. But advancement of new admixtures and industrial waste like fly ash, foundry sand, marble dust, plastic waste, waste glass available lime and cement are using less in stabilization of soil.

Geosynthetic Stabilization

Geosynthetic stabilization use geosynthetic reinforcement elements of provide constructability and access over very soft soils. They are manufactured from synthetic polymeric materials and sometimes from natural materials. They find use in Geotechnical engineering as separator, filters, drains, reinforcement, hydraulic barriers, protectors and erosion control system.establishes a well compacted and stable working platform by use of geo grids, geo textile, geo nets, geo membranes, geo composite, and geocells.

2. SOIL STABILIZATION BY WASTE GLASS POWDER AND LIME

Glass factory are also source of waste glass powder. In Powdered form this material is added to for stabilization. Glass is completely inert and so non-biodegradable. Glass powder has high angle of friction as compared to clayey soil which has very low angle of friction. It degrades in a manner just like natural rock. As an inert construction material, waste glass powder can increase the strength of assorted road and building elements.

Soil stabilization through addition of lime is simplest technique used to treat this kind of problematic soil. Because of cationic exchanges, lime can significantly reduce swell potential. Lime generate long term strength gain through a pozzolanic reaction. Therefore, this both additives help to bind the soil particles more closely. So the clay structure becomes more durable to weathering conditions.

In this present study, waste glass powder and lime has been used for alerting the properties of black cotton soil. Detailed laboratory tests were carried out to ascertain the advantages in terms of engineering properties.

3. MATERIALS AND METHODOLOGY

For the present research work, Black cotton soil was collected from Kadana in Mahisagar district Gujarat by method of distributed method of sampling. The air dried will be pulverized using wooden hammer. Various properties of expansive soil before stabilization from this study are as below:

Properties	Value
Colour	Black
Specific Gravity	2.38
Liquid Limit (%)	41.42
Plastic Limit (%)	26.85
Plasticity Index (%)	14.57
Free Swell Index	33.33
Maximum Dry Density(kN/M^2)	15.13
Optimum Moisture Content (%)	24.6
California Bearing Ratio (%)	0.6

Table 3.1: Properties of Black cotton soil on natural soil

Waste glass powder is collected from Kuber Glass, Halol, Gujarat, India. Lime purchased from local market of Gandhinagar. The main benefits of using lime to stabilization of soil particles by provide bond strength between waste glass powder and soil, also increase strength, and reducing shrinkage and swell characteristics. Lime is most commonly additive for the stabilization of expansive soils. Lime is produced from industrial processes and is relates to the emission of greenhouse gases like carbon dioxide (CO_2), sulfur dioxide (SO_2) and nitrous oxide (N_2O).

According to the above literature review, WGP and lime can be used for improving the geotechnical properties of different types of soil. The main objective of this study is to find the optimum percentage of waste glass powder to be used for improving the expansive soil. For this study different laboratory tests were carried out for expansive soil and sample by adding various percentage of waste glass powder (0%, 2%, 4%, 6%, 8%, and 10%) with lime (2%) to the oven dry weight of soil samples.

The various tests will be conduct in the geotechnical laboratory for engineering properties of black cotton soil. Various important tests are perform in the laboratory as per the relevant IS code:

1. Specific gravity (IS: 2720 PART III/ Sec I) – 1980

2. Liquid limit (IS: 2720 PART-V)-1985.

3. Plastic limit (IS: 2720 PART-V)-1985.

4. Free Swell index test of Soil (IS-2720-PART-40-1970)

5. Standard Proctor Test (IS-2720(Part-7), 1965)

6. CBR (California Bearing Ratio) test of soil (IS-2720-PART-16-1979)

4. RESULTS AND DISCUSSIONS

4.1. SPECIFIC GRAVITY TEST

NO.	DETAIL OF MIX		SPECIFIC GRAVITY
	LIME	WGP	
1	2%	0%	2.40
2	2%	2%	2.41
3	2%	4%	2.44
4	2%	6%	2.47
5	2%	8%	2.50

6	2%	10%	2.52

Table 4.1: Specific gravity of Stabilized BCS

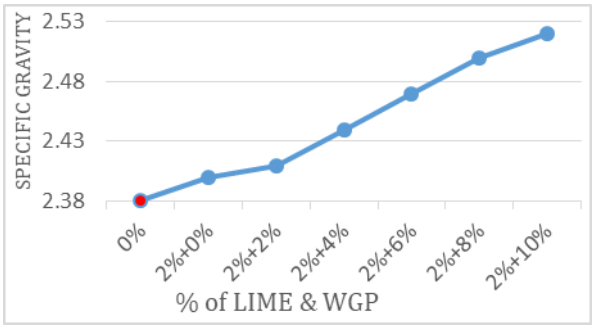

Fig. 4.1 Specific Gravity of diff. % of Lime & WGP in BCS

4.2. LIQUID LIMIT TEST:

NO.	DETAIL OF MIX		LIQUID LIMIT
	LIME	WGP	
1	2%	0%	37.8%
2	2%	2%	34.6%
3	2%	4%	31.6%
4	2%	6%	27 %
5	2%	8%	25.4%
6	2%	10%	23.5%

Table 4.2: Liquid limit of Stabilized BCS

4.3. PLASTIC LIMIT TEST:

NO.	DETAIL OF MIX		PLASTIC LIMIT	PLASTICITY INDEX
	LIME	WGP		
1	2%	0%	24.22%	13.58%
2	2%	2%	22.17%	12.43%
3	2%	4%	20.73%	10.88%
4	2%	6%	19.22%	7.78%
5	2%	8%	18.53%	6.87%
6	2%	10%	17.63%	5.87%

Table 4.3: Plastic limit of Stabilized BCS

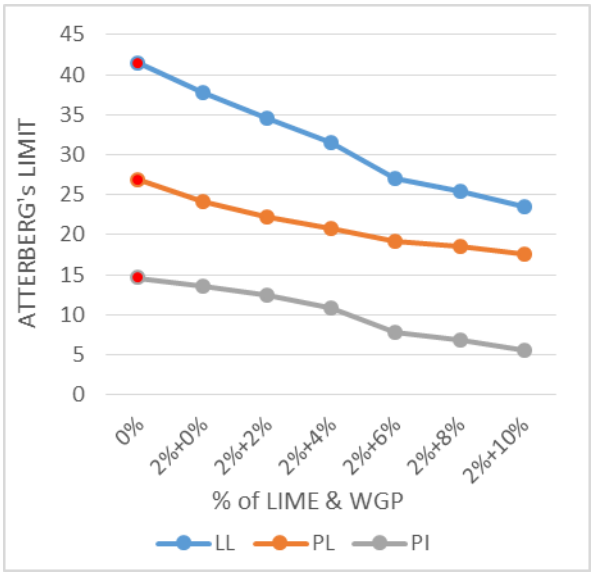

Fig. 4.2. Atterberg's Limit of Stabilized BCS

4.4. FREE SWELL INDEX TEST

NO.	DETAIL OF MIX		FREE SWELL INDEX
	LIME	WGP	
1	2%	0%	31.58%
2	2%	2%	28.21%
3	2%	4%	26.58%
4	2%	6%	23.46%
5	2%	8%	20.48 %
6	2%	10%	19.05%

Table 4.4: Free Swell Index of Stabilized BCS

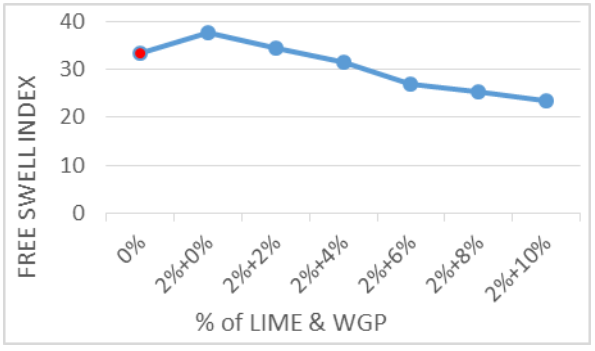

Fig. 4.3. Free Swell Index of Stabilized BCS

4.5. STANDARD PROCTOR TEST

NO.	DETAIL OF MIX		OPTIMUM MOISTURE CONTENT	MAXIMUM DRY DENSITY
	LIME	WGP		KN/m³
1	2%	0%	22.1 %	15.6
2	2%	2%	21.6%	16.0
3	2%	4%	21.05%	16.2
4	2%	6%	20.6 %	16.6
5	2%	8%	19.8 %	16.9
6	2%	10%	18.6 %	17.2

Table 4.5: MDD & OMC of Stabilized BCS

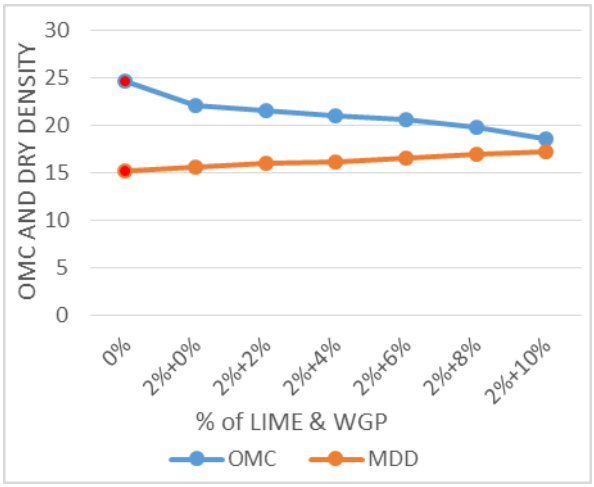

Fig. 4.4. OMC and MDD of Stabilized BCS

4.6. CALIFORNIA BEARING RATIO (CBR)

NO.	DETAIL OF MIX		CBR VALUE
	LIME	WGP	
1	2%	0%	0.63 %
2	2%	2%	3.52 %
3	2%	4%	4.87%
4	2%	6%	5.77 %
5	2%	8%	6.77 %
6	2%	10%	7.94 %

Table 4.6. CBR Values for stabilized BCS

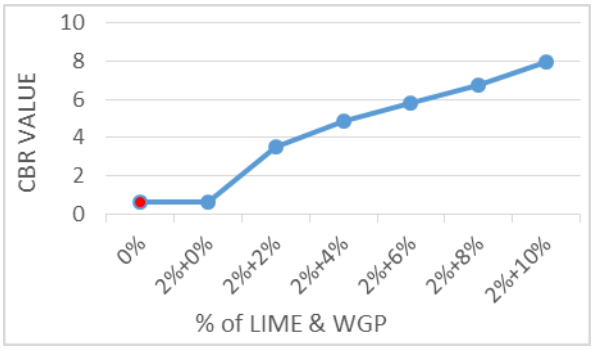

Fig. 4.7 CBR Values of Stabilized BCS

5. CONCLUSIONS

From the evaluation study of Improvement of expansive soil using lime & waste glass powder, it is concluded that the soil testing should be done first before any construction on expansive soil. The effects of WGP on the expansive soil properties were considered by adding 2%, 4%, 6%, 8%, 10% and 2% constant lime by dry weight of the sample.

Various properties of expansive soil after the stalization with Lime and WGP from this study are as below:

Properties	Unstabilized soil	Stabilized soil
Colour	Black	Black
Specific Gravity	2.38	2.52
Liquid Limit (%)	41.42	23.5
Plastic Limit (%)	26.85	17.63
Plasticity Index (%)	14.57	5.87
Free Swell Index	33.33	19.05
MDD (kN/M²)	15.13	17.2
OMC (%)	24.6	18.6
CBR (%)	0.6	7.94

Table 5.1: Properties of Stabilized BCS with Lime & WGP

Based on information from the experimental results, the subsequent conclusions can be drawn:

1) A substantial decrease Atterberg's limits such as LL, PL, PI about (43.26%, 34.33 %, 59.71%) because the increase of the glass powder and lime in soil.

2) The free swelling of untreated and treated expansive soil decreased by 42.84% due to an increase in the percentages of WGP and Lime.

3) The addition of 10% WGP and 2% Lime in the samples progressively decreased the OMC by 24.4%, which increased the MDD by 13.68 %, with the addition of 10% WGP+ 2%Lime.

4) The addition of 10%of WGP and 2% of Lime material to the BCS, the CBR values increase from 0.6% to 7.94%.

Therefore, it has been conclude that the addition of Lime and Waste glass powder had improved the properties of soil. Thus Combination of Lime and Waste glass powder shown Good result as a stabilizer for the weak soil, which applicable in Road subgrades, Foundation filling soil etc.

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