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COMPARATIVE STUDY ON EFFECT OF EXPANSIVE SOIL PROPERTIES WHILE USING STABILIZERS AS LIME AND GEOPOLYMER

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Abstract: Soil properties play an important role in any architectural and civil engineering marvel. Soil stabilization is the process by which engineering properties of soil such as Liquid limit, Plastic limit, Plasticity index, Optimum moisture content (OMC), Maximum dry density (MDD), CBR value, and specific gravity can be altered as per the requirements. There are numerous soil stabilizing agents available in the market. In our research paper, we have shown the comparative study of changes occurred in the engineering properties of soil when stabilized by GEOPOLYMERS and when stabilized by LIME. Geopolymers are largely produced from the raw materials which are industrial waste. Hence, it helps in reducing the carbon footprint and eventually contributing in sustainable development. Moreover, it helps in reducing the industrial waste. Lime on the other hand is easily available and has minimum negative impact on the environment. With the help of results shown in this research paper, one can easily bifurcate and choose the better stabilizing agent to get the desired soil parameters.

***Index Terms*: Expansive soil, Geopolymers, Lime, Soil stabilization, Swelling Pressure, Shear Strength, OMC, MDD and CBR values.**

I. INTRODUCTION

Indian subcontinent is largely covered with expansive soil. Expansive soil posses characteristics like swelling on gaining the moisture and shrinking on losing the moisture. Consequently, problems like settlement, partial structural damage, rupture of pavement surface, slopes etc... Therefore, to prevent any kind of human or material loss and to meet the structural demands of civil engineering projects, soil stability is of utmost importance. Soil stabilization helps in controlling swelling pressure, by reducing liquid limit of soil and altering other properties as well to increase the SBC (soil bearing capacity) of soil.

In modern day practices, various soil stabilizing agents such as Portland cement, Cement manufacturing dust waste (CMDW), Brick manufacturing dust waste (BMDW), Class F fly ash are commonly used. In this research paper, our aim is to find out the more effective stabilizer between 1] GEOPOLYMER and 2] LIME.

2. METHODOLOGY

2.1. INTRODUCTION

The sole purpose of the experiment is to evaluate the properties of expansive soil when treated with stabilizing agents like LIME and GEOPOLYMERS and to compare both the stabilizing agents in order to find out the most suitable stabilizing agent.

2.2. MATERIAL USED

Natural soil mainly consists of SiO2 famously known as Silica. Before carrying out the experiment, it is essential to have the in-depth knowledge of various soil properties. Soil for the experiment has been taken from Rajkot district of Saurashtra region of Gujrat. Various properties of this soil classified as CH soil as per Unified Soil Classification System is listed below.

Table 1 index properties of clayey soil

SR NO.	PROPERTIES OF SOILS	RESULTS
1	Liquid limit (%), LL	53
2	Plastic limit (%), PL	25
3	Plasticity index, PI	28
4	Shrinkage limits SL	18.5
5	% Free swell index	75
6	Specific gravity, G_S	2.63
7	% of Gravels	0
8	% of Sand	36
9	% of silt and clay	64
10	% of clay	28
11	% silt	36
12	OMC %	17.1
13	MDD gm/cm^3	1.7
14	Activity %	1
15	Type of soil	CH

Table 2 chemical properties of clayey soil

SR NO.	CHEMICAL PROPERTIES	RESULT
1	**pH**	7.74
2	**EC**	159
3	**TDS**	116
4	**TSS**	10
5	**N**	0.73
6	**P**	0.51
7	**COD**	10
8	**mg**	5.3
9	**Na**	62
10	**K**	0.3
11	**Cl**	84
12	**F**	0.1
13	**cl**	172

2.2.1 Lime

Soil stabilization by LIME done by two types of Lime (I) QUICKLIME (CaO) (II)HYDRAULIC LIME (Ca(OH) $_2$)

Choice from the above two agents should be made based on availability, cost efficiency, time available etc... Soil stabilization by LIME is essentially a process of exchange of ions by Lime and soil to each other. Extent of this exchange defines the strength of soil as more interaction between them will lead to reduction in Plasticity index as the plastic limit increases.

2.2.2 GEOPOLYMER

Materials having long range covalent bond in non-crystalline network are known as Geopolymers. They are ceramic materials and inorganic in nature. There is no. of various geopolymers namely Metakaolin based, Rice husk ash, Palm oil fuel ash, red mud, Alkali activated fly ash etc... In this experiment we have used Metakaolin based geopolymer. The main advantage of using Geopolymers in soil stabilization is that it contributes towards countries sustainable development goals. Industrial and Agricultural wastes are effectively utilized as Geopolymer.

3.0 TEST CONDUCTED.

To compare and find out better stabilizing agent of the Geopolymer and fly ash few tests needs to be conducted to determine the various soil properties which in turn represents the characteristics and soil bearing capacity of the soil. The tests conducted are as per the guidelines and norms provided by the Indian standards.

3.1 SAMPLE PREPARATION.

Sample preparation should be done precisely to make sure that soil collected is homogeneous and does not contain moisture. Sample is collected as per the guidelines from IS 2720 (PART 1) – 1983. Soil sample should be collected in sufficient quantity so that we can conduct tests with different concentrations of stabilizing agents.

3.1.1 SAMPLE 1 WITH LIME

Samples were taken by % of weight of soil and varied from 10 to 20%. Samples were named A, B, C respectively**.**
SAMPLE A: 10% LIME BY WEIGHT OF SOIL
SAMPLE B: 15% LIME BY WEIGHT OF SOIL
SAMPLE C: 20% LIME BY WEIGHT OF SOIL

3.1.2 SAMPLE 2 WITH GEOPOLYMERS

Geopolymers were also added based on % by weight of soil.
SAMPLE A: 10% GEOPOLYMER BY WEIGHT OF SOIL
SAMPLE B: 15% GEOPOLYMER BY WEIGHT OF SOIL
SAMPLE C: 20 % GEOPOLYMER BY WEIGHT OF SOIL

3.2 TEST PERFORMEND.

1. Liquid Limit Test.
2. Plastic Limit Test.
3. Unconfined Compressive Strength Test.
4. CBR Test.
5. Standard Proctor Test.
6. Swelling Pressure Test.

4 TEST RESULTS.

Table 4 Test Results

SR NO	TEST PERFORMED	TEST RESULTS					
		10% Geopolymer SAMPLE 1	15% Geopolymer SAMPLE 2	20% Geopolymer SAMPLE 3	10% Lime SAMPLE 1	15% Lime SAMPLE 2	20% Lime SAMPLE 3
1	LIQUID LIMIT TEST RESULST	42.2	40	40.1	43.39	41.5	40.4
2	PLASTIC LIMIT TEST RESULTS	20.6	18.9	16.4	21.8	18.99	17.2
3	OPTIMUM MOISTURE CONTENT (%)	20.4	20.12	21.1	21.66	21.01	21.31
	MAXIMUM DRY DENSITY (gm/cm^3)	1.67	1.88	1.91	1.6	1.81	1.89
4	UNCONFINED COMPRESIVE STRENGTH TEST (kN/m^2)	138	157.4	161.2	137.42	156.05	159.59
5	SHEAR STERNGTH OF SOIL (kN/m^2)	69.6	78.77	81.26	71.23	80.58	78.34

	CBR VALUE	2.94	3.72	3.85	2.9	3.68	3.8
7	SWELLING PRESSURE (kg/cm^2)	0.77	0.83	0.96	0.81	0.89	0.99

5 RESULTS COMPARISON

Results of the test conducted are useful in determining the effectiveness of both the stabilizers individually in different concentrations. To male analysis easier and more understandable we have depicted the results of various test in form of graphs which also makes comparisons way easier.

To identify the better stabilizing evaluation of the test result must be done properly. Here the results of both stabilizing agent are compared in form of graph with property investigated on y-axis and soil stabilizer mixed proportions as x-axis.

5.1 LIQUID LIMIT TEST RESULTS COMPARISON.

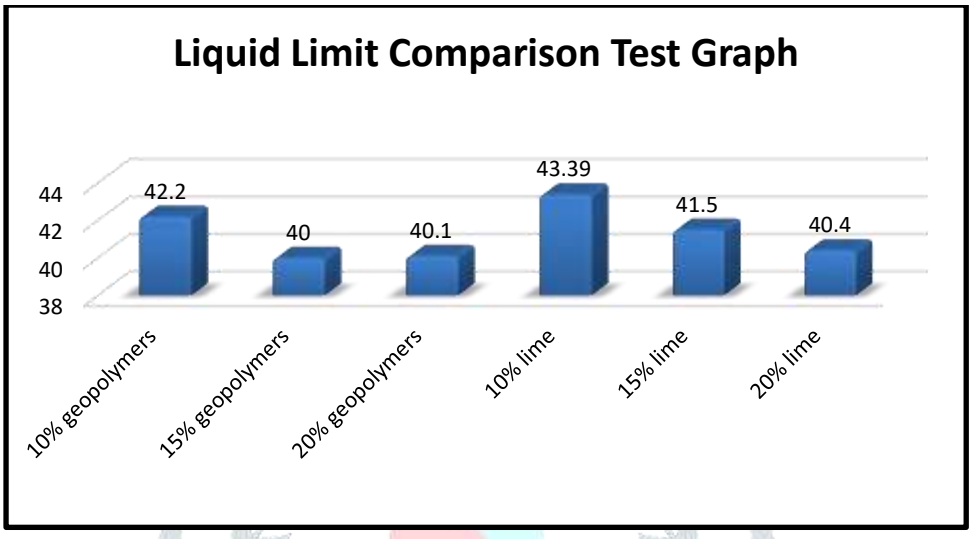

Chart 1 Liquid Limit Test

It is clear from the above graph that geopolymer as a stabilizing agent helps us to achieve lower liquid limit as compared to lime.

5.2 STANDARD PROCTOR TEST RESULTS COMPARISON.

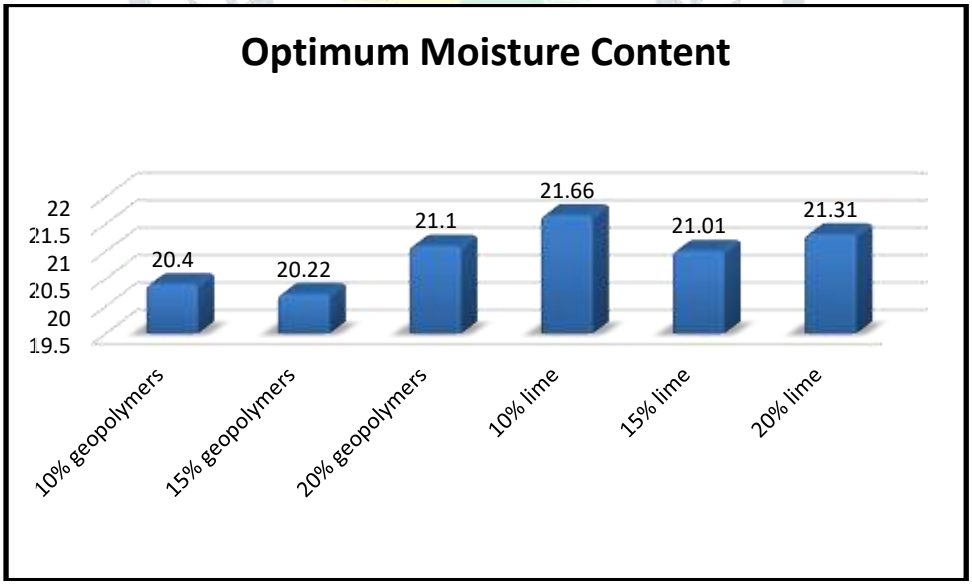

Chart 2 Optimum Moisture Content

graph of optimum moisture content is always in U-shape lower the value of OMC, greater will be the portion of soil. As shown in graph it clearly reflects that geopolymer helps to lower the moisture content of soil consequently providing greater Stability.

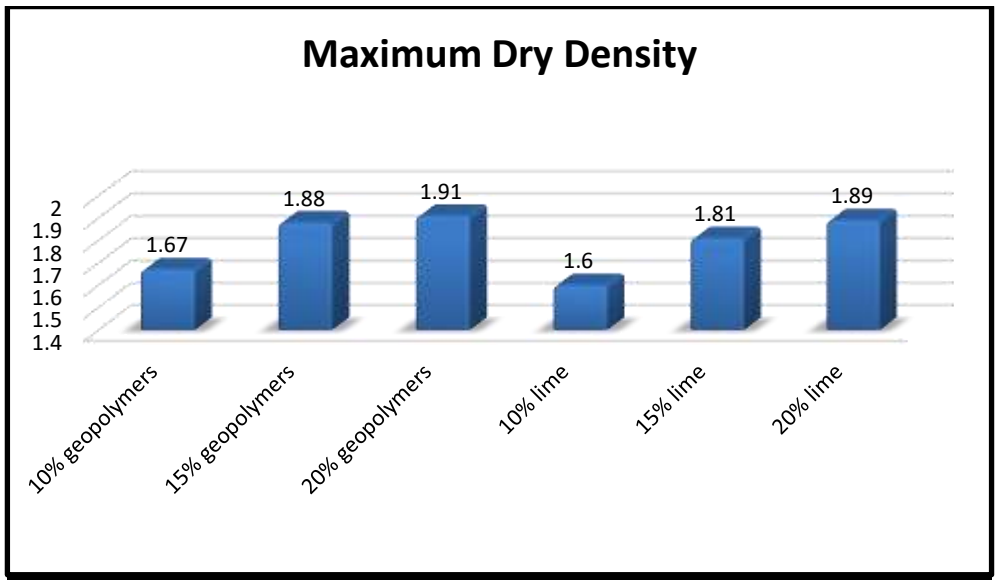

Chart 3 Maximum Dry Density

MDD is done by standard proctor test it is a typical test of compaction. Higher the compaction, higher will be the dry density. As it can be clearly observed from graph that by used geopolymer we can achieve MDD by lower compacting efforts. Moreover high MDD is also achieved at the same concentration.

5.3 UNCONFINED COMPRESIVE STRENGTH TEST

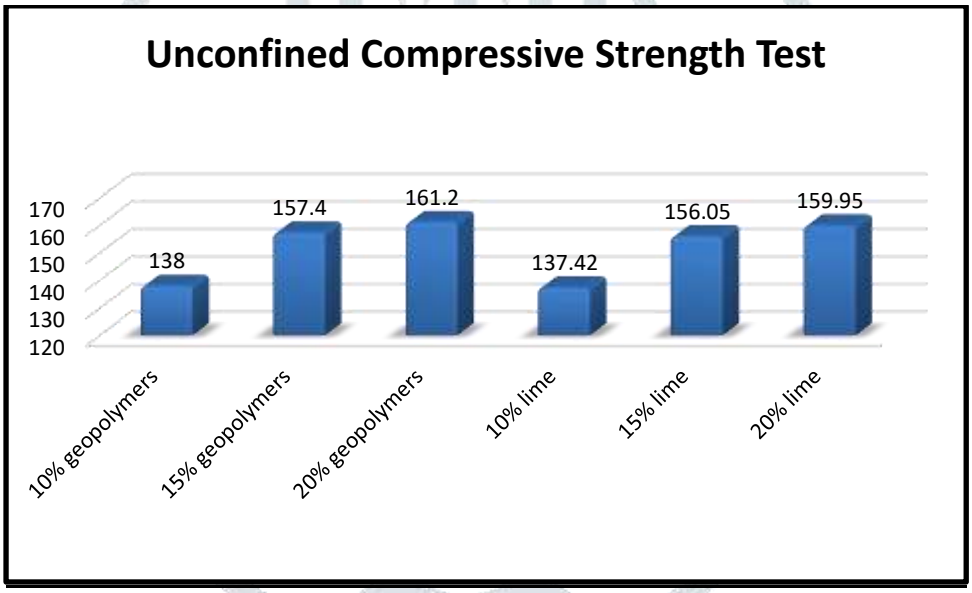

Chart 4 Unconfined Compressive Strength

However, it was observed that effect of both of the stabilizers were similar as far as the unconfined compressive strength is concerned. Hence from UCS Point of view any of the two stabilizing agent may be used.

6. CONCLUSION.

1] Both geopolymer and lime as soil Stabilizing agent help to improve the engineering properties of soil. However, On the basis of results obtained, It can be concluded that Geopolymer is Better stabilizing agent as compared to Lime.
2] Data of MDD gives us insight that soil stabilized with Geopolymer can be Compacted to higher density which means densified Soil. Also, it helps to achieve MDD at lower water content.
3] Soil may have liquidity at some fixed water content in lime as compared to geopolymer. It is responsible for soil Comparison and determining SBC of soil.
4] The studies of conducted so far on both stabilizing agents Emphasize on the use of geopolymer as soil stabilized agent as it helps to improve almost all engineering properties of soil.

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