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EFFECT OF SILICO MANGANESE DUST ON THE VARIOUS GEOTECHNICAL PROPERTIES OF CLAYEY SOIL STABILIZED WITH LIME

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ABSTRACT

The effectiveness of two different kinds of industrial waste, namely silica manganese dust and lime, was evaluated as part of the present experiment. The effects of dust and lime on the consolidation of loose soil are the subject unconfined compressive strength test, and the CBR test, were carried out by our team. This paper found inferences are susceptible to being made on the basis of the results of these tests. The optimal percentage of lime that should be present in the soil is three percent, and the ideal percentage of silica and manganese is eighteen percent. Increasing the amount of silica, manganese dust, and lime that is incorporated into the soil will result in an increased capacity for the soil to store liquid. The review papers that were discussed before allow for the conclusion to be drawn from them, Industrial waste has the potential to be used in a manner that is both effective and cheap in the stabilization of expensive or soft soil. One method to reduce the likelihood of adverse environmental effects is to put these wastes to use as a soil stabilizer in a way that is not harmful to the environment and that is also economically effective.

***KEYWORD**: CBR test, industrial waste, soil composition*

INTRODUCTION

Because soil composition has been left to the whims and complexity of nature, it is highly variable, convoluted, and unpredictable. Even within a same area, the quality of soil might vary based on its depth, ambient, stacking, and waste conditions. Dirt's features are influenced by both the kind of soil and the environmental conditions under which it was generated. Contrary to the transportation of other building materials like cement or steel, it is not economically possible to move dirt's from one area to another. As there is a lot of soil in this area, it cannot be evaluated at a deeper level for the foundations of different constructions. As a consequence, the need to improve the soil's characteristics became apparent very immediately after construction began, and the soil adjustment process now drives us to achieve the soil properties needed for structure construction. A widespread oil and totals setback in the middle of 1970 triggered a shift in soil adjustment in India, where professionals had to look for ways to enhance soil other than just replacing the bad soil at the development site. Soil adjustment started in earnest in the United States about midway through 1970, when oil and totals suffered a broad decline. Adjusting the soil failed owing to the employment of out-of-date procedures and a lack of a suitable strategy for doing so. Thus, soil adjustment was abandoned. Soil alteration has become more complex in recent years because to a rise in demand for framework, fragile components, and fuel. Due to enhanced research, materials, and gear, it is becoming a more important and cost-effective land development technology. A project's possible ramifications for the site, especially in terms of geotechnical activities, should be carefully considered before construction can begin. Before the planning process even starts, most sites are thoroughly researched. A choice on the layout of the project may then be made based on the features of the subsoil. When deciding on a site, the following geotechnical plan factors must be taken into account.

1. Determine the structure's load bearing capability and design it.
2. The kind of location that will be used.
3. The maximum load that the subsoil can support.

SILICO MANGANESE DUST

When silicon and manganese, two naturally occurring elements, are mixed together, a chemical compound called silicon manganese is formed. These constituents may be combined in a variety of ways to produce steel alloys with particular properties. As the name suggests, this alloy has 65 to 68 percent manganese, with 16 to 21 percent silicon and between 1.5 and 2 percent carbon in it. Silico manganese dust is an industrial by product which is obtained from arc furnace while extracting manganese from its ore in presence of coke and quartz. Quartz must be heated to very high melting points and subjected to massive amounts of energy in order to be transformed into silicon. As a consequence of this, the operation calls for an estimated 3,800 to 4,800 kilowatt-hours of power use each tone. Steel's inherent characteristics are enhanced as well as its appearance and durability when silica-manganese is added to the mix.

Figure 1: Silica Manganese Dust

LIME

Calcium-rich limestone is ground into a soil supplement known as lime. Limestone occurs naturally and is particularly calcium-rich. As a result of burning lime stone, lime is known as CaO or Ca (OH) 2. ($CaCO_3$). Soil-lime mixtures were used by the Romans to create roads more than 2,000 years ago and are one of the earliest building materials known to man.

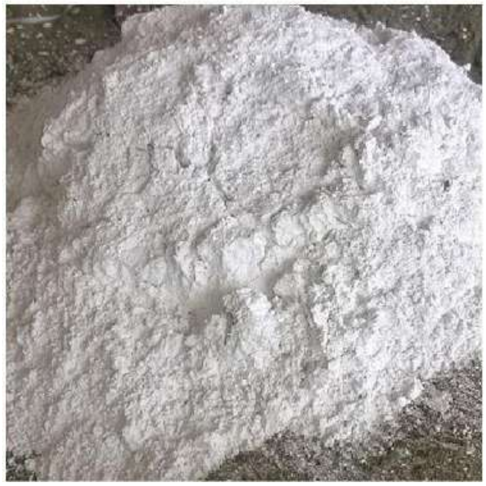


Figure 2: Lime Powder

EXPERIMENTAL PROCEDURE

In the course of this research, soil samples will be collected and examined in-depth. The resources utilized will be discussed in detail in this chapter. Additionally, this chapter provides a brief description of Atterberg's limits and discusses the essential tests that are done on soil samples. After that, the results of the various tests on the samples will be discussed.

MATERIAL USED

An overview of the many sources of information that went into the composition of this work may be found in this section.

Soil

The researchers in Srinagar city, Jammu and Kashmir, had to go over a number of routes in order to gather soil samples for their experiment.

Figure 3: Soil

Lime

Calcium-rich limestone is ground into a soil supplement known as lime. Limestone occurs naturally and is particularly calcium-rich. CaO or Ca (OH 2) is another name for the chemical compound formed when lime stone is burned ($CaCO_3$)

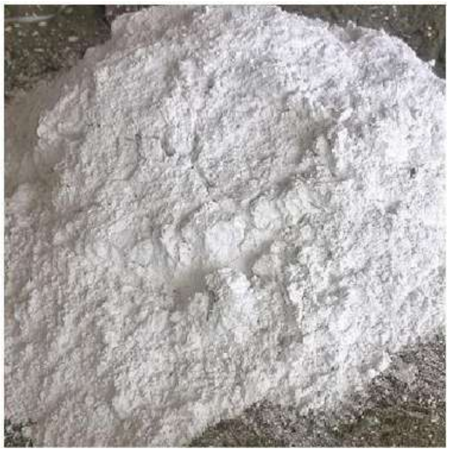


Figure 4: Lime Powder

Silico manganese Dust

The naturally occurring elements silicon and manganese may be combined to form the chemical compound known as silicon manganese.

Figure 5: Silica Manganese Dust

EXPERIMENTAL WORK

The following Properties of soil where calculated during study of this research work.

1) Specific Gravity of Soil
2) Liquid limit by Casagrande's apparatus
3) Plastic Limit
4) Maximum Dry Density (MDD) AND Optimum Moisture Content (OMC**)**

PREPARATION OF REINFORCED SOIL SAMPLES

For the purpose of the experimental program, the following mixes are created: 1. M-1 (Soil)
2. M-2 (Soil + 10 percent Lime)
3. M-3 (Soil + 20 percent Lime)
4. M-4 (Soil + 30 percent Lime)

5. M-5(Soil +10 percent Lime + 6 percent Silico manganese Dust)
6. M-6(Soil + 10 percent Lime + 12 percent Silico manganese Dust).
7. M-7 (Soil + 10 percent Lime + 18 percent Silico manganese Dust)
8. M-8 (Soil + 10 percent Lime + 24 percent Silico manganese Dust))
9. M-9 (Soil + 20 percent Lime + 6 percent Silico manganese Dust)
10. M-10 (Soil + 20 percent Lime + 12 percent Silico manganese Dust)
11. M-11 (Soil + 20 percent Lime + 18 percent Silico manganese Dust)
12. M-12 (Soil + 20 percent Lime + 24 percent Silico manganese Dust)
13. M-13 (Soil + 30 percent Lime + 6 percent Silico manganese Dust)
14. M-14 (Soil + 30 percent Lime + 12 percent Silico manganese Dust)
15. M-15 (Soil + 30 percent Lime + 18 percent Silico manganese Dust)
16. M-16 (Soil + 30 percent Lime + 24 percent Silico manganese Dust)

RESULT ANALYSIS

In this part of the article, analysed geotechnical characteristics of the native soil as well as the strength properties of soil that has been treated with lime and silico manganese dust have been provided.

LIQUID LIMIT

Table 1. Provides the values for the liquid limit that apply for the different combinations of clayey soil, lime, silica manganese dust. After the addition of wastes, the value of the liquid limit is raised in comparison to the soil in its untreated state. The results of the addition of waste material are shown in figures 7 to 10. these figures provide the results.

Table 1: Liquid Limit of Samples

Sr. No	Mix	Liquid Limit (%)
1.	M-1 (Soil)	42.6
2.	M-2 (Soil + 10 % Lime)	46.8
3.	M-3 (Soil + 20 % Lime)	54.69
4.	M-4 (Soil + 30 % Lime)	50.58
5.	M-5 (Soil + 10 % Lime + 6 % Silico manganese Dust)	49.6
6.	M-6 (Soil + 10 % Lime + 12 % Silico manganese Dust)	58.95
7.	M-7 (Soil + 10% Lime + 18 % Silico manganese Dust)	59.62
8.	M-8 (Soil + 10 % Lime + 24 % Silico manganese Dust))	54.58
9.	M-9 (Soil + 20 % Lime + 6 % Silico manganese Dust)	52.4
10.	M-10 (Soil + 20 % Lime + 12 % Silico manganese Dust)	59.6
11.	M-11 (Soil + 20 % Lime + 18 % Silico manganese Dust)	61.25
12.	M-12 (Soil + 20 % Lime + 24 % Silico manganese Dust)	62.54
13.	M-13 (Soil + 30 % Lime + 6 % Silico manganese Dust)	51.26
14.	M-14 (Soil + 30 % Lime +12 % Silico manganese Dust)	56.85
15.	M-15 (Soil + 30 % Lime + 18 % Silico manganese Dust)	62.53
16.	M-16 (Soil + 30 % Lime + 24 % Silico manganese Dust)	64.87

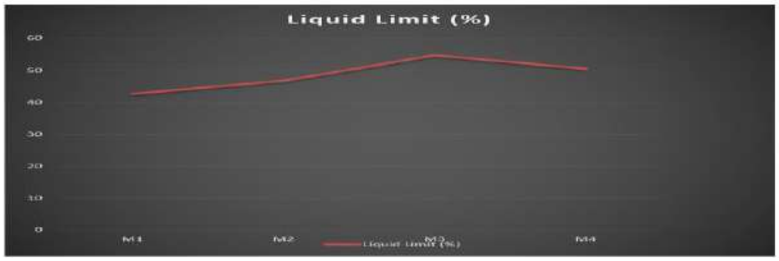


Figure 7: Effect on liquid Limit by using different proportions of Lime

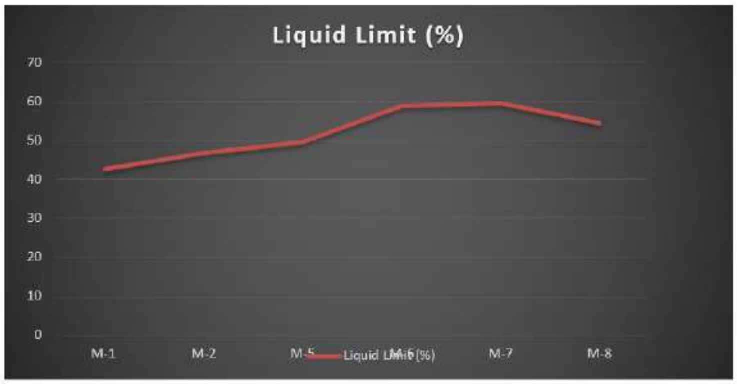


Figure 8: Effect on liquid Limit by using different proportions of Silico Manganese Dust with 10% Lime

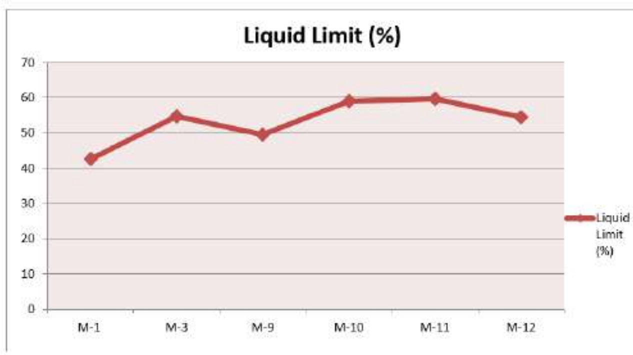


Figure 9: Effect on liquid Limit by using different proportions of Silico Manganese Dust with 20% Lime

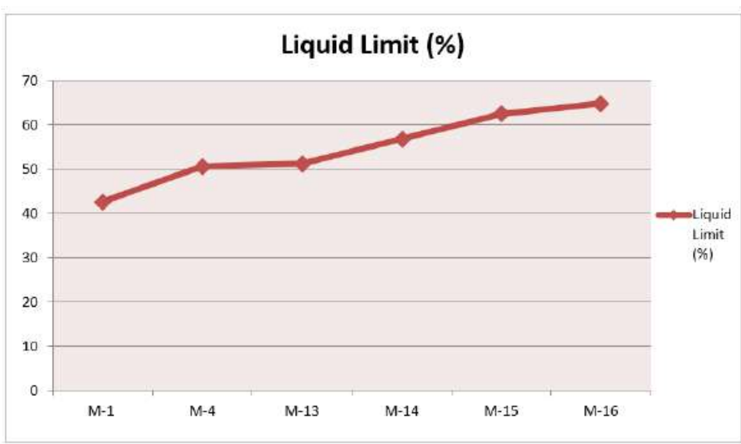


Figure 10: Effect on liquid Limit by using different proportions of Silico Manganese Dust with 30% Lime

In general, the grain size distribution is the most important factor considered for classifying soils. The information that is obtained from the grain size distribution curve is used for the construction of filters for earthen dams, as well as for determining whether or not soil is suitable for the building of pavement or landing strips, among other applications. In spite of the fact that vulnerability tests are often used, the data obtained from grain size distribution analyses might nonetheless be utilized to forecast the progression of soil water. Table 2 and Figure 9 both show the fraction of particles that are finer.

Table 2: Grain Size Distribution

Sieve Size (mm)	% Finer
4.75	87.8
2.36	75.8
0.600	56.8
0.425	54
0.300	29.2
0.150	26.2
Pan	17.2

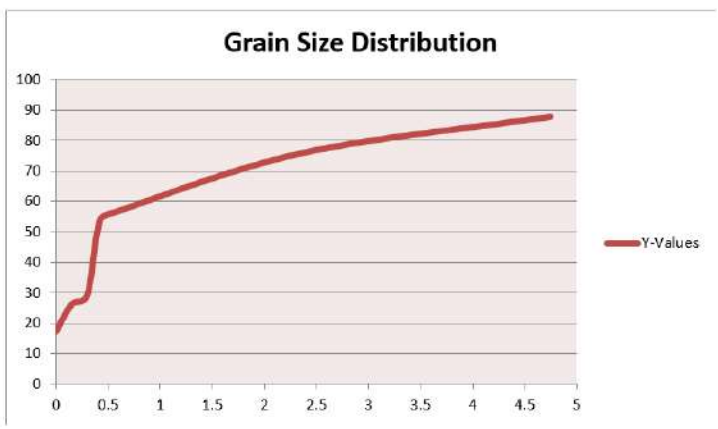


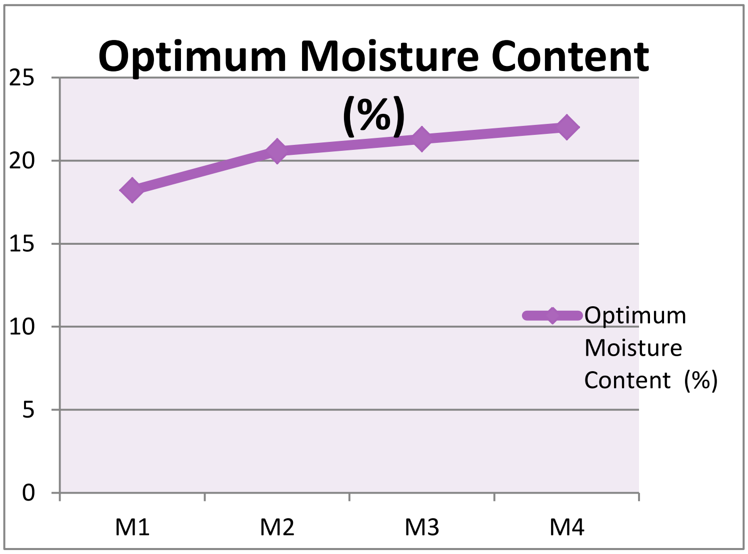
Figure 11: Grain Size Distribution

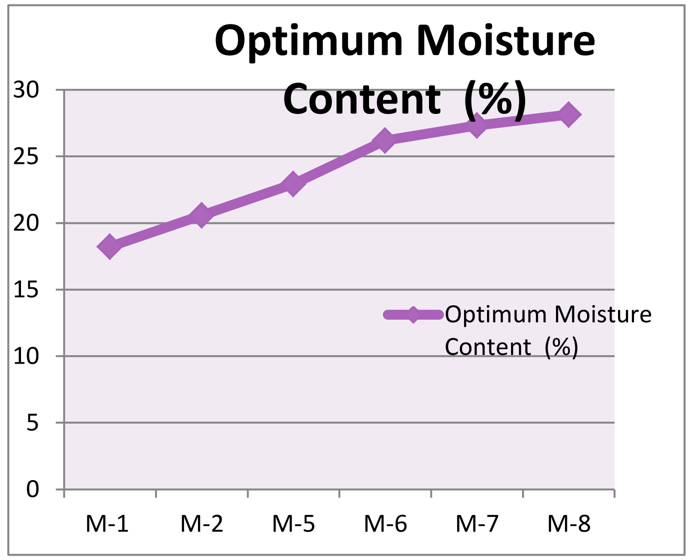
STANDARD PROCTOR TEST

The soil is subjected to this test in order to have its maximum dry density (MDD) and optimum moisture content (OMC) determined. In this experiment, the mould is layered with soil, and an equal number of blows intended to compress the soil are applied to each layer. The outcomes and observations are recorded. The optimal moisture content as well as the maximum dry density may be found as

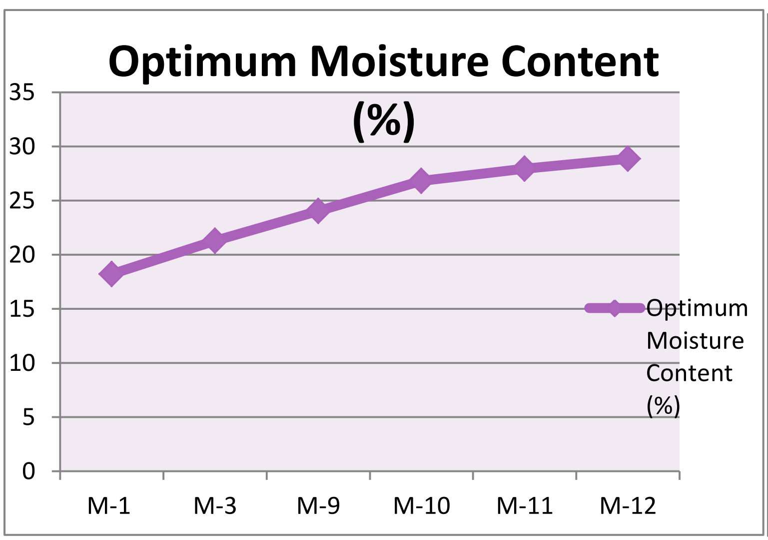
Table 4.5: Maximum Dry Density and Optimum moisture Content

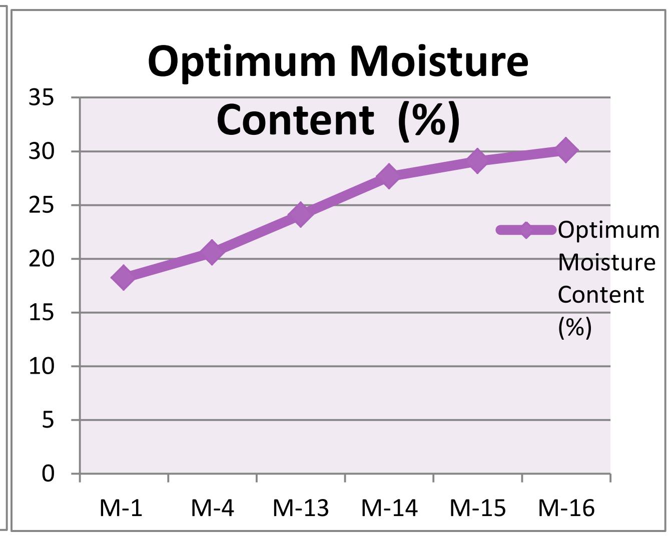
Sr. No	Mix	OMC (%)	MDD (gm/cc)
1.	M-1 (Soil)	18.22	1.88
2.	M-2 (Soil + 10 % Lime)	20.57	1.79
3.	M-3 (Soil + 20 % Lime)	21.29	1.76
4.	M-4 (Soil + 30 % Lime)	22.01	1.73
5.	M-5(Soil + 10 % Lime + 6 % Silico manganese Dust)	22.93	1.65
6.	M-6(Soil +10 % Lime + 12 % Silico manganese Dust)	26.2	1.59
7.	M-7 (Soil + 10 % Lime +18 % Silico manganese Dust)	27.33	1.58
8.	M- (Soil+10 % Lime + 24 % Silico manganese Dust))	28.15	1.56
9.	M-9 (Soil + 20 % Lime + 6 % Silico manganese Dust)	24.05	1.63
10.	M-10 (Soil + 20% Lime + 12 % Silico manganese Dust)	26.82	1.51
11.	M-11 (Soil + 20% Lime + 18 % Silico manganese Dust)	27.94	1.45
12.	M-12 (Soil + 20 % Lime + 24 % Silico manganese Dust)	28.86	1.42
13.	M-13 (Soil + 30 % Lime + 6 % Silico manganese Dust)	24.09	1.56
14.	M-14 (Soil + 30 % Lime +12 % Silico manganese Dust)	27.66	1.51
15.	M-15 (Soil + 30% Lime + 18 % Silico manganese Dust)	29.07	1.49
16.	M-16 (Soil + 30 % Lime + 24 % Silico manganese Dust)	30.09	1.44





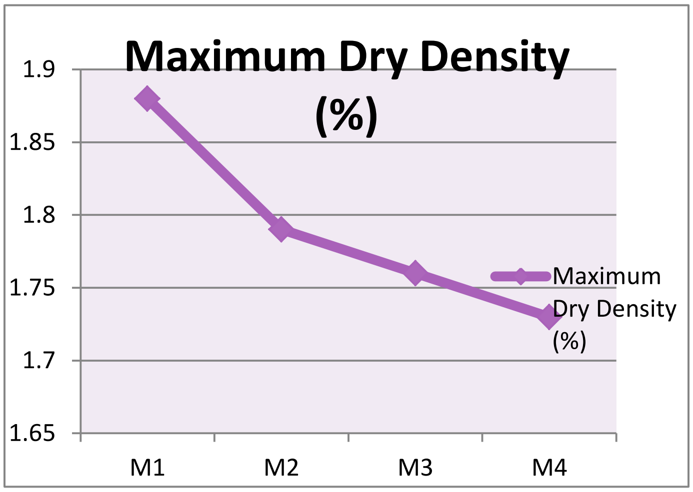
Effect on Optimum Moisture Content by using different proportions of Lime & Effect on Optimum Moisture Content by using different proportions of Silico Manganese Dust with 10 % Lime

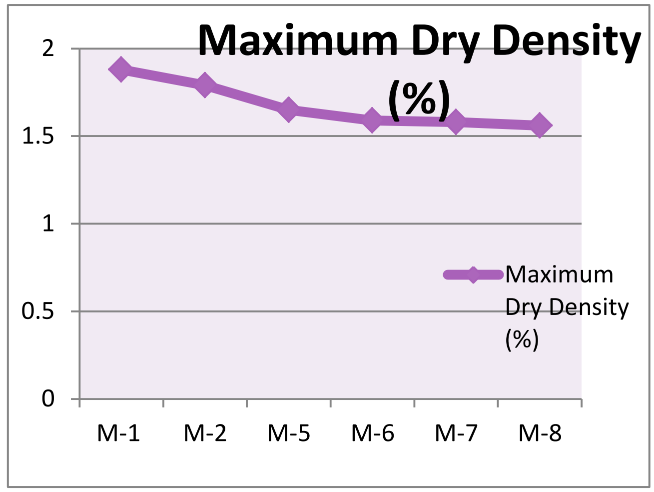




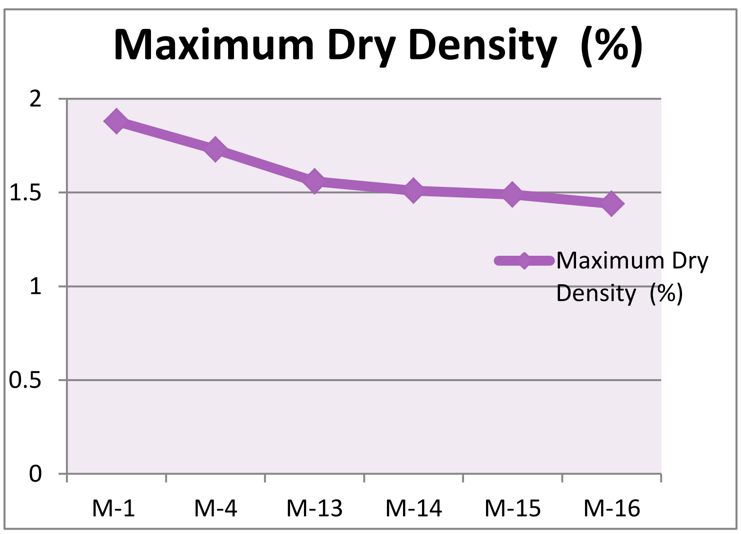
Effect on Optimum Moisture Content by using different proportions of Silico Manganese Dust with 20 % Lime & Effect on Optimum Moisture Content by using different proportions of Silico Manganese Dust with 30 % Lime

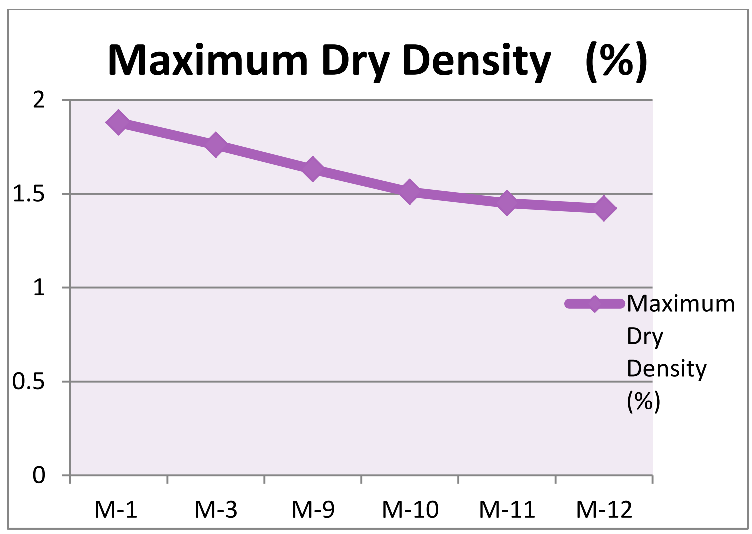
Effect on Maximum Dry Density by using different proportions of Lime & Effect on Maximum Dry





Density by using different proportion of Silico Manganese Dust with 10 % Lime as follows

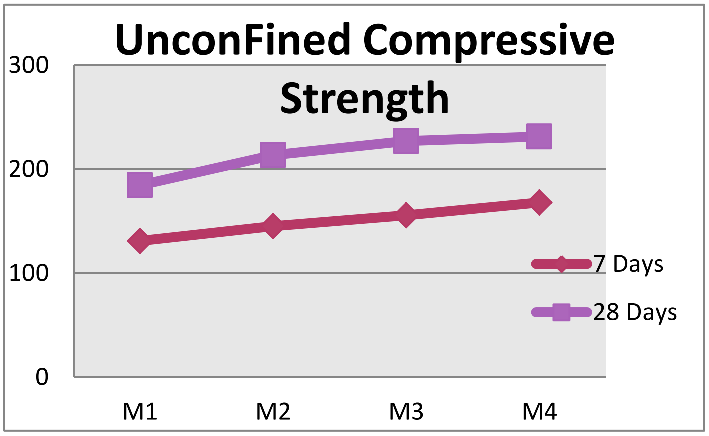


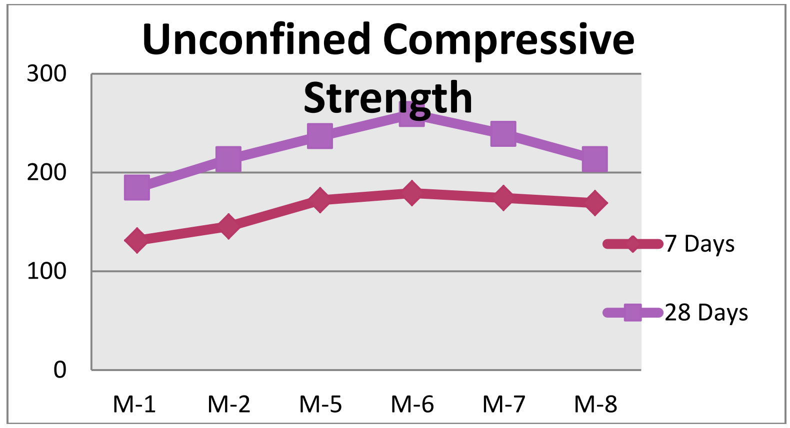


Effect on Maximum Dry Density by using different proportions of Silico Manganese Dust with 20 % Lime & Effect on Maximum Dry Density by using different proportions of Silico Manganese Dust with 30 % Lime

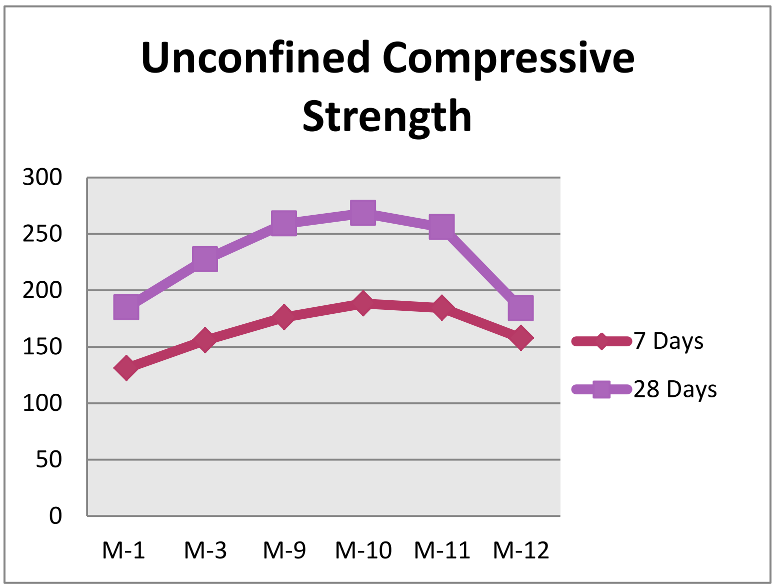
UNCONFINED COMPRESSIVE STRENGTH

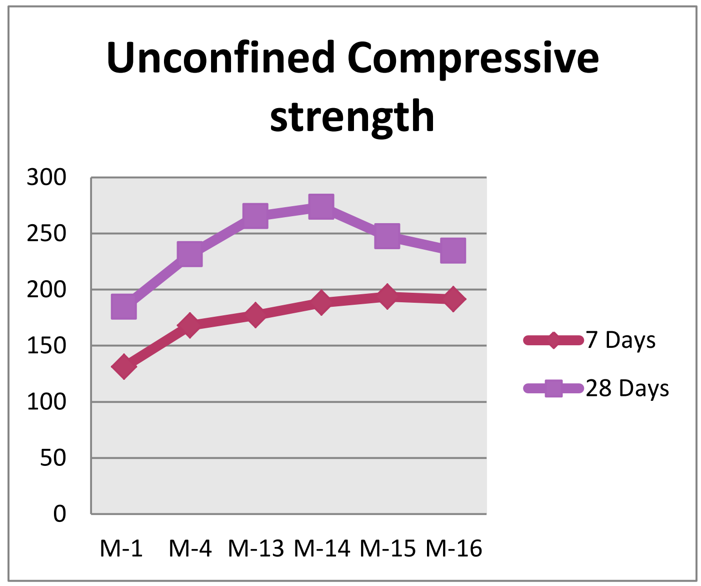
The compressive strength of a soil deposit is the most significant feature to look for since it provides a measurement of the amount of force the deposit can withstand before it gives way. The test was performed on the specimen after it had been wet-cured for a period of seven and twenty-eight days.





Effect on Unconfined Compressive strength by using different proportions of Lime & Effect on Unconfined Compressive strength by using different proportions of Silico Manganese Dust with 10 % Lime





Effect on Unconfined Compressive strength by using different proportions of Silico Manganese Dust with 20 % Lime& Effect on Unconfined Compressive strength by using different proportions of Silico Manganese Dust with 30 % Lime

EFFECT ON CBR

The California bearing ratio is the ratio of force per unit area necessary to penetrate a soil mass with a standard circular piston at the rate of 1.25 mm/min, to a specified extent, for the comparable penetration of a standard material. This ratio is also known as the California bearing ratio.

Table 3: CBR Variation for both soaked and unsoaked

Sr. No	Mix	Unsoaked	Soaked
1.	M-1 (Soil)	2.56	4.27
2.	M-2 (Soil + 10 % Lime)	4.42	6.15
3.	M-3 (Soil + 20 % Lime)	4.69	6.37
4.	M-4 (Soil + 30 % Lime)	5.13	6.60
5.	M-5 (Soil + 10 % Lime + 6 % Silico manganese Dust)	5.33	6.98
6.	M-6 (Soil + 10 % Lime + 12 % Silico manganese Dust)	5.60	7.35
7.	M-7 (Soil + 10 % Lime + 18 % Silico manganese Dust)	6.36	7.83
8.	M-8 (Soil + 10 % Lime + 24 % Silico manganese Dust))	6.69	8.15
9.	M-9 (Soil + 20 % Lime + 6 % Silico manganese Dust)	7.38	9.49
10.	M-10 (Soil + 20 % Lime + 12 % Silico manganese Dust)	8.03	9.23
11.	M-11(Soil + 20% Lime + 18% Silico manganese Dust)	8.40	9.60
12.	M-12 (Soil + 20 % Lime + 24 % Silico manganese Dust)	7.72	9.01
13.	M-13 (Soil + 30 % Lime + 6 % Silico manganese Dust)	7.41	8.84
14.	M-14 (Soil + 30 % Lime + 12 % Silico manganese Dust)	8.06	10.09
15.	M-15 (Soil + 30% Lime + 18 % Silico manganese Dust)	8.42	10.37
16.	M-16 (Soil + 30% Lime + 24 % Silico manganese Dust)	8.76	11.11

Figure 12: Effect on Unconfined Compressive strength by using different proportions of Lime

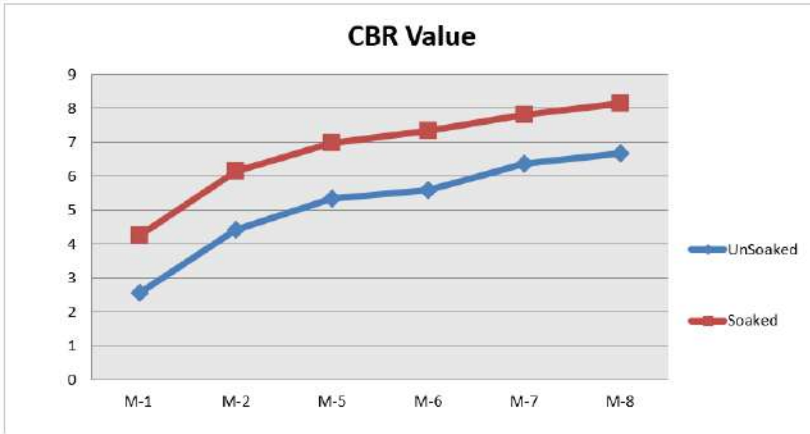


Figure 13: Effect on Unconfined Compressive strength by using different proportions of Silico Manganese Dust with 10 % Lime

Figure 14: Effect on Unconfined Compressive strength by using different proportions of Silico Manganese Dust with 20 % Lime

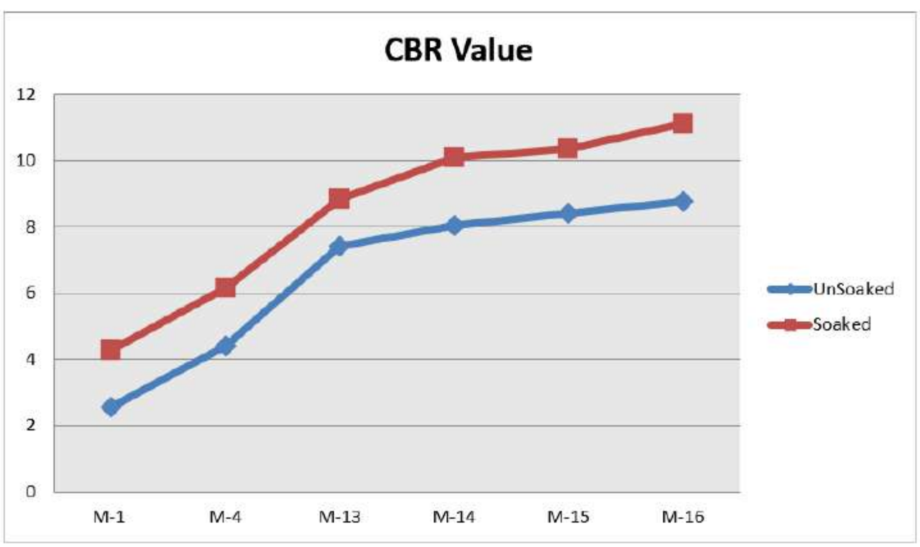


Figure 15: Effect on Unconfined Compressive strength by using different proportions of Silico Manganese Dust with 30 % Lime

CONCLUSION AND FUTURE SCOPE

In the current investigation, the performance of two types of industrial waste was analyzed silico manganese dust and lime. Laboratory research looks on the effects of dust and lime on the consolidation of loose soil. We carried out a number of different tests, including the liquid limit test, the standard proctor test, the unconfined compressive strength test, and the CBR test. Based on the outcomes of these tests, the following conclusions may be drawn:

1. The Mix 15 that contains 30 percent Lime and 18 percent Silico manganese Dust has the highest possible Unconfined Compressive strength.
2. The Mix 16 that contains 30 percent Lime and 24 percent Silico manganese Dust achieves the highest possible CBR.
3. The ideal amount of lime that should be present in the soil is 3 percent, and the ideal amount of silico manganese is 18 percent.
4. The incorporation of silico manganese dust and lime into soil results in an increase in the soil's capacity to hold liquid.
5. The incorporation of lime into the soil results in an increase in the plastic limit of the soil.
6. The increase in the amount of silico manganese dust that is added to the soil causes the plastic limit of the soil to rise.
7. When lime is added to soil, the optimal amount of moisture that may be contained in the soil also rises.
8. Increasing the amount of silica manganese dust and lime in the soil will result in an increase in the optimal moisture content of the soil.
9. An increase in the lime content of soil results in a reduction in the maximum dry density of the soil.
10. An increase in the amount of silico manganese dust and lime in the soil results in a reduction in the maximum dry density.
11. The unconfined compressive strength value of the sub base is increased more than it would be by using conventional procedures when lime and industrial waste mixtures are added to the sub base.
12. The geotechnical properties of yellowish clay soil may be improved by using lime as a stabilizer, and lime is employed for this purpose. The yellowish clay Soil that was studied had index qualities, compaction characteristics, and strength characteristics that were greatly improved when lime was added. The amount of lime that is combined into the study of yellowish clay soil has an influence on the outcomes of the lime treatment, which might vary from one instance to the next.
13. It would seem from the findings that loose soil may be efficiently stabilized with the addition of silico manganese dust and lime.
14. It is possible to draw the following conclusion from the review articles that were addressed earlier: industrial wastes have the potential to effectively and economically stabilize costly or soft soil.

6. Utilizing these wastes as a soil stabilizer in a manner that is both environmentally benign and economically efficient is one strategy to lower the risk of environmental risks.
7. Silico-manganese slag is a substance with a coarse grain that is not deformable and is largely composed of particles the size of sand.

FUTURE SCOPE

In the process of soil stabilization utilizing silico manganese dust, the effects of variation on CBR value and UCC value have been examined. Additional studies may be conducted to investigate the effects of silico-manganese dust on things like the free swell index, direct shear test, and permeability test, among other things.

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