International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 03 | Mar 2019 www.irjet.net p-ISSN: 2395-0072

Stabilization of Soil by using Limestone Powder

Bhanu Sri Routhu[1]

[1]*Assistant Professor, Department of Civil Engineering, Aurora's Engineering College, Telangana, India.*

Abstract – *The engineering properties of laterite soil for construction purposes will usually not have the sufficient properties as per the measures required for the construction. To increase the property of soil stability, we are mostly adopting combination of various waste materials. In this project I've taken limestone powder as a substitute to improve the soil stability. The geotechnical properties of lateritic soils when untreated and when treated with various percentages of limestone powder are found out. Various tests like Particle size analysis, Atterberg limits, Compaction Test, and California bearing Ratio (CBR) were performed to find the strength characteristics. In this investigation I've added various proportions of limestone powder to Mooram soil and Yellow soil to find out the variation in strength characteristics.*

Key Words: Engineering properties, soil stability, soils, limestone powder, Atterberg limits, compaction test, CBR Test, Stability and strength.

1. INTRODUCTION

Project sites are usually located in areas with soft or weak soils. Soft soils shows high plasticity characteristics, low shear strength properties and high swell shrinkage characteristics. Depending on the nature of the project the design solution may involve the expensive option of removal and replacement of the weak or compressible soils.

The replacement options usually include use of crushed rock, gravel or lightweight aggregates. Other options involve using ground improvement alternatives such as stone columns, grouting, wick drains and chemical admixtures such as cement or lime. Among them, one of the most effective and economical method is to use chemical additives. The processing of limestone results in approximately twenty percentage limestone dust (LSD) waste and this also require a large area of landfill for the disposal. Therefore it is better to utilize such type of waste materials as additives for soil stabilization to protect the environment. The main objective of soil stabilization is not only to improve the strength and stability of soil but also to lower the construction cost.

The main objective of the present project is to study the improvement in geotechnical properties of stabilized expansive soil treated with fly ash and lime stone dust. It includes:

- To study the basic properties of the chosen soils, lime stone dust/powder.
- To study the compaction and strength characteristics of both soils.
- To study the effect of different amounts of lime stone dust added to low grade yellow soil
- To find out the optimum quantity of lime stone dust by weight added to the soil where it shows the higher strength

2. LITERATURE REVIEW

Rathan Raj (2007) has made investigation on soil stabilization using rice husk ash(RHA). The proportions of 5%, 10%, 20%, 30%, 40%, 50% and 80% of rice husk ash were used. He found out liquid limit reduced from 57% to 30.5% for soil+80% RHA for alluvial soil and reduced from 60% to 26.5% for soil+80% of RHA for clay soil.

Aqeel Al Adili, Rafig et.al (2011) tried to find out soil strength with the addition of papyrus. They found out the stiffness of the soil increased considerably due to the fiber inclusion.

Laxmi Kant saini, Uendra singh et. al,(2014) investigated on engineering properties of black cotton soil using lime. They found increase in CBR values and decrease in plasticity index. The plastic nature of soil decreases and the stiffness of the soil improve as the lime content increases.

Naman Agarwal (2016) investigated on effect of stone dust on the geotechnical properties of soil. He found that adding 50% of stone dust is effective in decreasing optimum moisture content and adding 30% of stone dust is found to increase CBR value by nearly 50%.

Anu K, Rupesh Yadav et.al has treated soft clay with fly ash and lime stone dust. They found that the Atterberg limits increased due to addition of fly ash and limestone dust. The dry density and compaction characteristics also increased around 3% to 5%.

3. EXPERIMENTAL INVESTIGATION

Two types of soils were chosen for the investigation. First one was locally available Mooram Soil (Red Soil) and the second one was Low grade soil (Yellow Soil) which was taken from the nearby open lands. In order to find out the strength characteristics of these soils various laboratory test like Liquid Limit, Plastic Limit, Compaction Test and CBR Test were conducted.

Initially, these properties were found out with the plain soils. Later 5%, 10% and 15% of limestone powder was added to these soils to compare the strength parameters.

Fig- 1: Yellow Soil and Mooram Soil

Fig-2: Liquid Limit, Plastic Limit Apparatus

Fig-3: Compaction Test

Fig-4: CBR Test

Table-1: Tests on Mooram soil

S.No	Test	Sample	Value	Average Values
1	Liquid Limit	1	11.11	14.99
		2	22.22	
		3	11.66	
2	Plastic Limit	1	100	116.67
		2	150	
		3	100	
3	Compaction Test	1	2.04	2.08
		2	2.15	
		3	2.07	
4	CBR Test	2.5 mm	4.5	4.5
		5 mm	5.8	5.8

Table-2: Tests on Mooram soils with 5% Limestone powder

S.No	Test	Sample	Value	Average Values
1	Liquid Limit	1	16.6	19.89
		2	20	
		3	23.07	
2	Plastic Limit	1	50	61.11
		2	63.33	
		3	70	
3	Compaction Test	1	1.694	1.69
		2	1.79	
		3	1.60	
4	CBR Test	2.5 mm	5.1	5.1
		5 mm	5.9	5.9

Table-3: Tests on Mooram Soils with 10% Limestone Powder

S.No	Test	Sample	Value	Average Values
1	Liquid Limit	1	25	26.19
		2	28.57	
		3	25	
2	Plastic Limit	1	100	100
		2	100	
		3	100	
3	Compaction Test	1	1.88	1.94
		2	1.926	
		3	2.027	
4	CBR Test	2.5 mm	5.78	5.78
		5 mm	6.68	6.68

Table-4: Tests on Mooram Soil with 15% Limestone Powder

S.No	Test	Sample	Value	Average Values
1	Liquid Limit	1	40	58.88
		2	66.66	
		3	70	
2	Plastic Limit	1	100	100
		2	100	
		3	100	
3	Compaction Test	1	2.016	2.02
		2	2.014	
		3	2.03	
4	CBR Test	2.5 mm	6.29	6.29
		5 mm	7.02	7.02

Table-5: Tests on Low grade soil (Yellow Soil)

S.No	Test	Sample	Value	Average Values
1	Liquid Limit	1	33.33	36.59
		2	36.33	
		3	40.12	
2	Plastic Limit	1	50	56.67
		2	50	
		3	70	
3	Compaction Test	1	1.727	1.70
		2	1.8	
		3	1.59	
4	CBR Test	2.5mm	3.2	3.2
		5 mm	3.8	3.8

Table-6: Tests on Low grade soil (Yellow Soil) with 5% Limestone powder

S.No	Test	Sample	Value	Average Values
1	Liquid Limit	1	40.5	60.38
		2	60.66	
		3	80	
2	Plastic Limit	1	70	80
		2	70	
		3	100	
3	Compaction Test	1	1.74	1.8
		2	1.89	
		3	1.77	
4	CBR Test	2.5mm	3.59	3.59
		5 mm	4.28	4.28

Table-7: Tests on Low grade soil (Yellow Soil) with 10% Limestone powder

S.No	Test	Sample	Value	Average Values
1	Liquid Limit	1	65.5	70.16
		2	69.8	
		3	75.2	
2	Plastic Limit	1	100	100
		2	100	
		3	100	
3	Compaction Test	1	1.826	1.86
		2	1.83	
		3	1.909	
4	CBR Test	2.5mm	4.11	4.11
		5 mm	4.62	4.62

Table-8: Tests on Low grade soil (Yellow Soil) with 15% Limestone powder

S.No	Test	Sample	Value	Average Values
1	Liquid Limit	1	73.5	73.53
		2	71.8	
		3	75.3	
2	Plastic Limit	1	100	116.67
		2	100	
		3	150	
3	Compaction Test	1	1.97	1.947
		2	1.91	
		3	1.961	
4	CBR Test	2.5mm	5.13	5.13
		5 mm	4.96	4.96

4. EXPERIMENTAL RESULTS

The following results were observed from the conducted tests and initially though the strength remained normal, later as the percentage of limestone increased, an increase in strength was observed.

Low grade soil (Yellow soil) showed increase in strength with every proportional increase (i.e., 5%, 10%, 15%) of limestone powder. From the charts 3 and 4 it can be clearly understood that limestone powder helps in increasing the strength of low grade, low strength soils.

Table-9: Test Results for Mooram soil

S.No	Proportion	Liquid Limit	Plastic Limit	Compaction Test
1	Nominal	14.99	116.67	2.08
2	Nominal + 5% Limestone Powder	19.89	61.11	1.69
3	Nominal + 10% Limestone Powder	26.19	100	1.94
4	Nominal + 15% Limestone Powder	58.88	100	2.02

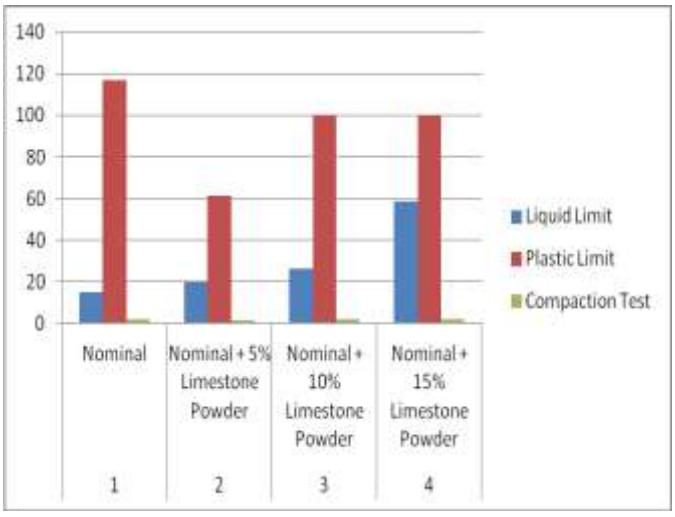

Chart-1: Liquid Limit, Plastic Limit and Compaction Test Results of Mooram Soil for various proportions of Limestone Powder

Table-10: CBR Test Results for Mooram Soil

S.No	Proportion	2.5 mm	5 mm
1	Nominal	4.5	5.8
2	Nominal + 5% Limestone Powder	5.1	5.9
3	Nominal + 10% Limestone Powder	5.78	6.68
4	Nominal + 15% Limestone Powder	6.29	7.02

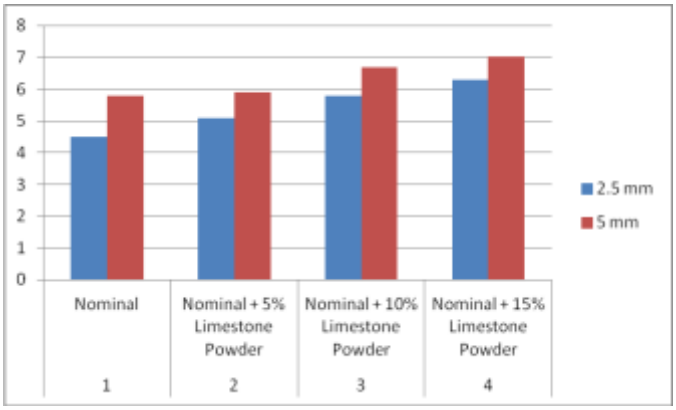

Chart-2: CBR Values for Mooram Soil with various proportions of Limestone powder

Table-11: Test Results for Low Grade Soil (Yellow Soil)

S.No	Proportion	Liquid Limit	Plastic Limit	Compaction Test
1	Nominal	36.59	56.67	1.70
2	Nominal + 5% Limestone Powder	60.38	80	1.80
3	Nominal + 10% Limestone Powder	70.16	100	1.86
4	Nominal + 15% Limestone Powder	73.53	116.67	1.947

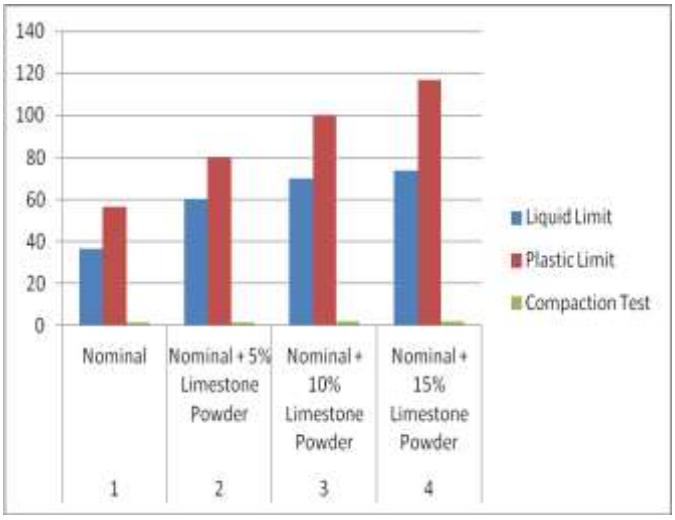

Chart-3: Liquid Limit, Plastic Limit and Compaction Test Results of Yellow Soil for various proportions of Limestone Powder

Table-12: CBR Test Results for Low Grade Soil (Yellow Soil)

S.No	Proportion	2.5 mm	5 mm
1	Nominal	3.2	3.8
2	Nominal + 5% Limestone Powder	3.59	4.28
3	Nominal + 10% Limestone Powder	4.11	4.62
4	Nominal + 15% Limestone Powder	5.13	4.96

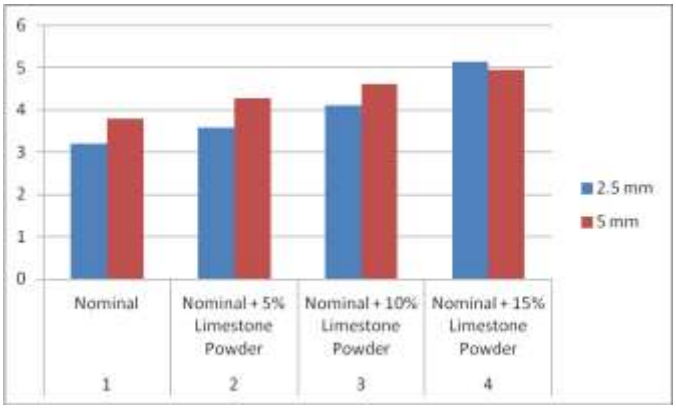

Chart-4: CBR Values for Yellow Soil with various proportions of Limestone powder

5. CONCLUSIONS

- Limestone powder is a waste material whose exposure to the atmosphere causes pollution. From the investigation it has been observed that, use of limestone powder increases the bearing capacity and strength of soils.
- With every 5% increase of limestone powder, there was an increase in the soil strength.
- In this investigation, addition of 15% limestone powder to the soils, showed the highest value of CBR i.e., bearing capacity. Therefore, further tests can be done with additional increase of limestone powder to know the maximum limit.
- In order to reduce pollution and increase the soil bearing capacity limestone powder can be preferred among the waste products available.
- Keeping in view the extinction of natural resources and environmental pollution, I've made an attempt to use limestone powder in soil which gave positive results.

REFERENCES

[1] Akbulut S. and Arasan S, "The Variations of Cation Exchange Capacity (*CEC*), pH and Zeta Potential in Expansive Soils Treated by Additives." International Journal of Civil and Structural Engineering, 2010, 1 (2), 139-154.

[2] Amu O.O., Bamisaye O.F., and Komolafe I.A., "The Suitability and Lime Stabilization Requirement of Some Lateritic Soil Samples as Pavement." International Journal of Pure and Applied Sciences and Technology, 2011, 2(1), 29-46.

[3] R. Bairwa, A.K. Saxena and T.R. Arora, "Effect of Lime and fly ash on Engineering Properties of Black Cotton soil." International Journal of Emerging Technology and Advanced Engineering, 2013, 3 (11), 535-541.

[4] Dash S.K. and Hussain M, "Lime Stabilization of Soils: Reappraisal." Journal of Materials in Civil Engineering, 2012, 24 (6), 707–714.

[5] M Davoudi and E Kabir. "Interaction of Lime and sodium chloride in low plasticity fine grain soils," Journal of Applied sciences, 2011, 11 (2), 330-335

[6] Kaur P. and Singh G, "Soil Improvement with Lime," International Organization of Scientific Research Journal of Mechanical and Civil Engineering, 2007, 1 (1), 51-53.

[7] Mitchell J.K and Soga K , "Fundamentals of Soil Behavior," 3rd Edition, John Wiley and Sons Inc., New York, 2005.