Stabilization of Subgrade Soil for Flexible Pavements Using Calcium Lignosulfonate and Granite Dust

P Chandrani[1], N Balaji[2], V Abhiram[3], Ch Anil[4], K Naresh[5]
[1,2,3,4]PG Student, PBR Visvodaya Institute of Technology and Science, Kavali
[5]assistant Professor, PBR Visvodaya Institute of Technology and Science, Kavali

***Abstract*— Soil forms the fundamental base for all civil engineering structures and must possess adequate strength to safely support the loads imposed upon it. However, in many locations the naturally available soil is weak and incapable of resisting these loads effectively, which may lead to settlement or structural failure. In such situations, soil stabilization becomes necessary to improve the engineering properties of the soil. Various soil stabilization techniques have been reported in the literature, including chemical stabilization and lime stabilization. However, some of these methods may adversely alter the chemical composition of the soil and may not always be environmentally suitable.**

In the present experimental study, clay soil samples were tested both without additives and with additives to evaluate their engineering characteristics. Laboratory tests were conducted to determine the Optimum Moisture Content (OMC), Maximum Dry Density (MDD), California Bearing Ratio (CBR), and Plasticity Index (PI). The results obtained from these tests were used to assess the improvement in soil properties due to stabilization.

***Index Terms*— Soil Stabilization, Clay Soil, Subgrade Improvement, Bitumen Emulsion, Optimum Moisture Content (OMC), Maximum Dry Density (MDD), California Bearing Ratio (CBR), Plasticity Index (PI).**

I INTRODUCTION

1.1 General

Transport in the Republic of India is an important part of the nation's economy. Roads are the vital lifelines of the economy making possible trade and commerce. They are the most preferred modes of transportation and considered as one of the cost-effective modes. An efficient and well-established network of roads is desired for promoting trade and commerce in any country and fulfills the needs of a sound transportation system for sustained economic development. To provide mobility and accessibility, all weather roads should connect every nook and corner of the country. To sustain both static and dynamic load, the pavement should be designed and constructed with utmost care. The performance of the pavement depends on the quality of materials used in road construction. Sub grade is the in-situ material upon which the pavement structure is placed. Although there is a tendency to look at pavement performance in terms of pavement structures and mix design alone, the subgrade soils can often be the overriding factor in pavement performance.

1.2 Scope of the project

1. To collect a particular soil sample and determine its basic physical property such as LL, PL, PI and grain size distribution
2. To study the soil under Standard proctor compaction and determine the MDD and OMC for the soil sample.
3. To carry out CBR Test for sample

1.3 Objectives of the project

The major objectives of the project are: To study the suitability of calcium lignosulfonate and Granite dust as a stabilizing material to improve the subgrade performance.

To evaluate the strength characteristics of local soil blended with different proportions of Calcium lignosulfonate and Granite dust.

II. LITERATURE REVIEWS

Geethu Vijayan et al (2019) studied the Stabilization of Clayey soil by exploitation Lignosulfonate. during this literature review clayey soil are going to be stable. They are various tests are conducted Standard compaction test, Unconfined compressive strength,C.B.R and Atterberg limits. The optimum wet are going to be decrease with addition of Lignosulfonate, Maximum dry density increase with addition of Lignosulfonate. And shear strength properties increase adidition of Lignosulfonate and Liquid limit decrease and Plastic limit increase with the addition of Lignosulfonate.

III. MATERIALS AND METHODOLOGY

In this chapter, a brief review of various experiments conducted using clay and the same stabilized with Calcium lignosulfonate and Granite dust are explained.

3.1 Materials

3.1.1 Clayey soil

In this study, clayey soil was collected from Kavali located in Andhra Pradesh, India. All natural soil samples were oven dried, crushed and sieved through 425 µ sieve prior to experimentation. The various geotechnical properties of the procured soil are as follows:

Fig 3.1 clayey soil

Table 3.1 Properties of Untreated Soil

Soil Property	Value
Grain size distribution (%) Fines Sand Gravel	68 24.8 7.2
Consistency limits (%) Liquid limit Plastic limit Plasticity index	60 42 18
Engineering Properties IS Standerd compaction. MDD (g/cc) OMC (%) CBR (%) @2.5mm	1.769 16 2.1

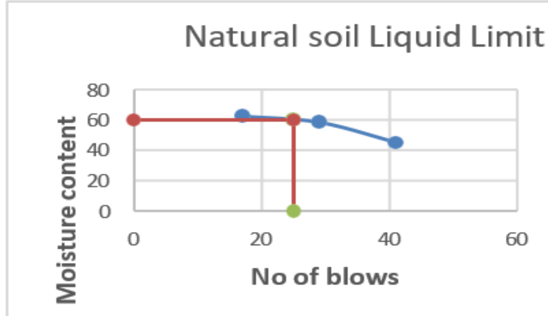


Fig 3.1 Liquid limit for Natural soil

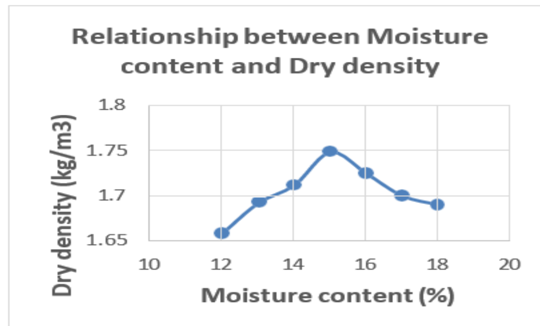


Fig 3.2 MDD & OMC for Natural soil

3.1.2 Calcium lignosulfonate

Lignosulfonate may be a polymer based mostly compound stabilizer derived as a waste by- product from wood/paper trade. Lignosulfonate has shown a promising prospect as a stabilizing agent particularly for soft soils. The main benefits of lignosulfonate over ancient stabilizers are non-toxicity and non-corrosiveness.

Fig 3.2 Calcium lignosulfonate

3.1.3 Granite dust

The granite waste may be a by-product created in granite factories whereas cutting vast granite rocks to the specified shapes. regarding 3000 MT of granite waste is created per day as a by-product throughout producing of granite tiles and slabs from the raw blocks. Economic means of stabilization as a result of granite that is out there in large quantity from granite industries. The properties of waste rely upon the granite from that it's taken.

Fig 3.4 Granite dust

Fig 3.5 Change in the particle gradation of clay soil with addition of granite

3.2 Methodology

3.3 Experimental procedure

All the tests are conducted as per IS Classifications.

- Grain size Analysis of soil: IS 2720(Part 4)- 1975
- Liquid & Plastic limit test: IS 2720 (Part 5) – 1970
- Compaction test: IS 2720 (Part 7) – 1965
- California bearing ratio test: IS 2720 (Part 16) – 1979

lignosulfonate and granite dust are limited in literature. In this Chapter, a series of experiments have been done to study the effect of the additives such as Calcium lignosulfonate and Granite dust are added in soil. There are many tests are done like geotechnical properties such as Compaction Characteristics, CBR.

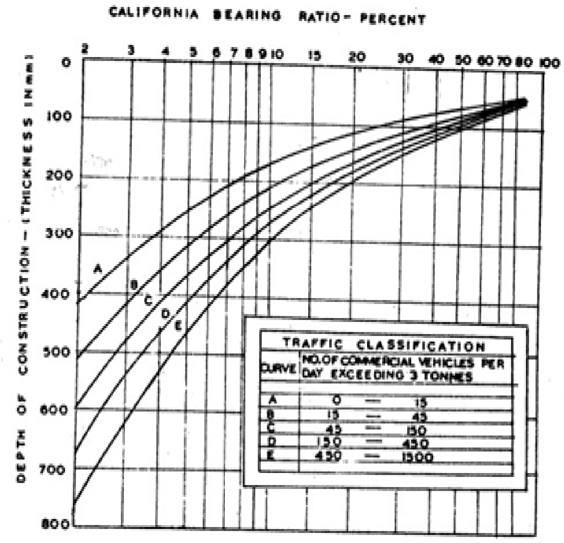
CBR corresponding to 2.5mm penetration = 2.1% Assume, Average Daily Traffic (ADT) = 250 Annual rate of growth of traffic (r) = 5%

Time taken for pavement construction (n) = 1 year No. of vehicles for design (A) = P (1 + r) (n + 10)

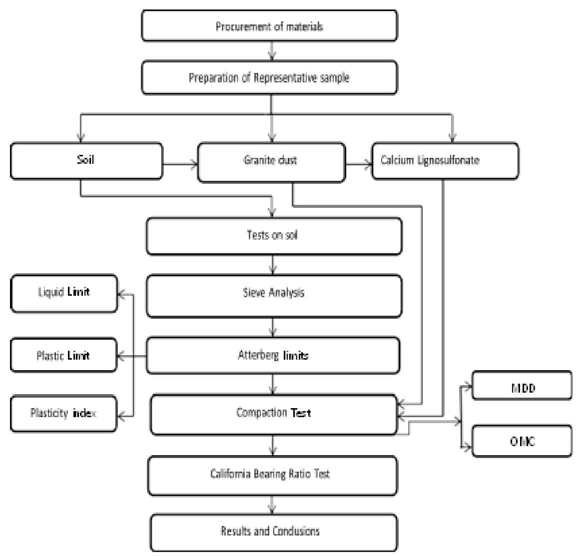
= 250(1 +5/100) (1 + 10)

= 427.58 vehicles/day

= 430 vehicles/day



CBR Curves for Flexible Pavement Design



IV. RESULTS AND DISCUSSIONS

4.1 Introduction

4.4.6 CBR Test of soil stabilization with 20% GD penetration is 2.1 and the thickness of pavement can be The CBR test is done as per IS: 2720 Part XVI- 1979 on found out by using the design formula given below. the soil. In this experiment we have taken soil + 20% GD. The standard load (PS) corresponding to 2.5mm penetration of the plunger into the standard sample is reported to be 1370 kg and 5mm penetration it was found to be 2055kg. In this proportion 2.5mm penetration value is 2.8% and 5mm penetration is 2.4% hence it is accepted.

V. DESIGN OF FLEXIBLE PAVEMENT BY CBR METHOD

Content (%)	MDD (g/cc)	OMC (%)
Soil+1CLS+10GD	2.05	13.6
Soil+1CLS+15GD	2.07	12
Soil+1CLS+20GD	2.12	10.8
Soil+2CLS+10GD	2.15	10
Soil+2CLS+15GD	2.17	9.7
Soil+2CLS+20GD	2.23	8.3
Soil+3CLS+10GD	2.26	8
Soil+3CLS+15GD	2.3	7.7
Soil+3CLS+20GD	2.33	7.4

Sample 1:

The CBR value of Natural subgrade soil @2.5mm
CBR corresponding to 2.5mm penetration = 2.1% Assume, Average Daily Traffic (ADT) = 250 Annual rate of growth of traffic (r) = 5%
Time taken for pavement construction (n) = 1 year No. of vehicles for design (A) = P (1 + r) (n + 10)
= 250(1 +5/100) (1 + 10)
= 427.58 vehicles/day
= 430 vehicles/day

Thus 580 mm of pavement materials is required to cover
the natural soil subgrade having 2.1% CBR value. Sample:2
The CBR value of Natural subgrade soil+3% Calcium lignosulfonate+20% Granite dust @2.5mm penetration is
3.98 and the thickness of pavement can be found out by using the design formula given below.
CBR corresponding to 2.5mm penetration = 3.98%

VI. CONCLUSIONS

Based on the results obtained and comparisons made in the present study, the following conclusions can be drawn:

- The chosen soil is clayey soil with fines 68% which is not suitable for construction activities, so it is required to be stabilized.
- The plasticity index of soil at natural state is 18%, by the addition of CLS it decreases due to it is non cohesive nature and the same is observed in Granite Dust also.
- MDD values increases by the addition of CLS and GD because the water holding capacity of the soil decreases due to its non-cohesive nature and there by results in the decrease of OMC

REFERENCE

[1] R. Chavali and B. Reshmarani, “Characterization of expansive soils treated with lignosulfonate,” International Journal of Geo-Engineering, vol. 11, no. 1, 2020.

[2] D. Alazigha, B. Indraratna, J. Vinod, and L. Ezeajugh, “The swelling behaviour of lignosulfonate-treated expansive soil,” Proceedings of the Institution of Civil Engineers – Ground Improvement, vol. 169, no. 3, pp. 182–193, 2016.

[3] D. Alazigha, B. Indraratna, J. Vinod, and A. Heitor, “Mechanisms of stabilization of expansive soil with lignosulfonate admixture,” Transportation Geotechnics, vol. 14, pp. 81–92, 2018.

[4] R. Au, P. Bj, and J. K, “Experimental investigation of lateritic soil treated with calcium lignosulfonate,” in Proc. Indian Geotechnical Conf., 2017, pp. 14–16.

[5] S. B. S. and S. Y., “Stabilization of Kuttanad soil using calcium and sodium lignin compounds,” International Journal for Research in Applied Science and Engineering Technology, vol. 6, no. 2, pp. 580–586, 2018.