

Enhancing Flexible Pavement Performance with Calcium Lignosulfonate and Granite Dust

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Abstract— Soil is the foundation for any civil engineering structures. It is required to bear the loads without failure. In some places, soil may be weak and cannot resist the oncoming loads. In such cases, soil stabilization is needed. Numerous methods are available in the literature for soil stabilization. But sometimes, some of the methods like chemical stabilization; lime stabilization etc. adversely affects the chemical composition of the soil.

In this test program, without additives and with additives clay was tested to find the optimum moisture content, Maximum dry density, CBR value, plasticity index.

Index Terms— Subgrade, Stabilization, Soil, Calcium lignosulfonate, Granite dust, CBR

1. 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.

2. 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 addition of Lignosulfonate and Liquid limit decrease and Plastic limit increase with the addition of Lignosulfonate.

3. 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	68
Sand Gravel	24.8
	7.2
Consistency limits (%) Liquid limit	60
Plastic limit Plasticity index	42
	18
Engineering Properties IS Standard compaction. MDD (g/cc)	1.769
OMC (%)	16
CBR (%) @2.5mm	2.1

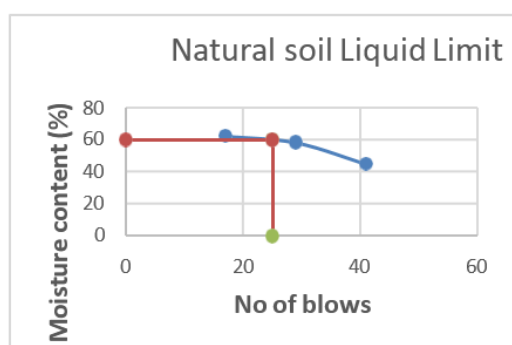


Fig 3.1 Liquid limit for Natural soil

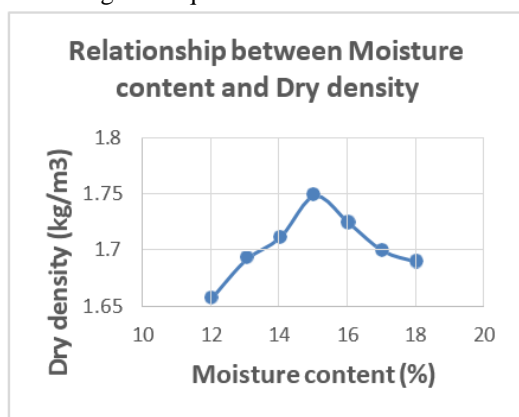


Fig 3.2 MDD & OMC for Natural soil

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

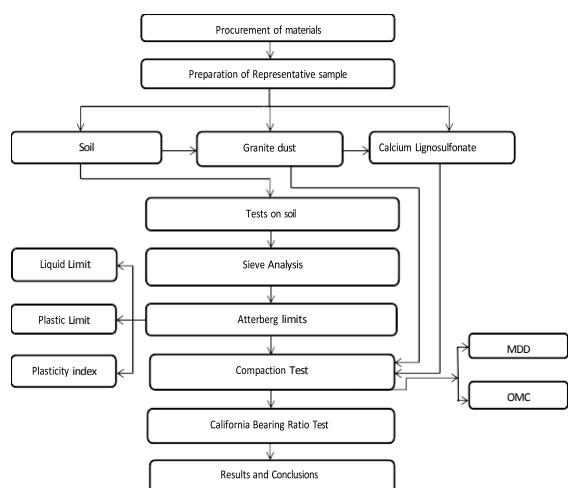
All the tests are conducted as per IS Classifications.

- 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.

Mechanism of granite dust:

- When the granite dust is added to a soil, dust particles will fill the missing sizes in the soil and turns the gradation of the curve to a well graded mix.



4. RESULTS AND DISCUSSIONS

4.1 Introduction

Several studies have been done on the engineering properties of the soil but the studies on Calcium

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.

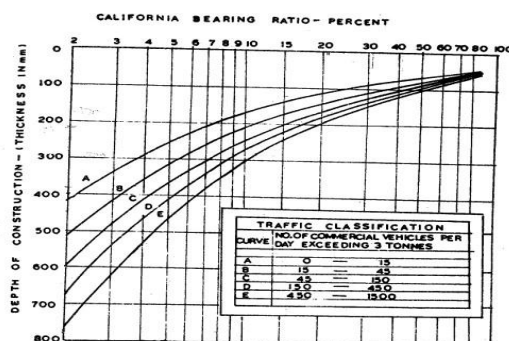
The soil. In this experiment we have taken soil + 20% GD. The standard load (PS) corresponding to 2.5mm penetration of the plunger into the standard sample is reported to be 1370 kg and 5mm penetration it was found to be 2055kg. In this proportion 2.5mm penetration value is 2.8% and 5mm penetration is 2.4% hence it is accepted.

5. 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



CBR Curves for Flexible Pavement Design

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% 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

Thus 460 mm of pavement materials is required to cover the natural soil+3% Calcium

lignosulfonate+20% Granite dust subgrade having
3.98% CBR

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

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