Stabilization of Clay Soil using Secondary Lime and Rubber tyre Powder

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Abstract - *In our project work, the possibility of using secondary lime & rubber tyre powder as an additive in clay soil was investigated. As the tyres are manufactured with synthetic rubber, disposal of wastes from the rubber tyre become difficult. It was approximately estimated that 60-70% of waste tyres are disposed in various areas. To avoid these wastes accumulation, usage of rubber tyre powder as soil stabilizing agent is experimentally studied. In the present investigation, a secondary lime was added into the soil at five different percentages like 5%, 10%, 15%, 20% & 25%. The geotechnical properties of stabilized soil are increased by increasing percentage of secondary lime up to 20%. Then addition of rubber tyre powder in the soil shows desirable changes in strength. The rubber tyre powder was added into the soil at various percentages like 3%, 6%, 9%, 12% & 15% by weight of the soil along with 20% of secondary lime. The addition of 12% of rubber tyre powder and 20%of secondary lime by the weight of soil shows the gradual improvement in strength of clayey soil.*

Key Words: **Stabilization, Clay Soil, Secondary lime, Rubber tyre powder, Soil**

1. INTRODUCTION

The Clay often is weak and has no enough stability in heavy loading. In this regard, it is necessary to stabilize the soil. Stabilization in a broad sense incorporates the various methods employed for modifying the properties of a soil to improve its engineering performance. Stabilization is being used for a variety of engineering works, the most common application being in the construction of road and airfield pavements.

The main objective of soil stabilization is to increase the strength (or) stability of soil and to reduce the construction costs by making best use of locally available materials. Stabilization is process of fundamentally changing the chemical properties of soft soils by adding stabilizers, either in wet (or) dry conditions to increase the strength of the originally weak soils.

Soil stabilization is a way of improving the bearing capacity of clayey soil. The prime objective of soil stabilization is to improve the unconfined compressive strength of the clayey soil.

1.1 Objective

- To investigate the impact of addition of secondary lime and rubber tyre powder on soil properties, in terms of the following parameter:
  - Maximum Dry density
  - Optimum moisture Content
  - Unconfined Compressive value
- To identify the Optimum percentage of additives in Soil, so as it improves the Geotechnical property of soil.

1.2 Materials

Clay Soil

Clay is a finely grained natural rock or soil material that combines one or more clay minerals with traces of metal oxides and organic matter. Geologic clay deposits are mostly composed of phyllosilicate minerals containing variable amounts of water trapped in the mineral structures.

Secondary Lime

Lime is calcium containing inorganic material in which carbonates, oxides and hydroxides predominate. Secondary lime is the byproduct obtained during production of quick lime. The Secondary lime consisting of calcium oxide, which is obtained by roasting limestone.

Rubber Tyre Powder

Tyre wastes can be used as light weight material either in the form of powder, chips, shredded and as a whole. Applications of tyre powder proven to be effective in protecting the environmental and conserving natural resources. The rubber tyre powder is low cost and effective to soil stabilization.

1.3 Methodology

The Soil sample used for this study was collected and the preliminary tests were conducted to find the geotechnical properties. Clay soil is also mixed with Secondary lime and Rubber tyre powder in different proportions and the tests were carried out to find the optimum percentage of additives to soil.

2. PROPERTY TESTS

The tests performed are:

- Sieve Analysis
- Specific Gravity
- Atterberg's limits
- Standard Proctor test
- Unconfined Compression test

Sieve Analysis

Chart 1 shows the particle size distribution of clay soil sample. For the collected clay soil sample, the coefficient of uniformity and coefficient of curvature is found to be 4 and 0.79 respectively.

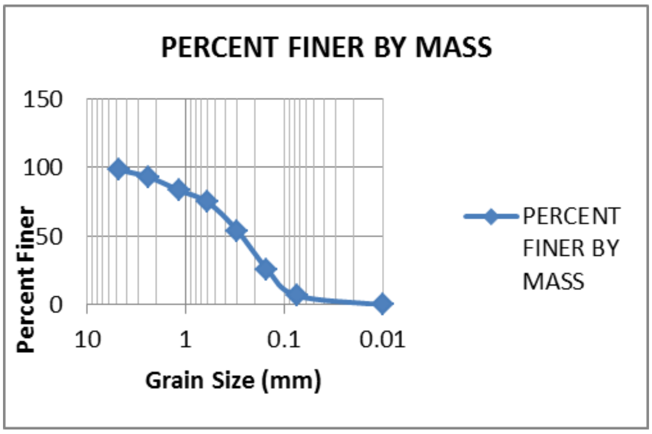

Chart -1: Particle Size Distribution

Specific Gravity

The Specific gravity of Clay soil, Secondary lime and Rubber tyre powder is found by pycnometer method and their values are shown in Table 1.

Table -1: Specific Gravity

Material	Specific Gravity
Clay Soil	2.02
Secondary Lime (SL)	2.14
Rubber Tyre Powder (RTP)	1.68

Liquid Limit

Liquid limit is the minimum water content at which the soil completely changes to liquid state. The observation for Clay soil is noted and graph is plotted between the water content and number of blows, the moisture content corresponding to 25 blows will give the liquid limit.

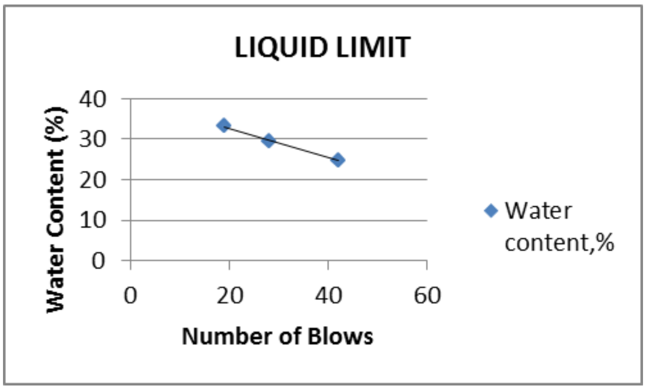

Chart -2: Liquid Limit

From Chart 2, the liquid limit of the clay soil is found to be 29.25 %.

Plastic Limit

Plastic limit is the minimum water content at which the soil will just begin to crumble when rolled into a thread approximately 3mm in diameter. The plastic limit for the clay soil is found to be 23.45 %.

Compaction Properties

The Standard Proctor Test (SPT) was performed to determine the compaction properties of soil i.e., to find the optimum moisture content (OMC) and maximum dry density of soil (MDD). The test results are shown in Chart 3.

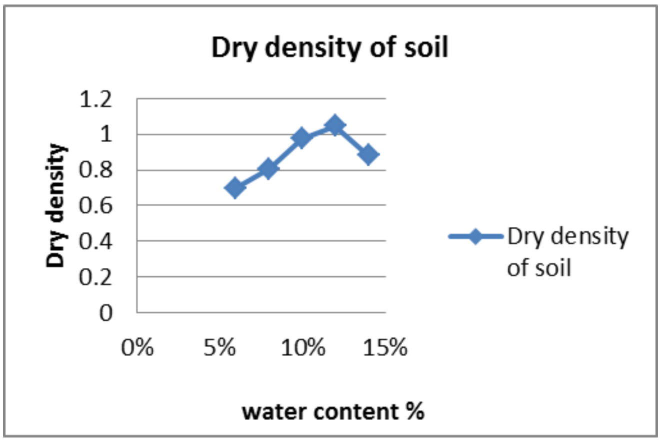

Chart -3: Compaction curve

From Chart 3, the Optimum Moisture content and Maximum Dry density of the soil is found to be 12 % and 1.048 g/cm^3.

Unconfined Compressive Strength

Chart 4 shows the Unconfined Compressive (UCC) strength of clay soil and it is found to be 3.255 kg/cm².

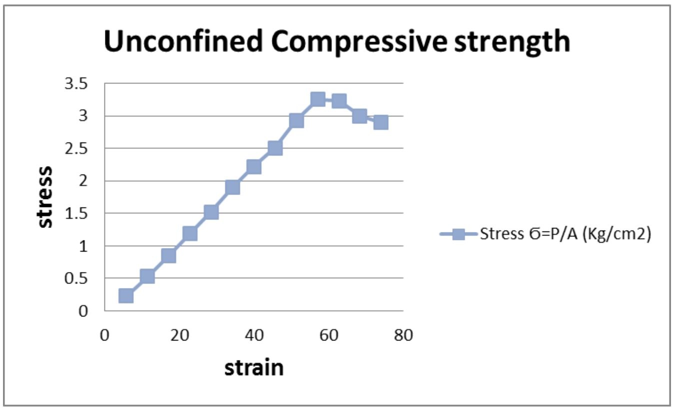

Chart -4: Unconfined Compressive Strength

3. PROPORTIONS AND THEIR TEST RESULTS

The clay soil is added with various percentage of SL and RTP and Standard proctor Compaction test and Unconfined Compression test is performed to determine the optimum proportion.

SPT of soil with various percentage of SL

The clay soil is added with various percentage of SL by weight of soil and the SPT was carried out to determine the MDD of Clay soil with secondary lime.

Table -2: Consolidated SPT results of soil with SL

Si.no	Sample description	OMC (%)	MDD (g/cm³)
1	Soil	12	1.048
2	Soil + 5% SL	14	0.947
3	Soil + 10% SL	12	1.057
4	Soil + 15% SL	12	1.125
5	Soil + 20% SL	14	1.20
6	Soil + 25% SL	12	1.11

Table 2 shows the OMC and MDD of the clay soil sample with various percentage of SL and the MDD is found to be 1.20 g/cm³ upon 20% addition of SL by weight of soil.

UCC Strength of soil with various percentage of SL

The clay soil is added with various percentage of SL by weight of soil and the UCC test was carried out to determine the UCC Strength of Clay soil with secondary lime.

Table -3: Consolidated UCC test results of soil with SL

Si.no	Sample description	UCC Strength (Kg/cm²)
1	Soil	3.255
2	Soil + 5% SL	3.319
3	Soil + 10% SL	3.351
4	Soil + 15% SL	3.549
5	Soil + 20% SL	3.758
6	Soil + 25% SL	3.302

Table 3 shows the UCC Strength of the soil with various percentage of SL and the maximum UCC Strength is found to be 3.758 kg/cm² upon 20% addition of SL by weight of soil.

SPT of soil with 20% SL and various percentage of RTP

The clay soil is added with 20% of SL and various percentage of RTP by weight of soil and the SPT was carried out to determine the MDD of Clay soil with 20% SL and RTP.

Table -4: Consolidated SPT results of soil with 20% SL and RTP

Si.no	Sample description	OMC (%)	MDD (g/cm³)
1	Soil	12	1.048
2	Soil + 20%of SL + 3% RTP	12	1.25
3	Soil + 20% SL + 6% RTP	14	1.36
4	Soil + 20% SL + 9% RTP	12	1.66
5	Soil + 20% SL + 12% RTP	14	1.92
6	Soil + 20% SL + 15% RTP	12	1.55

Table 4 shows the OMC and MDD of the clay soil sample with 20% SL and various percentage of RTP and the MDD is found to be 1.92 g/cm^3 upon 20% addition of SL and 12% addition of RTP by weight of soil.

UCC Strength of soil with 20% SL and various percentage of RTP

The clay soil is added with 20% of SL and various percentage of RTP by weight of soil and the UCC test was carried out to determine the UCC Strength of Clay soil with 20% SL and RTP.

Table -5: Consolidated UCC test results of soil with 20% SL and RTP

Si.no	Sample description	UCC Strength (Kg/cm^2)
1	Soil	3.255
2	Soil + 20%of SL + 3% RTP	3.787
3	Soil + 20% SL + 6% RTP	3.940
4	Soil + 20% SL + 9% RTP	4.15
5	Soil + 20% SL + 12% RTP	4.417
6	Soil + 20% SL + 15% RTP	3.749

Table 5 shows the UCC Strength of the clay soil sample with 20% SL and various percentage of RTP and the maximum UCC Strength is found to be 4.417 kg/cm^2 upon 20% addition of SL and 12% addition of RTP by weight of soil.

4. CONCLUSIONS

From the series of tests conducted on Clay soil mixed with Secondary lime and Rubber tyre powder the following conclusions are drawn:

- The addition of rubber tyre powder & secondary lime to the clay soil increases the compressive strength.
- The maximum improvements in UCC value of clay soil is obtained while using 20% of secondary lime and 12% of rubber tyre powder by weight of soil.
- Adding 20% of secondary lime and 12% of rubber tyre powder with the clay soil seems that the compressive strength is increased. And after adding 20% of secondary lime and 12% of rubber tyre powder the strength gets gradually decreased.
- The addition of secondary lime & rubber tyre powder will increase the geotechnical property of soil with increase in various percentages up to certain limit and beyond at certain percentage it reduces the strength value. Thus, using rubber tyre powder and secondary lime is an economical.

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