Strength Properties of Expansive Soil Treated With Lime, Gypsum and Coir Fibre

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***Abstract*- This paper presents the effect of coir fibers on the compaction and unconfined compressive strength of expansive soil-lime-gypsum mixture. The coir fiber content varied from 0.5 to 2 %. The results indicated that the dry unit weight and the optimum moisture content of expansive soil-lime mix increased with the addition of gypsum. The unconfined compressive strength of the expansive soil increased with the increase in the lime content up to 8%, but beyond 8 % the unconfined compressive strength decreased. The dry unit weight of the expansive soil-lime-gypsum mix increased, and the optimum moisture content decreased with the addition of coir fibre. The unconfined compressive strength increased for the mix of expansive soil and 8 % lime with addition of 4 % gypsum, but beyond 4 % addition of gypsum the unconfined compressive strength decreased. The unconfined compressive strength of the the expansive soil-lime-gypsum mix increased with the addition of coir fibre up to a fibre content of 1.5 %. The unconfined compressive strength of the expansive soil increased with the addition of lime and gypsum and with the increase in the curing period.**

***Index Terms*— Expansive soil, lime, gypsum, coir fibre and unconfined compressive strength.**

I. INTRODUCTION

Expansive soils are present in most of the places in India and around the world. These soils are very weak in bearing capacity. These soils in India are highly problematic, as they swell and shrinkage on evaporation.

Expansive soils pose serious problems for temporary roads constructed over them in terms of differential settlements, poor strength, and high compressibility, especially during a rainy season. Several states in India have vast deposits of expansive soils. The current approach adopted to treat such territories is to modify the properties with admixtures such as lime and gypsum to make them suitable for the construction of overlying temporary roads.

Expansive soils absorb water heavily, swell, become soft and lose strength. These soils are easily compressible when wet and possesses a tendency to heave during wet condition. Expansive soils shrink in volume and develop cracks during summer. They are characterized by extreme hardness and cracks when dry. These properties make them poor foundation soils and earth construction material. For developing a good and durable road network in expansive soil areas, the nature of soils shall be properly understood. On such soils suitable construction practices and sophisticated methods of design need to be adopted.

Soil stabilization is a collective term for any physical, chemical, or biological method, or any combination of such methods that may be used to improve certain properties of a natural soil to make it serve adequately an intended engineering purpose. It is the process of blending and mixing materials with a soil to improve certain properties of the soil. The main benefits of using lime to stabilize clays are improved workability, increased strength, and volume stability. Workability is improved because flocculation makes the clay more friable. Lime increases the optimum water content for compaction, which is an advantage when dealing with wet soil.

Lime increases the strength of clayey soil. Soil stabilization occurs when lime is added to a reactive soil to generate long-term strength gain through a pozzolanic reaction. The strength of lime mixture depends to a great extent on the quantity of lime added above lime fixation point. It is generally found that beyond a certain % of lime the increase in strength ceases & in fact a lowering strength may result due to present of unreacted free lime

indicating that there exists optimum lime content for maximum strength grain. So after a certain limit of lime content no development of strength but cost increases.

To further improve the mechanical properties of these stabilized soils, a variety of materials are being used as reinforcements. They are polymeric in composition, have a long life, do not undergo biological degradation, and are liable to create environmental problems from their manufacture till their end use. The use of coir fibres are therefore gaining in popularity as they too are biodegradable in nature and do not cause any environmental problems. In the present paper, an attempt has been made to study the compaction and unconfined compressive strength of a expansive soil-lime-gypsum mixture reinforced with coir fibres for possible use in improving soil.

II. MATERIALS AND METHODOLOGY

A. Materials

Locally available expansive soil was used in this study. The physical and engineering properties of the expansive soil are given in Table 1. Hydrated lime and gypsum procured from Vijayawada, Andhra Pradesh, India. And coir fibre (coconut fibre) was procured from a locally available in Tadepalligudem, Andhra Pradesh, India. The specific gravity of the lime, gypsum and coir fibre was 2.37, 2.89 and 1.9, respectively.

Table 1: Physical Properties of Expansive soil

Property	Value
Specific gravity	2.68
Liquid limit, %	82
Plastic limit, %	47.22
Optimum moisture content, %	24.3
Maximum dry density, kN/m^3	15.48
Type	CH

B. Methodology

Unconfined compressive strength (UCS) tests were conducted in accordance with IS: 2720, Part X (1991). The strain rate was kept 1.2 mm/min in all the experiments. The proving ring of capacity 2 kN

III. RESULTS AND DISCUSSION

Studies were carried out to obtain maximum dry unit weight and unconfined compressive strength for expansive soil and stabilized with lime, gypsum and coir fibre. The content of lime was varied from 2 % to 10 % by dry weight of expansive soil. The content of gypsum was varied from 2 % to 8 % by dry weight of expansive soil. The content of coir fibre was varied from 2 % to 10 % by dry weight of expansive soil.

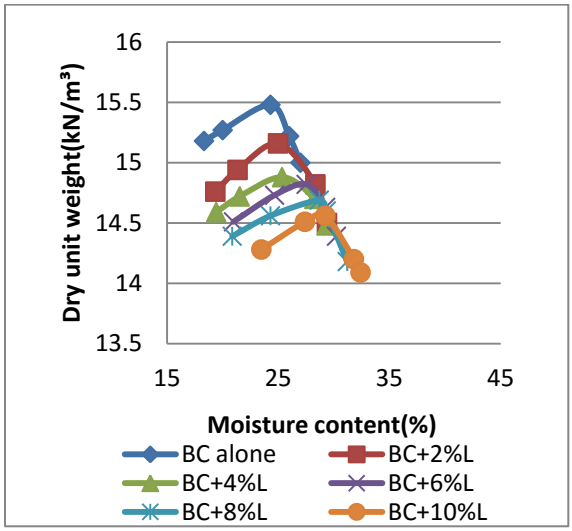

Figure 1: Compaction curves for expansive soil with varying percentage of lime

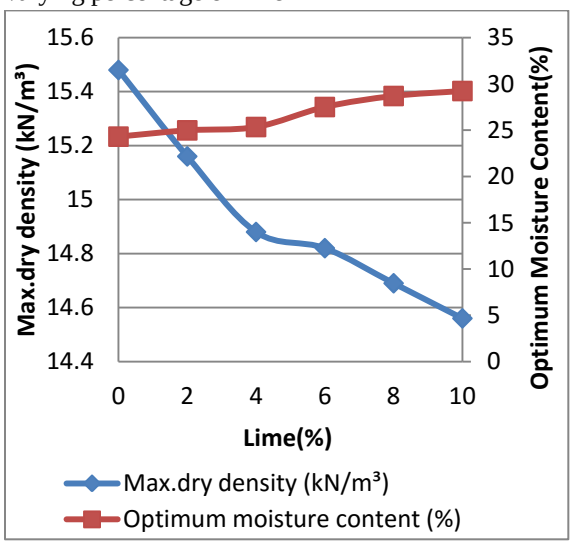

Figure 2: Variation of maximum dry unit weight and optimum moisture content of expansive soil with varying percentage of lime

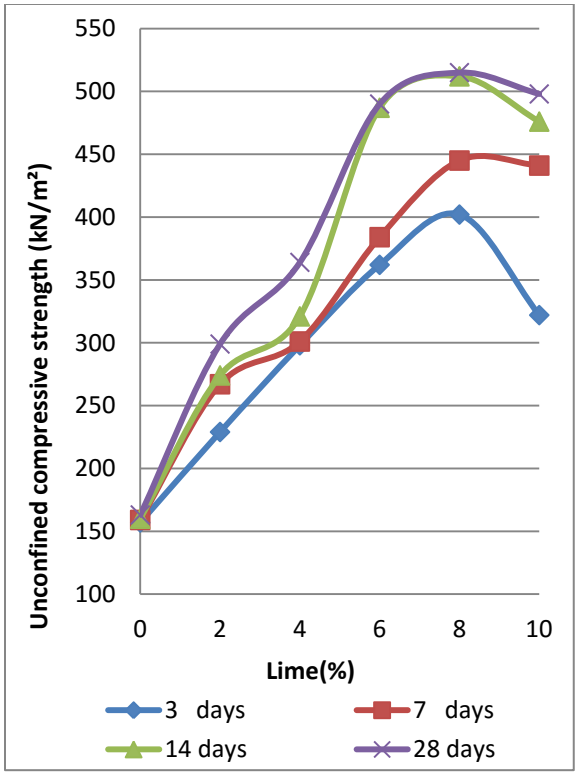

Figure 3: Variation of unconfined compressive strength of expansive soil with varying percentage of lime and curing period

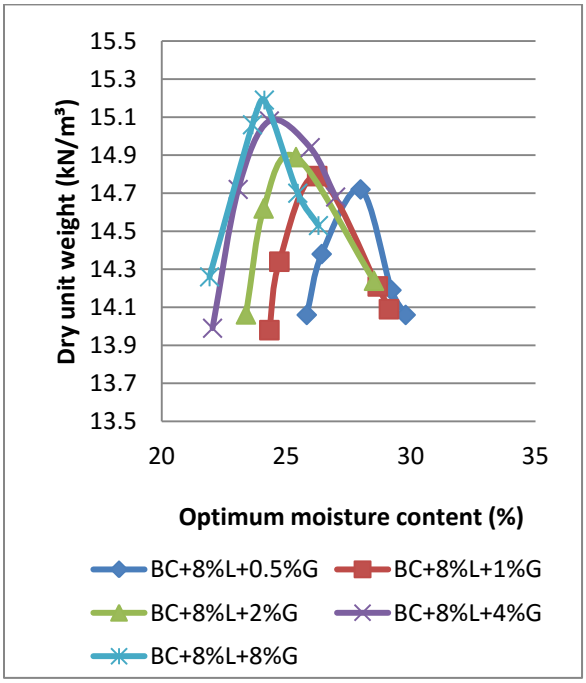

Figure 4: Compaction curves for expansive soil + 8 % lime with varying percentage of gypsum

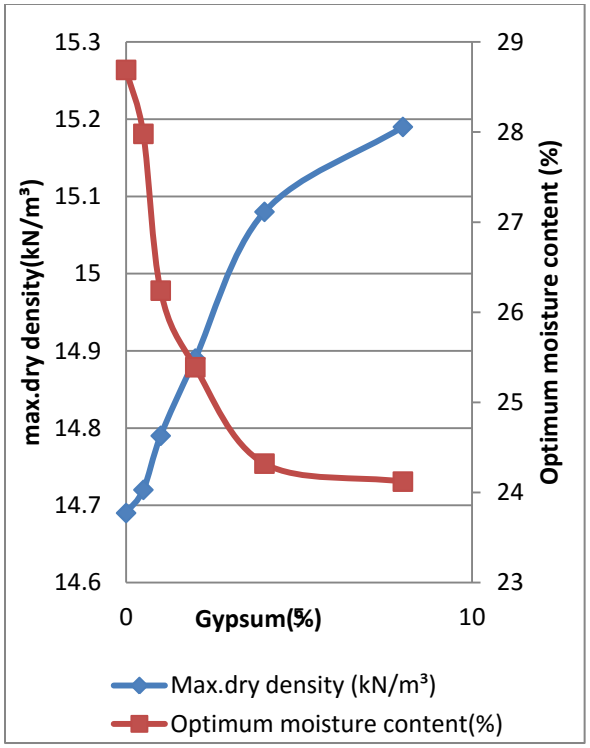

Figure 5: Variation of maximum dry unit weight and optimum moisture content of expansive soil + 8 % lime with varying percentage of gypsum

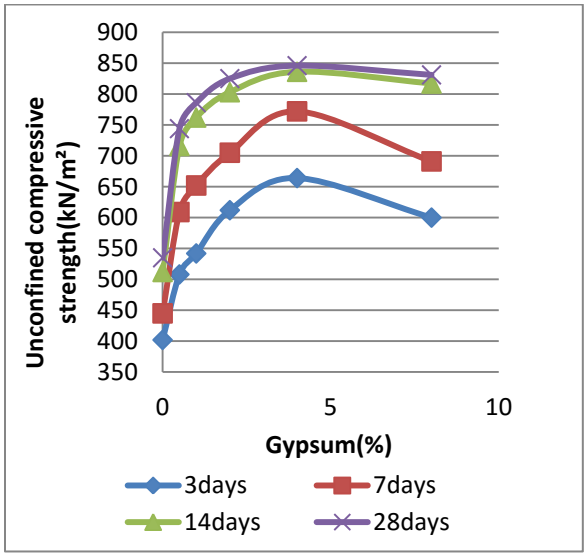

Figure 6: Variation of unconfined compressive strength of expansive soil + 8 % lime with varying percentage of gypsum and curing period

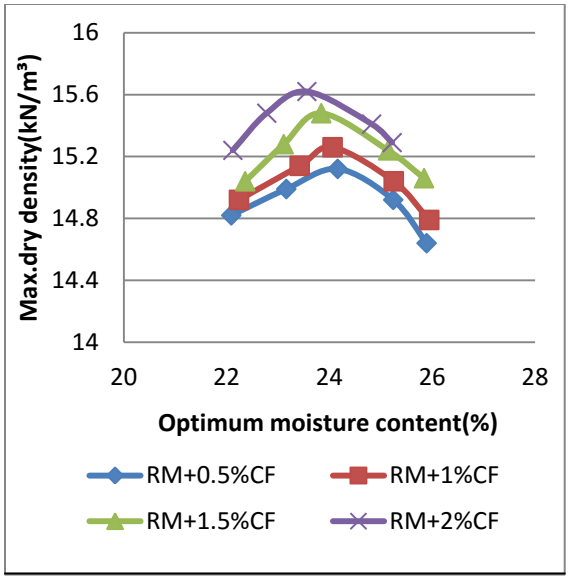

Figure 7: Compaction curves for expansive soil-lime-gypsum mix with varying percentage of coir fibres

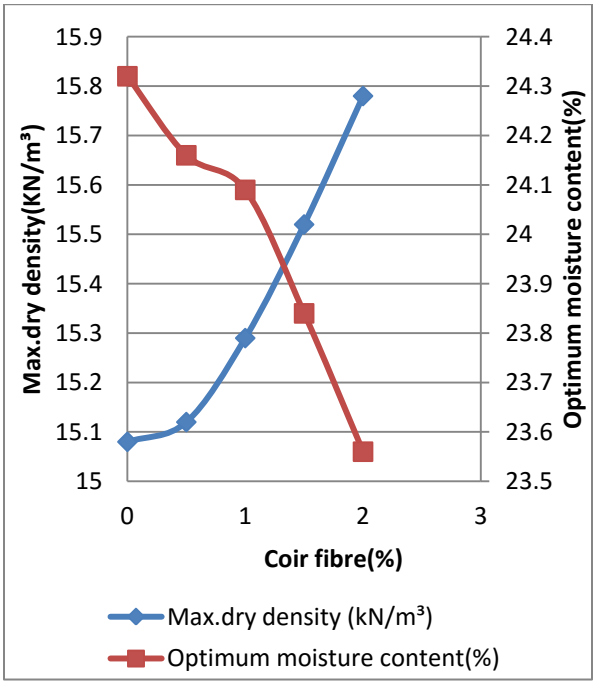

Figure 8: Variation of maximum dry unit weight and optimum moisture content of expansive soil-lime-gypsum mix with varying percentage of coir fibres

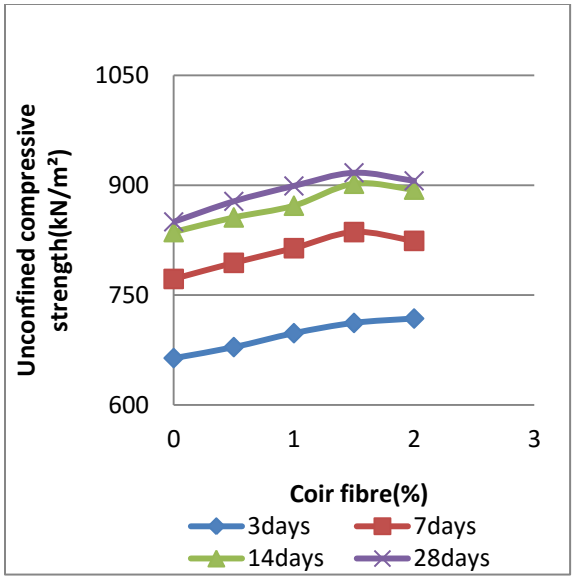

Figure 9: Variation of unconfined compressive strength of expansive soil-lime-gypsum mix with varying percentage of coir fibres and curing period

IV. CONCLUSION

An experimental study is carried out to investigate the strength characteristics of expansive soil treated with lime, gypsum and coir fibre. The study brings forth the following conclusions.

1. Addition of lime to the expansive soil caused a reduction in maximum dry density and increase in optimum moisture content. Considering a optimum amount of 8% lime content the MDD reduced from its original value of 15.48 kN/m^3 to 14.69 kN/m^3 and OMC increase from 24.3% to 28.69%.

2. Lime is effective in increasing the UCS value. For an optimum amount of 8% lime the UCS value of soil has increased from its original value of 157 kN/m^2 to 402 kN/m^2. Further improvement was observed with curing period. An optimum curing period of 14 days, the UCS value increased to 512 kN/m^2.

3. The combined effect of lime and gypsum to the expansive soil caused a increase in MDD and reduction in OMC. Considering a optimum amount of 8% and 4% lime and gypsum contents respectively, the MDD increased and OMC reduced.

4. Addition of optimum amount of lime (8%) and gypsum (4%) to the expansive soil has increased the UCS value. For an optimum curing period of 14 days the UCS increased upto 836 kN/m^2. And further addition of gypsum caused a decrease in UCS.

5. Addition of coir fibre to the lime + gypsum treated expansive soil caused additional increase in MDD. Coir fibre content of 1.5% shows the MDD increased from 15.08 kN/m^2 to 15.48 kN/m^2. Similarly the UCS value increased from 836 kN/m^2 to 902 kN/m^2.

Finally this study show an insight of the effect Lime, Gypsum and Coir fibre on the strength properties of the expansive soil. And the results reveals that 8%, 4% and 1.5% respectively are optimum contents and a curing period of 14 days was found to be effective.

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