STUDY ON GEOTECHNICAL PROPERTIES OF COHESIVE SOIL BY USING CEMENT AS REPLACEMENT

S ANIL KUMAR[1] S Venkata Mahesh[2] H LAVANYA[3], S HARIKA[4], G LUCKY LAHARINI[5], M INDHU[6]

[1, 2]Assistant Professor, Department of Civil Engineering, Ashoka Women's Engineering College, NH 7, Opp Dupadu Railway Station, Lakshmipuram post, kurnool, Dupadu, Andhra Pradesh 518002

[3,4,5,6] Bachelor of Engineering, Department of Civil Engineering, Ashoka Women's Engineering College, NH 7, Opp Dupadu Railway Station, Lakshmipuram post, kurnool, Dupadu, Andhra Pradesh 518002

Abstract *Among the several modes of transportation, the roads have been the most ancient and widely used medium. Since the ancient time for transportation of goods or travelling purpose, we used roads. Heavy loaded trucks running on the roads need special care and attention during construction phase so that they can bear the maximum load. Stabilization is the improvement of a soil or pavement material usually through the addition of a binder or additive. Some of the soil having good and sufficient load bearing capacity but some of having poor. This research work mainly focuses on soil stabilization using cement to improve geotechnical properties such as plasticity, compaction, and Unconfined Compressive Strength of the studied soil. These properties were determined before as well as after the stabilization of soil. In this work it was found that higher the quantity of cement added to the soil, dry density of soil decreased and optimum moisture content increased. With the addition of cement to the soil, unconfined compressive strength increased, and it was also found higher at higher curing period.*

Cement stabilization of soil is done by mixing pulverized soil and Portland cement with water and compaction the mix to attain a strong material. The material obtained by mixing soil and cement is know as soil-cement. Since 1915 more then 1 lakh miles equivalent 7.5m wide pavement bases has been constructed from cement stabilized soil. Soil Stabilization is a process of treating a soil to improve its stability and bearing capacity for using the soil as Construction material. The most Important Purpose of Soil Stabilization is the increase the strength of pavement layers like sub-base, base course etc. and to increase the stability of earth work in embankment as a whole. The soil to be stabilized is pulverized, water is added and is mixed. The bituminous material is then added and is remixed. The mixture is spread to the required grade and compacted. The compacted surface cured.

Key words: *Cement Stabilization, Unconfined Compressive Strength (UCS), Plasticity Index (PI), Compaction*

1. INTRODUCTION

Soil stabilization is used to strengthen road surfaces by enhancing the weight bearing capabilities of in-situ subsoil, sands and other waste materials. There are two primary objectives of soil stabilization; one is to enhance the California bearing ratio of soils that are in-situ from four to six times, the other is to create

solid base and sub-base courses by improving the in-situ materials.

Soil stabilization in the past depended mainly on the binding properties of clay soils and cement products, the technique was used is the 'Rammed earth technique' with lime, however now green technology techniques are introduced; some of the typical examples of green technologies are: bio-polymers, synthetic-polymers, enzymes, surfactants, calcium chloride, sodium chloride and more. These techniques create hydrophobic surfaces that prevents road failure by preventing the frost or water from penetrating the soil to the treatment layer.

The study of soil stabilization is very important for the geotechnical engineer to support the soil and prevent it from bending under the loading of the structure of the building. Cement and lime often used as chemicals to for the purpose of soil stabilization, however as time passed the prices of these two materials increased, and the production of cement is pollutant to the environment, that's why this research will help a lot in minimizing the excessive use of cement for engineering purposes.

Figure 1 shows a soil after and before stabilization. Before stabilization the picture on the left when 100psi pressure which is 689.5kPa is implied to the soil, there was a deflection of 15psi (103.4kPa) unlike after the stabilization where only 4psi (27.6kPa) of deflection occurred which means that the soil before stabilization included voids and low compressive strength and the stabilizer tended to fill these voids and increase its compressive strength.

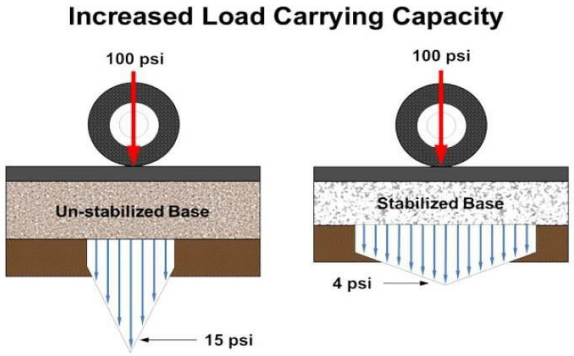


Fig 1: Soil after and before stabilization

Use of cement in soil stabilization

Cement is the oldest binding agent since the invention of soil stabilization technology in 1960's. It may be considered as primary stabilizing agent or hydraulic binder because it can be used alone to bring about the stabilizing action required (Sherwood, 1993; EuroSoilStab, 2002). Cement reaction is not dependent on soil minerals, and the key role is its reaction with water that may be available in any soil (EuroSoilStab, 2002). This can be the reason why cement is used to stabilize a wide range of soils. Numerous types of cement are available in the market; these are ordinary Portland cement, blast furnace cement, sulfate resistant cement and high alumina cement. Usually the choice of cement depends on type of soil to be treated and desired final strength.

Hydration process is a process under which cement reaction takes place. The process starts when cement is mixed with water and other components for a desired application resulting into hardening phenomena. The hardening (setting) of cement will enclose soil as glue, but it will not change the structure of soil (EuroSoilStab, 2002). The hydration reaction is slow proceeding from the surface of the cement grains and the centre of the grains may remain unhydrated (Sherwood, 1993). Cement hydration is a complex process with a complex

series of unknown chemical reactions (MacLaren and White, 2003).

Objectives of the study

For this project the following objectives were made

1. To determine the optimum moisture content, maximum dry density, shear strength for the original sample that is without additives.

2. To determine the maximum dry density, optimum moisture content, shear strength for the percentages of 0%Cement, 5% Cement, 10% Cement, 15% Cement and 20% Cement admixtures to the soil and choose the optimum percentage.

3. To compare the results obtained between the original sample and the optimum sample with admixtures.

2. LITERATURE SURVEY

Neha upadhyay el al,[2019] This research work mainly focuses on soil stabilization using cement to improve geotechnical properties such as plasticity, compaction, and Unconfined Compressive Strength of the studied soil. These properties were determined before as well as after the stabilization of soil. From this study we conclude that the comprehensive examination of the effectiveness of cement treatment on geotechnical properties of soils.

KhineZar Mon, SweSweKhaing et al, [2019]This paper presents the classification of soil and modification or stabilization of soil with cement. Soil samples are taken at about 3 ft depth from Mawlamyine which are denoted by soil From this paper we conclude that with respect to moisture content measurements and specimen size, the recommended amount of soil required to obtain an accurate measurement increases with increasing maximum particle size. The sieve sizes recommended for mechanical sieving in this laboratory exercise (No.4, No.10, and No.40) are based on the assumption that the soil contains little or no gravel-size particles (i.e.; particles retained by the No4 sieve).

3 METHODOLOGY AND MATERIALS

The methodology used in the present study is shown in the below chart

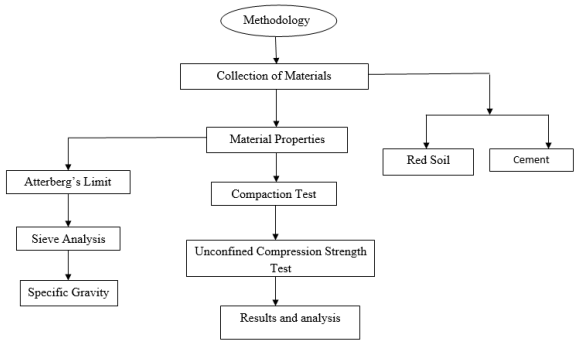


Fig 2: Methodology chart

Methodology is the systematic, theoretical analysis of the methods applied to a field of study. It comprises the theoretical analysis of the body of methods and principles associated with a branch of knowledge.

A methodology does not set out to provide solutions - it is therefore, not the same as a method. Instead, a methodology offers the theoretical underpinning for understanding which method, set of methods, or best

practices can be applied to a specific case, for example, to calculate a specific result.

Materials used

Red soil

Red soil is an important soil resource, which bears substantial implication for sustainable development of agriculture and healthy growth of economy. We also summarized how the iron redox cycling may be affected by other biogeochemical processes or active constituents, such as the nitrogen cycling, the sulfur cycling and humic substances.

Cement

The raw materials required for manufacture of Portland cement are calcareous materials such as limestone or chalk, and argillaceous material such as shale or clay. There are two processes known as wet and dry processes depending upon whether the mixing and grinding of raw materials is done in wet or dry condition. The raw materials used for the manufacture of cement consist of mainly of lime, silica, alumina and iron oxide. These oxides interact with one another in the kiln at high temperature to form more complex compounds.

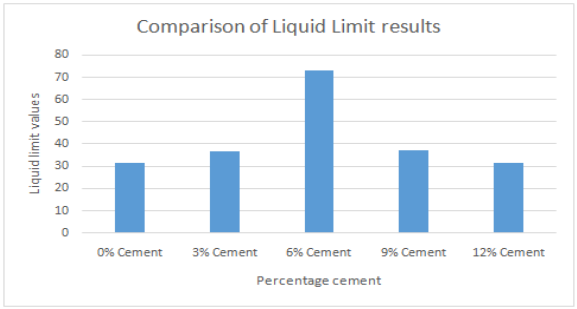
The chemical reactions that take place between cement and water is referred as hydration of cement. The hydration of cement can be visualized in two ways. The first is through solution mechanism in which cement dissolve to produce super saturated solution from which the hydrated products get precipitated. In this study an OPC 53 Grade cement is used

Fig 3: OPC 53 Grade cement

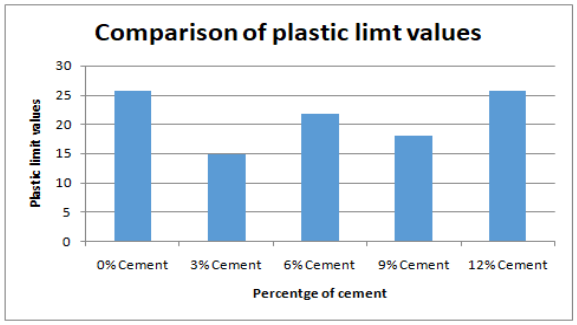
Tests to be conducted on the soil

1. Liquid limit test
2. Plastic limit test
3. Compaction test
4. Unconfined compressive strength test

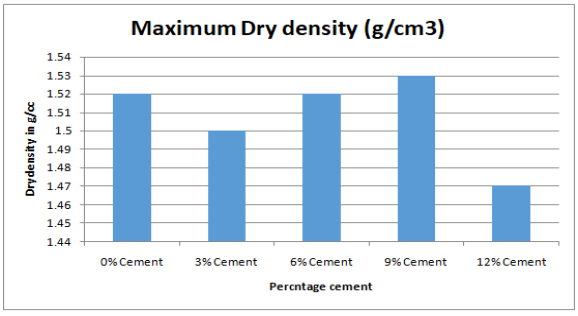
4. RESULTS AND ANALYSIS



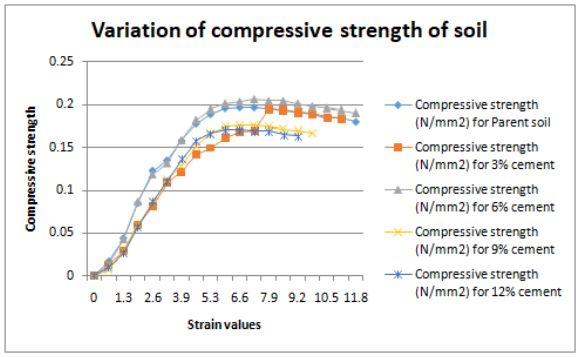
Graph 1: Comparison of liquid limit test results



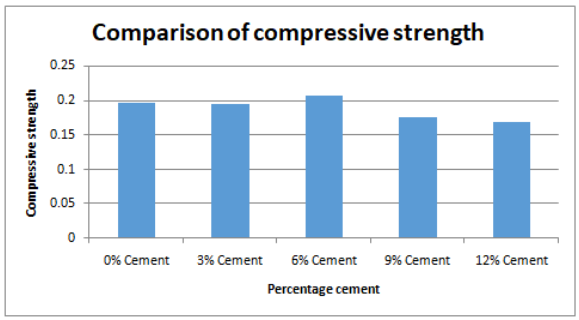
Graph 2: Comparison of plastic limit test results



Graph 3: Comparison of maximum dry density (MDD)



Graph 4: Variation of compressive strength of soil



Graph 5: Comparison of maximum compressive strength

5. CONCLUSIONS

This project is focused on the review of performance of cement as a recycle material in soil. The study suggests that if cement properly mixed and applied, can be used as a great soil stabilization technique .On the basis of this project the following results were obtained.

1. Cement is used as an excellent soil materials for highly active soils which undergo through frequent expansion and shrinkage.
2. The cement as an additive decreases the swelling, and increases the strength of the expansive soils.
3. The higher value of maximum dry density was observed at 9% cement content and the maximum value of Optimum moisture content was observed as 12% for all the cases
4. The optimal value of unconfined compressive strength was observed at 6% cement replacement.
5. The maximum values of liquid limit was observed at 6% cement replacement in the soil when we compared with other soil cases.
6. The maximum values of plastic limit was observed at 0% cement replacement and 9% cement replacement in the soil when we compared with other soil cases.

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