THE EFFECT OF CaCl2 AND Na2SiO3 CHEMICALS ON PROPERTIES OF CH SOIL

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ABSTRACT: The object of this paper is to present the effect of chemical admixtures such as CaCl2, Na2SiO3 and combination of two on the engineering properties of high compressible clay (CH). Various dosages of chemicals (0.5%, 1.0%, 1.5% and 2.0%) were added to the soil to study the effect of these chemicals on the consistency limits, compressive strength, and swell properties. As the percentage chemical dosage increases the strength properties of treated soil were found to be improved. The liquid limit; plastic limit, plastic index and swell properties of treated soil are decreased markedly. It is observed that the soil treated with combination of CaCl2/Na2SiO3 resulted in higher strength and controlling the swelling characteristics.

INTRODUCTION

Industrial development in India has necessitated construction of infrastructure facility such as highways, airports seaports and residential buildings. There is a need to select a good soil conditions for proper safety consideration of all these projects. The expansive soils are more problematic for construction and are predominantly available in majority places in Andhra Pradesh. These soils undergo swelling and shrinkage as their moisture content changes. Due to high swelling and shrinkage, these soils pose lot of problems to the structures found on them. Stabilization is the process of improving the properties of soil by changing its gradation. Two or more types of natural soils are mixed to obtain a composite material which is of superior to any of its components. To achieve the desired grading, sometimes the soils with coarser particles are added or the soils with finer particles are removed. The blended soil possesses both internal friction and cohesion. When properly placed and compacted, the blended material becomes stable and also load carrying capacity is increased. Seasonal moisture variations bring about volume changes in expansive soils (Hausmann, 1990)[1]. Continued efforts are being made all over the world to devise ways and means to solve the problems due to expansive soils. Several measures can be adopted such as application of adequate surcharge load, pre-wetting, moisture control, CNS layer technique (Katti, 1979)[3]. Chemical stabilization is sometimes effective alleviate the problems posed by expansive soils. Chemical modification by adding lime has been in practice for the last three decades. The CaCl2 could be an effective alternative to conventional lime treatment due to its ready dissolvability and to supply adequate calcium ions for exchange reactions. However, these and many other techniques are successful only to a partial extent and hence the attempts to devise better techniques are still going on. In the present work, an attempt is made to understand the effect of chemicals such as CaCl2 and Na2SiO3 on the behavior of expansive soils collected from Amalapuram in Andhra Pradesh. The variation in liquid limit, plastic limit, unconfined compression, soaked CBR and swelling properties of expansive soil are presented and discussed.

EXPERIMENTAL STUDY

Material used

Expansive soil is collected from the Amalapuram, coastal area in Andhra Pradesh. The basic properties of materials used in the study are presented below.

Soil: Liquid limit, \( W_L = 98\% \); Plastic limit, \( W_P = 36\% \); I.S. Classification=CH (Clay of high compressibility), Optimum moisture content (OMC) = 26%; Maximum dry density (MDD) = 16 kN/m\(^3\), Differential free swell index, DFSI =180%, Unconfined compressive strength, UCS =80 kPa; and soaked CBR = 1.5 %.

Chemicals

CaCl2 and Na2SiO3 chemicals were in used in the study. The quantity of the chemical was varied from 0 to 2% by dry weight of soil.

Admixture Proportions and Tests Conducted

The proportions of CaCl2 and Na2SiO3 used along with the soil in the study are 0%, 0.5%, 1.0%, 1.5% and 2.0% respectively. The liquid limit and plastic limit tests were conducted as per IS: 2720 (Part 5) – 1985[4]. Heavy compaction test was carried out according to IS: 2720(Part 8)-1991[4]. Unconfined compressive strength (UCS) tests were conducted at OMC and MDD as per IS: 2720 (Part 10) – 1991[4]. Free swell index (FSI) tests were conducted as per IS: 2720(Part -XL) – 1977[6]. The California Bearing Ratio (CBR) tests were conducted as per IS: 2720 (Part 16) – 1987[6].

RESULTS AND DISCUSSION

Atterberg’s limits, unconfined compressive strength, soaked CBR, Swell pressure and Swell potential tests were conducted with different percentages of CaCl2 and Na2SiO3 as admixtures in expansive soil.

Liquid Limit and Plastic Limit

The variation in Liquid limit and Plastic limit of expansive soil treated with CaCl2, Na2SiO3 and combination of CaCl2 and Na2SiO3 is presented in Figs. 1 and 2. From the Fig. 1, it can...
be seen that addition of CaCl₂ to the expansive soil is causing little decrease in the liquid limit value and Na₂SiO₃ is causing moderate reduction in liquid limit. The combination of CaCl₂, Na₂SiO₃ causing drastic reduction in liquid limit of soil. From the Fig. 2, it can be seen that addition of CaCl₂ to the expansive soil did not cause any change in plastic limit whereas the Na₂SiO₃ and combination of CaCl₂ + Na₂SiO₃ shown increase in plastic limit. Overall from these figures, it is understood that the plastic characteristics of expansive soil are very much reduced with addition of Na₂SiO₃ and combination of CaCl₂ + Na₂SiO₃.

**Unconfined Compressive Strength (UCS)**

The variations of unconfined compressive strength with respect to chemicals added such as CaCl₂, Na₂SiO₃ and combination of the two to the expansive soil and for zero days, 7 days and 14 days curing are presented in Figs. 3 to 5. Fig. 3 presents variation in unconfined compressive strength with percentage CaCl₂ and it is noted that there is a marked improvement in unconfined compressive strength especially at 14 days curing and noted that it is about 2.5 times higher than the untreated soil. Similar increase in unconfined compressive strength is observed for Na₂SiO₃ as shown in Fig. 4.
The addition of combination of CaCl₂ + Na₂SiO₃ of about 1% to the soil showed 4 times increase in the compressive strength compared to untreated soil at 14 days curing as shown in Fig. 5.

**Soaked C.B.R**

The effect of chemicals such as CaCl₂, Na₂SiO₃ and combination of both on soaked CBR is presented in Fig. 6. From this figure, it is understand that as the percentage of admixture increases from 0 to 2%, the soaked CBR values are found to be increased. This increase in soaked CBR is observed up to about 1% of admixture and there after it is seen that no change in the soaked CBR. Compared to CaCl₂ and Na₂SiO₃, the combination of these two additions to soil showed more increase in soaked CBR. The soaked CBR of the soil treated with 1% of CaCl₂+ Na₂SiO₃ has showed nearly 6.5 times higher value than the soaked CBR value of untreated soil.

![Fig.6. Influence of CaCl₂ and Na₂SiO₃ on soaked C.B.R](image)

**Differential Free Swell Index (DFSI)**

The variation in of DFSI with the addition of admixture to the soil is presented in Fig. 7. From this figure, it can be seen that as percentage of chemical increases from 0 to 2%, there is a gradual reduction in DFSI. The CaCl₂, is affecting more in the DFSI reduction. It is noted that there is a reduction in DFSI from 180% to 100%.

![Fig.7. Influence of CaCl₂/Na₂SiO₃ on DFSI](image)

**Swell pressure & Swell potential**

The swell pressure and swell potential variation with the addition of chemical admixtures to the expansive soil are presented in Figs. 8 and 9. From the Fig. 8, it can be seen that compared to Na₂SiO₃, the swell pressure is decreasing effectively in case of soil treated with CaCl₂ and combination of CaCl₂ + Na₂SiO₃. The reduction in swell pressure is observed about 85% incase of addition of chemicals such as CaCl₂ and combination of CaCl₂ + Na₂SiO₃ to the soil compared to untreated soil. The Na₂SiO₃ alone has shown no significant reduction in swell pressure.

![Fig.8. Influence of CaCl₂ and Na₂SiO₃ on Swell pressure](image)

![Fig.9. Influence of CaCl₂ and Na₂SiO₃ on Swell potential](image)
CONCLUSIONS
From the above discussions a few conclusions are drawn.

- The addition of chemical admixtures such as CaCl₂, and Na₂SiO₃ and combination both to the expansive soil resulted changes in properties of soil.
- The CaCl₂ + Na₂SiO₃ combination has resulted marked reduction the plasticity characteristics of soil.
- It is observed that the unconfined compressive strength of treated soil is increasing with the increasing number of curing days and this increase is observed at 1% addition of admixture to soil.
- CaCl₂, Na₂SiO₃ combination of 1% addition to soil showed about 5 times increases in soaked CBR value as compared to untreated soil.
- The combination of CaCl₂ + Na₂SiO₃ addition to soil has shown marked reduction in swell pressure and swell potential of soil.
- The swell pressure of soil treated at 2% of CaCl₂ + Na₂SiO₃ is 20 kPa. This value is so low as compared to untreated soil swell pressure of 200 kPa. This shows about 90% reductions in swell pressure of expansive soil when treated with combination of CaCl₂ + Na₂SiO₃ of 2%.

REFERENCES