

A STUDY ON BEHAVIOUR OF CLAY SOIL WITH ADDITION OF CHOLINE CHLORIDE

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Abstract— Soil is one of the nature’s most abundant construction materials. Almost all type of construction is built with or upon the soil. Generally clayey soil has low strength. It is normally replaced with stronger soil material so as to improve the strength but this is not advisable due to constraints. In this project the strength of soil is increased by chemical stabilization by adding choline chloride chemical instead of replacing with stronger soil. The process of soil stabilization refers to changing the properties of soil in order to improve its strength, durability, or other qualities. In chemical stabilization, soil is stabilized by adding different chemicals. The main advantage of chemical stabilization is that setting time and curing time can be controlled. Chemical stabilization includes the use of chemicals as compaction aids to soils, as binders and water repellents, and as a means of modifying the behaviour of clay. It also includes deep mixing and grouting. The initial strength of the soil is determined by conducting soil tests such as free swell index, specific gravity test, sieve analysis, plastic limit, liquid limit, shrinkage limit, IS Heavy compaction test and unconfined compression strength tests. The results obtained are then compared with the soil treated with 0.3%, 0.5%, 0.7% and 0.9% choline chloride (from reference 1)

Keywords— Clayey Soil, Choline Chloride, Compaction, Compressive Strength.

I. INTRODUCTION

Soil is formed due to weathering action of rocks may be physical or chemical means. The study of soil is needed in detail because it is the base to accept any type of load coming over it. Soils like soft clay deposits create problems in construction because of low bearing capacity, high compressibility, and tendency for lateral flow. So these grounds are to be treated for the improvement in their engineering behaviour as per the design requirements of the structure to be constructed. Clay is the densest and heaviest type of soil. They undergo severe volume changes corresponding to changes in moisture content. Soil that has been stabilized will have a vastly improved weight bearing capability and will also be significantly more resistant to being damaged by water, frost or inclement conditions. Choline chloride[C₅H₁₄ClNO] is a quaternary amine salt, it dissociates in water into the corresponding positively charged quaternary hydroxyl alkyl ammonium ion and the negatively charged chloride ion. Choline chloride is a highly active compound that acts as a clay stabilizer which helps to prevent clay particles from swelling with an activity of 75%. Stabilisation using Choline chloride works on the principle of ‘ion exchange’ process. This highly soluble material can be used in all environments and does not suffer from crystallization issues when used in a brine solution in cold climate.

A. Properties of Soil

Several tests are conducted on the soil to find out the Index and Engineering property of the soil.

TABLE I PROPERTIES OF SOIL SAMPLE COLLECTED

S.No	Property	Value
1.	Free swell index	20%
2.	Liquid limit	39%
3.	Plastic Limit	20.78%
4.	Soil gradation	Medium plastic clay
5.	Specific Gravity	2.683
6.	Compaction	10.35%-OMC 2.08g/cc-MDD
7.	Unconfined Compressive Strength	11.4kg/cm ²

B. Properties of choline chloride

Choline Chloride, which is used as a stabiliser in this work, bears the following properties.

TABLE II PROPERTIES OF CHOLINE CHLORIDE

S.No	Property	Value
1.	Molecular weight	139.6 g/mol
2.	P ^H	7-9
3.	Specific Gravity	1.1

II. EFFECT OF CHOLINE CHLORIDE ON SOIL PROPERTIES

A. Compaction Characteristics

The collected soil sample is tested for its compaction characteristics with addition of Choline Chloride in varying percentages. Choline chloride is mixed with water. The following are the results of the experimentation.

TABLE III VARIATION OF COMPACTION CHARACTERISTICS WITH ADDITION OF CHOLINE CHLORIDE

%Choline Chloride added	0.3%	0.5%	0.7%	0.9%
OMC%	9.09	10.14	9.64	9.42
MDD(g/cc)	2.04	2.02	1.94	1.91

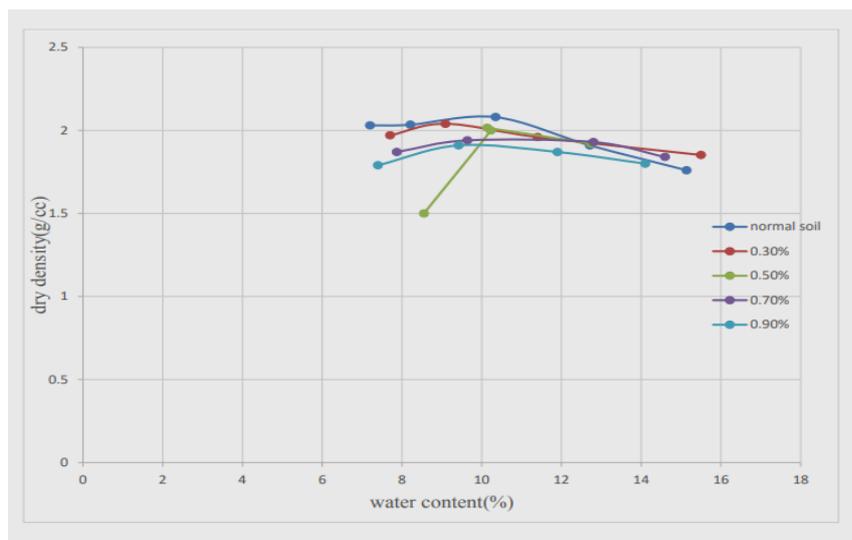


Fig1 Graphical representation of behaviour of compaction properties of soil upon addition of choline chloride

Clear variation of OMC and MDD with addition of Choline Chloride

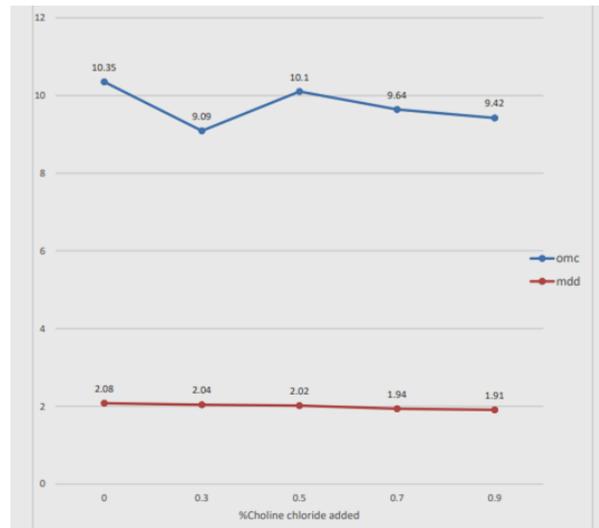


Fig2 Graphical representation of behaviour of compaction properties of soil upon addition of choline chloride

B. Unconfined Compressive Strength

The collected sample is tested for its shear strength properties using Unconfined Compressive Strength test. The following table indicates the response of soil with addition of varying percentages of Choline chloride.

TABLE IV VARIATION OF SHEAR STRENGTH AND COMPRESSIVE STRENGTH CHARACTERISTICS WITH ADDITION OF CHOLINE CHLORIDE

% Choline Chloride added	0.3%	0.5%	0.7%	0.9%
Unconfined Compressive strength (kg/cm ²)	12.91	18.86	16.82	15.14
Undrained Shear strength (kg/cm ²)	6.45	9.43	8.41	7.57

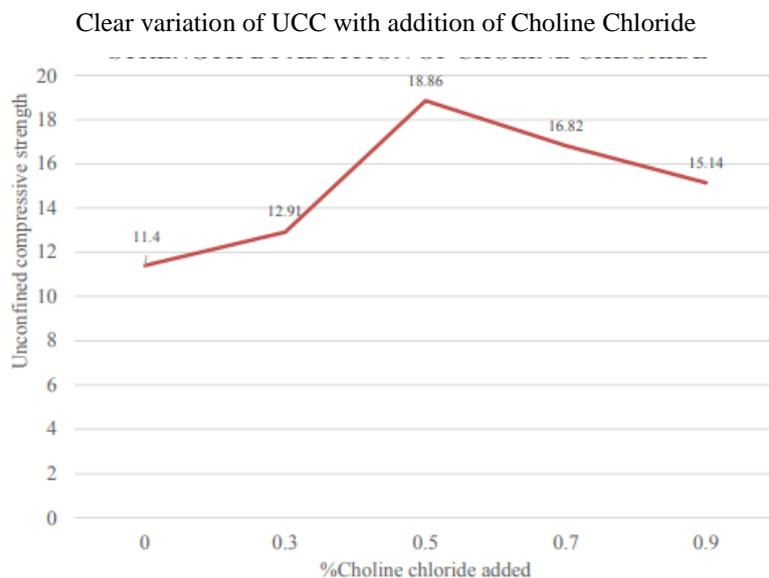


Fig3 Graphical representation of behaviour of Compressive strength characteristics of soil upon addition of choline chloride

III. CONCLUSION

- From the Atterberg limits and Free swell index shown in table 1, the collected soil sample is clay with medium swell character.
- At 0.5% addition of Choline chloride to clay shows good response in the case of Unconfined Compressive Strength from figure 3 where as from figure 2 it seems there is a constant decrease in Maximum dry density upon addition of choline chloride. This phenomenon also indicates that there must be a relative decrease in specific gravity.
- Choline chloride, base ion exchange phenomena it reduces the affinity of soil towards water as well increase in unconfined compressive strength upto 0.5% addition of choline chloride.

REFERENCES

- [1] Choline product for clay stabilisation BALCHEM(World class quality) from <https://www.balchem.com/wp-content/uploads/2019/04/Choline-Salts-Clay-Stabilizer.pdf>
- [2] “What Chemicals are used”. FracFocus.Retrieved 19th September 2014.
- [3] “Choline Chloride”. Screening Information Data Set (SIDS) for High Production Volume Chemicals.