

COMPACTION CHARACTERISTICS OF CLAYSOIL ADDED WITH LIME AND NANO CALCIUM SILICATE

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Abstract:

The current study evaluates the strength characteristics of soil treated with nano calcium silicate (NCS) and lime. The size of the nano particles plays a crucial role in geotechnical properties of soils. Because of the high specific surface area of NCS, these nano particles in stabilization influences dry density of the soil and makes more reactive to soil. In this study lime is added in different percentages from 2 to 8%. From the compaction result it is found that 6% lime is the optimum dosage. To this soil mixture tests are done with nano calcium silicate varying from 0.2 to 1%. The results shows significant improvement in maximum dry density.

Keywords - nano calcium silicate, lime.

I. INTRODUCTION

The present day needs demands the construction on soils having poor geotechnical properties. Clayey soil is one which non - suited soil which can causes failure of structures due to the applied stresses. The physical and geotechnical properties of soil can be improved by a process called stabilization. Stabilization of soils refers to improvement of soil behaviour against loads by reduction in deformation and disposition (Changizi and Haddad 2016). Stabilization of soil usually done by mechanical, chemical and physical methods. The usual method of stabilization which includes the replacing the problematic soil by strong materials like geogrid, geotextiles, strong soils etc. but these are time consuming and the cost is very high. To overcome these difficulties one of the techniques that has been used effectively with success in practice is chemical stabilization. In chemical stabilization the non - suited soil is blended with the stabilizers in order to initiate a suite of chemical reactions such as cation exchange, flocculation, carbonation and pozzolanic activity which consequently enhance the geotechnical properties of the soil. Nano technology can be used in geotechnical engineering to improve the properties of soil. Use of nano materials in soil stabilization is an emerging trend because of its high specific surface area compared to volume. This helps the parent soil and other additives used along with the soil for better interaction. Nano materials are filled in the voids of the soil mass and improve the strength of the soil. The use of the cementitious materials in the process of soil stabilization like lime and fly ash are well known, the use of Nano calcium

silicate (NCS) is for the purpose of increasing the performance of the cementitious stabilizers.

II. MATERIALS AND PROPERTIES

I. SOIL SAMPLE

The soil is collected from Neyyattinkara, Trivandrum. The soil was taken from 0.5m depth below the ground surface. Laboratory tests were carried out for salient geotechnical characteristics such as gradation, Atterberg's limits, compaction and strength test etc., and are shown in Table 1.

Table 1: Properties of soil

PROPERTIES	VALUES
Liquid limit (%)	36.95
Plastic limit (%)	24.44
Plasticity index (%)	12.51
OMC (%)	17.70
MDD (g/cc)	1.70
Specific gravity	2.62
Classification of soil	CI
Percentage of silt (%)	24.00
Percentage of sand (%)	19.00
Percentage of clay (%)	57.00
Unconfined compressive strength(kg/cm ²)	0.22

2. LIME

Hydrated lime (Ca(OH)₂) was used to improve the native weak CI soil.

3. NANO CALCIUM SILICATE (NCS)

Nano calcium silicate (NCS) is for the purpose of increasing the performance of the cementitious stabilizers. Properties are shown in Table 2.

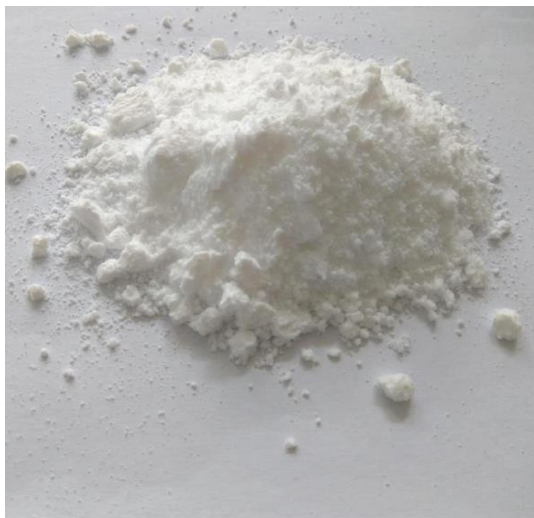


Fig 1: NCS

Table 2: Properties of NCS

PROPERTIES	VALUES
PH value	7 - 9
Ignition loss	2%
SiO ₂ content	< 53%
Fe content	< 0.2%
Ca content	< 45%
Moisture	< 0.3%
Colour	White

III. METHODOLOGY

The soil samples were collected and the laboratory tests were conducted to study the geotechnical properties of collected samples. Compaction and UCC test were conducted to find the optimum amount of lime in soil sample. 0.2%, 0.4%, 0.6%, 0.8% and 1% Nano calcium silicate is added with the optimum lime content to the soil. The samples for the unconfined compression strength tests were prepared at their

respective optimum water content that were obtained from a standard compaction test.

IV. RESULTS AND DISCUSSIONS

A. Compaction characteristics

IS light compaction test was conducted on various percentages of lime (2%, 4%, 6% and 8%) with red soil in accordance with the procedure laid in IS:2720 PART 7 to study the moisture content and dry density relationship.

Table 3: Compaction characteristics of soil - lime mixture

% Lime added	OMC (%)	MDD (g/cc)
0	17.70	1.70
2	17.85	1.74
4	17.99	1.78
6	18.18	1.81
8	19.10	1.69

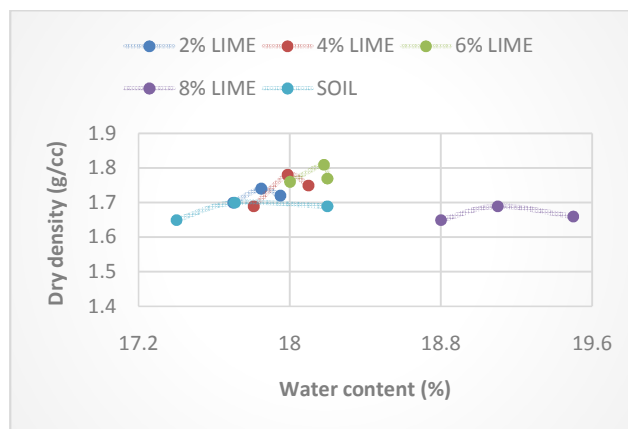


Fig. 2: Compaction curve

From the standard proctor test, the results obtained shows that 6% lime gives maximum dry density. So 6% is taken as the optimum amount of lime content. Maximum dry density is obtained as 1.81g/cc and corresponding optimum moisture content is 18.18%.

B. Effect of NCS on soil - lime mixture

NCS is added to 6% lime – soil mixture. Compaction is done with different percentages of NCS dosage such as 0.2%, 0.4%, 0.6%, 0.8% and 1%. From the result it is found that OMC got increased. MDD got improved.

Table 4: Variation of compaction characteristics.

% NCS added	OMC (%)	MDD (g/cc)
0	18.18	1.81
0.2	18.75	1.68
0.4	19.22	1.76
0.6	19.46	1.80
0.8	19.89	1.82
1.0	20.51	1.84

and cause soil particles to need more water to move on each other. Thus OMC is increased and a minor decrease in dry density weight.

V. CONCLUSIONS

Based on study and experimental investigation following conclusions were found.

- It was observed that with the addition of NCS in soil – lime mixture, the compaction values of the soil changes.
- The optimum moisture content of the soil mixture increase with increase in NCS content.
- The maximum dry density of the soil mixture decreases first. But with the increase in the NCS content, MDD of soil mixture get improved.

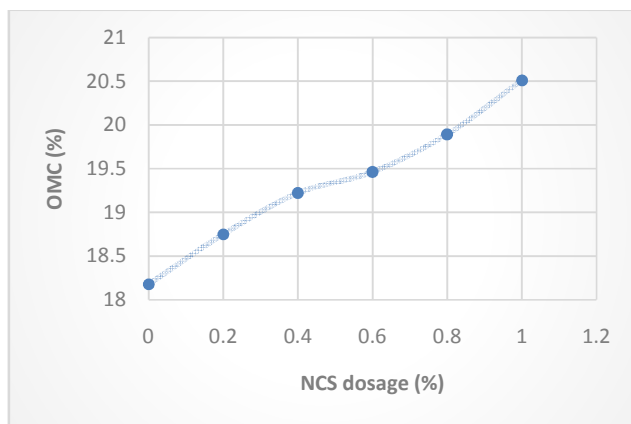


Fig.3: Variation of NCS on OMC of soil – lime mixture.

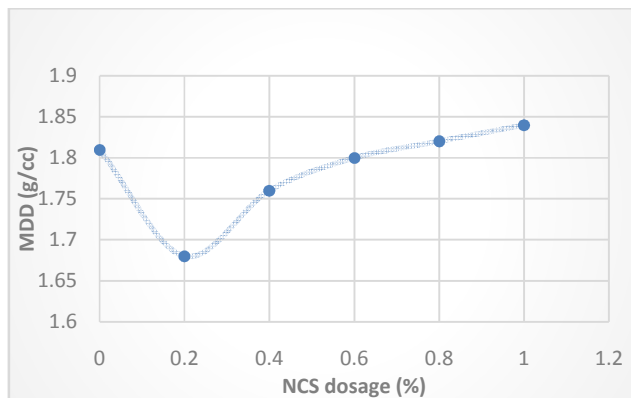


Fig.4: Variation of NCS on MDD of soil – lime mixture.

From the table it is clear that while increasing the percentage of NCS, OMC get increased and MDD get reduced. In samples where lime is mixed due to the rapid reactivity. Properties of silica nanoparticles with lime, soil particles are flocculated in immediate reactions. This makes compaction process difficult

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