International Journal of Scientific Research and Engineering Development-– Volume 3 Issue 3, May – June 2020

Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

Study on the Geotechnical Properties of Nano silica Stabilized Soil

Divya S Nair*, Tara Leander**

*(PG Student, Department of Civil Engineering, Marian Engineering College,Thiruvananthapuram
Email: divyasnair1996@gmail.com)

** (Assistant Professor, Department of Civil Engineering,Marian Engineering College, Thiruvananthapuram
Email :leander.tara@gmail.com)

--************************----------------------------------

Abstract:

One strategy to achieve the goal is to alter the mechanical properties of the soil through the methods known as soil improvement technique. Nano silica are added in varying percentages like 0.2,0.4,0.6,0.8 and 1% to the soil samples. From compaction test, maximum dry density (MDD) and optimum moisture content (OMC) are to be determined for bentonite soil. Strength parameters for clayey soil are obtained from unconfined compressive strength. Increasing the nano silica to soil ratios led to a reduction in the plasticity index due to increase in plastic limit and decrease in liquid limit.

Keywords **—Stabilization, Nano silica, Compaction, CBR, Unconfined compressive strength.**

--************************----------------------------------

I. INTRODUCTION

Soil stabilization is widely used in connection with road, pavement and foundation construction. It improves the engineering properties of soil such as strength, volume, stability, durability, to reduce the pavement thickness as well as cost. Soil is a construction material which is available in abundance. Earth has been used for the construction of monuments, tombs, dwellings, etc. The study of engineering behaviour of different types of soils is extremely important because all civil engineering structures will have to be rested and founded on soil. The purpose of soil stabilization is to increase bearing capacity and reduce settlement and deformation.

In recent years, large steps have been taken in the field of nanotechnology, and many of the nanotechnology-based breakthroughs have been made in geotechnical engineering. It is apparent that nano materials will be used to improve the geotechnical properties of soils soon, extensively. The presence of even very small amount of nanomaterial can have significant effects on the engineering properties of soil. Addition of nano-silica in the soil gives short term strength rapidly. The rapid strength in the enhancement and compressibility reduction by nano-silica is useful for the expansive soils, where settlement failures of foundations are prominent. This additive meets unique features which makes it suitable to be applied in soil improvement methods among the other additives. Moreover, research on pozzolanic activity of silica nanoparticles indicated a high pozzolanic activity of nano-silica compared to micro silica due to presence of high amorphous SiO2. Since silica nanoparticles act as an accelerator, structure of cementitious materials becomes denser and more uniform even in a short time of curing .

II. MATERIALS AND METHODOLOGY

A. *Soil*

The soil in this study is collected from kochi..The properties of the soil are studied using standard procedures and the results are tabulated in table.

TABLE 1
Properties of Bentonite clay

Soil properties	Specifications
Specific gravity	2.59
Liquid limit (%)	336
Plastic limit (%)	46.79
Shrinkage limit (%)	12.4
IS classification	CH
UCS (kPa)	112.7
OMC (%)	38
Dry density (g/cc)	12.65

B. *Nano silica*

The stabilizing agent used in the investigation is nano silica. For studying the effect of nano silica in soils, different tests were conducted and were added in different concentrations i.e., various percentages. The properties of the nano silica are given in table below:

TABLE 2.
Properties of nano silica

Properties	Specifications
Nano type	silicon dioxide
Purity (%)	99
Particle size (nm)	15
Specific surface area (m2/gm)	600-785
Bulk density (g/cc)	0.1
Specific gravity	2.4
Colour	White

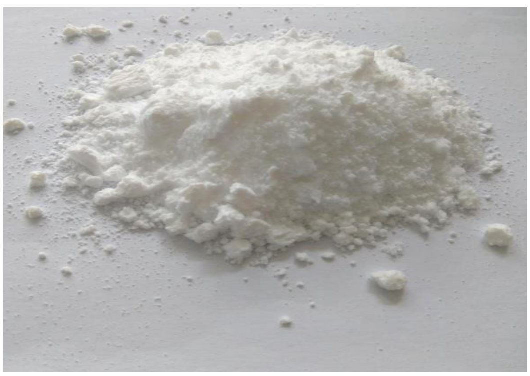

Fig 1 Nano silica

III.TEST PROCEDURE

In this study the soil is stabilized using nano silica. The soil was treated with different percentages of nano silica like 0.2,0.4,0.6,0.8 and 1%. The atterberg limit, compaction characteristics and unconfined compressive strength are determined as per IS.

IV. RESULT AND DISCUSSIONS.

A. *Compaction characteristics.*

IS light compaction test was conducted on various percentages of nano silica (0.2%, 0.4%, 0.6%,0. 8% and 1%) with bentonite soil in accordance with the procedure laid in IS: 2720 PART 7 to study the moisture content and dry density relationship. From the test result it is observed that increase in large amount of nano silica percentage in soil-nano silica mix, OMC got increased and MDD got increased. The variation in the compaction characteristics are represented in Fig 1 and Fig 2. The data from the test indicates that the optimum moisture content of stabilized soil are increases than that of raw soil due to absorption of water by nano silica. The maximum dry density was noted to increase slightly with increase in addition of nano silica.

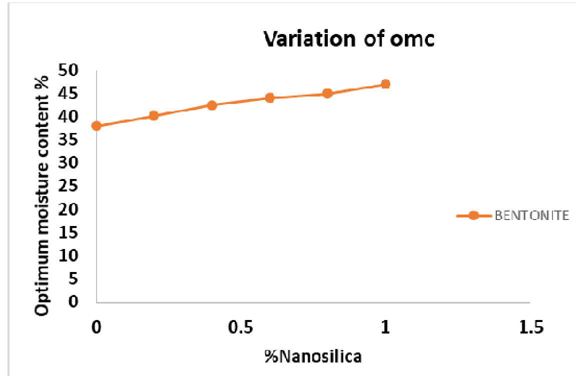

Fig 2Variation on OMC with different percentages of Nanosilica.

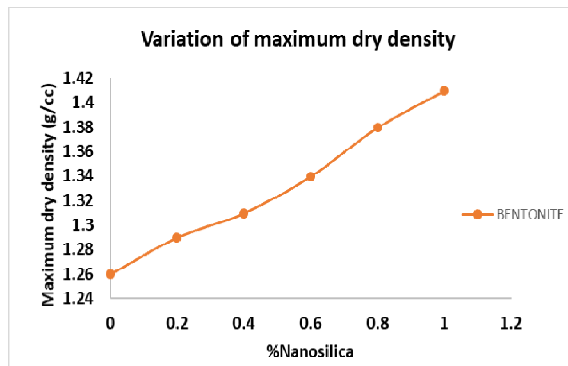

Fig 3 Variation of maximum dry density

B. Atterberg limits

Atterberg's limit test was performed as per IS: 2720 (Part 5) 1985. Soil sample passing through 4.25 mm IS sieve was used to determine liquid limit, plastic limit, and plasticity index characteristics. Variation of Atterberg's limit with the addition of Nano silica and soil was also studied.

Bentonite was treated with varying percentages of Nano silica such as 0.2%, 0.4%, 0.6%,0.8% and 1%. The test result indicates the liquid limit decreases and plastic limit increases.

The decrease in liquid limit on increasing the nano silica content due to reduction in thickness of diffused double layer and absorption of water content by nano silica.

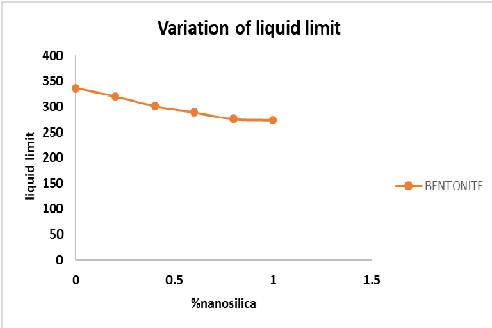

Fig 4 Variation of liquid limit

When Nano silica was added into soil, the plastic limit increased. The variation of plastic limit is shown in the Fig 4. Plastic limit increases with increase in dosages of Nano silica due to the reaction adduced by liquid limit.

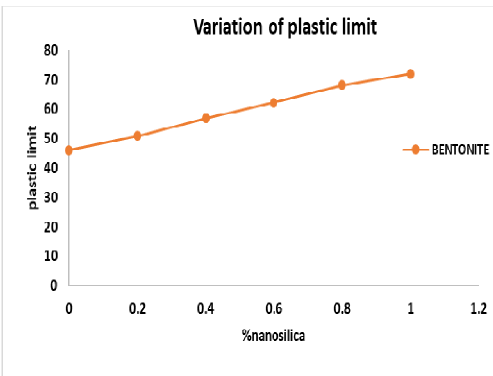

Fig 5 Variation of plastic limit with the addition of Nano silica.

When Nano silica was added into soil, the plasticity index is reduced. The variation of plasticity index is shown in the Fig 5. This reduction is due to decrease in liquid limit and increase in plastic limit.

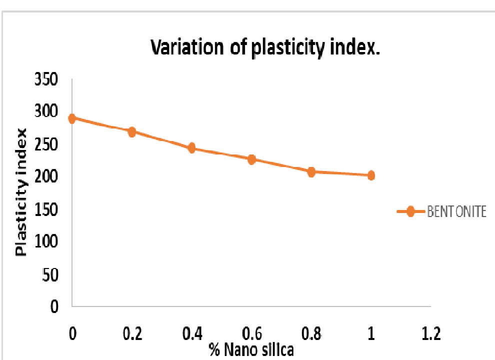

Fig 6 Variation of plasticity index

C. Effect on Nano silica on UCS on soil mixtures

Effect of Nano silica on the soil with different dosages shows that the compressive strength increases with increase in the dosage of the Nano silica , however the dosage of a Nano material is preferred to be kept within 0.8%, since it absorbs more water. Fig 6 represents the UCS results for samples It can be observed that the increase in dosage of Nano silica increases the UCS value, which is an indication that the Nano silica causes a change in the behavior of the soil mass by producing greater bonding between the soil particles. Nano silica also reduces the spacing between the soil particles, even the generation of viscous gel is proposed to be formed due to Nano material (Changizi and Haddad 2016). The effect of Nano material is achieved by the polar and electrostatic interactions leading the behavior between particles at nano range due to weak Vander Waals forces, and further aggregation of particles due to the forces developed, is controlled by the effect of Brownian diffusion, fluid motion and gravity

The UCS increases with an increase in nano-silica content up to 0·8%, beyond which it decreases. Thus, the optimum nano-silica content is 0·8%. At constant moisture content, due to the absorption of water by nano-silica, the clay became less compressible, which was worsened with increasing nano-silica content. This may be the reason for the reduction in the peak strength of stabilised clay with 1% nano-silica in comparison with clay stabilised with 0·8% nano-silica.

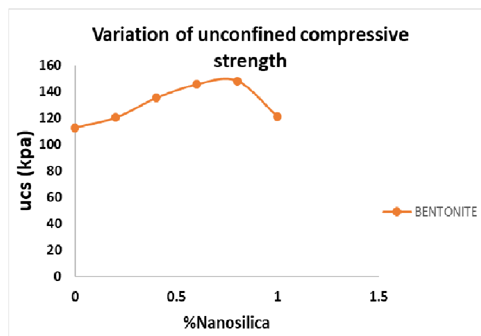

Fig 7 Variation of unconfined confined compressive strength

V. CONCLUSION

- The present study deals the geotechnical properties of the soil amended with Nano silica in different dosages.
- The results of the Atterberg limits experiments indicate that, with the addition of each percentage of nano-silica, the liquid limit decreases and plastic limit increases. Thereby the plasticity index decreases. A further increase in additive percentage beyond the optimum for soil stabilisation causes a

reduction in the overall rate of PI of the stabilised soil.

- The addition of nano-silica leads to an increase in water absorption and a reduction in pores between clay particles, resulting in an increase in both the maximum dry unit weight and increase in optimum moisture content of soil.
- The UCS increases with an increase in nano-silica content up to 0·8%, beyond which it decreases. Thus, the optimum nano-silica content is 0·8%.
- The reason is that at constant moisture content, due to the absorption of water by nano-silica, the clay became less compressible, which was worsened with increasing nano-silica content. This may be the reason for the reduction in the peak strength of stabilised clay with 1% nano-silica in comparison with clay stabilised with 0·8% nano-silica.

REFERENCES

[1] FoadChangizi,Abdolhosein,“ strength properties of soft clay treated with mixture of nanosilica and recycled polyester fibre”, Journal of Rock Mechanics and Geotechnical Engineering 7: 367-378, 2015.
[2] FoadChangizi, Abdhosein Haddad, “Improving the geotechnical properties of soft clay with nanosilica particles”, Journal of geotechnical engineering, 2017.
[3] Joju M R , “Comparitive study on stabilization of marine clay using nanosilica and lime”marine geotechnology,7 (7):189-209, 2018.
[4] N.Ghasabkolaei, N.Roshan , “Physical and geotechnical properties of clayey soil using silica nanoparticles” indian geotechnical society, pp 319-322,2016.
[5] R Iswaraya , V Satheeshkumar, “ Influence of nanosilica on the geotechnical properties of clayey soil stabilized with lime”, Asian Journal of Engineering and Applied Technology”, Vol 7,28-32,2018.
[6] SamanSoleimani,Kutanaei,Asskar,Janalizadeh,Choobbasti,”Effect of nanosilica particles and randomly distributed fibres on the mechanical properties of cemented sand”,ASCE , Issue 1, pp 381-384, 2016.
[7] Sayed HessamBahmani,AfshinAsadi ,”Stabilization of residual soil using sio2 nanoparticles and cement”, Journal of construction and building materials,vol 64, 350-359, 2014.

.

