STABILIZATION OF WEAK CLAY SOIL USING NANOCLAY

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ABSTRACT

Nanomaterials are effective technique to improve some behavioural parameters of soil such as strength, permeability, selfrepairing etc. In this project nanoclay is used as additive to overcome the weakness of soil. The weak soil obtained from manavilai is a clay soil. Various amount (1%,2%.3%,4%,5%) of nanoclay were added to study the improvements. Soil compaction test was performed to find the optimum moisture content(12%). Tests were conducted using nanoclay and then without it. The engineering properties of soil is found out by specific gravity test, sieve analysis, atterbergs limit test and proctor compaction test. The mechanical properties of soil is found out by unconfined compressive strength test, direct shear strength test and CBR test. In unconfined compression strength test the maximum yield is obtained at 4% of nanoclay is added. When more than 3% of nanoclay is added the CBR value increases and shear strength value decreases. In this project the optimum mixture design for stabilization of clay soil was selected as 3% of nanoclay.

Keyword: - *Soil stabilization, Nanoclay, Unconfined compression, Direct shear test, CBR test, Clay soil*.

1. INTRODUCTION

The loads of the structure are effectively distributed to the soil so that the strength and stability of the soil play a major role in preventing structural subsidence, cracks and fissures. To prevent or to overcome or to improve the weakness of soil , a cementing material or other chemical material is added to the natural soil is known as soil stabilization. Homogeneous mixing of additives leads to proper soil stabilization. Now a days the stabilization process is carried out by nano materials .The nano technologies idea was suggested by Richard Feynman in 1959, its application in soil mechanics including seepage, grouting ,soil stabilization. The chemical reaction of nano materials occur in nano scale, many of natural soil and rock minerals are nanomaterials. The soil selected from Manavilai is weak clay soil. The additive nano composite reduce the swelling property and improves the geotechnical properties

of clay. The nano composite which we selected is nanoclay, it is the nano particles of layered mineral silicate, depending on the chemical composition and nano particle morphology.

While adding the additive agent nanoclay to the weak clay soil, it is noticed that the bearing strength increases by increasing the amount of nanoclay. Various tests such as direct shear strength test, unconfined compressive strength test, california bearing ratio test are performed. About 1% to 5% of nanoclay is added for effective result. This paper presents the results of the experimental study on clay soil by stabilizing it with nanoclay.

1.1 Objectives and scope

- Utilization of local weak soil
- To study the properties of soil
- To improve the properties of soil
- To increase the strength of the soil by using nanoclay
- To improve the density of the soil

2. EXPERIMENTAL WORK

The soil used in this project obtained from Manavilai is a weak clay soil. The grain size distribution of soil is found by sieve analysis .The particle size distribution curve of soil is shown in figure (1).

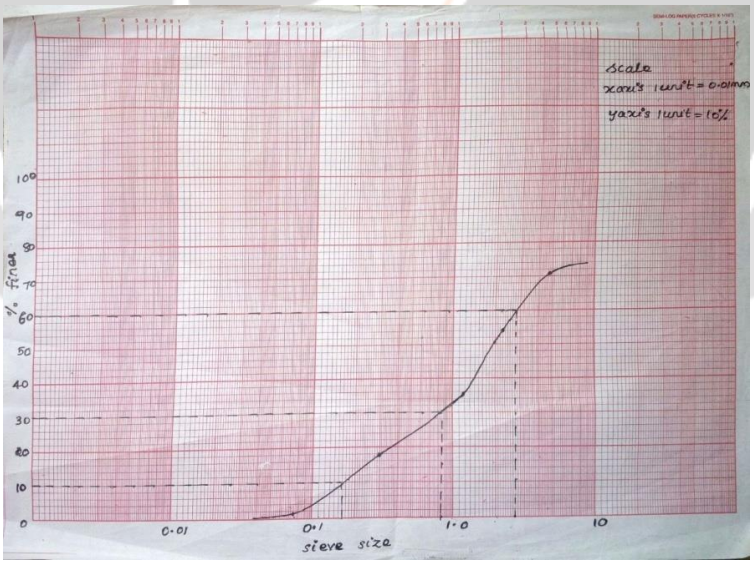

Fig -1: Particle size distribution curve

The engineering properties of soil sample were found by specific gravity test (pycnometer), liquid limit test (casagrande apparatus), shrinkage limit test, plastic limit test, proctor compaction test. The result obtained from these test is found in table(1).

Table -1: Results of engineering properties of soil sample

S.no	Properties	Result
1	Specific gravity	2.66
2	Liquid limit (W_c)	29.5%
3	Flow index (I_F)	10.32
4	Plastic limit (W_p)	15.21%
5	Plasticity index(I_p)	14.29
6	Toughness index (I_T)	1.38%
7	Shrinkage limit (W_S)	3.04%
8	Shrinkage ratio (R)	1.529
9	Volumetric shrinkage (V_S)	13.56%
10	Optimum moisture content	12%

Mechanical properties of soil were found out by unconfined compression test, CBR test, direct shear strength test. The result obtained from these test is shown in table (2)

Table -2: Results of mechanical properties of soil sample

s.no	**Mechanical properties**	**Result**
1	Unconfined compression test	31.5KN/m^2
2	Direct shear strength test	0.69kg/cm^2
3	CBR test	0.034%

The chemical composition and physical properties of nano clay is shown in table (3) and (4)

Table -3: Chemical composition of nanoclay

s.no	Chemical compounds	Result(%)
1	Na_2o	1.13
2	Cao	1.02
3	Al_2o_3	18.57
4	Sio_2	43.77
5	H_2o	36.09

Table -4: Physical properties of nanoclay

s.no	Properties	Result
1	Specific surface area	$750m^2/g$
2	Particle size	10nm
3	Density	$2.35g/cm^3$

3. RESULTS AND DISCUSSION

The optimum moisture content is found out by standard proctor test. The soil attain maximum density at optimum moisture content.The result of optimum moisture content is shown in figure (2).The water content corresponding to the maximum density is called the optimum water content W_o

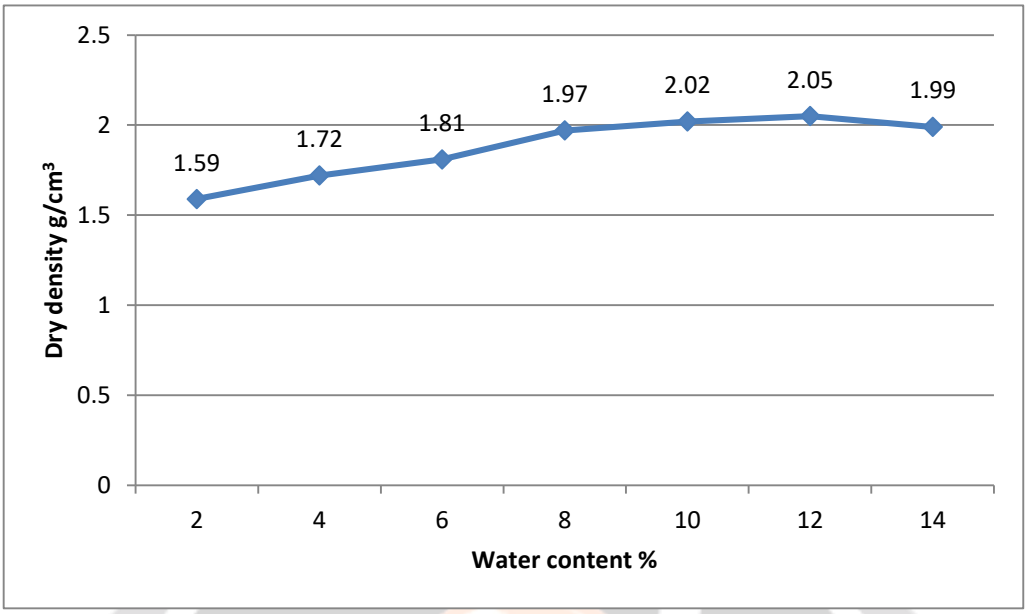

Chart -1: Comparison result of compression strength of soil and soil with different % of nanoclay

The unconfined compression tester is used to determine the compressive strength of soil. The result is shown in figure (3). The compression value is maximum when 4% of nanoclay is added and the value reduces when more than 4% is added.

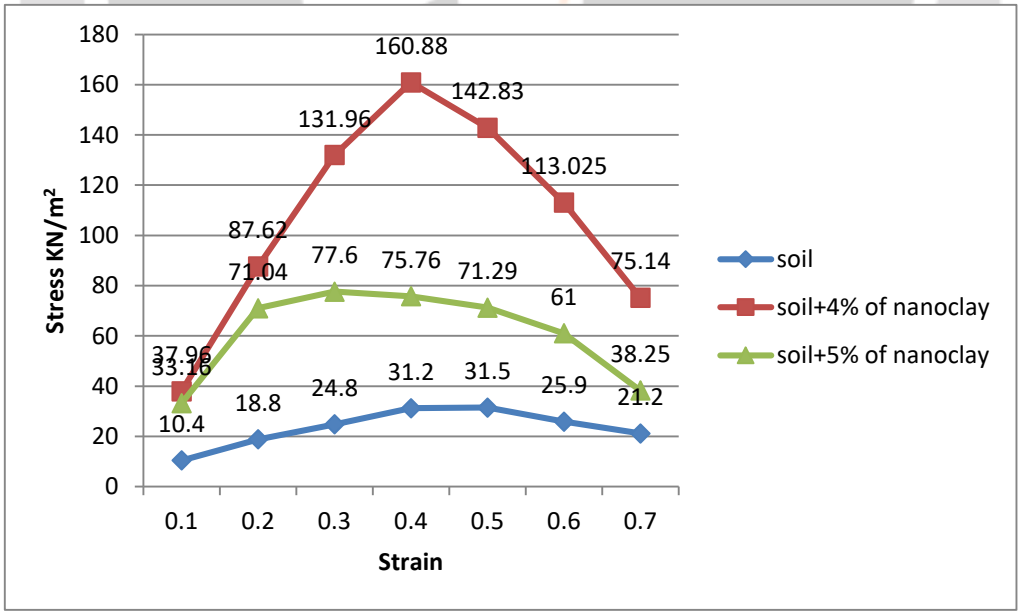

Chart -2: Comparision result of compression strength of soil and soil with different % of nanoclay

When soil is loaded, shearing stresses are induced in it. When the shearing stresses reach a limiting value, shear deformation takes place, leading to the failure of the soil. In order to overcome these failure nanoclay is added.

By using shear box apparatus the shear strength is determined .The result is shown in figure (4). The shear strength value is maximum at 3%.

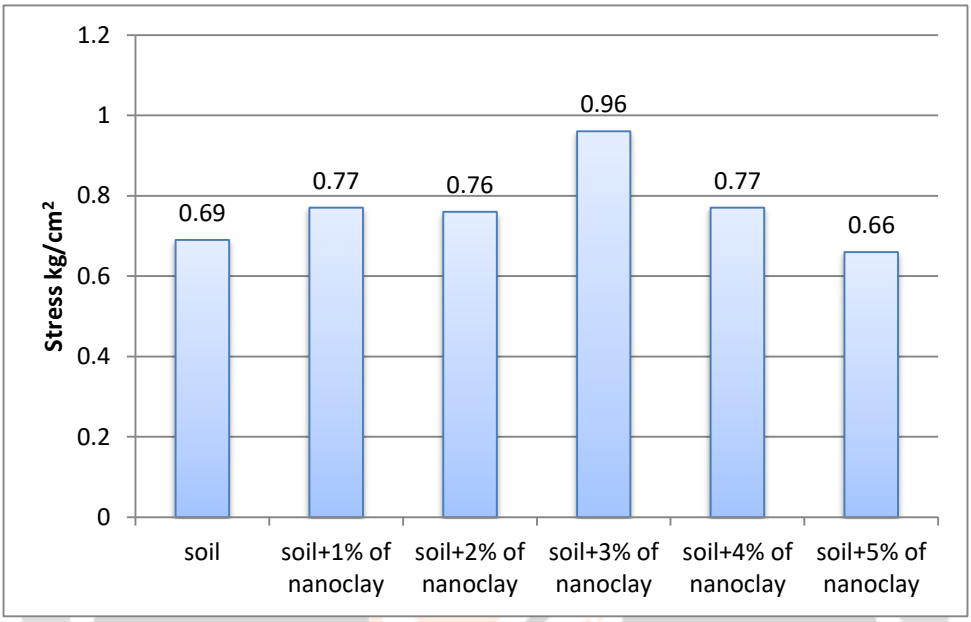

Chart -3: Comparision result of shear strength of soil and soil with different % of nanoclay

The california bearing ratio test is penetration test meant for the evaluation of subgrade strength. The CBR value obtained for soil with various percentage of nanoclay is shown in figure (5). The maximum yield is attained when more than 3% of nanoclay is added.

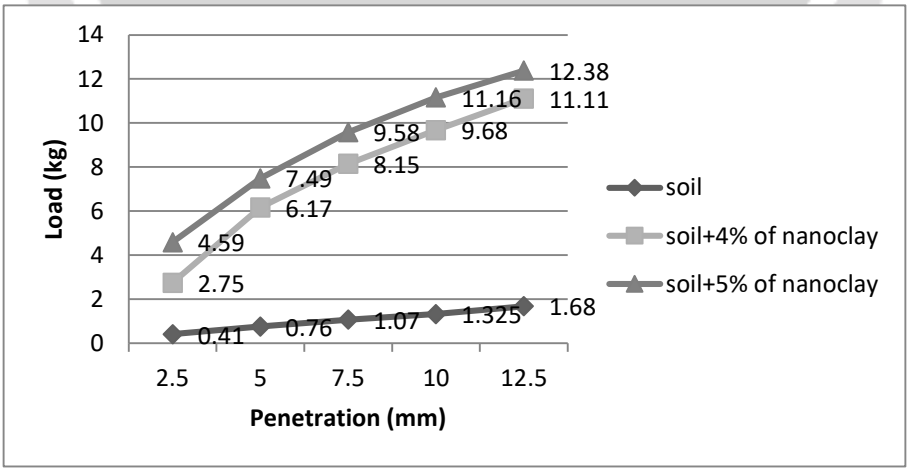

Chart -3: Comparision result of CBR value of soil and soil with different % of nanoclay

4. CONCLUSIONS

From the above result the application of nanoclay in the stabilization of weak clay soil is achieved. The optimum moisture content of soil is 12%. The compressive strength is increased in 4% and decreased in 5%, hence the soil attained required bearing strength and compressive strength when 4% of nanoclay is added. The shearing strength of soil is maximum when 3% of nanoclay is added, so in this project the optimum mixture design for stabilization of weak clay soil is 3% of nanoclay.

5. REFERENCES

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