

Behaviour Of Fibre Inclusion on Nano Silica Stabilized Soil

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Abstract—The use of techniques for soil stabilization has increased significantly to adopt cost effective solutions to achieve reductions in the quantities of material used and etc. Nano particles are one of the latest additives used. The use of Nano additives in some field such as soil improvement, grouting, liquefaction risk mitigation, seepage has offered greater advantages in geotechnics. The main objective of the project is to investigate the optimal combination of Nano silica and polypropylene fibre content in kaolinite and bentonite soil. Five different combinations of Nano silica are added in varying percentages like 0.2, 0.4, 0.6, 0.8 and 1%. Polypropylene fibres are added in the varying percentages such as 0.5, 1, 1.5 and 2% used in integration with optimum amount of Nano silica. The engineering properties such as liquid limit, plastic limit, compaction characteristics, Unconfined compressive strength are analyzed with virgin soil, the soil with Nano silica and combination of soil with Nano silica and polypropylene fibres. From these experiments, it has been analyzed that with the increase in polypropylene fibre content in addition to Nano silica, the Unconfined compressive strength increases and maximum value of Unconfined compressive strength is obtained.

Index Terms—*Compaction, Nano silica, Stabilization, 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 Nano technology, 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.

II. MATERIALS

A. Soil

Soil used in the study is bentonite clay and kaolinite clay. It has been collected from Kochi. Nano silica was used to improve the properties of the soil. The basic properties of soils obtained through experimental investigation are presented in subsequent sections.

B. Nano Silica

The stabilizing agent used in the investigation is nano silica used in the project is purchased from India Mart as online from Astra chemicals Pvt Ltd. For studying the effect of nano silica in soils, different tests were conducted and were added in different concentrations i.e., various percentages.

C Polypropylene Fibres.

Polypropylene is also known as polypropylene, is a thermoplastic polymer used in a wide variety of

application including packing, it is widely used in ready mix concrete and it is easily available. In synthetic fibre polypropylene is the world’s second widely product after polyethylene. Polypropylene is processed into film for packaging and into fibres.

III. TEST PROCEDURE

Stabilized clayey soils with optimum amount of nano silica is mixed with various percentages of polypropylene fibres (0.5%, 1%, 1.5%, and 2%) of clay. Plasticity characteristics (liquid limit, plastic limit, and plasticity index (Ip), compaction characteristics (OMC and MDD), strength (UCS) were determined in accordance with IS specifications. Mixes that give maximum UCS were selected for further studies.

IV. RESULT AND DISCUSSIONS.

To find out the effect of polypropylene on geotechnical properties on nano silica stabilized kaolinite and bentonite. The soil is mixed with polypropylene fibres by different percentages of dry weight along with the addition of optimum percentage of Nano silica such as 0.6% Nano silica for kaolinite and 0.8% Nano silica for bentonite and various tests are done. The results obtained as follows

A. Compaction characteristics.

The strength of soil can be altered by the addition of Polypropylene fibre in varying percentages in nano silica stabilized soil. In this study a series of compaction tests were carried out by varying polypropylene fibre on nano silica stabilized soil, the corresponding optimum moisture content are presented. The results shows that there is a slight reduction in the optimum moisture content as the percentage of polypropylene fibre increases.

The data from the test indicates that the optimum moisture content of stabilized soil decreases. When clay was stabilized with polypropylene fibre, the compacted nano silica soil composite yielded to a 25% to 23.8% of optimum moisture content (OMC) for kaolinite soil

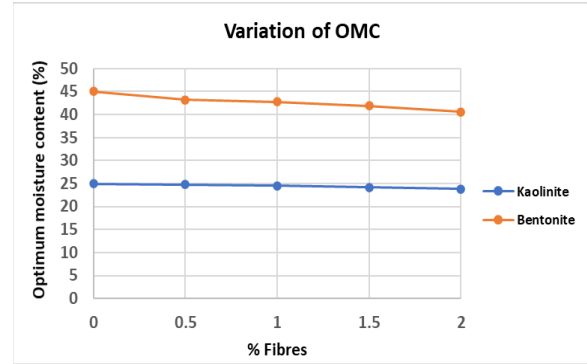


Fig 4.1 Variation of Optimum moisture content on addition of Polypropylene fibres

For bentonite the optimum moisture content decreases from 45% to 40.6% by increasing the polypropylene fibre content. It can be noticed that there was slight difference in the OMC for unstabilized soil

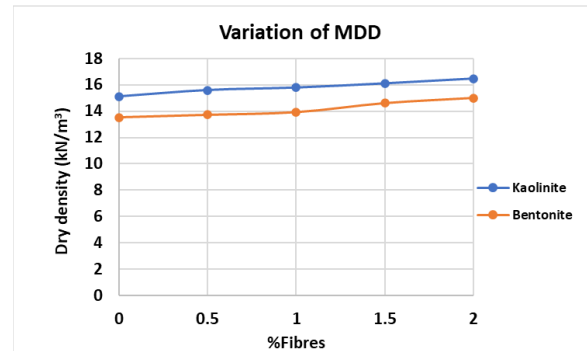


Fig 4.2 Variation of drydensity on addition of Polypropylene

Figure 4.2 shows the results of the maximum dry unit weight of soil stabilized with polypropylene fibre on nano-silica stabilized soil obtained from compaction tests. The figure indicates that an increase in nano silica content contributes to an increase in the maximum dry unit weight as the percentages of polypropylene fibres increases to a limit as shown in.

B. Atterberg limits.

The relationship between the liquid limit and polypropylene fibre content on nano silica stabilized soil is illustrated in Figure 4.3

From Figure 4.3, one can conclude that the addition of 2% of fibre on nano-silica stabilized kaolinite leads to an increase in plastic limit from 25.5% to 27.3%, compared with the natural clay, indicating an increase of plastic limit of 6.5%.

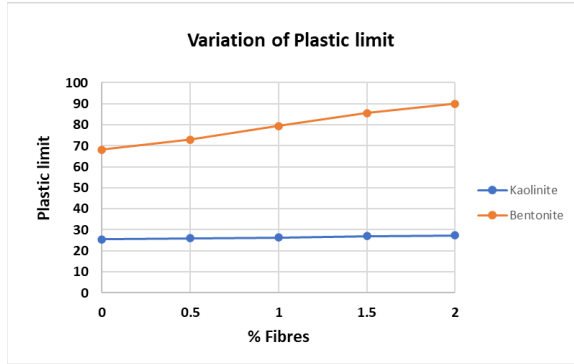


Fig. 4.3 Variation of plastic limit with addition of Polypropylene fibres on nano silica

Similarly, from Figure 4.8, by the addition of 2% nano-silica in bentonite leads to an increase in plastic limit from 68.1% to 90%, compared with the natural clay, indicating an increase of 24.3%. The increase in plastic limit on increasing the nano silica content due to cationic exchange reaction adduced by liquid limit.

C. Unconfined compressive strength.

The results of the unconfined compression tests on clay stabilized with various nanosilica contents are presented in Figure 4.4

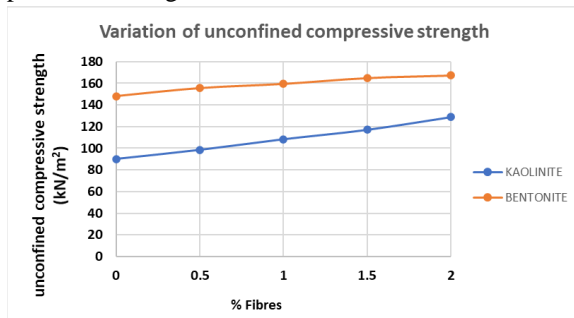


Fig. 4.4. Variation of Unconfined compressive strength with polypropylene fibre on nano silica stabilized soil.

The Unconfined compressive strength has been conducted on nano silica stabilized soil in the ratios of 0, 0.5, 1, 1.5, 2% of polypropylene fibres. It seen that Unconfined compressive strength increases from 90.1 kN/m² to 128.7 kN/m² in kaolinite. In case of bentonite, it increases from 148 kN/m² to 167.4 kN/m². The strength of clay evidently increases with increasing polypropylene fibre content. The Unconfined compressive strength increases to maximum value at 2% of polypropylene fibre content.

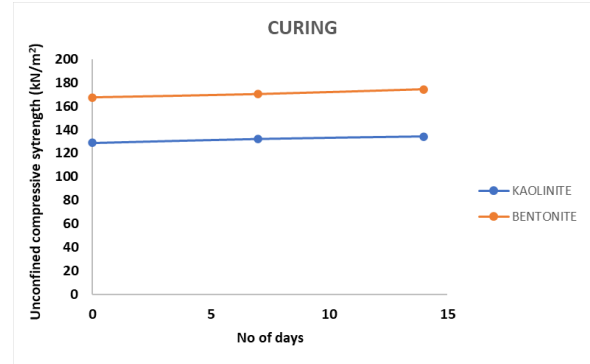


Fig. 4.5. Variation of Unconfined compressive strength with polypropylene fibre on nano silica stabilized soil on curing.

2% of polypropylene fibre in nano silica stabilized soil is cured for 7 and 14 days. At 7 days the unconfined compressive strength increases to 132 kN/m² and for 14 days increases about 134.1 kN/m² in kaolinite stabilized soil. In case of bentonite stabilized soil at 7 days the unconfined compressive strength increases to 170.2 kN/m² and for 14 days increases about 174.3 kN/m².

V. CONCLUSIONS

- The results of the Atterberg limits experiments indicate that, with the addition of each percentage of nano-silica, the liquid limit decreases from 34% to 27.5% on kaolinite and for bentonite it decreases from 336% to 274%. Plastic limit increases from 23% to 27.5% on kaolinite and for bentonite it increases from 46.09% to 72%. Thereby the plasticity index decreases. A further increase in additive percentage beyond the optimum for soil stabilization causes a reduction in the overall rate of PI of the stabilized soil.
- With the addition of polypropylene fibres on nano silica stabilized soil the liquid limit decreases from 31.5% to 28% on kaolinite and for bentonite it decreases from 276% to 260.5%. Plastic limit increases from 25.5% to 27.3% and for bentonite it increases from 68.1% to 90%. Thereby the plasticity index decreases.
- 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 decrease in optimum moisture content of soil.

- The optimum moisture increases from 20% to 29% on kaolinite and for bentonite it increases from 38% to 47%.
- In the case of maximum dry density, it increases for kaolinite and for bentonite.
- With the addition of polypropylene fibre on nano silica stabilized soil the optimum moisture content decreases from 25% to 23.8% on kaolinite and for 51 bentonite it decreases from 45% to 40.6%. In the case of maximum dry density, it increases for kaolinite and for bentonite.
- The UCS increases on addition of nano silica up to 0.6% in case of kaolinite and thereby get decreased on increasing the nano silica content. In case of bentonite the UCS increases up to 0.8% and thereby increasing the nano silica it gets reduced.
- The results showed that nano-silica has a positive influence on the stiffness of treated specimens. The addition of nano-silica to clay causes a reduction in failure strain of the specimens compared with untreated clay. An increase in the content of nano-silica was associated with an increase in the brittleness of the treated specimens. With added nano-silica, failure of the specimens was sudden; consequently, on increasing the content of nano-silica, the residual UCS of composite decreases.
- The optimum content of nano silica in kaolinite is about 0.6% and 0.8 % nano silica in bentonite.
- The result showed that Unconfined compressive strength increases from 90.1kPa to 128.7 kPa in kaolinite. In case of bentonite, it increases from 148kPa to 167.4 kPa. The strength of clay evidently increases with increasing polypropylene fibre content. The Unconfined compressive strength increases to maximum value at 2% of polypropylene fibre.

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