

Study of Basalt Fiber On Compaction Characteristics Of Black Cotton Soil

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Abstract:

With increase of population demand of land increases, therefore civil engineering structures have to be carried out on weak or soft soil. Various ground improvement techniques such as soil stabilization and reinforcement are employed to improve mechanical behavior of black cotton soil. Black cotton soil is one of the major soil deposits of the India. It exhibit high swelling and shrinkage when subjected to change in moisture content and hence it is very troublesome for engineering consideration. Basalt fiber is relatively a new soil stabilizer material. It is made from basalt rock melted at high temperature. It is non-metallic, high performance and inorganic fiber. The length as well as content of basalt fiber was considered in this paper. The study has been conducted on 12 mm long basalt fiber with five different fiber contents of 0%, 2%, 4%, 6%, and 8% by weight of soil sample. The Compaction characteristic (OMC and MDD) of fiber reinforced soil was determined using Standard Proctor test. The experimental results indicated that compaction characteristics of black cotton soil can be improved by reinforcing it with Basalt Fibers.

Introduction

For any land-based structure, the foundation is very important and hence it is to be strong to support the entire structure. For strong foundation the soil around it as well as below it should be strong. A large part of central India and a portion of South India are covered with Black Cotton soils. Black cotton soils are clay of high plasticity. They contain essentially the clay mineral montmorillonite, which is the most unstable clay mineral, thus it has high shrinkage and swelling characteristics. The shear strength of such soil is very low. It is highly compressible and has very low bearing capacity. The wetting and drying process of a subgrade layer of a black cotton soil results in failure of pavements in the form of settlement and cracking. So, it is very difficult to construct structure on Black Cotton soil. Therefore, to make construction on such soil it is important either to improve the existing soil and replace it with a non-expansive soil or to improve the engineering properties of existing soil by stabilization. There are various methods used to improve the performance of poor quality soil. The general method is to replace it with a good quality soil. The choice of a particular method depends mainly on the type of the soil, its characteristics and the type and degree of the improvement desired in a particular application.

Many stabilizers are used to improve performance of black cotton soil like steel fiber, glass fiber, polypropylene fiber. Out of the various fibers available, Basalt Fibers are one of newly introduced stabilizer made up of natural material. The French Paul Dhe was the first with the idea to extract fibers from basalt and has received U.S. patent in 1923. No chemical additives as well as any solvents, pigments or other hazardous materials are used for their production. They do not have toxic reaction with air or water, and are non-combustible and explosion proof.

Ndepote and S.Sert^[9] investigated evaluation of the increase in soil strength, which is reinforced, in different percentages, by basalt chopped fibers. Gisymol P George, Ramya K^[5] studied the effect of Basalt Fiber in Organic Soil. Lei Gao, Guohui Hu, et al^[4] did an experimental study on unconfined compressive strength of basalt fiber reinforced clay soil.

Materials Used

Black Cotton Soil: The soil sample for the present study was collected from Kotwal farm, Chandwad, Dist-Nasik, Maharashtra. It was collected within 0.5m of ground surface. The soil is then sieved from 4.75mm IS sieve and passed soil is oven dried and then used for test. It is as shown in figure below



Figure1: Collected soil sample

Table1– Properties of collected Black Cotton Soil

Sr.No.	Property	Value
1	Field density	1.5g/cm ³
2	Liquid limit	56.5%
3	Plastic limit	36%
4	Specific gravity	2.75
5	Soil classification	CH
6	Color	Black

BasaltFiber: The Basalt Fiber required for the study is collected from JR Chitaliya, Mumbai. The fiber is as shown in following figure. The Basalt fiber is also known as the “21st Century non-polluting green material”. It is 100% natural and inert. Mechanical parameters are as shown in table given below.



Figure2: Basalt Fiber
Table 2 Properties of Basalt Fiber

Sr.No.	Properties	Value
1	Density	2.65 gm/cm ³
2	Elastic Modulus	85.9 GPa
3	Tensile Strength	2611 Pa
4	Length	12 mm
5	Filament Diameter	0.16 micro meter

6	Color	Golden green
7	Cost of basalt fiber	Rs.400/- per kg

Methodology

The soil was passed from 4.75mm IS sieve and it is oven dried for 24 hours. Basalt fiber is mixed with soil sample had been taken as the prime sample material, in order to determine the Compaction characteristics of sample. The length of fiber used was 12mm. Fibers of five different percentages that is 0%, 2%, 4%, 6%, and 8% by weight of soil sample were added to the soil and mixed properly to obtain uniform mixture of reinforced soil. The optimum moisture content (OMC) and maximum dry density (MDD) of corresponding sample is determined by Standard Proctor Test.

Results and discussion

Table 3 Effect on OMC and MDD with % of Basalt Fiber

Sr.No.	Basalt Fiber Content (%)	OMC %	MDD (gm/cm ³)
1	0	18.30	1.646
2	2	13.15	1.808
3	4	10.80	1.820
4	6	17.83	1.590
5	8	19.18	1.530

Figure 3 Variation of OMC with % of Basalt Fiber

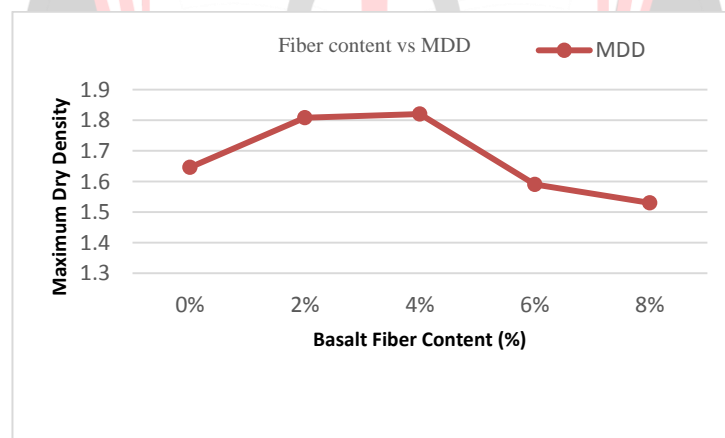


Figure 3 Variation of MDD with % of Basalt Fiber

- Initially as fiber content increases from 0% to 4%, OMC decreases, but corresponding MDD increases. Further increase in fiber content from 4% to 8% causes increase in OMC value and decrease in MDD value.

Conclusion

Test conducted on Black cotton soil with various contents of basalt fiber, leads to following conclusion,

- Highest MDD is obtained when 4% basalt fibers by weight of soil mass were added in soil.
- There is 9.56 % increase in MDD of black cotton soil due to addition 4% of basalt fibers in comparison with MDD of unreinforced soil.
- Lowest OMC is obtained at 4% of basalt fibers by weight of soil mass.
- OMC of soil reinforced with 4% of basalt fiber is 41% less than that of unreinforced soil.
- Above result indicates that the compaction properties of black cotton soil are improved by reinforcing it with basalt fiber.

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