Soil Stabilization Using Waste Fiber Material

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Abstract- *In this research, an attempt is made to use E-glass fiber as stabilizing material for critical clayey soils. An experimental investigation is carried out to study the effect of waste fiber materials on engineering properties of clayey soil. The engineering properties that taken into consideration are optimum moisture content, maximum dry density and compressive strength. The changes in these properties of the natural soil with the addition of waste fiber in different proportions were evaluated. It is observed that the above properties have optimally improved by adding waste fiber. This study shows that waste fiber can be satisfactorily used as a stabilizing martial. The study area considered is Ahmedabad, Gujarat, India.*

Keywords- Soil stabilization, Waste fiber, E-Glass fiber, Clayey Soil, OMC, MDD, Compressive strength

I. INTRODUCTION

Soil stabilization is the process which is used for modifying the properties of soil and thus enhancing its engineering performance. With help of stabilization, many major properties of soil such as stability, strength, compressibility, durability, permeability etc. get improved. The method of soil stabilization helps to attain the specified properties in a soil needed for the development work.

Since the beginning of construction soil stabilization existed. But due to use of outdated methods stabilization lost its meaning. Due to emerging new and advanced techniques soil stabilization has found new meaning.

There are mainly two methods of soil stabilization:

1. Mechanical Method:

In this method, various types of soils are mixed together to attain the soil having required properties. This method is performed at the site or someplace else from where it can be transported without any difficulty. The ultimate soil mixture is then compacted by using the conventional methods.

2. Additive Method:

In this procedure, manufactured products are added to the soil in proper quantity to improve the soil quality. Various materials such as fly ash, coal, lime, cement etc. Every so often fibers are also used as additives.

In this research randomly distributed E-Glass fibers are used as reinforcements to improve soil's engineering properties.

Uses of soil stabilization:

1. To improve the bearing capacity of soil for foundations.
2. To improve stability of slopes.
3. To prevent erosion and formation of dust in dry weather.
4. To control the volumetric change in expansive soil.
5. To improve strength, durability and workability of soil, etc.

II. EXPERIMENTAL INVESTIGATION

Scope of work

The experimental work consists of following:

- Particle size distribution by sieve analysis
- Determination of Specific gravity
- Determination of soil index properties (Atterberg limits)
  - Liquid limit
  - Plastic limit
  - Shrinkage limit
- Determination of Maximum Dry Density (MDD) and Optimum Moisture Content (OMC) by Heavy proctor compaction test
- Preparation of reinforced soil sample
- Determination of compressive strength by Unconfined compression test

Materials

1. Soil sample (Location- Sanathal, Ahmedabad)

2. Reinforcement: E-Glass Fiber

Figure 1: E-Glass fiber

Parameters	Value
Average length	3-20 μ
Average diameter	5 cm
Density	2.6 mg/m^3
Compressive strength	5000 MPa
Tensile strength	2050 MPa
Elastic limit	2875 MPa
Acid alkali resistance	Very good
Despicability	Excellent

Table 1: Index and strength parameters of fiber

Preparation of sample

- Content of fiber in the soils is here in decided by the following equation:

$$\rho f = \frac{Wf}{W}$$

Here,
ρf = ratio of fiber content
Wf = weight of the fiber
W = weight of the air-dried soil

- The different values adopted in the present study for the percentage of fiber reinforcement are 0%, 0.5%, 1.0%, 1.5%, 2.0% and 2.5%.

- If fiber reinforcement was used, the adopted content of fibers was first mixed into the air-dried soil in small increments by hand, making sure that all the fibers were mixed thoroughly, so that a fairly homogenous mixture is obtained, and then the required water was added.

III. RESULTS

Soil characteristics:

Various experiments were performed to determine the type of soil.

The obtained results are tabulated below:

Property	Value
Specific gravity	2.5
Plastic limit	16.98%
Liquid limit	33%
Shrinkage limit	8.68%
Plasticity index	16.02%

Table 2: Soil properties

According to IS 1498-1970,
Type of soil: CL- Clay, Low plasticity

Heavy proctor compaction test:

The Optimum moisture content (OMC) and Maximum dry density (MDD) of the soil samples for various percentage of plastic Fiber materials (0%, 0.50%, 1.0%, 1.5%, 2.0%, 2.5%) were determined by performing the Heavy proctor compaction test. The dry density was determined and plotted against the corresponding water content to find the optimum moisture content and the corresponding maximum dry density. The values of OMC and MDD of various percentages of fiber materials are given below in tabular form:

Sample	MDD (gm/cc)	OMC (%)
Normal soil sample	1.90	8.8
Soil 99.5% + 0.5% fibers	1.93	10
Soil 99.0% + 1.0% fibers	1.96	10
Soil 98.5% + 1.5% fibers	1.93	10
Soil 98.0% + 2.0% fibers	1.86	12.2
Soil 97.5% + 2.5% fibers	1.77	16

Table 3: Results of heavy proctor compaction test

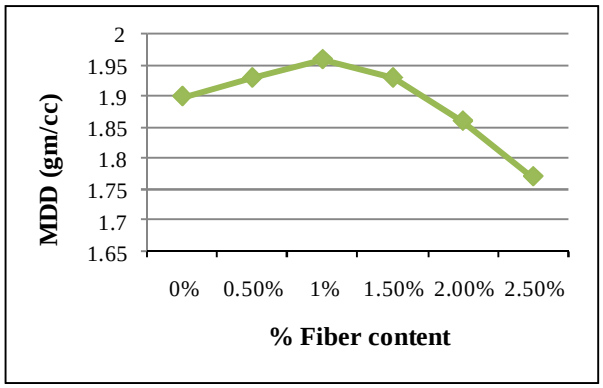

Figure 2: Variation in Maximum Dry Density (MDD) with increase in fiber content

Unconfined compression test:

This test is used to find out the compressive strength of soil. With increase in percentage fiber content the variation observed in compressive strength of soil is tabulated below:

Sample	Compressive strength (MPa)
Normal soil sample	0.0098
Soil 99.5% + 0.5% fibers	0.0220
Soil 99.0% + 1.0% fibers	0.0321
Soil 98.5% + 1.5% fibers	0.0225
Soil 98.0% + 2.0% fibers	0.0210
Soil 97.5% + 2.5% fibers	0.0082

Table 4: Results of Unconfined compression test

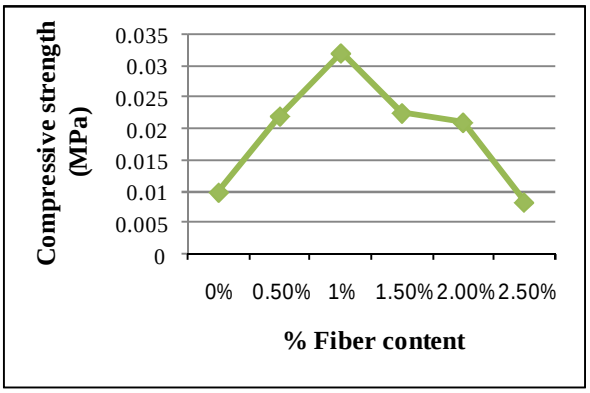

Figure 3: Variation in compressive strength with increase in fiber content

IV. CONCLUSION

The research is focused on utilization of E-Glass fiber as soil stabilization material. The study suggests that the fibers if properly mixed and applied can be used as effective soil stabilizing material. On the basis of results the research following results are obtained:

1. The replacement of 0.5% and 1.0% fibers to the clayey soil increases the Maximum Dry Density.
2. The unconfined compressive strength of the soil was found to be increased for 0.5% and 1.0%.
3. With 1.5% replacement it was observed that the MDD and compressive strength was less than the 1.0% reinforcement but was greater than the untreated soil.
4. After 1.0% further increase in fiber content results in decrease in MDD and compressive strength of soil.
5. From the results the optimum percentage of fiber is recommended as 1.0% which will improve the engineering properties of clay.

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