STABILIZATION OF CLAYEY SOIL BY USING POLYPROPYLENE FIBRE

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Abstract - *Various reinforcement techniques are used in practice among them soil reinforced with fibre technique is one of the recent ones. In this dissertation, the effect of polypropylene fibre on the various mechanical behaviour of soft soil is experimentally investigated. The effects of reinforcement have been studied using two different polypropylene fibres of the different tensile strength (BAJAJ fibre and CETEX fibre). Parameters like percentage of reinforcement, length, and tensile strength are varied and their effects on compaction characteristics, compressive strength, and CBR value have been observed experimentally. In the case of BAJAJ fibre (6 mm and 12 mm length) percentage of fibre was varied as 0.15%, 0.25%, 0.50%, 0.75% and 1%, and the strength of fibre-mixed soil gradually increased with increase in fibre quantity up to its peak point at 0.25% fibre content then it was observed to be decreasing. Similarly, in case of CETEX fibre (6 mm and 12 mm length), the percentage of fibre varied as 0.25%, 0.50%, 0.75% and 1% here also strength was observed to be increasing and after the peak point at 0.50% fibre strength got decreased. In BAJAJ fibre strength increased by 143% in 6 mm length and 175% in 12 mm length whereas in CETEX fibre strength increased by 96% in 6 mm length and 155% in 12 mm length. High tensile strength fibre gives high strength as compared with low tensile strength fibre. 12 mm length fibre gives high strength as compared with 6 mm length fibre from both the manufacturer.*

***Key Words*:** Fibre-reinforced clay, polypropylene fibre, soil stabilization, compressive strength

1.INTRODUCTION

Stabilization alters the physical and mechanical properties of soil to produce an improved soil material which has all the desired engineering properties. Soft clayey soil is generally associated with various undesirable engineering properties. They tend to low shear strength on physical disturbances. Clayey soil is normally associated with volumetric changes when subjected to change in water content because of seasonal water fluctuations. Furthermore, problems of high compressibility can cause severe damage to civil engineering structures.

Various methods are available for stabilization soft clay. Randomly distributed fibre-reinforced soil(RDFS) is one of the latest ground improvement techniques in which desired type and quantity of fibre are added in the soil, mixed randomly and laid in position after compaction. Thus, the method of preparation of RDFS is similar to conventional stabilization techniques. RDFS is different from other soil-reinforcing methods in its orientation. In reinforced earth, the reinforcement in the forms of strips, sheets, etc. is laid horizontally at specific intervals, whereas in RDFS fibres are mixed in the soil thus making a homogeneous mass and maintain the isotropy in strength. Polypropylene fibres are generally non-bio-degradable. Fibre enhances the mechanical properties of soil employing interface friction between fibre and soil particles. The fibre content and fibre length are the key parameters associated with the mechanical properties of the fibre-soil. Polypropylene fibre uses as binding material and it also useful for filtration.

Fibres can be classified into two types as synthetic fibre and natural fibre. Both types are being used for civil engineering purposes. Some commonly use fibres are coconut fibre, sisal fibre, wool fibre, cotton fibre, rubber fibre, asbestos fibre, polyester fibre, polypropylene fibre, glass fibre etc.

Polypropylene fibre is a 100% synthetic fibre, which is transformed from 85% propylene so the monomer of polypropylene is propylene. It is a by-product of petroleum. Some properties of polypropylene fibre include: lightweight (floats on water), extremely low moisture regain, quick-drying, highly resistant to mechanical abuse, mildew and insect resistant, better durability, sunlight resistant, chemical resistant, abrasion resistant etc.

1.1 Properties of reinforced soil

1. Increased shear resistance of soil after reinforcing (by interface friction, interlocking etc.)
2. Reduction in the settlement of the structure.
3. Higher resistance to erosion.

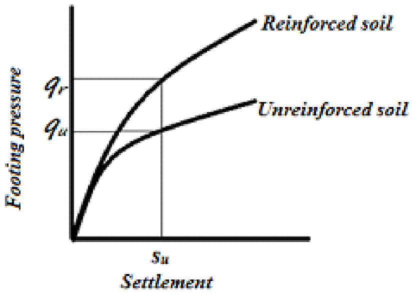

Fig -1: Load-settlement curves for soil with and without reinforcement

1.2 Scope of the study

To observe the effect of polypropylene fibre experimentally on the strength behaviour of clay soil. Perform various tests to observe the compaction characteristics, strength and stability aspects of the soil.

1. Light Compaction test
2. California bearing ratio
3. Unconfined compression test

1.3 Objectives of the study

The objective of this present research is

To carry out a literature review regarding fibre-reinforced soil

To study the effect of different fibres on the strength behaviour of clay soil. The effects of polypropylene fibre are observed by considering the following parameter.

1. By changing the percentage of fibre content.
2. By changing the length of fibre content.
3. Changing the tensile strength of fibre content.

2. MATERIALS USED

2.1 Soil

The soil was collected from Anantasayan village, district-Dhenkanal. The soil was obtained by excavating between 1 to1.5 meter and excluding organic contents. Various tests were conducted to determine the index and physical properties of the soil. All the experiments were carried out the geotechnical laboratory of the civil engineering department, IGIT Sarang.

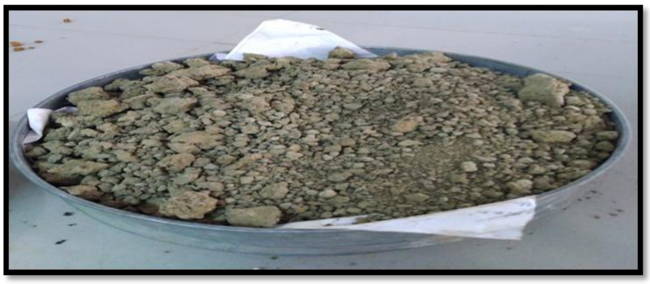

Fig -2: Oven-dried soil sample

Table -1: Properties of collected clayey soil

Sl.no	Test conducted	Properties of soil
1.	Soil passing through 75 micron	78.6%
2.	Specific gravity	2.59
3.	Liquid limit	53.79%
4.	Plastic limit	29.62%
5.	Plasticity index	24.17
6.	Optimum moisture content	17.59%
7.	Maximum dry density	1.699 g/cc
8.	California bearing ratio	8.34
9.	Unconfined compressive strength	44.11kpa
10.	Direct shear test	C=0.3505 kg/cm2 Ø=26.49°

2.2 Fibre

Polypropylene fibre was collected from two manufacturers as BAJAJ FIBRE GUARD (Nagpur) and WALTER ENTERPRISE (Maharashtra). Both 6 mm and 12 mm length fibres were collected from each manufacturer.

Polypropylene fibre is the most common synthetic material used to reinforce concrete and soil. These fibres present a good crack reduction in landfill cover barriers. The primary attraction is that of low cost. It is easy to mix with soil and has a relatively high melting point which makes it possible to place the fibrous soil in the oven and conduct the moisture tests. Also, polypropylene is a hydrophobic and chemically inert material which does not absorb or react with the soil moisture.

Fig -3: Bajaj fibre 6 mm and 12 mm length.

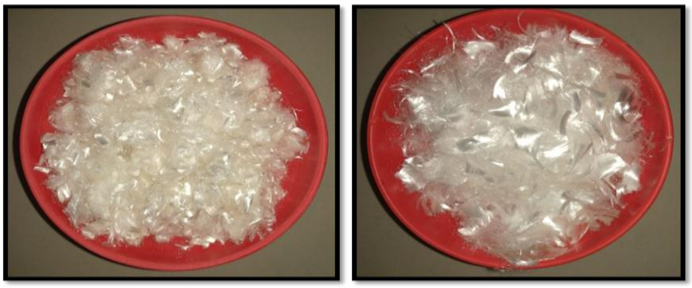

Fig -4: Cetex fibre 6 mm and 12 mm length.

Table -2: Physical properties(from manufacturer)

Technical specification	Walter enterprise	Bajaj fibre guard
Length	6,12,24,36,50	6,12,15,20,24,30,40,60
Melt point	162 °C	>165 °C
Specific gravity	0.91	0.91
Ignition point	360 °C	600 °C
Chemical resistant	Good	Excellent
Alkali resistance	100%alkali proof	Alkali proof
Acid and salt resistance	High	Chemical proof
Diameter(approx)	19-40 micron	27-50
Aspect ratio(approx)	215-1250	200-2000
Tensile strength	450 N/mm^2	670 N/mm^2

3. PREPARATION OF SAMPLE

The study was planned to investigate the compaction test, compressive strength and bearing ratio of soil with fibre on different percentages. The study aims to investigate the effect of four kinds of fibre by varying their percentage i.e. 0.15%, 0.25%, 0.50%, 0.75%, and 1%. A homogeneous paste was prepared by using oven-dried soil and fibre in every experiment with different percentage of soil and fibre. All the experiments were conducted in the laboratory as per their corresponding IS code.

Bajaj's fibre

1. Soil 100% + 0% fibre
2. Soil 99.75% + 0.15% 6 mm lengthfibre
3. Soil 99.75% + 0.25% 6 mm length fibre
4. Soil 99.5% + 0.5% 6 mm length fibre
5. Soil 99.25% + 0.75% 6 mm length fibre
6. Soil 99% + 1% 6 mm length fibre

Like 6 mm Bajaj fibre from the above scenario, 12 mm Bajaj fibre and both 6 mm and 12 mm Cetex fibre with soil proportion was used in all the experiment program

A series of 18 Standard proctor tests were conducted to perform all Unconfined compressive strength and California bearing ratio test.

From the 5 points of standard proctor test obtain the full compaction curve to determine the maximum dry density and optimum moisture content of clayey soil as well as fibre-reinforced soil. Among their values required soil and fibre quantity calculated to perform a different percentage of fibre mixed soil.

In unconfined compressive strength test, 3 numbers of remoulded moulds were prepared in each experiment to get a more accurate result for determining the strength of the fibre reinforced soil. The load applied uniformly in each mould until

a. When there is an appearance of crack.
b. When the stress reaches the highest peak value and then decreases.
c. When the axial strain reaches 20% of the value.

Then maximum strength and failure strain was obtained.

Fig -5: Cylindrical sample before load applied and afterload applied with failure.

The California bearing ratio (CBR) test is a penetration test used for evaluation of the mechanical strength and resistance of natural ground, sub-grade and base courses material. The test was performed by measuring the pressure required to penetrate the soil with a plunger of standard area. Mould was prepared with proper compaction. The load applied uniformly by the plunger until the stress reaches the highest peak value and then decreases. The graph was plotted from the experiment to know the CBR value of the experiment.

3.2 Modified behaviour of soil with polypropylene fibre

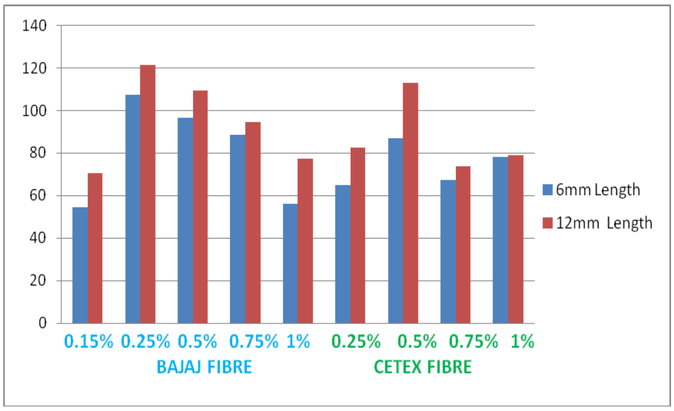

Fig -6: Strength variation of graph lengthwise

From this above graph observed that in all percentage of fibre the strength of 12 mm length fibre gives more strength as compared with 6 mm length fibre from both the manufacturer's fibre.

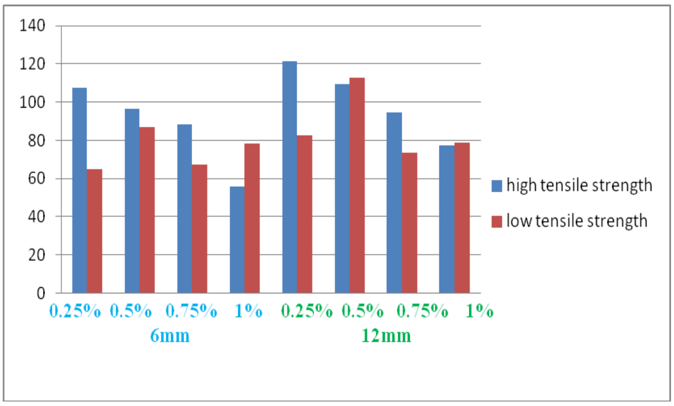

Fig -7: Strength variation of the graph with different strength fibre

From this above graph found that in comparison with high tensile strength fibre and low tensile strength fibre, in the maximum cases strength of high tensile strength fibre gives more strength as compared with low tensile strength.

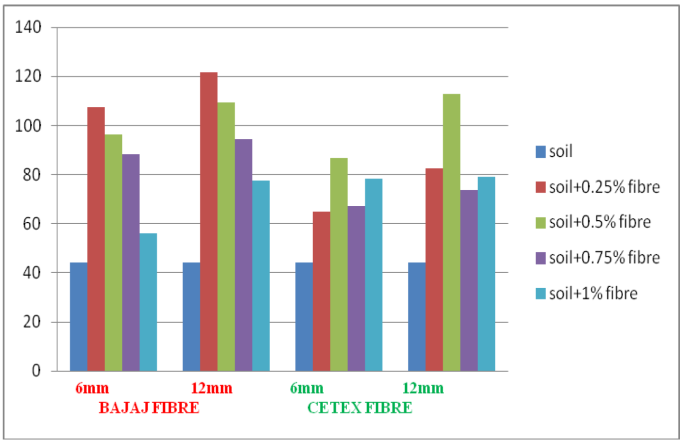

Fig -8: Final comparison graph of all fibres

Form this above graph it was visible that among all four kinds of fibre with different percentage of 0.25% of 12 mm length BAJAJ fibre gives the maximum strength after that 0.50% of 12 mm CETEX fibre gives the maximum strength. When the comparison goes under two manufactures a lesser quantity of BAJAJ fibre gives higher strength as compared with a higher quantity of CETEX fibre.

4. CONCLUSIONS

In this research work, fibre was used to stabilize the clayey soil resulting in improvement of geotechnical properties of the soil. Two different polypropylene fibres (BAJAJ fibre and CETEX fibre) with different properties are used. Various experiments were carried out to determining the behaviour of fibre reinforced soil.

From this investigation following conclusion were found out

- In the case of BAJAJ fibre, the optimum percentage of fibre was 0.25% in both 6 mm and 12 mm length here strength increased by 143% in 6 mm length and 175% in 12 mm length.
- In the case of CETEX fibre, the optimum percentage of fibre was 0.50% in both 6 mm and 12 mm length here fibre strength increased by 96% in 6 mm length and 155% in 12 mm length.
- The reinforced soil failed at a higher strain than the unreinforced soil for most of the cases.
- 12 mm length fibre gives high strength as compared with 6 mm length fibre from both the manufacturer.
- High tensile strength fibre gives high strength as compared with low tensile strength fibre.

From this experimental investigation concluded that BAJAJ fibre with having 12 mm length gives the high compressive strength as compared with other fibres.

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