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Experimental Study On The Atterberg Limit's Of Expansive Soil Reinforced With Polyester Triangular Fibers

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Abstract:

Expansive soil reinforced with polyester fibers is a modified method developed in recent years. This paper reports the results of laboratory study performed on expansive soil reinforced with polyester fiber and demonstrates that randomly distributed fibers are useful in restraining the shrinkage tendency of expansive soils. Polyester fibers of 12 mm size having triangular cross section were used. Attebergs limits of expansive soil reinforced with varying fiber content (f = 0%, 0.2%, 0.5% and 1%) were studied. The effect of fibers is studied for liquid limit, plastic limit and shrinkage limit.

1. Introduction

Expansive soils are widely distributed worldwide, and so far they have found in over 40 countries. Expansive soil has a high clay content and is rich in bentonites, illites and exchangeable cations with strong hydrophilic propery, and its liquid limit is uaually more than 40%, and plasticity index is generally higher than 20, both of them are more than those of ordinary clays. Expansive clay swell upon absorption of water and shrink upon evaporation of water. Hence, civil engineering structures found in expansive soil are severely damaged. To overcome the problems caused by expansive soil, many innovative techniques have been developed. Belled piers (Chen,1988), granular pile-anchors (Phanikmuar,1997) and chemical stabilization with lime and fly ash (Chen,1988; Hunter,1988; Cokca,2001) have been suggested for mitigation heave problems. Geosynthetic inclusions (Ayyar,1989) were also found effective in reducing swelling potential of expansive soils.

Now a days, discrete fibers have been added and mixed into soils to improve its properties. Nilo Cesar Consoli; Karla Salvagni Heineck, Michele Dal Toé Casagrande(2007) studied the Shear Strength Behavior of Fiber-Reinforced Sand Considering Triaxial Tests under Distinct Stress Paths. Santoni R.L.(2001) obtained five primary conclusions from the investigation. First, the inclusion of randomly oriented discrete fibers significantly improved the unconfined compressive strength of sands. Second, an optimum fiber length of 51 mm (2 in.) was identified for the reinforcement of sand specimens. Third, a maximum performance was achieved at a fiber dosage rate between 0.6 and 1.0% dry weight. Fourth, specimen performance was enhanced in both wet and dry of optimum conditions. Finally, the inclusion of up to 8% of silt does not affect the performance of the fiber reinforcement.

Thus, this paper presents the efficacy of the use of polyester fibers in expansive behavior of soil. A laboratory study was undertaken to evaluate the feasibility of using fibers in expansive soil.

2. Experimental investigation

2.1 Test materials

2.1.1 Expansive soil

For the present study, soil sample of Blackish colour was collected from SVNIT campus, surat city. The soil sample was collected in polythene gunny bags and then air-dried. Soil was classified as CH according to Unified Soil Classification System. Engineering properties of this soil are listed in Table 1.

Table 1 Basic properties of expansive Soil

Properties	Quantity
Specific gravity	2.7
Gravel,%	1
Sand,%	35.2
Silt,% + Clay,%	63.8
IS classification	CH

Liquid limit,%	67.2
Plastic limit,%	28
Shrinkage limit,%	12.285
Free swell,%	50
Optimum moisture content,%	19.5
Max. dry density(g/cc)	1.7

2.1.2 Polyester fiber

The polyester fibers used in the experimental work was collected from Reliance Industries Ltd., Mumbai. The supplier provided the properties of fibers and is mentioned in Table 2.

Table 2 Specification of Polyester fiber

Type	Polyester
Cut length	12.1 mm
Cross section	Triangular
Diameter	30-40 µm
Tensile elongation	>100%
Specific Gravity	1.34-1.39
Tensile Strength	400-600 N/mm^2
Colour	Almost colourless

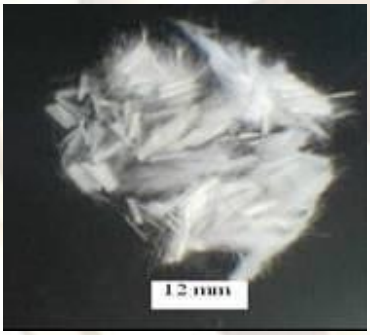

Fig 1 Photograph showing loose 12mm polyester fibers

2.2 Tests conducted

Liquid limit test was conducted as per IS: 2720(part-V), 1985. Casagrande device was used to find out liquid limit for unreinforced specimen and specimen reinforced with polyester fibers. Plastic limit tests was conducted as per IS: 2720(part-V), 1985. Shrinkage limit tests was performed as per IS: 2720(part-VI), 1972.

3. Discussion on test results

3.1 Effect of fiber reinforcement on liquid limit

Figure 2 show the variation of liquid limit with different fiber content. On being reinforced with polyester fibers, liquid limit decreases as fiber content increases. After 0.5% of fiber content, the variation is very less.

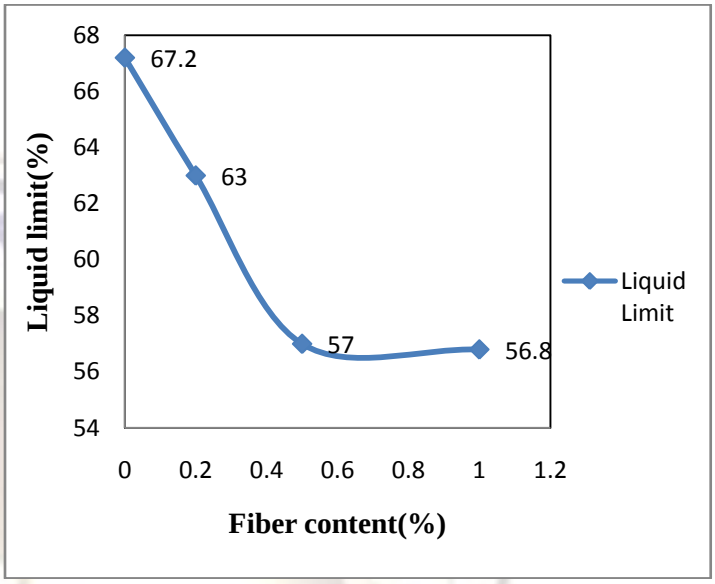

Fig.2 Variation of liquid limit with fiber content

3.2 Effect of fiber reinforcement on plastic limit

Figure 3 show the variation of plastic limit with different fiber content. On being reinforced with polyester fibers, plastic limit increases as fiber content increases. After 0.5% of fiber content, the it starts decreasing.

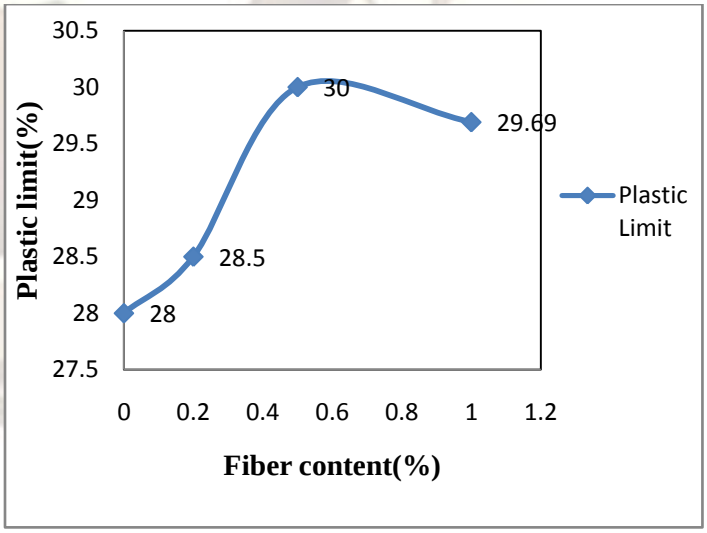

Fig.3 Variation of plastic limit with fiber content

3.3 Effect of fiber reinforcement on shrinkage limit

Figure 4 show the variation of shrinkage limit with different fiber content. On being reinforced with polyester fibers, shrinkage limit increases as fiber content increases. After 0.5% of fiber content, the variation is very less.

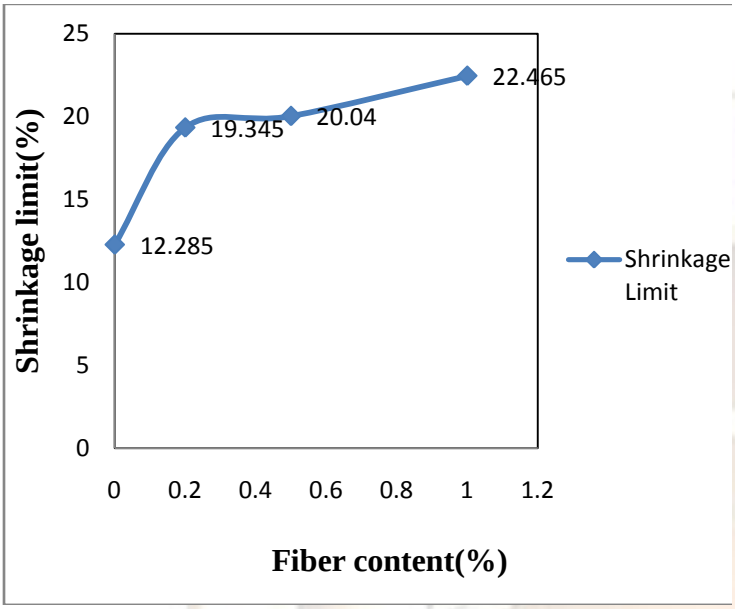

Fig.4 Variation of plastic limit with fiber content

It can be clearly stated that the technique of fiber reinforced soil is very effective method and which helps to restrain the shrinkage behavior of expansive soil.

4. Conclusions

The chief conclusions are as follow:

1) Reinforcing expansive clay specimens with polyester fibers reduce the shrinkage tendency.
2) Optimum percentage fiber found as 0.5%.

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