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Swelling pattern of polypropylene fiber reinforced expansive soils

M.Muthukumar
Assistant Professor (Sr), SMBS, VIT University,Vellore-632014.

ABSTRACT:

Expansive soils are considered to be the one of the highly problematic soil. These soils undergo large volume change based on the amount of moisture content.. Because of this behaviour, lightly loaded civil engineering structures founded on the expansive soils gets severely damaged. There are several mitigating techniques available to counteract the problems posed by the expansive soils. In recent years geosynthetic fibers have been added to the soil to improve the strength behaviour of soils. Laboratory investigations were carried on expansive soil reinforced with short nylon fibers of length 10mm with varying content of 0%, 0.25%, 0.5%, 0.75% and 1% by dry weight of the soil. Surface heave of all the expansive clay specimens were monitored. It was observed that maximum reduction in heave occurred when the fiber content was 0.75%. The reduction in heave is due to the replacement of swelling soil and due to the reinforcing effect which resist the swelling nature of the soil.

Key Words: Expansive soils, swelling, fiber, stabilization, reinforcement

I. INTRODUCTION

Expansive soils as the name implies undergo volume change in presence of water. These soils increase in volume on absorbing water during rainy seasons and decreases in volume when the water evaporates from them (Chen, 1988). Due to this peculiar behaviour many civil engineering structures constructed on these soils gets severely distressed. Some times the cost of repair becomes much more than the cost of the structures (Gourley et al.1994). The problems posed by these soils can be counteracted either by mechanical stabilization like CNS layer, Prewetting, sand cushion technique or by chemical stabilization by using lime, cement, fly ash and salts (Hunter, 1988; Petry and Little, 1992; Rollings et al. 1999; Phanikumar and Sharma, 2004; Desai and Oza, 1997; Phankikumar et al. 2000, Phanikumar,2009.) or by adopting special foundation techniques lime under-reamed piles, belled piers and granular pile anchors (Phanikumar 1997). In recent years geosynthetic fibre has been used extensively to improve the strength and mechanical behaviour of the soils (O.Ple & TN.H.Le, 2012; Chaoshing Tang et al., 2007; J.Prabakar & R.S.Sridhar, 2002). Only limited research has been carried out to stabilize the expansive soils (Sayyed et al. 2012; B.V.S Viswanatham et al., 2009). In this present study short nylon fibers were used in different proportions by dry weight of the soil to study the heave behaviour of expansive soils. All the specimens were prepared to the same density of 15kN/m^3 at 20% water content.Surface Heave was monitored continuously until equilibrium achieved.

II. EXPERIMENTAL INVESTIGATION

2.1. Test materials and Variables

The soil used for the investigation was collected from Amalapuram district, Andrapradesh , India. The soil was collected at a depth of 1.5m from ground level. Various basic tests were conducted and listed in table 1. According to USCS the soil classified as CH.

The fiber used for the test was short nylon fibers of diameter 0.1mm and of length 10mm. The fiber content was varied in different proportions as 0.25%, 0.5%, 0.75% and 1% by dry weight of the soil.

2.2. Test Procedure

The soil was oven dried and sieved in 4.75mm sieve. Soil passing 4.75mm sieve was used for the test. For all the specimens a predetermined amount of soil was mixed with corresponding fiber content and compacted in a proctor mould to a height of 50mm in three layers to attain a dry density of 15 kN/m^3. After compacting the soil to the required height, heave stake was placed on the soil inside the proctor mould. A dial gauge was fixed on the top of the heave stake to measure swelling. After setting the dial to zero expansive soil was inundated with water on the top and the heave was monitored continuously till the equilibrium heave was achieved. Similar test procedure was adopted for all the specimens mixed with different fiber proportions.. Figure 1 illustrates the experimental set up.

Table 1. Properties of soil

Soil properties	Value
Specific gravity	2.73
Grain –size distribution	
Sand %	14
Silt %	44
Clay %	42
Consistency limits	
Liquid limit %	102
Plastic limit %	20
Shrinkage limit %	12
Free swell index	200
USCS Classification	CH

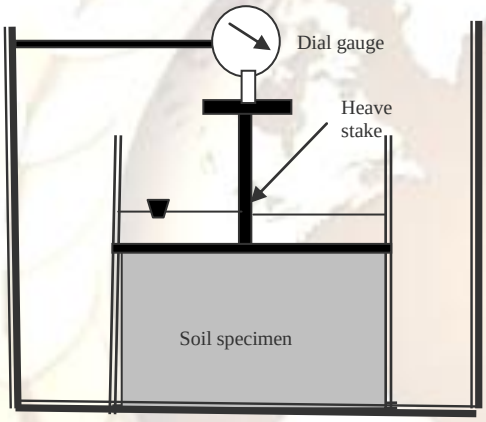

Fig 1. Experimental setup

III.RESULTS AND DISCUSSIONS

Figure 2 shows the variation of heave with respect to time. Time was plotted in minutes on x axis and heave was plotted in mm on y axis. It can be observed that there is an increase in heave with respect to time and finally attained constant. Same pattern of heave was observed in all the cases. It is also observed that there is a significant reduction in heave with increase in the fiber content upto 0.75%. At 1% fiber content the heave was increased.

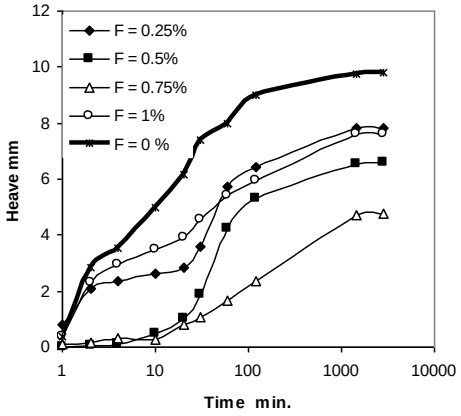

Fig 2. Variation of heave with time

Swell potential which is defined as the ratio of the change in thickness ΔH to the initial thickness was also calculated for all the fiber content and it has been shown in figure 3. The swell potential is found to be nearly 20% when the clay specimen was unreinforced and reduces to 15%, 13% and 10% when the fiber content was increased from 0.25% to 0.75%. At 1% fiber content the fiber

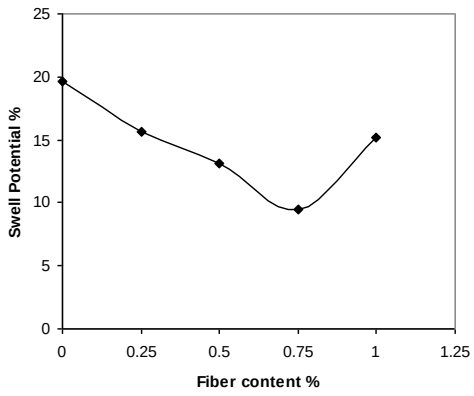

Fig 3. Variation of Swell potential with fiber content

IV.CONCLUSIONS

It is concluded that the nylon fiber is effective in controlling the heave of the expansive soil. Heave reduces when the fiber content was increased upto 0.75%. It is observed nearly 50% of heave reduced at a fiber content of 0.75%. The reduction in heave is mainly due to two reasons, one is due to the increase in the fiber content which replaces the expansive soil and the other is due to the reinforcing affect which binds the soil together and does not allow to swell.

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