ABSTRACT

Expansive soils, referred to as black cotton soils in India, are rich in mineral montmorollinite, which has an expanding lattice structure. When water is absorbed by these soils, the building blocks of the mineral montmorollinite, get separated easily, leading to expansion or swelling of these soils. Hence, expansive soils swell in rainy seasons upon infiltration of rain water into the ground and shrink in summer seasons when water is lost to atmosphere through evaporation. Thus, these soils are subjected to alternate swelling and shrinkage as seasons change. Lightly loaded civil engineering infrastructure built on these soils would also be, therefore, subjected to alternate upward and downward movement, which leads to distress in structural members such as columns, walls and flooring, resulting in unsightly cracking. Expansive soils exist in many countries across the world and they are also abundantly available in India.

Many innovative foundation techniques have been devised to counteract the above problems posed by the expansive soils. Physical and chemical alteration methods, sand cushion and CNS layer, belled piers and drilled piers are some of the innovative foundation practices in vogue in the case of expansive soils. Granular pile-anchors (GPAs) are another innovative foundation technique, recently proposed for expansive soils. GPA foundation system has been found to control heave significantly and improve the engineering properties of the ambient expansive clay. Extensive experimentation conducted on laboratory scale and field scale GPAs gave promising results. Apart from the knowledge of the behaviour of the GPA system during swelling, a thorough knowledge of its behaviour during shrinkage is also required.

This thesis is a work on swell-shrink behaviour of laboratory scale GPAs installed in remoulded expansive clay beds. The behaviour of GPA-reinforced expansive clay beds was studied varying the number of GPAs (n) as 0, 1, 2 and 3. All the GPAs were of diameter 40mm and of length 200mm. Hence, they had an l/d ratio of 5. All the clay beds were 200mm thick. The GPA-reinforced expansive clay beds were subjected to three swell-shrink cycles or wetting-drying cycles (N). The heave data during swelling of each clay bed were monitored for 10 days, and shrinkage data were monitored for 90 days. It was observed that, for a given swell-shrink cycle, both heave and shrinkage decreased with increase in the number of GPAs in the clay bed. It was also observed that,
with increase in the number of swell-shrink cycles, both heave and shrinkage decreased significantly irrespective of the number of GPAs reinforcing the clay beds.

Pullout tests were also conducted on GPAs subjected to different periods of shrinkage (0 days, 15 days, 30 days and 45 days). The test data revealed that the GPA on which pullout test was conducted at full saturation (zero days of shrinkage) failed under pullout load. However, the GPAs subjected to pullout testing after allowing shrinkage of the clay bed did not fail in pullout. The pullout load (in N) for a given upward movement (mm) was found to have increased with increase in shrinkage period.