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Ground Improvement Using Granular Pile Anchor Foundation

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Abstract

The use of granular pile is one of the effective and efficient methods of ground improvement because of its ability in improving the bearing capacity and reducing the settlement of different soft soils. Conventional granular piles cannot be used as tension members to offer resistance under pull out loads. Granular Pile Anchor (GPA) is one of the recent ground improvement technique in devised for resisting pull out forces. In a granular pile anchor, the footing is anchored to a mild steel plate placed at the bottom of the granular pile through a reinforcing rod or a cable.

The main objective of the present study is to investigate the effect of relative density of fill material, granular pile diameter on the pull capacity of the granular pile anchor and the comparison of encased and non-encased granular pile has been done. The laboratory model tests using GPAF system revealed that the pull-out capacity of the granular pile anchor increased with increasing relative density of the granular material. There was a maximum percentage increase of 35% in the ultimate load when the relative density was increased from 50 to 70% for 50mm diameter pile. It was also revealed that the pull-out capacity of the granular pile anchor increased with increasing diameter of the granular pile anchor. The increase of 35% was also obtained when the diameter was increased from 30mm to 50mm at a relative density of 70%. For the encased pile, maximum increase in the percentage ultimate pullout load was obtained for pile diameter of 30mm and it was about of 13.2%.

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1. Introduction

Stone columns/granular piles are effective and efficient over various other methods of ground improvement because of their ability to improve the performance of different soils varying from soft, loose sand deposits to waste fill sites. Granular piles in conventional form cannot be used as tension members to offer resistance to pullout or uplift forces generated under tall structures like transmission towers, overhead tanks or other similar structures and also for the footings resting on expansive soil. The inherent nature of the granular pile is modified by placing a metallic plate at the bottom of the granular pile and connecting the same to the footing with a cable or a rod.

The pullout or tensile forces generated are transmitted to the base of the granular pile with the modification at the base of the granular pile. The uplift resistance depends on (i) the weight of the granular pile and (ii) the shearing resistance along the soil-granular pile interface. The force in the pile anchor is transmitted to pile-soil interface by virtue of a base plate that is rigidly connected to the anchor. The uplift capacity of pile anchor determines the behaviour of foundation connected to it.

2. Experimental study

2.1 Materials used

Soil used for the study was black cotton soil collected from Coimbatore, Tamil Nadu at a depth of 1m from the ground level and it was blackish in colour. The soil was initially air dried in open atmosphere prior to the testing. The soil passing through 4.75mm sieve was used for the entire study. The properties were determined and are listed in Table 1.

Table 1.Properties of soil

Properties	Values
Specific gravity	2.5
Liquid limit(%)	62
Plastic limit(%)	31
Plasticity index(%)	31
Shrinkage limit(%)	14
Clay(%)	11
Silt(%)	54
Sand(%)	35
Maximum dry density(kN/m^3	17
Optimum moisture content(%)	18
Free swell index	30

The granular materials that were used for the installation of the granular piles was sand and copper slag. Fill material which passes through 4.75 mm and retained on 2mm sieve was used as the column fill material. The properties of sand and copper slag were given in table 2 and 3 respectivelySection headings

Table 2. Properties of sand

Properties	Values
Specific gravity	2.7