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A Comparison Between the Results of the Numerical and Experimental Analysis of Pull- Out Strength of Geogrid and Grid- Anchor Surrounded by Coarse Soil Layer in Cohesive Soil

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ABSTRACT

The pull- out strength of the reinforcement has a significant role on the function of the most reinforced soil structures. Since the coarse grain soils have a better interaction with the reinforcement, they are mostly used in these structures. In most situations, we have to transfer these granular soils from the borrow area, usually far from the site of the project. This will impose a considerable amount of cost to the project. In this research, it is trying to use just a thin layer of coarse grain soil for surrounding the reinforcements. This is because of the important role of the pull- out strength on determining the kind of the reinforcements. From this point of view, in this paper, the results of the pull- out experiments conducted on an ordinary geogrid and an innovative reinforcement, that is named Grid- Anchor, are presented. While just a layer of coarse grain soil, with the selected thicknesses, is surrounding the reinforcement, the remained volume is replaced with the fine grain soils. Furthermore, the numerical analysis for these experiments is conducted using the finite element code, Plaxis 3D Tunnel. The numerical and experimental results indicate the efficiency of the cited method for cutting the expenses while keeping the function of the reinforced soil.

KEYWORDS

Pull- Out Test, Geogrid, Grid- Anchor, Fine Grain Soil, Coarse Grain Soil, PLAXIS3D Tunnel.

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1- INTRODUCTION

Dense granular soils, which exhibit the expansion in volume during shear test, are proper materials for using in the reinforced soil structure. The granular soil in the reinforced soil structures, under the usual load conditions, behaves as elastic materials. The only disadvantage of these soils is that they are usually imported materials and so, for many cases, this imposes further cost to the project. On the other hand, cohesive soils are not suitable for using in the reinforced soil structures. These soils behave as plastic or elasto- plastic materials. Reinforced cohesive soils under high stress can actually be susceptible to creep and corrosion, [1]. The most important advantage of these soils might be their availability and this makes them more affordable. So far, various numerical and experimental researches have been conducted by different researchers about the effective factors and behavior of the geosynthetics during pull- out tests.

Mosallanejad, et al., 2008, conducted the experimental tests on the Netlon geogrid with hexangular apertures and an innovative reinforcement that is named Grid- Anchor. The results indicate the superiority of Grid- Anchor over the usual geogrid, [2]. Hataf and Sadr, 2008, conducted the experimental studies on Netlon CE131 geogrid (with hexangular apertures) and Grid- Anchor in SW soil while the surcharge pressures were 8 and 18 kPa. Their results show that in the same situation, the pull- out strength of Grid- Anchor is more than that for an ordinary geogrid and near the applied load, the Grid- Anchor displaces less than the geogrid, [3]. So, in this paper, the purpose is to consider and compare the effect of various thicknesses of the cohesion- less soil on the pull- out strength of these two kinds of reinforcement via analyzing the results of these tests. Furthermore, in this paper, in order to compare the experimental and numerical results, the numerical study is done using the finite element code, Plaxis3D Tunnel.

2- THE MATERIALS

2- 1. EARTH MATERIALS

The earth materials are fine grain and coarse grain soils. The fine grain soil is CL with internal friction angle of 28.42 degrees and little amount of cohesion. The coarse grain soil is SW with internal friction angle of 43 degrees. The relative density of the coarse grain layer, in all samples, is 70 percent. In this study, we spread out the fine grain soil and dried it in the laboratory temperature, then ground it by a plastic hammer and sieved it by sieve number 10, so that it would be uniform in all tests. In this study, the soil moisture is not considered as a variable parameter.

2- 2. THE REINFORCEMENTS

One of the reinforcements is two axes Netlon geogrid with the commercial name, CE131 (16×40 cm) (see FIG.1). The geometric and strength characteristics of this reinforcement are presented in T.

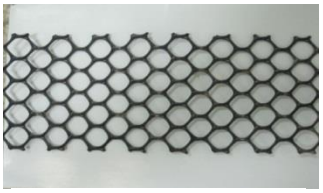

FIG.1. GEOGRID SAMPLE

TABLE 1. GEOGRID CHARACRERISTICS

Value	Property
11.7	Elastic Stiffness (kN/m)
27×27	Cavities Dimensions (mm)
2.2	Average thickness of transversal members (mm)

Another reinforcement used in this study is Grid- Anchor. It is an innovative reinforcement, made of some anchors connected to the Netlon geogrid, [2]. These anchors consist of a cubic- shaped element made of compressed plastic (see FIG 2). The characteristics of Grid- Anchor are presented in TABLE .

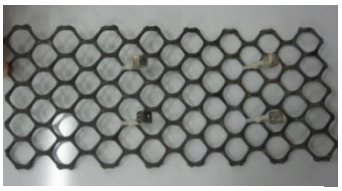

FIG 2. GRID- ANCHOR SAMPLE

TABLE 2. GRID- ANCHOR CHARACRERISTICS

Value	Property
0.18	Axial stiffness of anchor (kN)
30	Anchor length (mm)
1.1	Anchor thickness (mm)

3- METHODOLOGY

About 30 tests have been performed in this study. Some of them are conducted on the usual geogrid and the others on the Grid- Anchor while they are surrounded by the various thicknesses of sandy soil and the remained volume of the test box was filled with the CL soil. Five centimeter soil layers were compacted enough by applying 36 impacts by a wooden hammer (In this research, soil compaction effect is not considered). A vertical load of 5 kPa is applied to these samples.

4- MODELING THE TEST BY PLAXIS 3D TUNNEL

The amount of parameters used for modeling the elements such as the coarse and fine grain soils (see TABLE 1), geogrid, and anchors are as follows:

1- The soil model: Mohr- Coulomb.
2- Geogrid: EA=0.117 kN/cm
3- Anchors: EA=0.18 kN

TABLE 1. SOIL PARAMETERS FOR NUMERICAL ANALYSIS

Soil Type	Fine grain soil	Coarse grain soil
γ_{sat} (kN/cm^3)	16×10^{-6}	20×10^{-6}
γ_{unsat} (kN/cm^3)	14×10^{-6}	17×10^{-6}
(degree) Ψ	0	13
(degree)φ	28.42	43
C(kN/cm^2)	1×10^{-3}	1×10^{-6}
N	0.3	0.1
E (kN/cm^2)	0.9	1
$R_{interface}$	0.6	0.3

5- CONCLUSIONS

The following results are obtained from this study:

- Using Grid- Anchor behaves better than the usual geogrid due to having more pull- out strength with less displacement along its length.
- The displacement of the first points in reinforcements is more than the medial and the end ones.
- According to Figures IG **3** and IG **4** , using the coarse grain soil around the reinforcements increases the pull-out strength of the reinforcements.
- Figures IG **3** and IG **4** show those 5 centimeters thickness is the optimal thickness for surrounding the upper layer of the both reinforcements.
- According to the test results , the maximum pull- out strength of Grid- Anchor was increased more than the ordinary geogrids using this method, because the anchors cause more friction and this increases the interaction between soil and Grid- Anchor. Less displacement in Grid- Anchor was also observed.

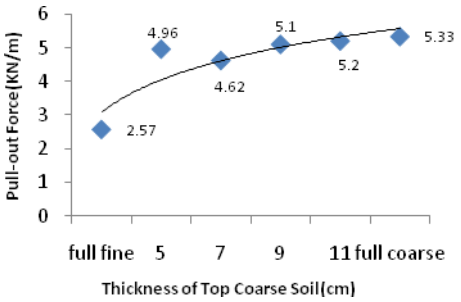

FIG 3.THE RESULTS OF PULL-OUT TESTS FOR DETERMINING THE COARSE SOIL LAYER THICKNESS SURRONDING THE TOP OF THE GEOGRID

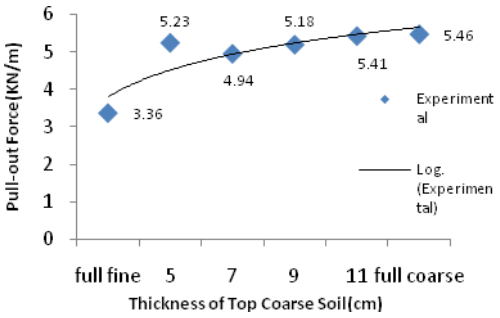

FIG 4.THE RESULTS OF PULL-OUT TESTS FOR DETERMINING THE COARSE SOIL LAYER THICKNESS SURRONDING THE TOP OF THE GRID-ANCHOR

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