

DETERMINATION OF CEMENT IMPROVED SOIL AND GEOGRID PULL-OUT INTERACTION PROPERTIES

Hazama Ando Corporation Regular Member ○Luisa Fernanda Santa-Spitia
Hazama Ando Corporation Regular Member Takuya Miyawaki

1. INTRODUCTION

In order to increase the strength of cement improved soil structures by incorporating geogrids, it is necessary to understand their interaction. In this research, geogrids were placed inside cement improved specimens for pull-out tests performance. The tests were conducted on two different types of improved soil, one based on sandy soil and the other on cohesive soil, using a confining pressure that reproduced confining pressures. The frictional properties between the two materials were determined.

2. TEST MATERIAL

Two case studies were carried out: sand-case and clay-case. Each of them has a compressive strength of about 600 kN/m². The materials used are kaolinite (Specific Gravity 2.58 g/cm³, particle Size (d₅₀) 4.0 μm), silica sand No. 7 and cement. The mix proportions of the manufactured specimens and their compressive strength are shown in Table 1 and Table 2. The geogrid used has a tensile strength of 154 kN/m.

Table 1 Sand-case properties

Sand case	
Percentage of sand	85%
Percentage of clay	15%
Cement content	70 kg/m ³
Water/cement ratio	2.0
Initial soil water content	15%
Average q_u at 28 days	637.3 kN/m ²

Table 2 Clay-case properties

Clay case	
Percentage of sand	0%
Percentage of clay	100%
Cement content	160 kg/m ³
Water/cement ratio	1.6
Initial soil water content	70%
Average q_u at 28 days	619.5 kN/m ²

3. SPECIMEN

Specimen dimensions are 300 mm x 200 mm x 200 mm. Geogrid with 40 mm x 40 mm spacing was placed in the middle of the specimen as shown in the figure, leaving a free length to connect to the pull-out apparatus. In addition, cables were connected to measure the displacement at different points of the geogrid. The tests were performed after 28 days of curing.

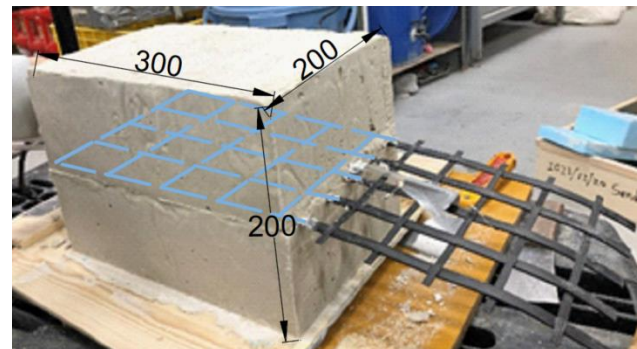


Figure 1 Specimens' arrangement

4. APPARATUS AND TEST

The apparatus developed (Figure 2) consists of a pull-out box with openings at the front to allow the geogrid to pass through and at the back to allow the cables connecting the geogrid to the displacement gauges to pass through. A normal stress loading device consists of an airbag placed at the top of the pull-out box. The pull-out device pulls continuously the geogrid out of the specimen at a constant displacement rate of 1mm/min. A load cell measures the pull-out force and 6 displacement gauges measure the displacement of the geogrid at 4 points inside the improved body and at 4 points in the free length.

Test procedure is as follows: After the normal stress pressure has been applied (200 kN/m²), the pull-out procedure start and it continues constantly until either the geogrid ruptures, the pull-out device has indicated a maximum or the displacement at the aperture (point O) reaches 10% of the length of the pull-out box (30 mm).

Keywords: Cement improved soil, geogrid, geotextile, pull-out test.

Contact address: Hazama Ando Corporation. 6-1-20, Akasaka, Minato-ku, Tokyo 107-8658, Japan. Tel: 81-3-6234-3600

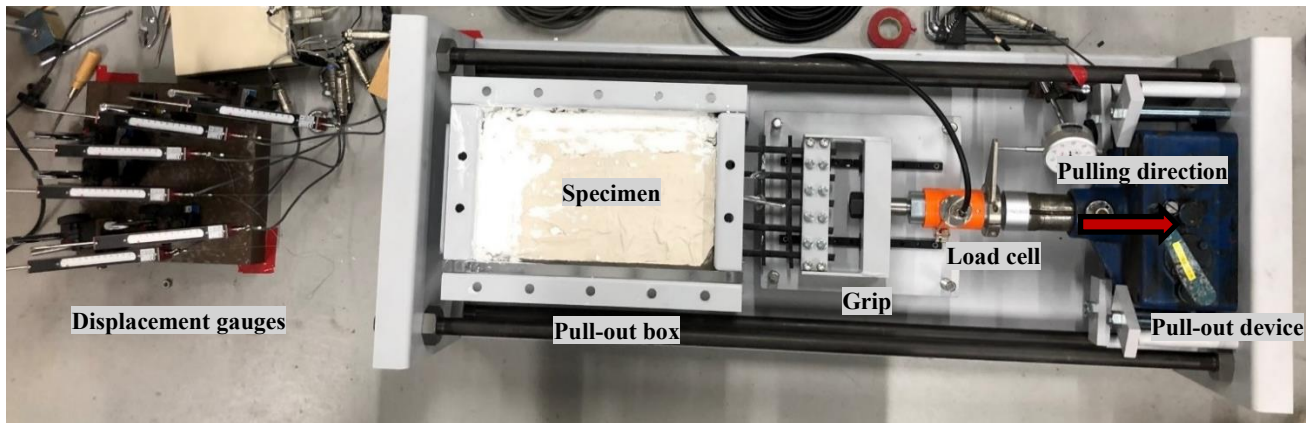


Figure 2 Pull-out apparatus

5. RESULTS

The pullout force reached 6.0 kN/m and 4.9 kN/m for sand and clay respectively, which is equivalent to 4.0% and 3.3% of the maximum strength of the geotextile (150 kN/m).

The displacement at the points inside the specimen (points E, 3, 2, 1) is approximately 33% of the displacement at the free points (points O, C) for sand and 14% for clay. The pull-out frictional strength is 178.6 kN/m² for the sand case and 145.1 kN/m² for the clay case.

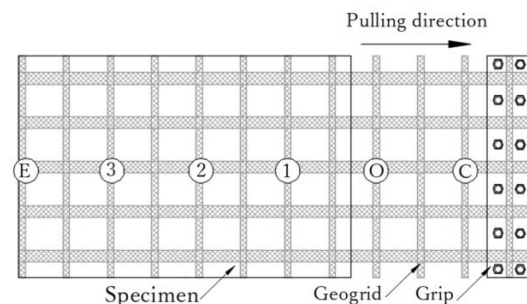


Figure 3 Measurement points

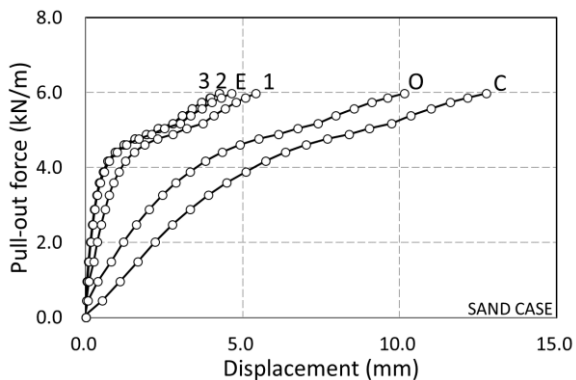


Figure 4 Pull-out force vs. displacement Sand case

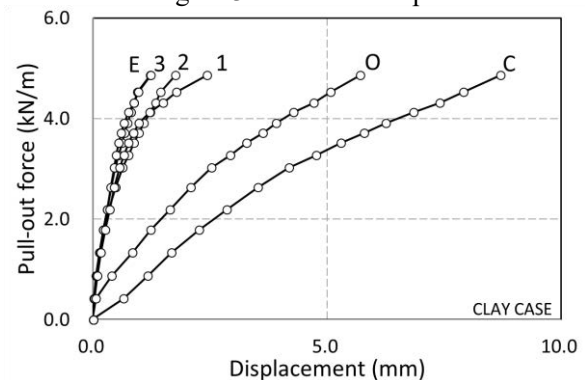


Figure 5 Pull-out force vs. displacement Clay case

4. CONCLUSIONS

- Under the same conditions of normal pressure and compressive strength, the interaction of cement improved soil and geogrids exhibits higher pullout strength for sandy soils than for clayey soils. However, this resistance is equivalent to only about 4% and 3% of the maximum geotextile strength. According to similar investigations in non-improved soils (Park et al), the maximum pull-out strength is equivalent to one third of the geotextile tensile strength, which shows that the stiffness of the soil in which the geogrid is located greatly affects the performance of the reinforcement.
- As for the displacement of the geotextile within the improved soil, in the sand specimens the displacement is 225% more than in the clay specimens. In the sand case, displacement reaches a yield point around 4.5 kN/m from where the displacements increase until failure is encountered. In the clay case, failure occurs brittle after 4.5 kN/m.

REFERENCES

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