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Pullout tests on geogrids buried in lateritic soils

S.S. Lin, M.C. Chen & M.Y. Cheng
Department of Harbor and River Engineering, National Taiwan Ocean University, Taiwan

S.H. Kuo
Measurement Instrument Co., Taiwan

ABSTRACT: Lateritic soils are abundant on many terraces in Taiwan. It has been planned to use these lateritic soils as backfilling materials for earth reinforcement structures. Laboratory pullout tests were conducted using polymeric geogrids buried in lateritic soils, for the purpose of better understanding on the interaction behavior between polymeric geogrids and lateritic soils. Tested lateritic soil properties, testing equipment, specimen preparation and testing procedures are presented for displacement rate controlled pullout tests. Preliminary test results were reported and discussed in this paper.

1 INTRODUCTION

There are many terraces, blanked with lateritic soils, in Taiwan. These materials are often used as construction backfill materials for embankments or highway fills. Many new town development projects are also planned by the government on these lateritic soils covered terraces. The gradual shortage of good quality soils has been becoming a very serious problems in Taiwan. It is unavoidable to use locally poor quality backfill materials for earth reinforcement structures in the future.

Pullout tests have been used to study the anchorage function of the reinforcing elements in soil reinforced walls and steep slopes. Most of the available studies are emphasizing on reinforcements embedded in sandy soils (Alfaro et al. 1995; Berg et al. 1990; Farrag et al. 1993; Palmeria et al. 1989; and Wilson-Fahmy et al. 1994). Although some extensive pullout tests have been conducted by Bergado et al. (1992, 1993a and 1993b) at Asia Institute of Technology for steel grid reinforcements in lateritic soil backfill, the pullout resistance on polymeric geogrids in lateritic soil remains further study, in order to have better understanding on the interaction behaviors of these two materials. This paper discussed the preliminary results of some laboratory pullout tests.

2 PROPERTIES OF LATERITIC SOIL

Lateritic soils, often found in tropical or semi-tropical area, are formed from highly weathered rock under high temperature, high rainfall and low pH environments. The decomposition process results in a soil leached of silica and calcium carbonate but retaining high concentrations of iron and aluminum sesquioxides (McCarthy 1993).

The lateritic soil used in this study is reddish brown in color, and is classified as CL in unified

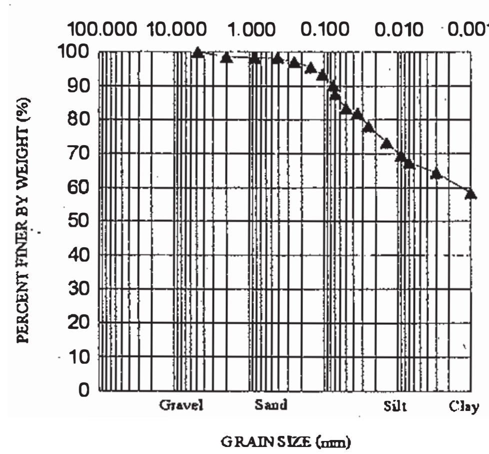

Fig.1 Test Soil Particle Size Distribution

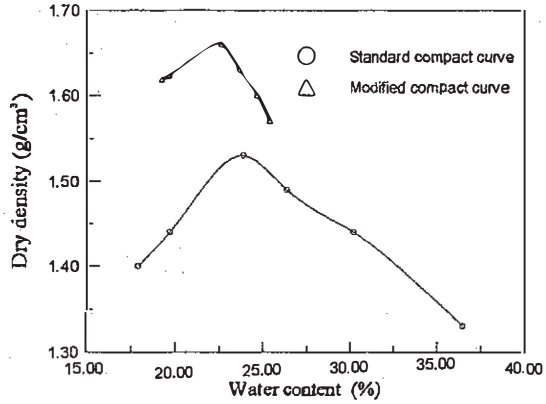

Fig.2 Compaction Test Result

Table1 . Strength parameters of compacted lateritic soil

Type of test	Normal Stress range (kg/cm^2)	Cohesion (kg/cm^2)	Friction angle (deg.)
UU	1.0-4.0	0.31	2.82
	1.0-4.0	0.39	0
CU	1.0-4.0	0.18	21.8
DS	0.5-2.0	0.12	25
UC		1.4	

UU:Unconsolidated Undrained
CU:Consolidated Undrained
DS:Direct Shear
UC:Unconfined Compression

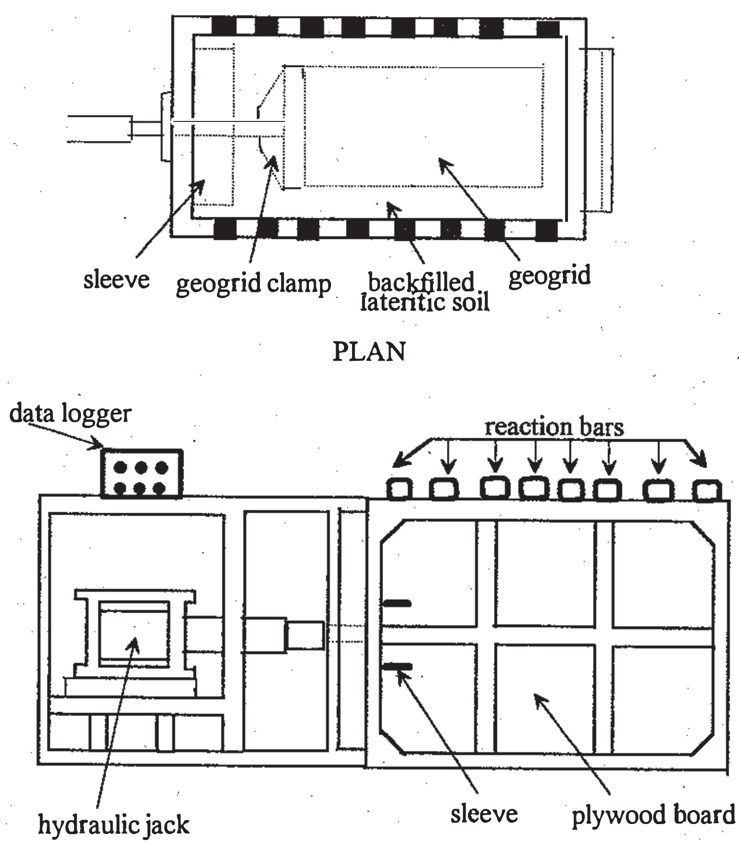

Fig.3 Pullout Test Apparatus

soil classification system. Particle size distribution is shown in Fig. 1. The specific gravity of the soil particles is 2.6. The liquid limit and the plastic limit are 49.8 and 27.7, respectively. The standard Proctor compaction test gives an optimum moisture content of 23.75% and corresponding maximum dry density of 1.53 g/cm^3, as shown in Fig. 2. The strength parameters obtained from direct shear test and some triaxial tests of compacted lateritic soils are shown in Table 1.

3 TESTING PROGRAM

3.1 *Equipment*

The pullout test was conducted in the soil mechanics laboratory at Taiwan Ocean University, in a pullout box with inside dimensions of 1.5m x 0.91m x 0.84m (length x width x depth). The pullout box was made of steel beams using both welded and bolted connections and plywood boards, as shown in Fig. 3. The thickness of the soil layers above and below the reinforcement was 42 cm. A horizontal sleeve is used at the facing to transfer the interface pullout load behind the rigid front wall. A paper air bag was used at the top of the box to provide a uniformly distributed vertical pressure, and the reaction was transmitted through a plywood board to eight reaction beams connected to the top of the box.

The pullout load was applied by a hydraulic loading system through clamping plates which extend inside the sleeve. Either a constant pullout rate or a constant pullout load of the loading system can be applied. The total displacement and the pullout load were monitored at the clamping plates by using a LVDT and a load cell for the first test, respectively. However, the flexible steel wires will be used to attach to the rib junctions at the desired locations in the future for junction movement measurement.

3.2 *Materials*

The lateritic soil used for this study is detailed in section 2. The geogrid, Tensar SR 80, which is normally used for reinforced soil walls and steep slopes, is selected in performance assessment evaluation tests. Geogrid specimen of 36.5 cm in width and 90 cm in length was tested in the box.

3.3 *Testing procedures*

The lateritic soil was backfilled and then compacted at equal lift of 15 cm thickness. The compaction was conducted on the dry side and on the wet side of optimum compaction to 95% of the standard Proctor density, up to the sleeve elevation. The reinforcement was then placed on the compacted layer of lateritic soil. Geogrid specimen was bolted to the clamping plates which were then inserted through sleeves on the front wall. Subsequently, the top layer of soil is placed

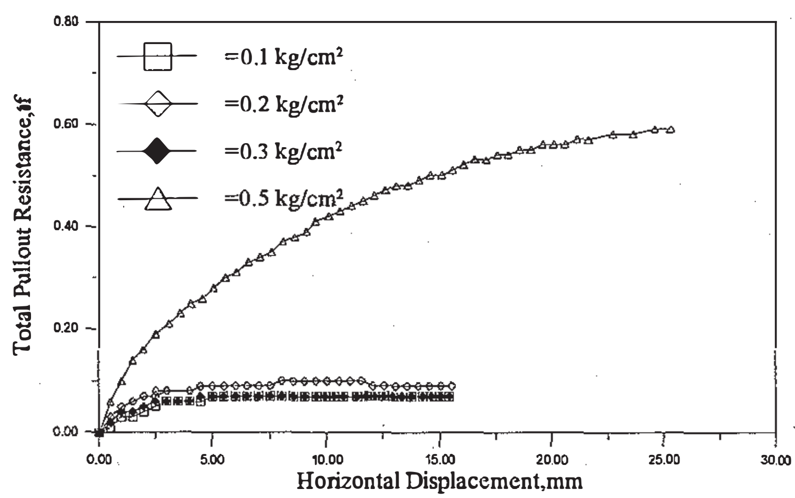

Fig.4 Pullout Force-Displacement Relationship

in layers of 15 cm and compacted.

A multi-stage pullout program proposed by Bergado et al. (1992,1993a and 1993b) was followed in this study. In each set-up, multiple pullout tests were conducted by increasing the vertical normal pressure at each stage. In the first stage, the geogrid specimen was pulled out under a given normal stress. Secondly, the pulling force was released and the normal stress was increased for the next stage. After allowing about 30 minutes for normal stress to be stabilized in the suggested by Bergado et al. (1992,1993a and 1993b). The pullout rate was controlled by a displacement rate of 1.0 mm/min.

4 TEST RESULTS

A one set-up pullout test result is shown in Fig. 4. The maximum pullout resistance is obtained after a pull of 5 mm for normal stresses of 0.1, 0.2, and 0.3 kg/cm^2. This is different from the steel grids in lateritic soil, whose pullout results showed the maximum pullout force was obtained after a pull of 8 to 10 mm (Bergado et al. 1993a). However, when normal stress is increased up to 0.5 kg/cm^2, the geogrid failed when 25 cm displacement was reached. At low normal stress, the specimen was pulled out by 15 mm at each stage, since the maximum pullout force was obtained after a pull of 5 mm. The maximum pullout resistance versus applied normal pressure is shown in Fig. 5, which showed the maximum pullout resistance is increased along the increasing of applied normal stress.

5 CONCLUSIONS

Testing equipment, specimen preparation and testing procedures are presented for displacement rate controlled pullout tests for polymeric geogrids in lateritic soils. Only very first step preliminary results are obtained at this moment. The preliminary result showed the mobilized maximum pullout resistance is reached at very short displacement, when the normal stresses are low. When the applied normal stress is raised to a higher magnitude, the geogrid failed at larger displacement. Some further studies are required to verify this preliminary results. In addition, the mobilized resistance forces at geogrid junctions, ribs and longitudinal elements, the effect of transverse ribs on pullout strength, and the effect of lateritic soil properties on pullout interaction behavior etc. for the polymeric in lateritic soils are the main studying points for the subsequent tests.

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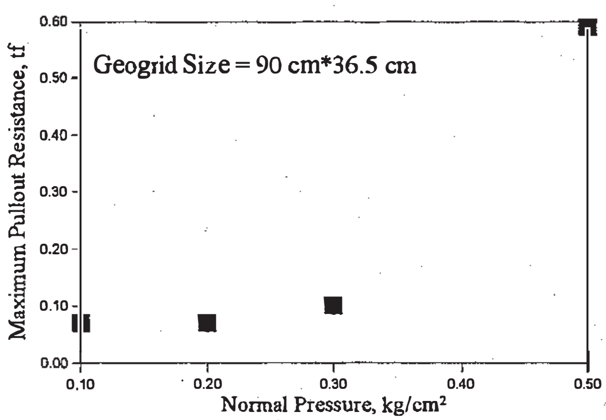

Fig.5 Maximum Pullout Resistance V.S. Normal Pressure

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