NYLON GRID REINFORCEMENT IN C-Φ SOILS

By

Dr. Noor Ul Amin *, M. Babar Khan **

ABSTRACT

In this study nylon rope has been considered as soil reinforcement in the form of grid at 6 x 6 inches spacing. To determine the resistance of the ropes under different normal stresses, simulating 2, 4, 6, 8 feet high embankments, pullout tests were performed. The apparatus for pullout test was fabricated. Five nylon ropes (¼ inches thick) in the grid were pulled out of the test pit, with the help of motorized jack. The resistance offered by the ropes was measured with the help of proving ring. Tests were conducted on Risalpur soil. Laboratory tests were carried out to determine the index properties of soil. After conducting the pullout tests, it is found that the nylon grid can be used as soil reinforcement for low to moderate height slopes i.e. 8 to 15 feet high slopes or embankments and it can also be used in the subgrade stabilization of weak soils. In this hypothesis nylon was used as reinforcement because it is cheaper than the other polymeric reinforcement (Paraweb straps) and steel reinforcement. It can be practiced in stabilizing slopes of the embankments. In the temporary works it can also be utilized efficiently for reinforcing the military bunkers and underground trenches for its stability.

1.1 INTRODUCTION

In the past, natural inclusions have most often been used to improve the mechanical properties of soils and structures: straw in clayey soils to develop construction material; palms or branches at the base of structures founded on soft soils and so on. It is also interesting to mention the reinforcement of natural slopes provided by plant roots in the nature.

In the recent past polymeric materials are being used in earthworks construction with ever increasing frequency. The term "Geosynthetics" was recently coined to encompass a diverse range of polymeric products designed for geotechnical purposes. One such purpose is the tensile reinforcement of soils. As tensile reinforcement, polymers have been used in the form of textiles, grid, linear strips and single filaments to

*Associate Professor Military College of Engineering Risalpur , ** MSc student NIT

reinforce earth structures such a road embankments, steep slopes and vertically faced soil retaining walls. A considerable number of retaining structures have been successfully constructed using the tensile reinforcing properties of 'Geosynthetics" their primary means of stabilization. Despite such successes sufficient uncertainty exists concerning the performance of these new materials, their manner of interaction with the soil and the new design methods needed that many authorities are still reticent concerning their use in permanent works.

1.2 BRIEF BACKGROUND

Reinforced soil is a term, which means to enhance the shear strength of marginal as well as good quality soils by including some kind of reinforcing materials whose tensile strength must be greater than that of the soil. The soil or the backfill material ranges from heavily over-consolidated clay to the granular material. While the reinforcing materials include bamboo, geotextiles and galvanized construction steel.

In this study nylon rope of 1/4-inch diameter is used as soil reinforcement in the form of grid at 6 X 6 inches spacing. To determine the resistance of the ropes under different normal stresses simulating the 2, 4, 6 and 8 feet high embankments, pullout tests are performed. Tests are conducted on c- φ soils of Risalpur, which is collected at the back of National Institute of Transportation building in Risalpur Cantt. Pullout test apparatus is fabricated. It comprised of clamp for holding the nylon ropes during pullout action and proving rings to determine the pullout resistance under different normal pressures. The normal load is applied with help of jack and proving ring arrangement. Laboratory tests are performed to determine the properties of the selected soil. Elongation test and tensile strength test is also conducted on nylon. The pullout tests are conducted on different moisture contents i.e. dry and wet of optimum.

1.3 RESEARCH METHODOLOGY

1.3.1 Laboratory Test

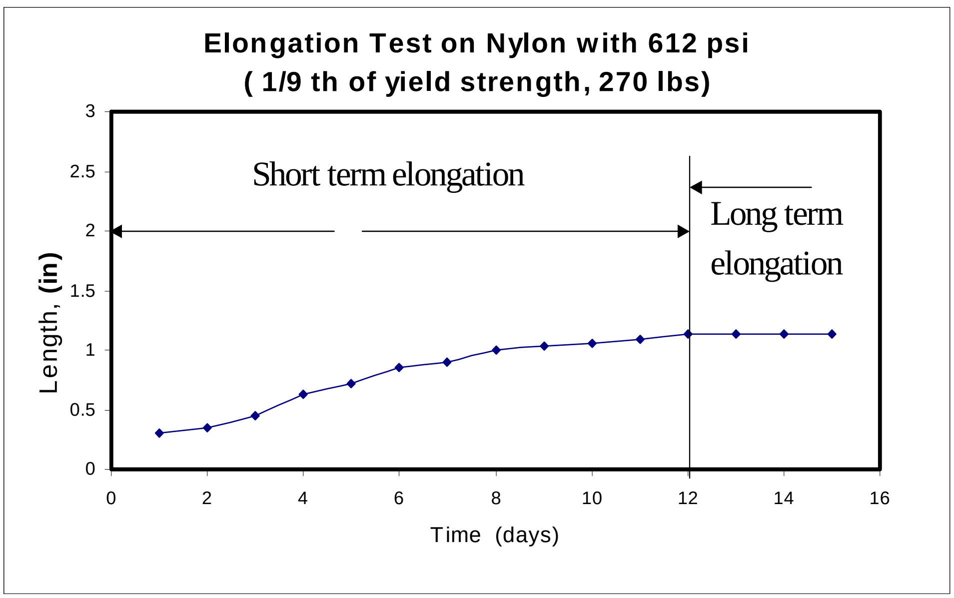
First of all the laboratory tests were performed for the determination of engineering properties of the Risalpur soil samples collected from the field. The

laboratory test results enabled determination of material properties and the classification of the soil. All laboratory tests have been performed as per the ASTM standards.
The results of the laboratory tests are tabulated in Table 1.1.

*Associate Professor Military College of Engineering Risalpur , ** MSc student NIT

1.3.2 Elongation Test

After conducting the laboratory tests, elongation test was done on the nylon in the soil laboratory. The purpose of this test was to check the short-term elongation in nylon. Loads equivalent to 612 psi, 1836 psi and 4000 psi were hanged on one side of the nylon specimen of length 12 inches and the other end was tied to a fixed support as shown in Figure 1.1. After allowing the initial elongation reading were taken after every hour for 20 days. Results of elongation tests are plotted below.



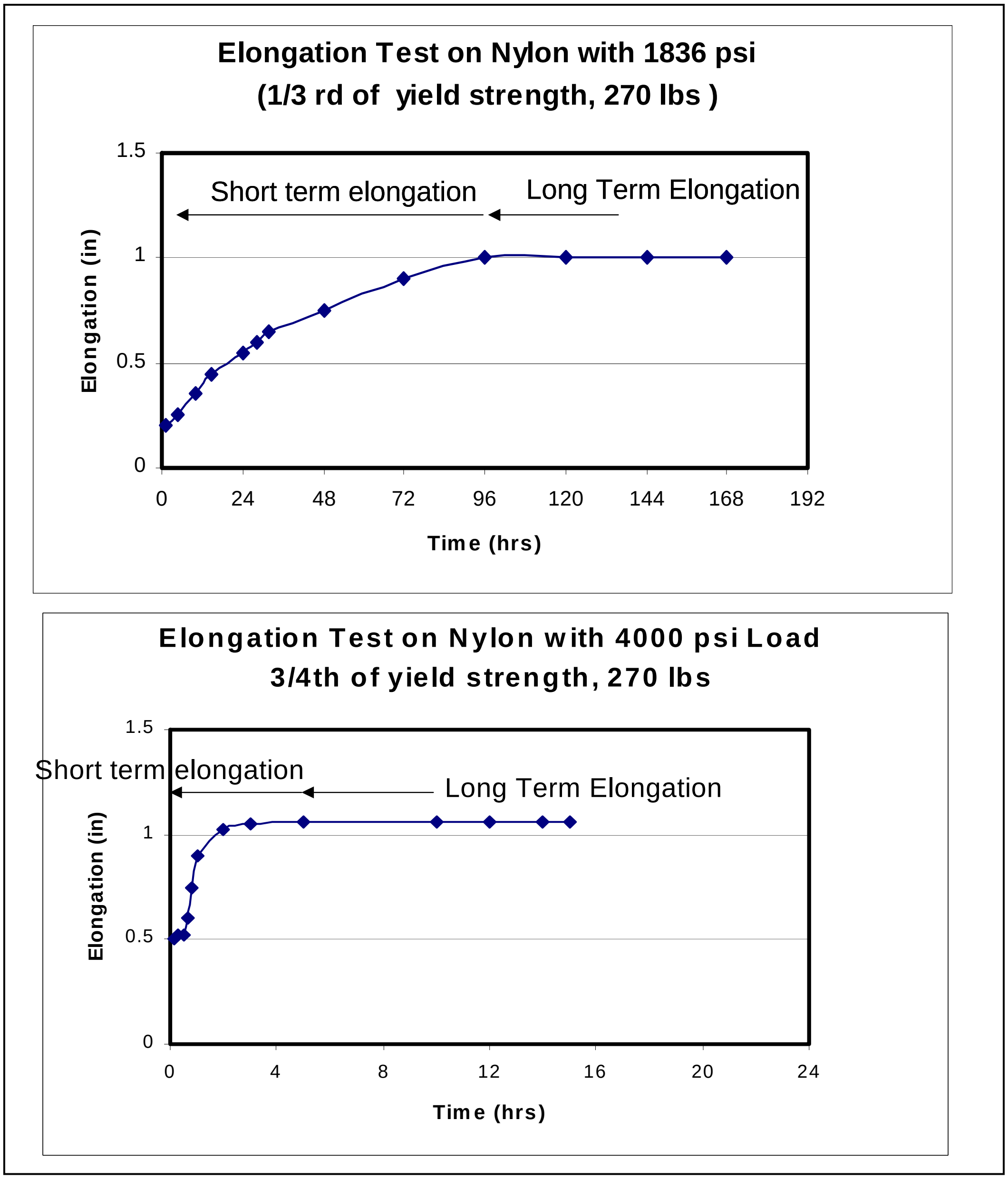
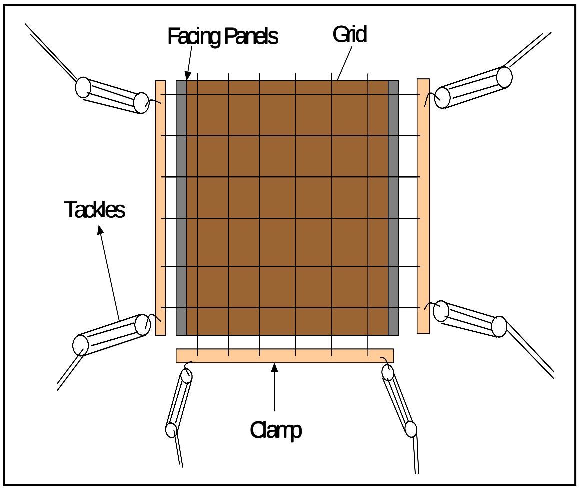


FIG. 1.1. Elongation Test

After conducting elongation tests, it was observed that pre-stretching would be required in the nylon rope to prevent the large deformations in the initial stages as can be noted in graphs of Figure 1.1. Therefore for pre-stretching, installation arrangements would be required.

- **Installation Arrangement**

  Due to flexibility in nylon rope observed in elongation tests, pre-stretching has to be done to prevent the short-term elongation. Nylon rope would be stretched between the facing panels with help of clamp and tackles arrangement as shown in Figure 1.2.



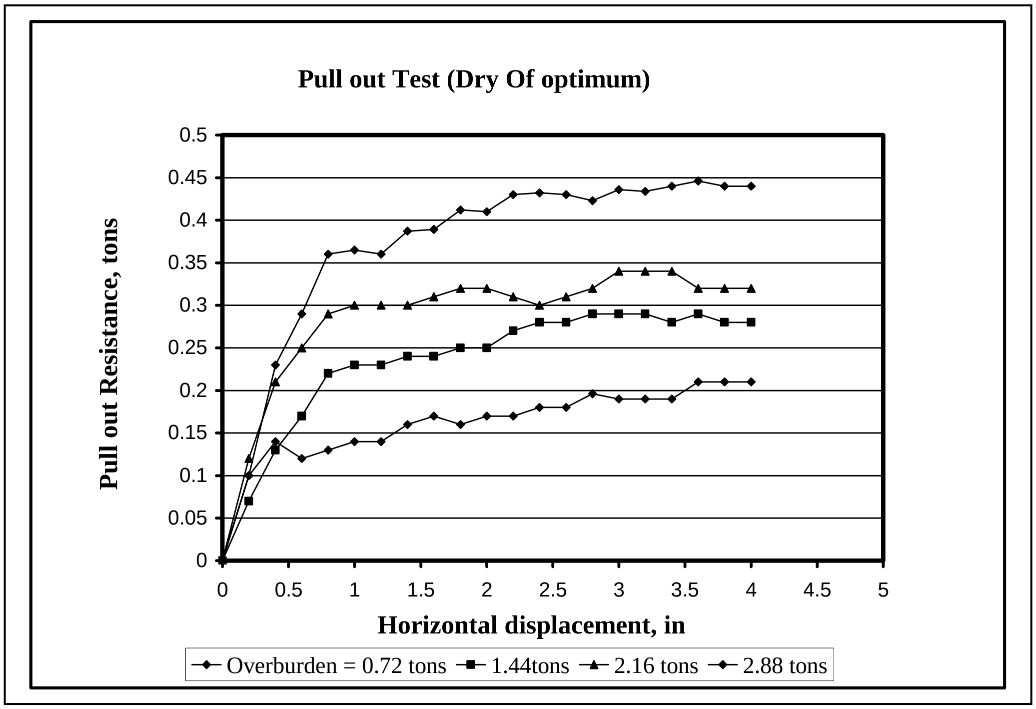
1.3.3 Pullout Test

The apparatus for pullout test was placed in the concrete box for testing. Plastic sheet was placed inside the concrete box and grease was applied on the four sides to minimize the friction between soil and the walls. Then soil was filled in 6 inches thick layers, each layer was compacted using mechanical compactor until the drilled holes, which were at 1-foot height from the bottom of the box. Then the nylon grid was laid above the soil and the ends of the ropes were passed through the holes on both the sides. The ropes were then fixed into the clamp on one side to measure the pullout resistance offered by the nylon gird under different normal stresses, while on the other side, the rope ends remained free. A thin metallic wire was tied to the joint of the nylon grid to determine the displacement at the free end.

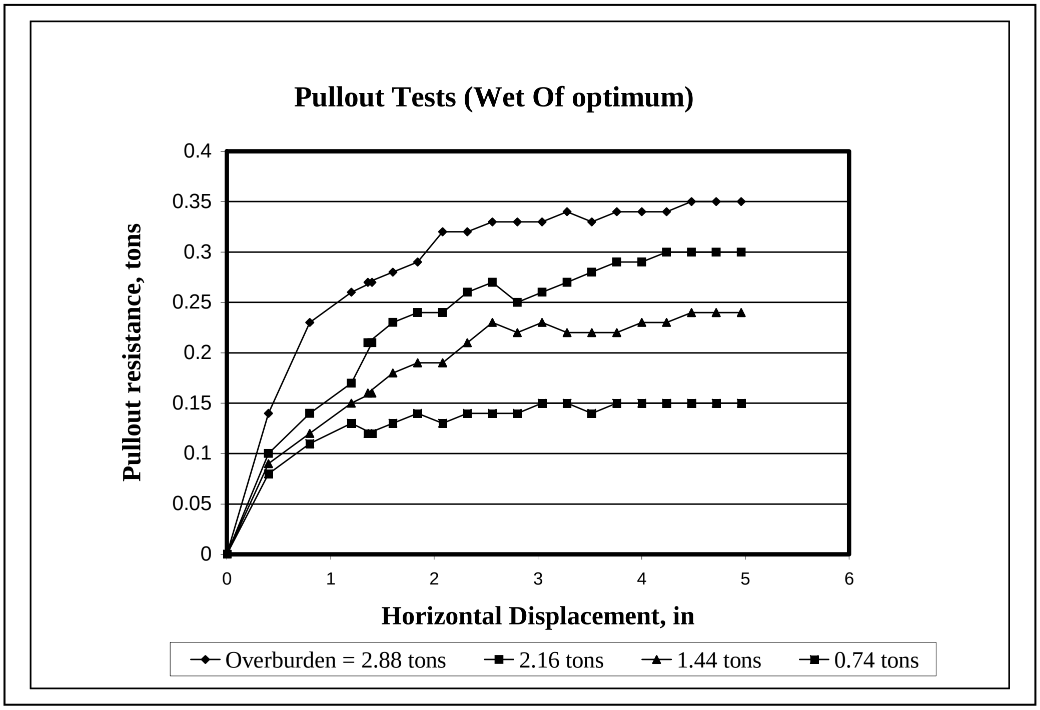
Then the remaining portion of the concrete box was filled with the soil in layers. After the soil is completely filled in the box, a steel plate is placed at the top of the test pit for uniform distribution of load over the entire concrete box.

The arrangement of the apparatus for applying the horizontal pullout force and determining the elongation was done. A hydraulic jack with proving ring and dial gauge was also placed at the top of the plate to apply a vertical uniformly distributed load.

Finally the normal load was applied simulating the different heights of embankments i.e. 2 ft, 4 ft, 6 ft, and 8 ft and for each normal load, horizontal pullout resistance was noted. The vertical loading was applied in four steps with varying over burdens of 0.72 ton, 1.44 ton, 2.16 ton and 2.88 ton.



1.4 Discussion on The Results


Pullout Tests (Wet Of optimum)
Pullout resistance, tons
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
1
2
3
4
5
6
Horizontal Displacement, in
Overburden = 2.88 tons
2.16 tons
1.44 tons
0.74 tons