Texas A&M Transportation Institute

PROJECT SUMMARY

Texas Department of Transportation

0-6784: Creep Behavior of Soil Nail Walls in High Plasticity Index (PI) Soils

Background

Soil nailing is a convenient and economic stabilization method for the reinforcement of existing excavations by installing threaded steel bars into cuts or slopes as wall construction progresses from top down (Figure 1). An aspect of particular concern in the soil nail wall guideline is the creep behavior of this type of system in high-plasticity (HP) clays (i.e., those soils with a plasticity index greater than 20). However, soil nail walls have been constructed with success in HP soils (particularly in Texas), and no issues associated with creep behavior have been observed so far, including walls that were built more than 20 years ago. The main motivation of this research project is to gain a better understanding of the behavior of soil nail walls in HP clays and to suggest possible modification to the current guideline.

What the Researchers Did

In order to assess the effect of creep behavior in HP clays, the following tasks were conducted:

1. Pullout tests on eight existing anchors installed in 1991 at the clay site at the National Geotechnical Experimentation Site at Texas A&M University (NGES-TAMU) were performed to explore any effect on the bond strength related to long-term installation (i.e., soil ageing).
2. Pullout tests on 16 new vertical soil nails installed at the NGES-TAMU clay site were carried out following different protocols to learn about the effect of stress level on creep behavior.
3. Pullout tests on six new sacrificial nails installed at different heights in a new soil nail wall at Beaumont were carried out to learn about the nail creep behavior under actual conditions.

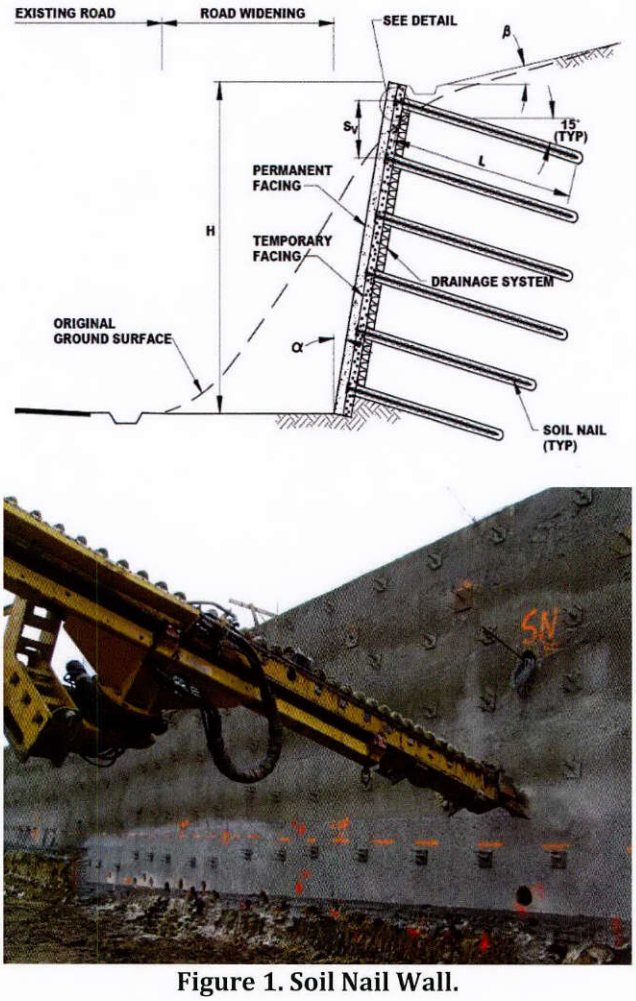

Figure 1. Soil Nail Wall.

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4. The actual soil nail wall was monitored at Beaumont (453 ft. long and 25 ft. high) for 13 months to learn about the service load in nails and different wall movements in time.
5. Laboratory tests (e.g., triaxial creep and oedometer tests) were performed on samples gathered from the two sites investigated in this project (i.e., NGES-TAMU and Beaumont).
6. Numerical simulations were conducted using FLAC-3D. All components of the soil nail wall were simulated. The simulations were first calibrated against the pull-out tests and lab data. Then the Beaumont soil nail wall was modeled, and a parametric study was performed.

What They Found

Two main types of issues can be associated with creep effects in soil nail walls:

- Local problems related to the creep behavior of the nails and the surrounding soils.
- Problems associated with the long-term behavior of the creeping soil mass, inducing lateral wall movements, and associated increase in the nail load.

For the first type, from all the pullout tests conducted, it was concluded that the creep rate was well below the guideline acceptance criterion and the same until 80 percent of ultimate load (at least for the studied soils and conditions).

For the second type, the analyses showed that the load in the nails could increase significantly in the long term (i.e., in some cases it doubles the estimated service load; however, the safety factor remained above one in the cases analyzed in this project) (Figure 2). A tentative procedure to incorporate creep effects in the design of soil walls was suggested.

What This Means

Now engineers can have a better idea about the effect of creep in soil nail walls in HP clays and, using the proposed procedure, estimate it when designing soil nail walls.

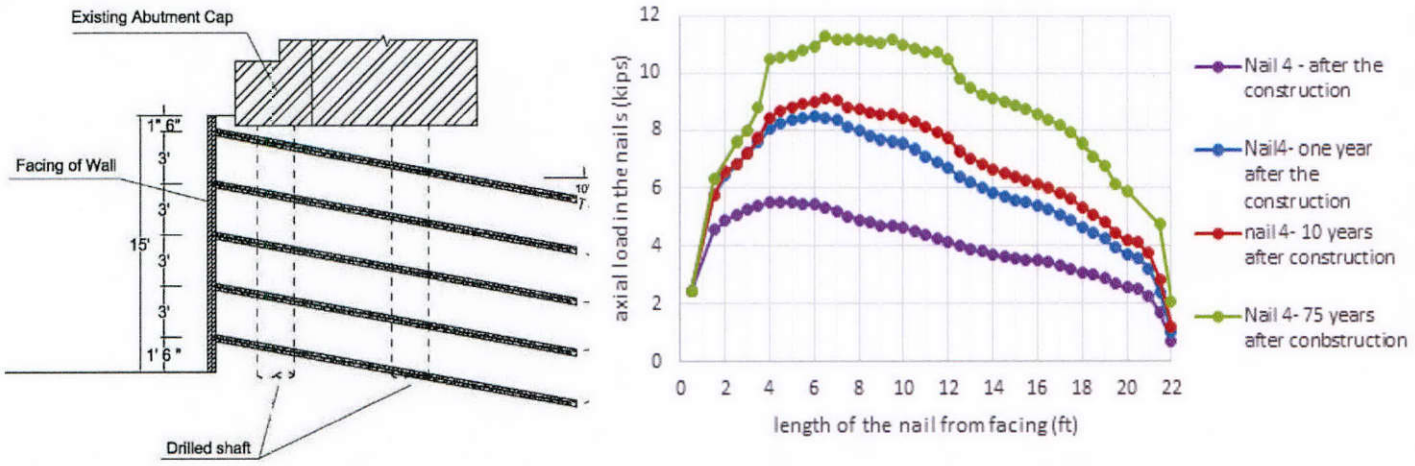

Figure 2. Increase in the Soil Nail Load Due to the Creep of the Soil Mass.

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