An Innovative Solution for Slope Stabilization Using Recycled Plastic Pins

Highway embankments in North Texas are predominantly constructed on highly expansive clayey soils. However, due to repeated drying and wetting cycles, clays in embankment slopes experience significant loss of strength. These cause sloughing and shallow slope failures in many of the embankment slopes in and around north Texas and pose a significant slope maintenance problem for TxDOT. Most of these slides are limited to a depth of 6-8 ft. A new technique for slope stabilization for shallow slides has been developed using recycled plastic pins. The slope stabilizing method utilizes a distributed network of pins (Figure 1), constructed from recycled plastics and other waste materials.

The application is similar to stabilizing slope using micropile and soil nail but is less expensive. The technique utilizes plastic pin as a reinforcing member to intercept potential sliding surfaces and provide additional resistance to the soil slope. The feasibility of the stabilizing method has been demonstrated in a field test site located along Hwy 287 S in Waxahachie, Texas. The stabilization was carried out with different scheme to evaluate if an adequate margin of safety can be attained with more widely spaced reinforcing members.

Field Demonstration Site
The selected site is located along Hwy 287 S near St. Paul Overpass in Waxahachie, Texas. The test site is an embankment fill slope with 2.5:1 (H:V) inclination and approximately 30 ft height. The slope is constructed of medium to high plasticity clays.

Extensive site investigation and laboratory test program was undertaken to determine the physical and strength characteristics of the embankment soil. Resistivity Imaging (RI) was conducted as a part of site investigation to have an idea of the baseline moisture content. Stability analysis was performed using both limit equilibrium and finite element method for different array configuration of the reinforcing members to determine the stability of slope. The stabilization program was implemented with different configuration of the reinforcing members (Figure 2) to optimize the technique based on cost and performance of the slope. A section was left unattended between the two reinforced section to serve as control section. Figure 3 presents the stability analysis of the reinforced slope for reinforced section 1 using finite element program PLAXIS.
Field Installation
Installation of the reinforcing members were performed using Klemm 802 with a vibratory hammer (Figure 4). The rate of installation generally averaged 115 members per day, with a maximum installation rate of 130 members per day. The installation of the reinforcing members was performed in March 2011 and a total of 460 recycled plastic members were installed in 4 days.

Performance Monitoring
The stabilized slope was instrumented with inclinometer, 9 (nine) instrumented reinforcing members, moisture sensors, tensiometers and rain gauges to evaluate the performance of the stabilizing technique. Monitoring of the Instrumented site will be continued for next two years (2012-2013).

Summary
The use of recycled plastic pin as a reinforcement for slope stabilization can be a fast and cost effective solution for shallow slides. The unit cost for stabilization of the slope using plastic pin was $3.85/ft². During a rainfall in April 2011, movement was observed at the control section while no movement was observed at the reinforced sections. Monitoring of the installed instrumentation will be continued and few other failed slopes will be stabilized using recycled plastic pin to evaluate a design protocol for Texas Department of Transportation (TxDOT).

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