Additionally Selected Technologies
Priority, Market-Ready Technologies and Innovations

2007

Slope Stabilization Using Recycled Plastic Reinforcement

The Challenge:

Slope failures and landslides put infrastructure at risk.

Landslides and slope failures are responsible for millions of dollars of damage to public and private property each year. The primary factors driving this trend include aging slopes constructed for major transportation systems during the 1950s and 1960s and the ever-increasing need to develop land on steep natural slopes and fills for public and private use.

Surficial slope failures (nuisance slides) constitute a significant economic and manpower burden for many transportation agencies due to the frequent and recurring nature of the slides. A new, cost-effective alternative for stabilizing these slopes was desired.

The Solution:

Recycled Plastic Reinforcement

Recycled Plastic Pins (RPPs) stabilize slopes in procedures comparable to soil nailing and conventional piling. RPPs are lightweight, composite members of plastic, wood and other waste products that can be produced in various sizes and are easily customizable with conventional construction equipment.

How Do Recycled Plastic Pins Work?

Recycled plastic members are installed in the slope to intercept potential sliding surfaces and provide additional resistance needed to maintain the long-term stability of the slope.

To determine the number of pins required to increase slope stability to an acceptable level, design methodology estimates the resistance provided by each pin, incorporates that into conventional slope stability analyses and calculates safety factor improvements under various reinforcement scenarios.

While required member spacing depends on conditions present at a site, a "standard" pattern that appears for most sites consists of using recycled plastic reinforcing members placed in a 3' x 3' staggered arrangement over the entire slide area. Recycled pins can be installed with either a percussion hammer or a simple drop-weight hammer similar to that used to install guard rail posts.

Image on the right: Recycled plastic pins are driven into a slope using the percussion hammer from a track-mounted drilling rig.

Putting It In Perspective

Repair and maintenance costs of U.S. highway slope failures have been estimated to exceed $100 million annually.

Indirect costs of landslides (loss of revenue, use or access to facilities) were conservatively estimated to equal or exceed direct costs.

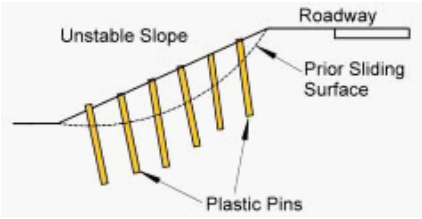
Costs to maintain slopes for other highways, roads, levees and railroads maintained by government and private agencies significantly increase the total costs for landslide repairs.

Landslides: Investigation and Mitigation, NRCSR 247, TRB 1996

Successful Application: Missouri Department of Transportation

RPPs were used to stabilize two slides in an earthen embankment located on Interstate 70 at milepost 62 near Emma, Missouri. The embankment had a history of repeated slope failures, each of which were repaired by pushing the soil back into place. The embankment is 25 feet high and has slopes of approximately 2H:1V. Soil is a mixture of lean and fat clays with some silt.

317 eight feet long RPPs were installed on a three foot staggered grid with every other row offset by 1.5 feet. Pins were installed using a Davey-Kent DK 100B crawler mounted drilling rig.



Reinforcement of unstable slope with recycled plastic pins

Ten pins were instrumented to monitor strains, stresses and bending movements in the pins. Inclinometers and piezometers were also installed to monitor lateral movements and determine groundwater conditions.

Laboratory testing included tension and compression tests as well as bending and shear tests to evaluate the mechanical properties, durability and long-term performance of the recycled materials. Sustained loading tests were also performed. To-date (October 2003) all slopes remain stable. Based on the success of the I70-Emma site, additional sites were tested in October 2000: two embankment slopes on I-435 in southern Kansas City, an excavated slop on US Highway 36 near Stewartsville, an additional embankment slope at the I70-Emma site and an excavated slope on US Highway 54 near Fulton. Slope heights range from 15- to 46-ft.; inclinations vary from 2.2:1 (H:V) to 3.2:1. Subsurface conditions also vary. Each site was monitored for periods ranging from two to five years using varied field instrumentation. By December 2003, all slopes were successfully stabilized.

The Result

When used in appropriate conditions and constructed following established procedures, this technique is effective in stabilizing surficial slides at costs often substantially less than other potential options.

Additional Resources

Further information about Slope Stabilization Using Recycled Plastic Reinforcement is available **here**

Slope Stabilization Using Recycled Plastic Pins – The Missouri Story
Organizational Results Research Report January 2007 | PDF
Research Report October 2003 | PDF
Research Report July 2000 | PDF

Design Methodology for Stabilizing Slopes Using Recycled Plastic Reinforcement
BY J. Erik Loehr, Eng Chew Ang, Jorge R. Parra, and John J. Bowders | PDF

Slope Stabilization Using Recycled Plastic Pins (Power Point Presentation)
BY J. Erik Loehr and John J. Bowders | PPT

Benefits

Costs to perform pinning are 20% to 70% of the cost to repair shallow (nuisance) slides

More permanent slope repair and stabilization

Low susceptibility to degradation

Maintenance personnel free to perform other operations

Environmentally sound use of waste material that might otherwise be land filled

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