RITA Office of Research, Development, and Technology

UTC Spotlight

University Transportation Centers Program

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Stabilizing Marginal Soils With Fibers and Chemicals for Roadways and Airports

Alaska is well-known as a land of extremes. Extreme cold, long summer days and long winter nights, large mountain ranges and the Iditarod Sled Dog Race all come to mind. But another extreme is the high cost of gravel in western Alaska. There is little gravel in the lower Yukon and Kuskokwim river regions; the soils are dominated by sands, silts, and clays. To build a road—or just about any structure—gravel must be barged from hundreds of miles at a cost of $200–$600 per cubic yard or about $6,000 for a 10 yd. dump truck load. This simple fact prompted the Alaska University Transportation Center (AUTC) to search for alternatives. The goal: find a way to use local material at a cost lower than the price of importing gravel. A secondary goal was to minimize the size and number of pieces of equipment required to stabilize the soil.

Three New Products

Peter Jackson

Applying geofibers to Horseshoe Lake Road near Wasilla, Alaska.

After 4 years of hard work by AUTC graduate and undergraduate students and hundreds of tests, not one but three soil stabilizing techniques were developed. Each has its own properties and use. The first stabilizer developed incorporated the use of plastic fibers that reinforce the soil, much like reinforcing bars in concrete. Using fibers about 1.75 by 0.24 inches in size, researchers can double—and in some cases triple—the strength of sands and uniform silts. This technique is useful for strengthening sub-base materials (a load-bearing layer in the pavement structure). However, this stabilizer lacks abrasion resistance and is not useful as a surface layer.

The second technique developed combines chemical stabilizers with the fiber-reinforced soil. Doing so increases strength while adding abrasion resistance and reducing the impacts of weathering. This technique is applicable to strengthening soil for low-volume, low-speed roads.

Peter Jackson

Applying chemical soil stabilizer to Horseshoe Lake Road.

The Federal Highway Administration (FHWA) Western Lands funded a full-scale test near Wasilla, AK, to determine whether this combination of fiber and liquid techniques would work in the field. The Horseshoe Lake test section was constructed during the summer of 2010. These additives stabilized the local sand underlying the test section, making solid a segment of roadway that typically was impassible during dry weather. The performance of the test section will be monitored over the next 3 years to determine the functional life of the stabilizers. So far the residents are delighted with the results. The surface remains hard, no matter the weather.

The third technique came about because of a new challenge. The Alaska Department of Transportation and Public Facilities asked AUTC to determine whether the two new techniques would work at Kwigillingok, AK, a small community at the mouth of the Kuskokwim River—the most challenging soil to date. Kwigillingok silt contains 9 percent clay with an in-situ moisture content of 50 percent. AUTC found that simply drying the soil made it usable in an embankment, but local weather does not allow this option. None of the new techniques tested to date worked, nor did any of the traditional stabilization methods, including soil cement.

Peter Jackson

Mixing the fibers into the roadway on Horseshoe Lake Road.

So the search for a new option began. AUTC graduate student, Rodney Collins, combined a drying agent with one of the two readily available chemical stabilizers AUTC was already using. He obtained an increase in unconfined compressive strength exceeding 400 psi (150 psi is strong enough to carry traffic). This is even more impressive given that the soil was mixed at 30 percent moisture content, the lowest moisture content thought obtainable at Kiwigillingok.

When AUTC repeated the test using Horseshoe Lake sand, values exceeding 1,000 psi were reached (as a comparison, compressive strength of concrete is between 3,000 and 10,000 psi). The estimated cost is under $200 per cubic yard. The first goal of obtaining an economic alternative to importing gravel was achieved.

The second goal—to keep the required application equipment minimal—has also been met. Chemicals can be added in-situ using only an agricultural rototiller and a water truck. The roadway or airport under construction is shaped and compacted normally, using a motor grader and compactor. The new road can open to traffic after 24 hours.

The techniques developed for Alaska have applications throughout the world. The U.S. military is interested in the technology for rapid construction of dust-free surfaces in desert environments. AUTC is also exploring the use of chemical stabilizers with catalysts to stabilize base courses and gravel surfaces as an alternative to asphalt. Perhaps the greatest advantage of this technology is the wide range of soils it will work with. AUTC has demonstrated it will work with base courses, sands, silts, and silts containing clay.

About This Project

The Alaska University Transportation Center (AUTC), at the University of Alaska Fairbanks Campus is headed by Billy Connor, Director, who joined AUTC after retiring from the Alaska Department of Transportation and Public Facilities (DOT&PF). The graduate student on this project, Rodney Collins, is working to reduce transportation costs in Western Alaska through soil stabilization techniques. This research is supported by the Department of Transportation through the Safe, Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA-LU) and matching funds from the Alaska DOT&PF.