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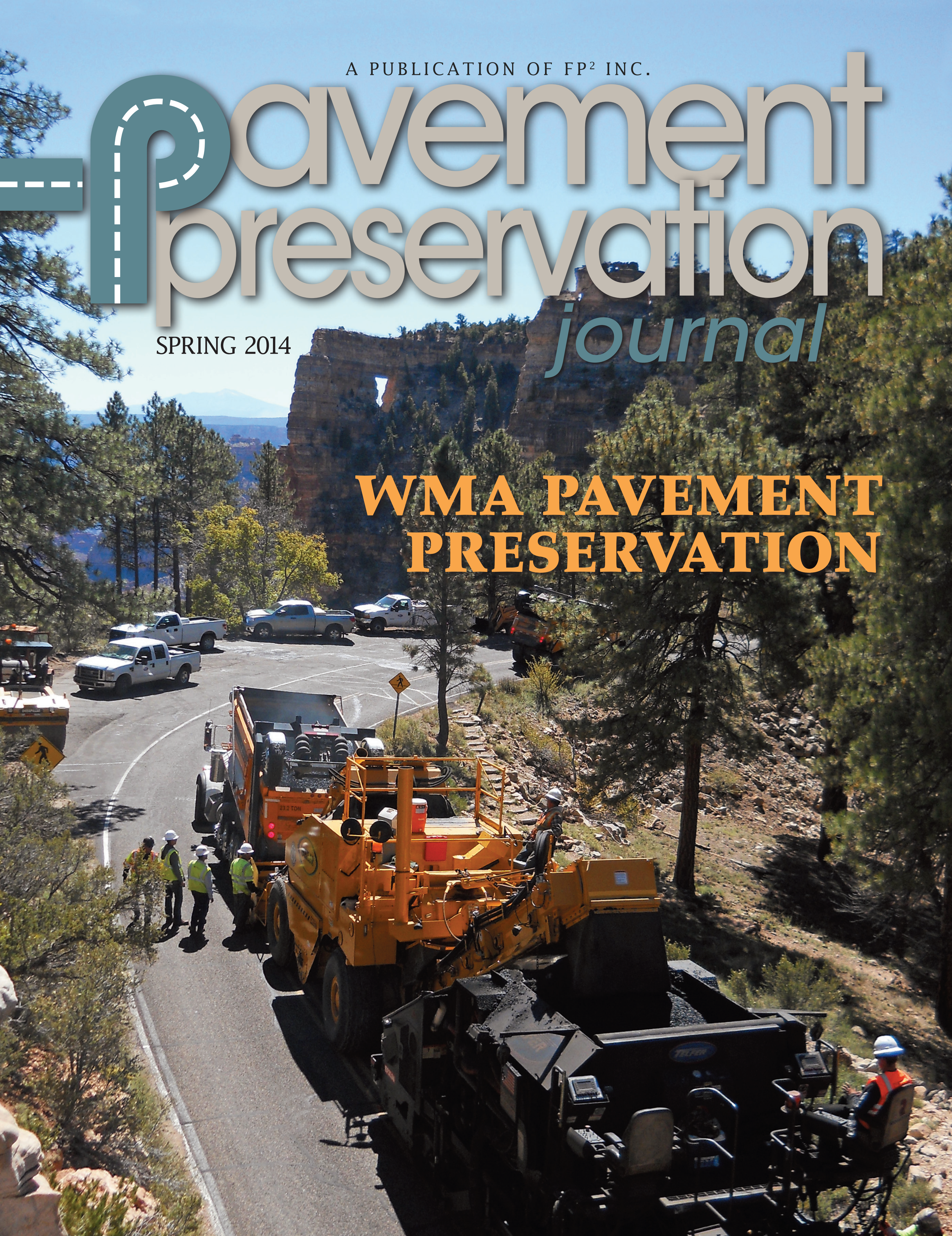


Under Tight Deadline, Deep Injection Process Stabilizes Missouri U.S. 65

On U.S. 65, grid pattern provides guidance during UDI injection process

MoDOT completed falling weight deflectometer (FWD) testing while Uretek finished DCP testing on the problem area of concern

Just weeks before Memorial Day 2011, the Missouri Department of Transportation, District 2, was faced with a roadway which began to rapidly deteriorate under traffic loads. With little time to spare in advance of the holiday weekend, an innovative process involving deep injection of expansive, high density polymer material into the highway's sub-base was used to quickly and economically stabilize the highway's base and sub-base.

U.S. Highway 65 is a two-lane asphalt highway with gravel shoulders. This area of Missouri is mostly farm land, amid rolling prairie and small stream crossings. Near the intersection of U.S. 65 and State Road WW—about 70 miles east of Kansas City—MoDOT had begun a project to lower the crest of a troublesome hill by 5 ft. in order to enhance driver visibility. To expedite the repair, MoDOT had completely closed this roadway section and detoured all traffic.

On Wednesday, May 18, an empty 18-wheeler had caused wide cracks in the exposed base course of the road. Later the same day a MoDOT coring rig created a 2-in. rut in the base as it backed away from the coring spot. The base course material was 10 to 12 in. of reclaimed asphalt pavement (RAP) mixed into crushed stone. The sub-base soil was comprised of "in-situ" materials taken from a nearby hillside cut.

MoDOT project personnel surmised that the problem was likely this composite subgrade material. The localized area of concern for stabilization of the sub-base was a 541 ft. long X 24 ft. wide section totaling 12,984 sq. ft. where the vehicle transit damage had occurred. Time constraints and budget concerns would not

On U.S. 65, substantial cracking indicated base failures below

MoDOT coring rig created a 2-in. rut in the base as it backed away from the coring spot

allow total removal and replacement of the sub-base.

MoDOT contacted one of its specialty highway repair contractors, Uretek USA, Inc., for a review of the problem. Following on-site meetings, Uretek's stabilization proposal was approved on Friday, May 20. MoDOT needed to open the road before the upcoming Memorial Day weekend, allowing a project time line of only 10 days from proposal to completion. The project's goal was to effectively stabilize the soils underlying this asphalt roadway using the Uretek Deep Injection (UDI) polymer injection system. Uretek dispatched a crew and began the project testing and subsequent work within 48 hours.

WHAT IS POLYMER INJECTION?

The proprietary UDI process used on U.S. 65 is a patented technique for stabilizing weak or poorly compacted foundation soils by injecting an expansive high-density polyurethane through holes drilled in the pavement directly into the targeted soils. Additional lifting of the soil structure and overlying pavement is often included in the project scope.

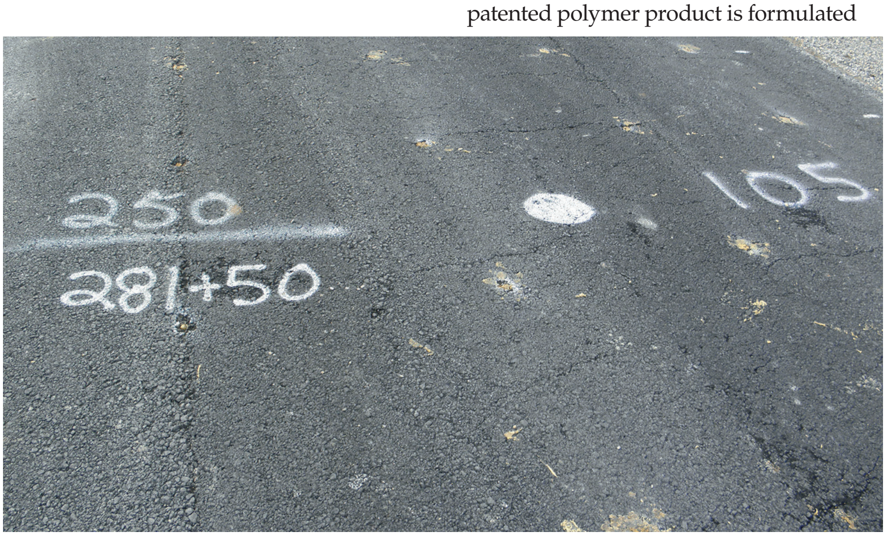
The UDI process is a chemical compaction grouting technique which uses a unique low viscosity polymer to void-fill, infiltrate, and strengthen certain weak soils. The high expansive force results when the two components of the specially formulated polymer react and create a large volume increase. This patented polymer product is formulated to resist the intrusion of strata water or moisture which would otherwise compromise the structural characteristics of the injection material.

The polymer is placed via direct drilled holes (or injection tubes) which allows the polymer to be "surgically" placed in the strata where stabilization is needed. An injection grid (typically 4 to 5 ft. on centers) provides full coverage of the area being stabilized.

Movement is always monitored at the surface during the injection process. The very first surface movement indicates that the soil matrix has been stabilized around that injection point. If stabilization is the desired goal, injections at that location point cease. Additional pavement lifting is often accomplished by further polymer injections into the soils.

The first step is site assessment, including collection of available geotechnical information, execution of dynamic cone penetrometer (DCP) tests, examination of the structure for load-related distresses, and determination of design, current usage and projected future loading.

A treatment plan then is formulated, including engineering review of the geotechnical information and DCP test data to fully identify those areas of weak and/or poorly compacted soil strata. The data is analyzed and an injection pattern,



Results from the post-injection FWD testing indicated the designed treatment was effective in stabilizing the targeted soil matrix often with multiple depths of injection, is then designed.

In the case of U.S. 65, the aggregate base composite mixed with coarse sand required an injection system to fill voids, strengthen and to bind the soil matrix.

Lower percentages of smaller particles in these soils permit greater infiltration into the layer prior to expansion. These soils benefit from the dual events of polymer infiltration (binding) and polymer expansion (compacting). The injection process is repeated until the surface movement is detected indicating that the soil is now stable and the expansive force is constrained in all directions except up.

The UDI process is often applied to a variety of different soil categories such as saturated fine sands, layers comprised of silts and clay-size particles, and even soft, organic soils.

A PLAN FOR U.S. 65

MoDOT and Uretek engineers designed a project plan for rapid, efficient, and cost-effective remediation if the U.S. 65 problem. MoDOT completed falling weight deflectometer (FWD) testing while Uretek finished DCP testing on the problem area of concern.

Part of the area received a 3 ft. X 3ft. grid of injection to a depth of 3 ft. But in relatively better areas, a pattern of 4 ft. X 4 ft. to a depth of 4 ft. was specified. Despite severe weather problems (a nearby tornado), Uretek began the actual injection process on the Tuesday before Memorial Day. The crew worked in 12-hour shifts to speed the process of stabilization. Their work was completed in just two days, well ahead of schedule.

MoDOT designed and implemented a geo-grid system topped with 3.75 in. of hot mix asphalt to overlay the base course stabilized areas in order to provide an open highway prior to the holiday weekend. The road's wear course was applied the following week.

Following stabilization, MoDOT conducted FWD testing throughout the project to evaluate the effectiveness of the UDI process. Results from the post-injection FWD testing indicated the designed treatment was effective in stabilizing the targeted soil matrix.

John O, Donahue, P.E., MoDOT's construction and materials liaison engineer, provided detailed analysis of all FWD data collected pre- and post-project completion. His analysis showed the average increase in sub-grade modulus after deep injection was 60 percent.

The average decrease in maximum deflection after UDI was 35 percent. The UDI process produced an increase in base soils stiffness which should result in the pavement system being capable of supporting the original design loads. Donahue reported that the geo-grid system would also assure surface ride quality along with providing extended pavement life.

The Uretek UDI Deep Injection process and 486 Star water resistant polymer are protected by U.S. patents. The Federal Highway Administration now allows sole-source products and services for federally funded projects. Fifteen states have now used UDI for federally funded pavement stabilization projects.