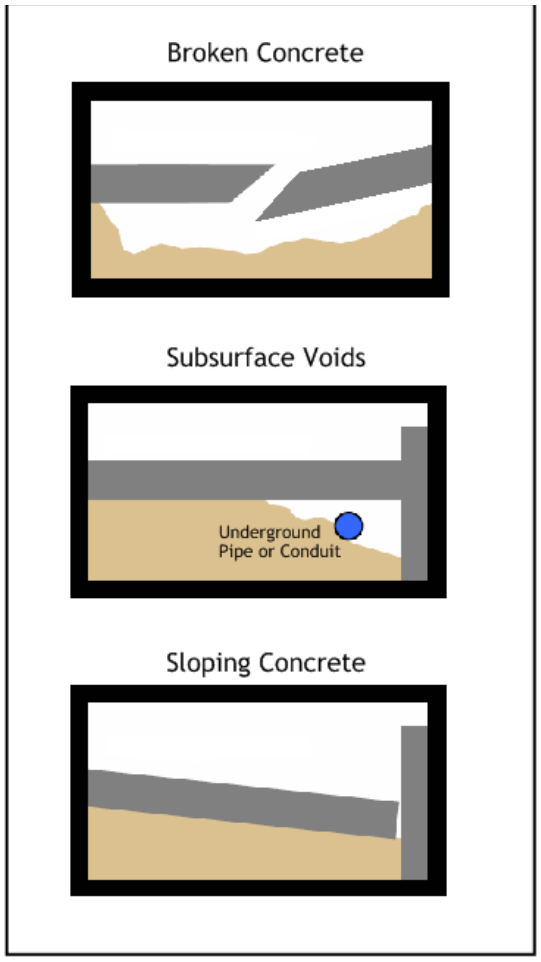
The URETEK Method™ for Roadways and Transportation Assets

A URETEK USA White Paper
www.worldofuretek.com

Introduction

Since the inception of the National Highway Act in the 1950's, our interstate highway and bridge transportation system has become an essential component of our modern society. According to the U.S. Department of Transportation (DOT), Americans use this system each year to log more than 238 billion miles for commuting to work, hauling freight, and for a variety of recreational travel.

Roadway Problem Areas



For roads and highways, deficiency problems include broken or separated concrete slabs, faulted joints, subsurface voids, and sloping or inconsistent pavement levels (see diagram) that also result in poor driving conditions and greater vehicle maintenance. According to Federal Highway Administration statistics, only 58 percent of our nation's roadways were considered to have either "acceptable" or "good" ride quality. For bridges, an astounding 28 percent were rated as either structurally deficient or functionally obsolete.[1]

With so many citizens dependent on these assets, pavement problems can have a significant impact on the flow of traffic and the amount of traffic congestion. According to a study conducted by the Texas Transportation Institute, over 64.5 million person-hours were spent in traffic congestion in 2003 costing the average commuter $865 dollars in wasted fuel and lost productivity time in Texas alone.

A detailed analysis conducted by Virginia Polytechnic Institute of the 166 worst freeway bottlenecks in the United States concluded that commuters and citizens would enjoy more than $336 billion in economic benefits if improvements were made to transportation assets in these areas.[2]

Traditional methods of addressing these problems have provided less than ideal results. The older systems and materials required lengthy installation time and provided temporary repairs and minimal life expectancy at best.

This White Paper both reviews these older systems and explains the URETEK Method™, which offers remarkable time, cost and longevity advantages for pavement and infrastructure management.

1 Federal Highway Administration Report, Status of the Nation's Highways, Bridges, and Transit: 2002 Conditions and Performance Report

2 "Saving Time, Saving Money: The Economics of Unclogging America's Worst Bottlenecks", 2000

Traditional Methods for Addressing Deficient Transportation Assets

Over the years, Federal and State DOTs, Departments of Public Works, Airport Authorities and other transportation asset managers have applied an assortment of solutions to address the repair and maintenance of their deficient transportation assets. Some of these traditional solutions include:

1. Asphalt Overlay - Just as asphalt is used as a primary material for roadways, because of its reduced cost and greater flexibility, it is also frequently used to repair deficiencies such as uneven surfaces, misaligned panels and pavement settlement. To address these problems, a hotmix of asphalt (HMA) is spread over an existing surface to fill in and cover up the deficient area. The thickness of the asphalt overlay can vary anywhere from a half of an inch to several inches depending on the magnitude of the problem. The success of this technique depends to a great extent on the condition of the base soil beneath the roadway. If the base is weak, unstable or voided, the repaired surface is likely to experience a repetition of the failure.

2. Cementitious Grouting - This process typically involves the use of a water/soil/fly ash/cement mixture injected by hydraulic pressure under pavements to void fill and support the damaged or settled areas. Unfortunately, the cementitious material is slow to cure (causing extended lane closures); as it cures it shrinks (taking any lifted panels out of level); and once cured lacks sufficient tensile strength for long term effectiveness.

When used to fill subsurface voids, significant amounts of the material must be pumped in to ensure the underground space is completely filled. Once the cementitious material hardens, its inherent weight of 140 lbs/ft^3 adds excessive weight burden to an already distressed base soil condition.

When used to repair bridge approach slabs, the added weight issue of cementitious grout can also complicate adjacent utility conduits and piping located beneath the surface of the structure. If enough force is applied, the pressurized grout can move existing utilities out of alignment or force its way into cracks that exist within underground pipes or lines.

3. Full Depth Pavement Removal and Replacement - The typical full depth replacement process can take weeks or months to fully complete and rehabilitate. During this period, traffic must be re-routed around the repair area, contributing to greater delays and disruption, to say nothing of the higher cost of such projects.

Since 1989 URETEK USA has provided viable solutions to roadway and airport pavement repair and maintenance problems. In the subsequent sections of this White Paper we discuss the benefits of the URETEK Method, and how it compares to more traditional processes for transportation asset repair, restoration and rehabilitation.

Understanding the URETEK Method

URETEK's advanced polymer technology solves complex pavement lifting and transportation asset restoration projects. URETEK is the industry's fastest, most cost effective, safest and longest lasting solution for these challenges.

The URETEK Method is a multi-step process designed to identify and facilitate the repair and restoration requirements of highways, roadways, airport pavements and other transportation assets:

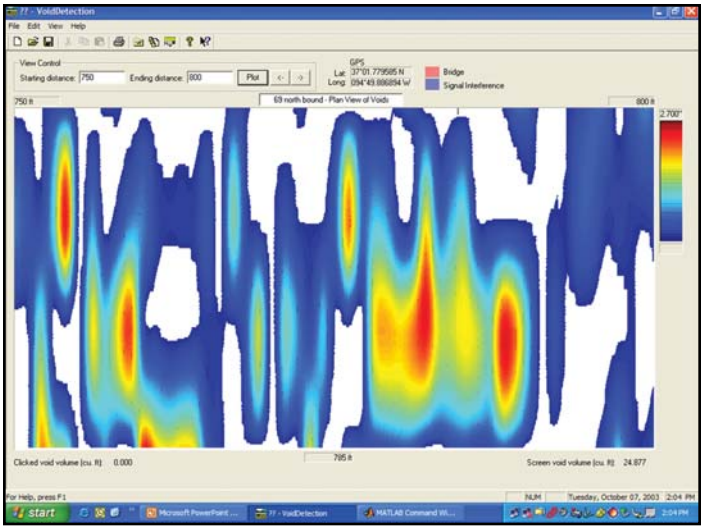
Locating the Problem Area

Where long expanses of highways and roadways are involved, URETEK begins the analysis process by using state of the art "Hyper Optics Pavement Void Analysis" (PVA) to determine the location and extent of voids beneath the surface. The System (see printout below) locates and quantifies voids and eliminates lane closures and traffic disruptions that would normally occur with traditional detection methods. This optional service is available through a URETEK affiliated company, EPIC Inc., upon request.

URETEK can also provide on-site dynamic cone penetrometer testing (see image below) which is used to measure the comparative strength of the base soil layers beneath roads, airport pavements and bridge approach/departure slabs. This information is used to determine exact locations and levels for the injection of the polymer materials used to strengthen and densify problem soil strata.

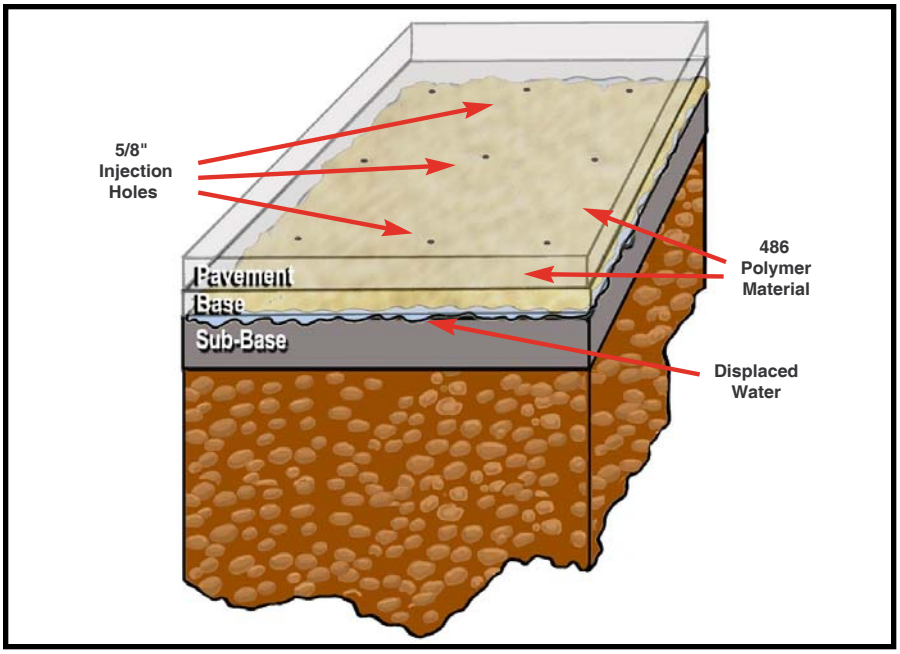
Tools Used to Locate Subsurface Problem Areas

A Hyper Optics Void Detection Scan Printout



The Penetrometer Testing Device

A URETEK Sub-Surface Injection Pattern



Repairing the Problem Area

Next, surface profiles are made to properly identify any differential settlement of the pavement. Then the URETEK 486 polymer material is precisely injected via small (5/8") diameter holes drilled through the pavement, into any existing void spaces. Once injected, the polymer begins to expand and forms a stable, strong, lightweight replacement base material. Being hydro-insensitive, any trapped subsurface water or wet soil has no detrimental effect on the material's structural integrity or performance. In fact, the water is forced away and the the wet soil densified. The injection process is repeated, using a gridwork of hole locations (see diagram), until the entire area is sufficiently filled and sealed by the polymer. If the road, runway or panel also needs to be leveled or raised, this is achieved through further monitored injections.

Monitoring the Repair Process

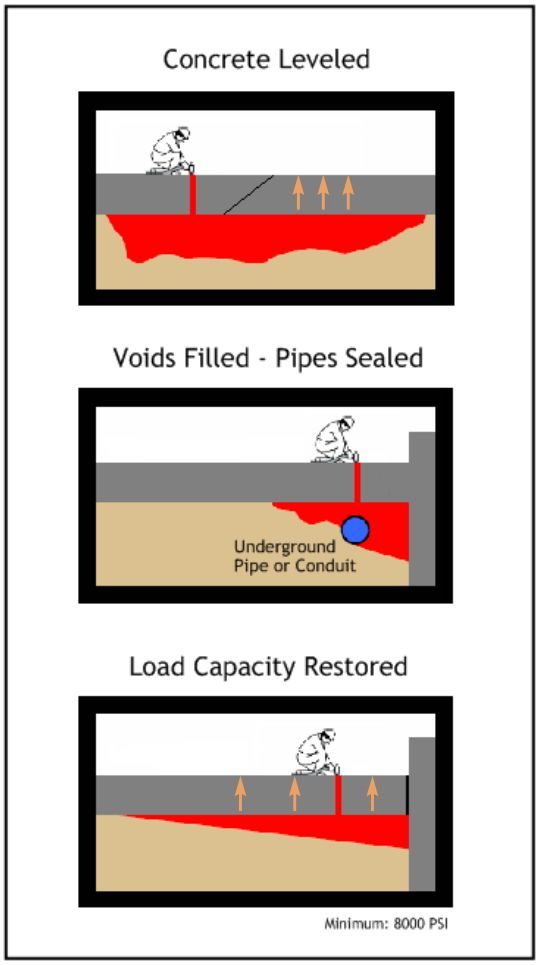
As the pavement is lifted, its movement is precisely monitored on the surface using laser level measuring devices. The polymer expansion reaches 90 percent of its full compressive and tensile strength within approximately 15 minutes. Because the polymer material is extremely light, any additional overburden weight is kept to a minimum. The properties of URETEK's polymers are carefully matched to typical base material compressive strength characteristics.

Applications for The URETEK Method

There are four key applications where The URETEK Method provides a significant advantage over more traditional methods in solving complex pavement lifting and soil densification problems:

A. Void Filling - When weather conditions produce rain, snow, or severe temperature shifts, expanses such as fissures and water pockets can be created that in turn form voids just below the pavement surface. These voids can result in settlement, potholes, sink holes or cracking that in turn, can destabilize pavements.

Roadway Problems Fixed Using the URETEK Method



The URETEK Method is very effective in addressing these types of voids. The expansive, hydro-insensitive polymer material, which is at the core of the URETEK Method, drives out any standing water and aggressively fills voids. This also densifies the soil and prevents the expansion and formation of new voids in the future.

B. Stabilization - By undersealing and void filling, the URETEK Method stabilizes roadways and prevents pumping or further differential settlement of these assets. The URETEK Method effectively fills, compacts and stabilizes the base soils beneath pavements and seals the area from any further water intrusion that could contribute to degradation. It is the only process that combines the benefits of sealing, stabilizing, and asset protection with rapid curing time; this allows the project area to be quickly repaired and returned to service.

C. Lifting - The URETEK Method is quickly and economically applied to solving the densification, lifting and realignment of both concrete and asphalt roadways. The expansive, hydro-insensitive properties of the URETEK 486 polymer and the 10 year material guarantee ensure that settlement problems are properly corrected. Since the material is injected in layers, the amount of lifting can be controlled to within one tenth of an inch, which assures accurate lifting profiles.

D. Sealing - Sealing joints and cracks from water leakage and seepage is one of the most important and frequently recurring problems facing many roadway surfaces. If left unattended, leaking joints and cracks can grow, further damaging the pavement and compounding void and settlement problems.

To underseal pavements in these environments, the patented URETEK polymer material is strategically injected in a uniform grid pattern just below the surface. As the material is injected, it begins to expand, seeking out and filling sub-surface cracks, leaks, voids and joints, providing a strong, stable and long lasting seal that resists further water intrusion.

About The Patented URETEK Polymer Material

URETEK USA effectively puts states, counties, cities, municipalities and other transportation asset authorities in control of their deficient transportation assets by saving both time and money. Using URETEK's soil stabilization and pavement lifting technology, decision makers can now choose an accurate, precise and cost effective asset repair solution.

To summarize, the URETEK 486 material is:

1. Expansive - When the URETEK 486 polymer material is injected into a subsurface layer, it expands up to 20 times its original liquid volume, filling any voids or fissures in its path while further compressing and densifying the surrounding area.

2. Hydro-Insensitive - The patented URETEK 486 polymer material displaces trapped water and is not compromised by wet conditions during or after installation. Once the curing process is complete, the hardened material retards further water infiltration. The material is excellent for sealing pavement cracks or joints.

3. Faster Installation - Using the URETEK Method and URETEK 486 polymer material, time requirements for the repair process are reduced to hours instead of the days or weeks for alternative techniques. As a result, projects are completed on time and on budget, minimizing the impact on traffic flow.

4. Lightweight - The URETEK 486 material is extremely lightweight, weighing less than 10% the weight of a comparable cementitious-based grouts or asphalt materials. The polymer thereby adds only a minimum amount of overburden weight into a project area which may already have distressed base and sub-base soils.

5. Long Lasting - The URETEK 486 polymer is guaranteed for ten years against any loss of dimensional stability or deterioration. The longevity of the material means the repaired system remains in service long after other methods have failed.

6. Safe - The cured URETEK 486 polymer material is inert, environmentally neutral and does not contribute to soil or water contamination, leaching, or pollution. The material is impervious to mildew and fungi

The URETEK 486 material, when combined with the URETEK Method, provides transportation authorities with a highly effective solution for their transportation asset repair and rehabilitation requirements.

Case Study #1: The URETEK Method Applied to a State Highway Project

Customer Profile: Kansas Department of Transportation (KsDOT).

Customer Environment: A fifty mile section of a major state highway.

Customer Situation: Increased levels of surface cracking occurring much earlier than expected.

Kansas U.S. Highway 50 runs approximately 250 miles from the border of Colorado through three counties, ending at Interstate 135 just north of Wichita. While it is considered a secondary state roadway, it stills receives a significant amount of traffic volume with over 2500 cars and 1850 trucks each day.

One fifty mile segment between Harvey and Marion Counties that was rebuilt in 1995 and 1998 had more than its share of problems due to rampant asset deterioration. According to Joe Palic Area Engineer for KsDOT, *"We have been monitoring this section for the past five years. While the road was built to last over 20 years, we have barely received three good years out of it due to increased levels of pavement cracking".* In fact, up to 25% of this section of roadway was seeing some form of structural faulting with several slabs having up to an inch of differential settlement.

Upon closer inspection of several soil cores that were taken from this particular area, it was determined that the limestone treated clay sub-grade was failing and loosened particles from its subsurface limestone aggregate were infiltrating and clogging its 4-inch drainable base. The failed drainage had caused large voids to develop beneath the concrete pavement and coupled with the heavy traffic loads and vibration above, had led to its current state of deterioration. Upon closer inspection, KsDOT also determined that approximately 75% of the highway was still structurally sound and could be repaired.

With this information, KsDOT had to choose between two different solutions to repair the problem: Either stabilize the pavement by sealing and solidifying the drainable base or replace the entire roadway. Complete replacement was ruled out due to the extensive costs involved and the impact to traffic. In addition, overlaying the roadway with asphalt paving would not save the asset from progressive structural deterioration. After reviewing these and several other alternatives, KsDOT decided to seal the drainable base area. KsDOT set a target of completing the project within 50 days, equating to a mile of roadway that needed to be completed each day.

URETEK 486 being injected under sections of Kansas Highway 50

KsDOT evaluated three different materials for this task: a cementitious grout, an asphalt emulsion, and the URETEK 486 polymer material. To provide each of the materials a fair and equitable evaluation, similar

sections of Highway 50 were chosen for field testing. All three products were installed and evaluated for their durability and their capability in sealing the limestone and clay base.

KsDOT taking post injection core sample

The test results for the cementitious grout and the asphalt emulsion were not favorable. The grout would not flow freely between the lime-treated clay and the drain section, and demonstrated a spotty presence as an under seal. The asphalt emulsion on the other hand, did not level out between the two layers and became too viscous. According to Rick Barezinsky, the senior KsDOT engineer for the project, *"The only thing we were sure of at this point was that we could not get the quality seal we needed to correct the problem".*

When the URETEK 486 polymer was applied it was met with success. The liquefied material was injected through small 5/8-inch diameter holes, and expanded under controlled pressure to penetrate all of the voids, even into small areas within the base aggregate. Since the material was hydro-insensitive, the trapped water in the void area did not have any detrimental effect on the material reaction. The post-installation cores showed a satisfactory seal and that the expanding polymer had indeed penetrated and consolidated the bound drainable base.

After the testing phase, URETEK was awarded the initial contract to underseal the proposed 50 lane-miles in 50 workdays. This consisted of drilling the grid pattern holes, injecting the polymer, and finally sealing the holes with a cementitious grout. Shortly into the project the scope was expanded, significantly increasing the amount of material used. Even with this expansion, the project was completed three days ahead of its adjusted mandatory completion date.

According to Barezinsky, "*We were surprised to find that the polymer is capable of both establishing an underseal and filling all the voids. This gives the roadway double protection. We think this method will give the roadway an additional 10 years of service. We were extremely pleased with how well this work has gone*".

A Roads & Bridges Magazine article on this project is on the Resources Page of the company's website, at www.uretekusa.com.

Case Study #2: Concrete Slab Lifting on a Major Municipal Boulevard

Customer Profile: The Department of Public Works - Plano, Texas.

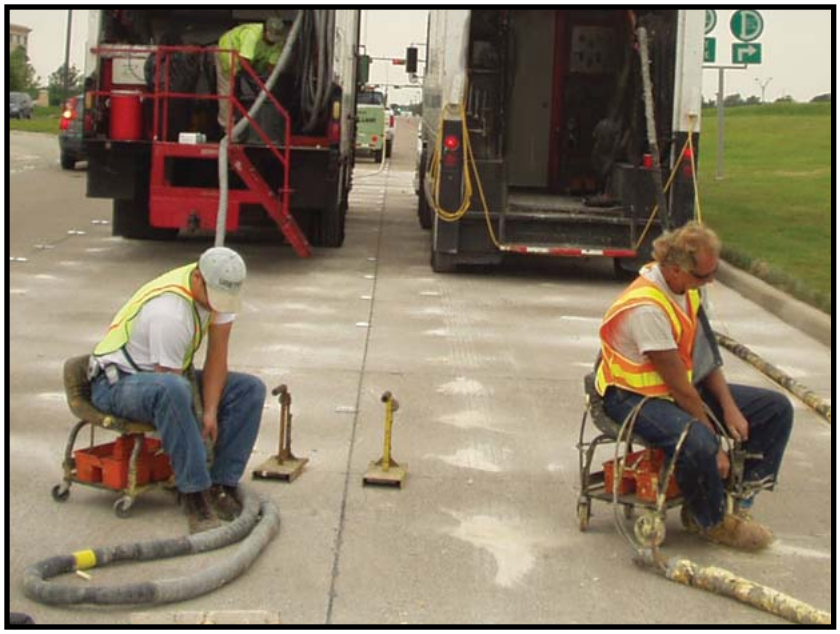
Customer Environment: A major boulevard running through a large business park.

Customer Situation: Uneven concrete street slabs resulting in poor ride quality.

Legacy Road is a major thoroughfare running through Legacy Business Park, one of two major business districts within the city of Plano. Given the significance of this section to the city, a roadway problem can quickly turn into a very visible source of trouble for the city's Department of Public Works.

Since the city installed concrete slabs, the boulevard has been clogged with traffic delays and congestion every time a portion of the roadway surface needed to be repaired. Problems with the road were the result of periodic over-irrigation and water runoff that seeped under the street and hollowed out sections of the base soil. The resulting voids caused the road to settle and fault, creating an uneven road surface and a problematic driving condition.

URETEK 486 being applied to westbound Legacy Drive



According to Mike Rapplean, Plano's Manager of Public Works, "*Sections of our roadway would settle and you would get a 'thump, thump, thump' every time you drove over them*". The problem was made even worse for businesses along the boulevard as they had to cope with rattling vibrations every time large trucks and busses drove by.

One method for alleviating the problem was to have the individual slabs re-milled, which involved extensive diamond grinding. Each time this occurred, major traffic delays resulted, frustrating commuters even further. According to Rapplean, "*In a lot of cases, repairing the top surface of the road didn't really fix the problem since we continued to have voids under the street which were causing it to sink or crack further*". To repair these voids, the Plano DPW tried injecting cementitious grout under the pavement to level the slabs. Rapplean added, "*When we pumped the materials underneath we were astounded at how much water came out. Given the weight of the hardened grout, the material eventually sank, creating a larger void, compounding the uneven roadway condition*".

In August of 2002, the city of Plano called on URETEK USA to help with this major roadway problem. During an initial test, the city engineers watched the URETEK 486 polymer material repair a nearby roadway. They were surprised as they witnessed a problem that would have taken more than two weeks to repair using traditional grout accomplished in only three hours!

Based on this trial, URETEK was contracted to repair a large section of Legacy Road. All of the road surfaces were finished in three days and since the work was performed at night, the completed road sections were available for commuters by day break. Manager Rapplean added, "*The big benefit of this process was that the five locations were finished both successfully and fast. Had we used older methods, a job like this would require lane closures for two weeks*".

Besides the expediency of repairs, another winning factor for Plano was the long term cost savings. With $1.94 billion in total infrastructure assets and over half of those at least 10 years old, lengthening the life of the roads meant significant savings in terms of manpower and financial reserves for the city.

Eastbound Legacy Drive traffic alongside URETEK repair process

According to Rapplean, "*This process is 10 percent of the replacement cost in some cases, and we can extend the life of the asset significantly. I expect to extend the life of our roadways by as much as 10 to 12 years or more. It already has transformed the way that our roads are repaired. We are quite pleased with the URETEK solution*".

Summary

The combination of the URETEK Method™ and the patented URETEK Deep Injection Process™, both using URETEK's patented hydro-insensitive 486 polymer material, provides remarkable lifting, sealing, and stabilizing benefits.

*** Lifting** - The patented URETEK 486 polymer material provides exceptional lifting capabilities for restoring sunken or damaged infrastructures, reducing both the time and cost of repair as compared to conventional methods.

*** Sealing** - The hydro-insensitive nature of the patented URETEK 486 polymer material drives out standing water, effectively retarding further water penetration.

*** Stabilizing** - The expansive nature of the URETEK 486 polymer material aggressively fills any ground fissures or voids. When the material cures, it provides a strong and secure level of support for the infrastructure.

*** Densifying** - URETEK's unique processes are designed to strengthen, stabilize and densify weak soils even to depths of 30 feet and beyond.

*** Minimizing Overburden** - The lightweight nature of the URETEK 486 polymer material minimizes additional overburden on already distressed base soils.

*** Providing Longevity** - URETEK USA guarantees the 486 polymer material against shrinkage or deterioration in underground service for a minimum of 10 years.

*** Is Environmentally Friendly** - The URETEK polymer is extensively tested, meets EPA standards and is an inert and environmentally neutral product.

URETEK USA puts customers in control of their infrastructure revitalization, pavement lifting and soil stabilization problems by reducing the repair cost, time, and disruption through proprietary, safe, predictable products, people, and methods. Since 1989, with over 75,000 successful worldwide jobs, URETEK focuses on resolving complex concrete lifting and soil stabilization projects.

For more information about URETEK and the URETEK Method for Roadways and Transportation Assets, please visit our website at **www.worldofuretek.com** or call 1-888-287-3835.

URETEK USA, Inc.
13900 Humble Road
Tomball, TX. 77377
888-287-3835
www.worldofuretek.com