Welcome

POLYURETHANE GROUTING
Ground Modification

todays agenda

✓ History of Polyurethane grouting
✓ Polyurethane grouting applications
✓ Poly-jacking
✓ URETEK deep injection™ Summary
✓ Testing
✓ Case Studies
URETEK's Deep Injection Process patent is issued, a process to increase the load bearing capacity of weak soils at individual depths through polymer injection.

Chapter in progress...

URETEK's story continues as our business growth and value are at an all time high. New materials and solution offerings to clients to be unveiled later this year.

Lift sunken paving and structures
Provide Strength to weak subgrade
Extend pavement life by strengthening subgrade
Restore/increase soil bearing capacity for existing structural footings including bridge footings
Halt settlement caused by weak load bearing soils
Infrastructure Stabilization, Soil Erosion Remediation
method

SLABleveling I POLYjacking

Before

- 1993
- Two culverts run under road
- As much as 12” settlement

15 Years Later

- 2008 photo
- Still smooth today after nearly 25 years
Deep Injection

increasing bearing capacity and halting settlement

Deep Injection

- Multiple injection locations
- Expanding chemical substance is injected
- Injections result in compaction of soils
- Surface is monitored for motion
- 5 x Expansion of chemical after injection
Deep Injection

- drill 5/8" hole through foundation or footing as required
- set half inch steel rod at injection depth
- inject structural polymer
- continuously monitor surface elevations for movement

soil box injection demonstration

Injection inside steel reinforced, plexi-glass box so material flow could be observed
soil box injection demonstration

Stabilized soil mass was free-standing after box removed
soil box injection demonstration

Vertical load applied using a backhoe

soil box injection demonstration

Vertical load applied using an excavator
Laboratory Research
Deep Injection Process

Effect on Unbound Pavement Base Layer

PURPOSE

Test Geo-materials with and without polyurethane injection treatment to determine effect on Strength

- Axial Strain
- Repeated Load Permanent Deformation (NCHRP 598)
- Youngs Modulus
Three geo-materials studied:
- graded aggregate base
- 57 stone,
- natural sand.

**Laboratory Research**

**Deep Injection Process**

- Geo-material is comprised of solids, liquid (water), and gas (air).
- Common physical properties, such as moisture content, density, void ratio, porosity, specific gravity, and saturation are all derivatives of this phase composition.
- The polyurethane product infiltrates the void structure (displacing air and most of the free water) to create a bound matrix.

### 3-Phase Composition

<table>
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<th>Mass</th>
<th>Volume</th>
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Laboratory Research
URETEK Deep Injection Process

Strength Increase

Graded Aggregate Base
• 700%
57 stone
• 1,000%
Natural sand
• 7,000%

Repeated Load Permanent Deformation Test
(NCHRP Report No. 598)

• Polyurethane injection promotes a very high resistance to strains.

* These strains often produce pavement distresses such as rutting (flexible pavements) and faulting (rigid pavements).
Asphalt pavement systems - stabilization and lifting

Composite pavement systems – stabilization and lifting (including pavement systems that demonstrate reflective cracking)
Bridge approach and departure slabs – stabilization and lifting, including stabilization of MSE walls.
September 2003
- 6” Dip in road, 25’x15’ section

August 2013, ten years later
Asphalt Pavement Repair

US 65 @ Route WW

CARROLL COUNTY
MISSOURI

US 65 is a two-lane asphalt highway with gravel shoulders; terrain = rolling hills

Hill in the project area was cut down 5' to provide better visibility

Base: 10” – 12” of reclaimed asphalt with crushed stone placed over the cut

Paving operations were stopped when the base exhibited 2” ruts and finger-width cracks

Emergency stabilization of subbase needed to open the road in time for Memorial Day 2011
Rutting in Base
Water Truck used for coring – caused ruts in base material

Data Collection / Analysis
- MODOT = Falling Weight Deflectometer (FWD)
- URETEK USA = Dynamic Cone Penetrometer (DCP)

Injection Summary
- Injection depths and pattern based on FWD and DCP
- 12,984 square feet of pavement stabilized
MoDOT’s falling weight deflectometer trailer

Injection Area

Displaced Water During Injection
Results

• Average increase in subgrade modulus after polyurethane injection = 60%

• Average decrease in maximum deflection after polyurethane injection = 35%

• By injecting continuously for 24 hours, the crew met the deadline and the road was open for the Memorial Day weekend

Frost Heave Mitigation

WY - 70

Encampment, WY

October, 2011
Frost Heave Mitigation

WY - 70

Encampment, WY

October, 2011

Abstract

This project investigated a novel procedure to reduce or prevent subgrade freezing non-destructively by injecting a two-part polymer foam at the top of the subgrade. Contrasted sections of Unicell E8 foam expanded and reduced freeze heave. Two sections were treated with a 2-inch-thick layer of insulation significantly reduced the frost heave around the pole and almost totally eliminated frost heave at a site on highway WY-71. The project explored the effectiveness of subgrade, insulation, and typical redistribution of frost heave. The foam layer, when penetrated, created a porous upper reservoir from the warmer regime under the foam to the upper frozen regime above the foam. This prevented any segregational freezing in the upper zone.

The two-year research project consisted of measuring pavement elevation changes along five 200-foot-long lanes over the heave area and monitoring subsurface temperatures at six locations within and outside of the injection zone. The collection time for the 100-foot sections was one week for injection and setting the surface. Construction was continued in one lane, leaving a lane open for the entire duration without a barrier, increasing safety and minimizing impact for the driving public.

Additionally, a procedure is developed for estimating the thickness of the foam layer required for other sites with different average temperatures.

Key Words: Frost Heave, Remediation, Unicell Foam, Injection, Insulation, Silt, Wyoming

Site Layout
Summary

- Reduce/Prevent Subgrade Freezing
- Non destructive injection of URETEK Polymer
- Create layer of insulation to reduce heat loss from lower soils
- Prevent upward movement of water from warmer lower soils
- 2 year monitoring of pavement elevations and subgrade temperatures
- “Almost Totally Eliminated Frost Heave”

Site Considerations

- Frost Heave creating dangerous driving conditions
- Sharp hump in road
- During Construction road raised by placing 3’ of subgrade soil over non rippable rock outcrop
  - Silty Sand, Highly susceptible to frost heave
- Prior remediation attempts unsuccessful
  - Drainage pipes installed
  - Lateral drains installed
**Proposed Remediation**

- Injection of polymer at 18” below grade
- Level road surface and provide insulated polymer layer
- The road surface was milled
- Instrumentation was placed and wired to the data logger.
- The collection of data began on November 18, 2011
- The site was monitored over the next two winters

**Frost Heave Reduction**

Prior to Treatment = 4”  Post Treatment = 0.5”

![Graph](image-url)

*Figure 42. Graph. Frost heave along centerline of east bound lane (CLEB) – Year 1 (Dashed) and Year 2 (Solid)*
BENEFITS OF INVESTING IN THE RESTORATION OF PAVING INFRASTRUCTURE

Pavement Preservation is Cost Effective

- 40% Drop in Quality
- 75% of Life
- 40% Drop in Quality
- 12% of Life

Spending $1 on pavement preservation before this point . . . .

... eliminates or delays spending $6 to $14 on rehabilitation or reconstruction here.

Injected containment barrier

DOT Application: Re-direct flow away from road base
INSITU SHORING SYSTEM
And
Containment Wall

Underground Infrastructure
Extend the service life and rehabilitate existing underground infrastructure.
Manhole Sealing

Manhole Sealing/Rehabilitation
Rehabilitate and restore structural integrity. Quickly eliminate soil erosion and seepage concerns.

Leak Sealing and restoration
Seal eroded and deficient manholes and lateral lines.

Soil Erosion Control
Extend the service life and rehabilitate aging infrastructure without excavation.

Sewer Main Sealing

Lateral Line Sealing/Encapsulation
Rehabilitate and restore structural integrity. Quickly eliminate soil erosion and seepage.
Infrastructure Stabilization/Soil Erosion Control

erosion control
emergency infrastructure

Dam and spillway
Rehabilitate and restore structural integrity. Quickly eliminate soil erosion and seepage concerns.

Sea and lake wall
Seal eroded bulkhead and wall joints and eliminate water and soil seepage/erosion.

Conduit and outfall
Extend the service life and rehabilitate existing conduit and outfall structures quickly, safely.
Dam & Spillway Stabilization

Extend the service life and rehabilitate existing dam and spillway structures.

Thank You!

QUESTIONS???

THOUGHTS???