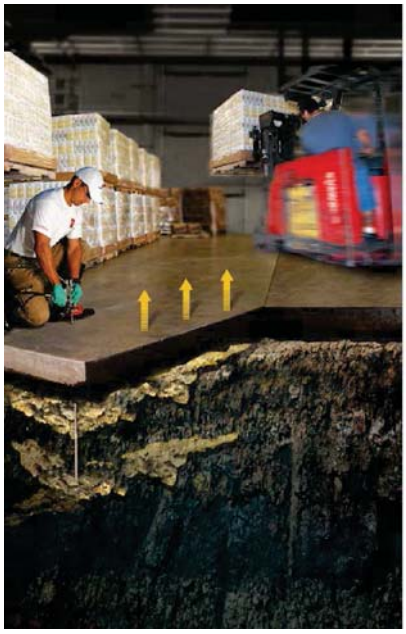
REX KLENTZMAN, P.E.
DIRECTOR OF ENGINEERING,
URETEK USA
URETEK ICR

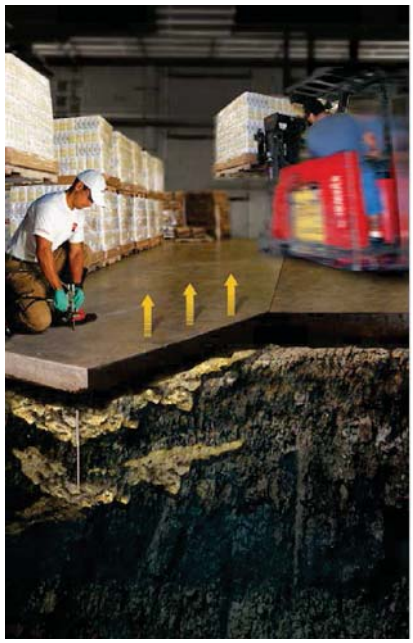
Welcome

POLYURETHANE GROUTING
Ground Modification



todaysagenda

- ✓ History of Polyurethane grouting
- ✓ Polyurethane grouting applications
- ✓ Poly-jacking
- ✓ URETEK deep injection™ Summary
- ✓ Testing
- ✓ Case Studies



1979

URETEK patents the polyurethane grouting process

URETEK advances equipment technology of total proportion and injection control of polyurethane and patents **The URETEK Method™** (U.S. Patent No. 4,567,708).

1988

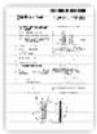
Exclusive rights in U.S.

URETEK USA, Inc., is granted the **exclusive license rights for sales and installment of product and services** in the U.S. and Mexico.

2003

Deep Injection Patented

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.



2017

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.

applicationsoverview

- ✓ 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

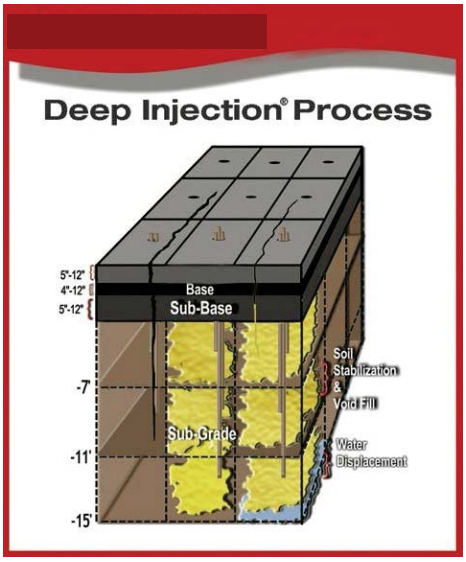
SLABleveling | POLYjacking

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

- 2008 photo
- Still smooth today after nearly 25 years

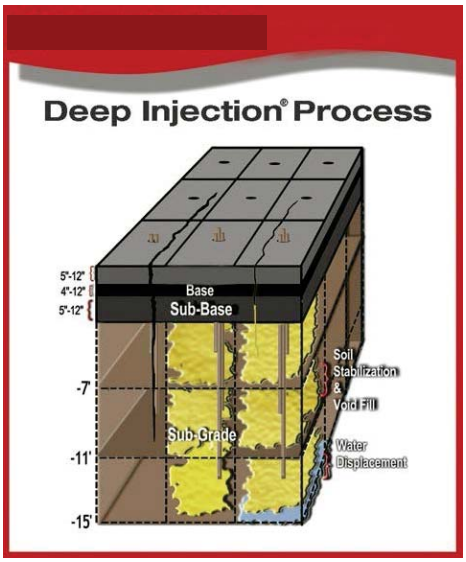
DeepInjection

increasing bearing capacity and halting settlement



DeepInjection

- 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



DeepInjection

- 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

Deep Injection

soil box injection demo

soil box injection demonstration

Vertical load applied using a backhoe

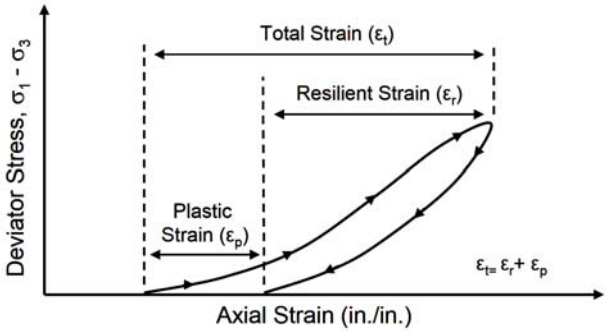
soil box injection demonstration

Vertical load applied using an excavator

TEC Services
Testing • Engineering • Consulting
Boudreau Engineering, Inc.
Pavement Design, Evaluation & Materials Consultants

Laboratory Research
Deep Injection Process

Effect on Unbound Pavement Base Lay



Laboratory Research
Deep Injection Process

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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

Laboratory Research
Deep Injection Process

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Three geo-materials studied:

- graded aggregate base
- 57 stone,
- natural sand.

Laboratory Research
URETEK Deep Injection Process

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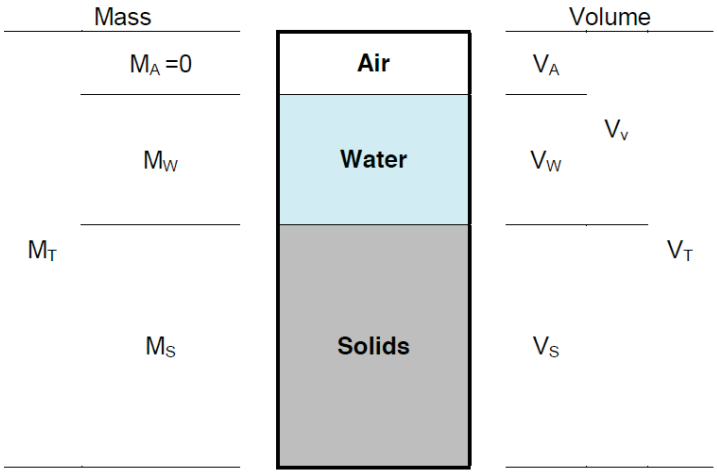
- Geo-material is comprised of solids, liquid (water), and gas (air).
- Common physical properties, such as moisture content, density, void ratio, porosity, specific gravity, and saturation are all derivatives of this phase composition.
- The polyurethane product infiltrates the void structure (displacing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

3-Phase Composition



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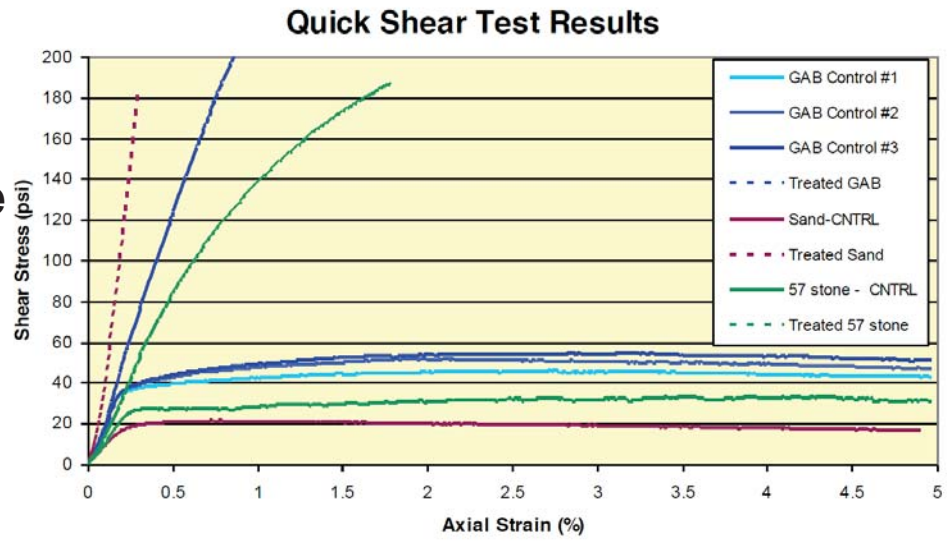
Strength Increase

Graded Aggregate Base
- **700%**

57 stone
- **1,000%**

Natural sand
- **7,000%**



Laboratory Research
URETEK Deep Injection Process

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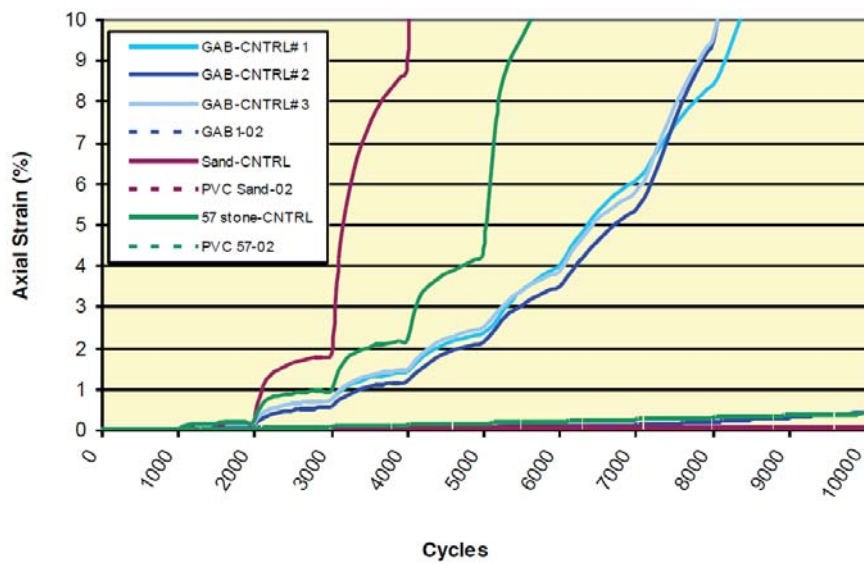
Repeated Load Permanent Deformation Test
(NCHRP Report No. 598)

- Polyurethane injection promotes a very high resistance to strains.



* These strains often produce pavement distresses such as rutting (flexible pavements) and faulting (rigid pavements).

TRANSPORTATION

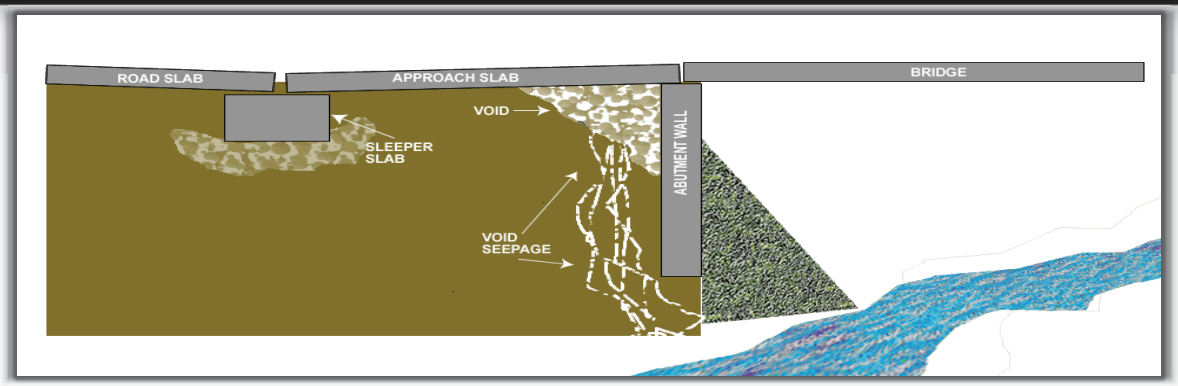
Asphalt pavement systems - stabilization and lifting

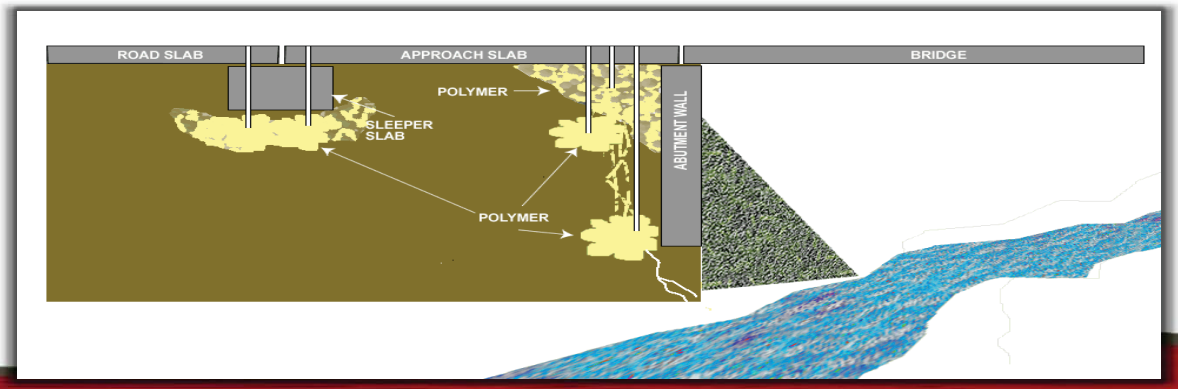
TRANSPORTATION

Composite pavement systems – stabilization and lifting (including pavement systems that demonstrate reflective cracking)

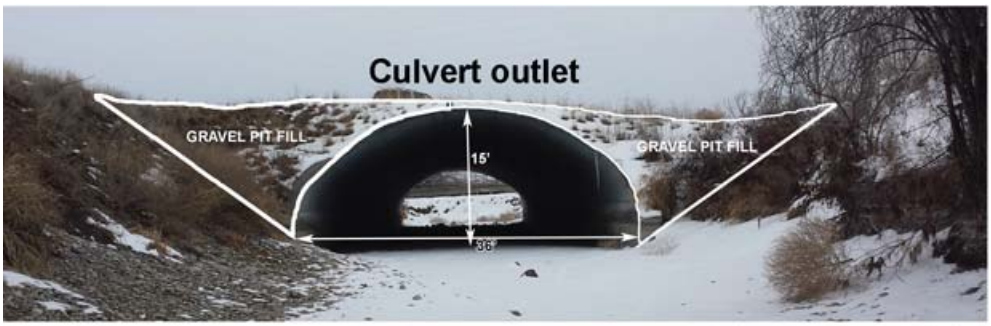
TRANSPORTATION

BRIDGE APPROACH & DEPARTURE



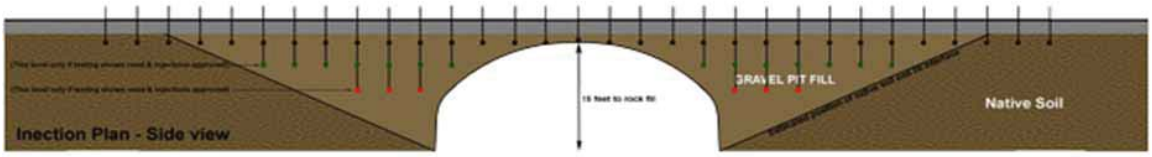


Road Settlement over Culvert Shelley, ID



Road Settlement over Culvert

● Approximate Location of Injections, on 4' grid pattern



● Injection points for 1st level - approximately -3.5 feet depth
● Injection points for 2nd level - approximately -6.5 feet depth, if DCP testing shows significant weakness at this level
● Injection points for 3rd level - approximately -10 feet depth if DCP testing shows significant weakness at this level

MD Route 410, ROAD DIP

September 2003

- 6” Dip in road, 25’x15’ section

MD Route 410, ROAD DIP

- 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

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

US 65 - Carroll County, Missouri		DCP	DCP #1	DCP #2	DCP #3	DCP #4	DCP #5
in	ft	cm					
depth	depth	depth	Blows	Blows	Blows	Blows	Blows
3.94	0.33	10	asphalt	base	base	base	base
7.87	0.66	20	asphalt	base	base	base	base
11.81	0.98	30	asphalt	base	base	base	base
15.75	1.31	40	60	10	58	9	8
19.69	1.64	50	90	16	40	26	27
23.62	1.97	60	50	12	7	10	8
27.56	2.30	70	28	7	2	2	5
31.50	2.62	80	13	1	3	4	10
35.43	2.95	90	2	3	6	4	7
39.37	3.28	100	0	5	5	5	6
43.31	3.61	110	0	5	5	5	6
47.24	3.94	120	0	5	6	5	5
51.18	4.26	130	1	5	5	4	7
55.12	4.59	140	2	6	7	5	8
59.06	4.92	150	4	5	6	5	10
62.99	5.25	160	5	5	7	8	10
66.93	5.58	170	4	6	10	11	9
70.87	5.90	180	5	7	15	14	11
74.80	6.23	190	4	8	12	14	12
78.74	6.56	200	6	18	11	15	15
82.68	6.89	210	6	13	11	13	14
86.61	7.22	220	10	16	9	10	12
90.55	7.54	230	10	16	8	11	11
94.49	7.87	240	9	21	7	12	11
98.43	8.20	250	10	20	6	11	10
102.36	8.53	260	12	18	7	11	9
106.30	8.86	270	10	19	8	7	7
110.24	9.18	280	10	20	10	6	6
114.17	9.51	290	12		8	6	6
118.11	9.84	300	12		14	11	12
122.05	10.17	310	16		15	14	14

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

FINAL REPORT

FHWA-WY-14/01F

State of Wyoming Department of Transportation

U.S. Department of Transportation Federal Highway Administration

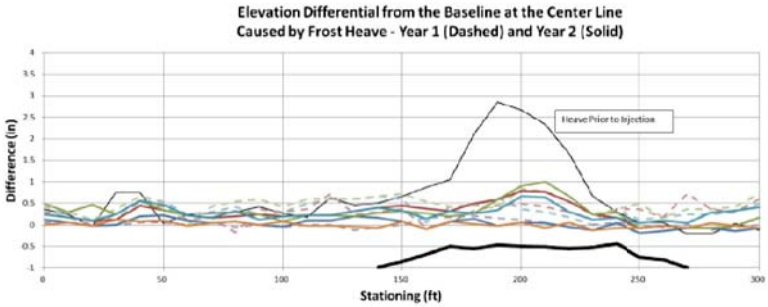
Frost Heave Mitigation

WY - 70

Encampment, WY

October, 2011

Instrumentation and Analysis of Frost Heave Mitigation on WY-70, Encampment, WY



FINAL REPORT

FHWA-WY-14/01F

Frost Heave Mitigation

WY - 70

Encampment, WY

October, 2011

Technical Report Documentation Page

Report No. FHWA-WY-14/01F	Government Accession No.	Recipients Catalog No.	
Title and Subtitle: Instrumentation and Analysis of Frost Heave Mitigation on WY-70, Encampment, WY		Report Date: May 2014 Performing Organization Code	
Author(s): Thomas V. Edgar, P.E., Ph.D.		Performing Organization Report No.	
Performing Organization Name and Address: Department of Civil and Architectural Engineering, University of Wyoming, 1000 E. University Avenue, Laramie, Wyoming 82071		Work Unit No. Job No: RS05(211) Contact or Grant No. 1001139-4211-11681	
Sponsoring Agency Name and Address: Wyoming Department of Transportation, 5300 Bishop Blvd., Cheyenne, WY 82009-3340 WYDOT Research Center (307) 777-4182		Type of Report and Period Covered: Final Report, June 2011 – May 2013 Sponsoring Agency Code	
Supplementary Notes: Research Director: Timothy McDowell, 307-777-4412			
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. Controlled injection of Uretek Star, expanding structural polymer foam, created a continuous three-inch thick layer of insulation that significantly reduced the heat loss from the deeper soil and almost totally eliminated frost heave at a site on highway WY-70, four and one-half miles west of Encampment, WY. The foam layer also prevented the upward movement of water 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 300-foot long lines over the heave area and monitoring subsurface temperatures at six locations inside and outside of the injection zone. The construction time for the 100-foot section was one week for injection and milling the surface. Construction was contained in one lane, leaving a lane open for the entire duration without a detour, 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, Urethane Foam, Injection, Insulation, Soils, Wyoming		Distribution Statement: Unlimited	
Security Classif. (of this report): Unclassified	Security Classif. (of this page): Unclassified	No. of Pages: 125	Price

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FINAL REPORT

FHWA-WY-14/01F

Site Layout

FINAL REPORT

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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"**

FINAL REPORT

FHWA-WY-14/01F

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

FINAL REPORT

FHWA-WY-14/01F

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

FINAL REPORT

FHWA-WY-14/01F

Frost Heave Reduction

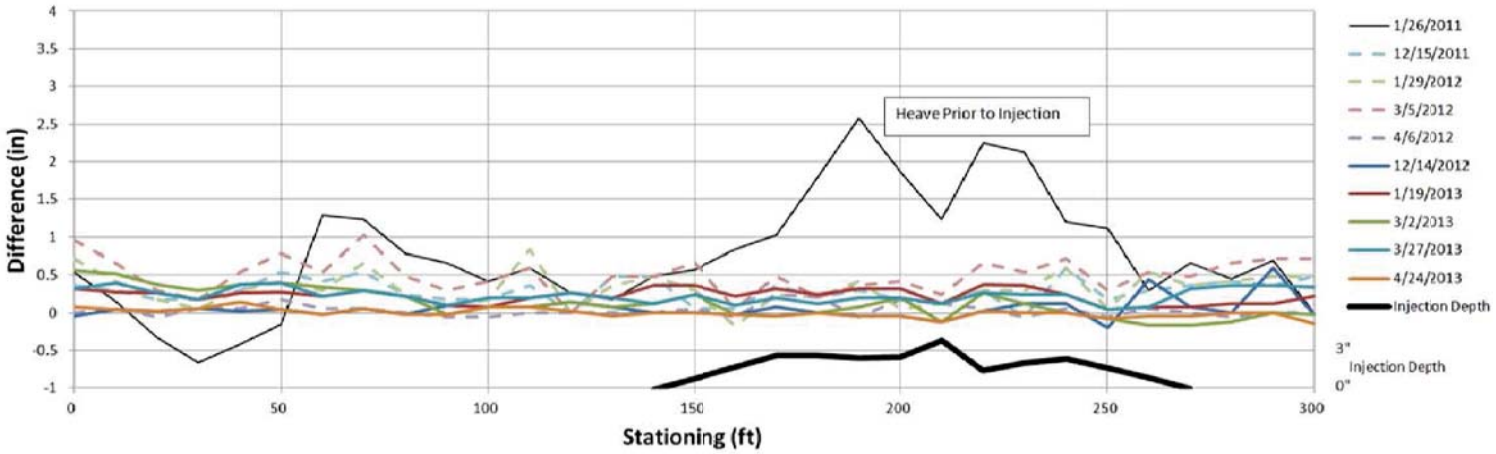
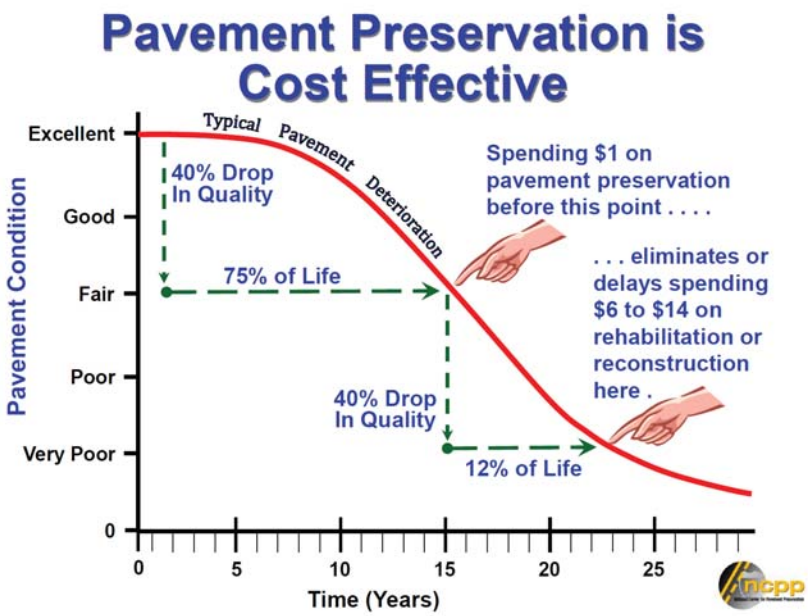


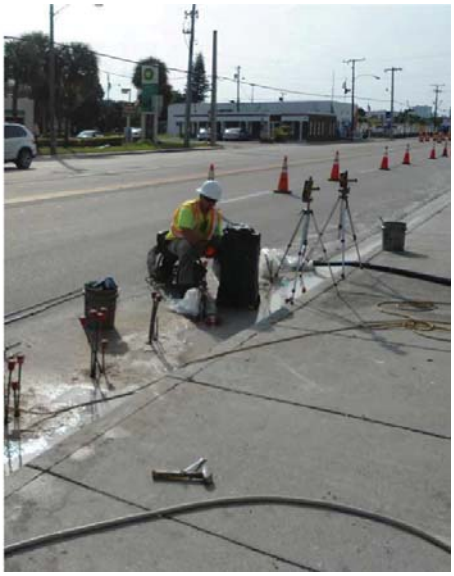
Figure 42. Graph. Frost heave along centerline of east bound lane (CLEB) – Year 1 (Dashed) and Year 2 (Solid)

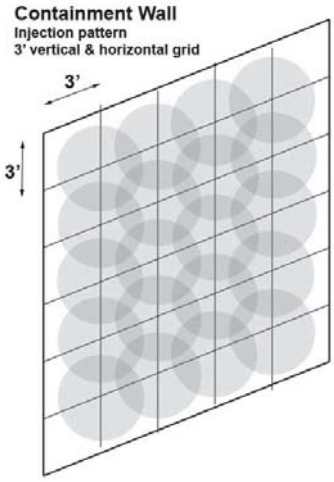
Prior to Treatment = 4″ **Post Treatment = 0.5″**

BENEFITS OF INVESTING IN THE RESTORATION OF PAVING INFRASTRUCTURE



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.

ManholeSealing

Manhole Sealing/Rehabilitation

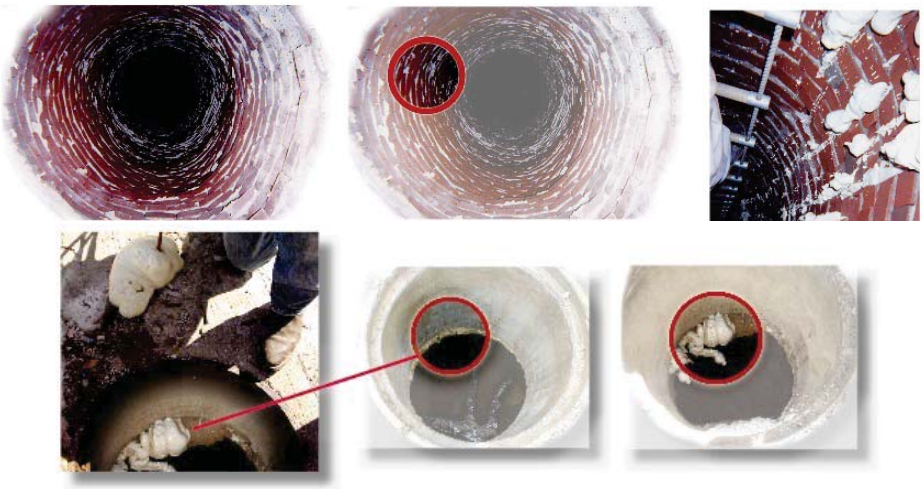
Rehabilitate and restore structural integrit
Quickly eliminate soil erosion and seepage concerns.

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.

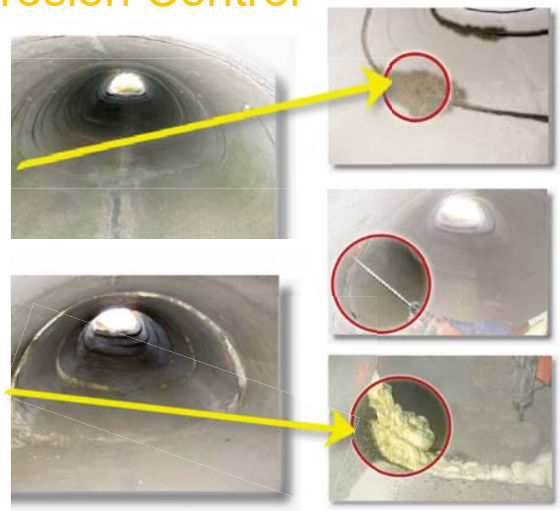


Sewer MainSealing

Lateral Line Sealing/Encapsulation

Rehabilitate and restore structural integrity.
Quickly eliminate soil erosion and seepage.

Infrastructure Stabilization/Soil Erosion Control



erosioncontrol

emergencyinfrastructure

Dam and spillway

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

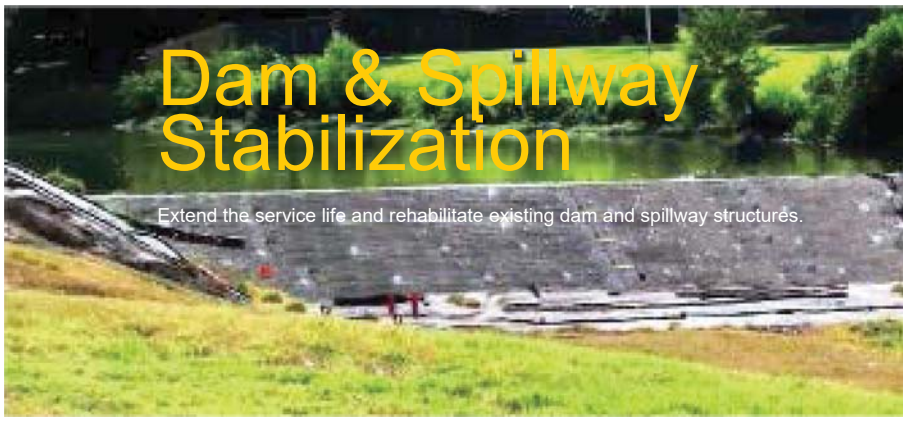
Sea and lake wall

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.

emergencyinfrastructure



ThankYou!

QUESTIONS???
THOUGHTS???