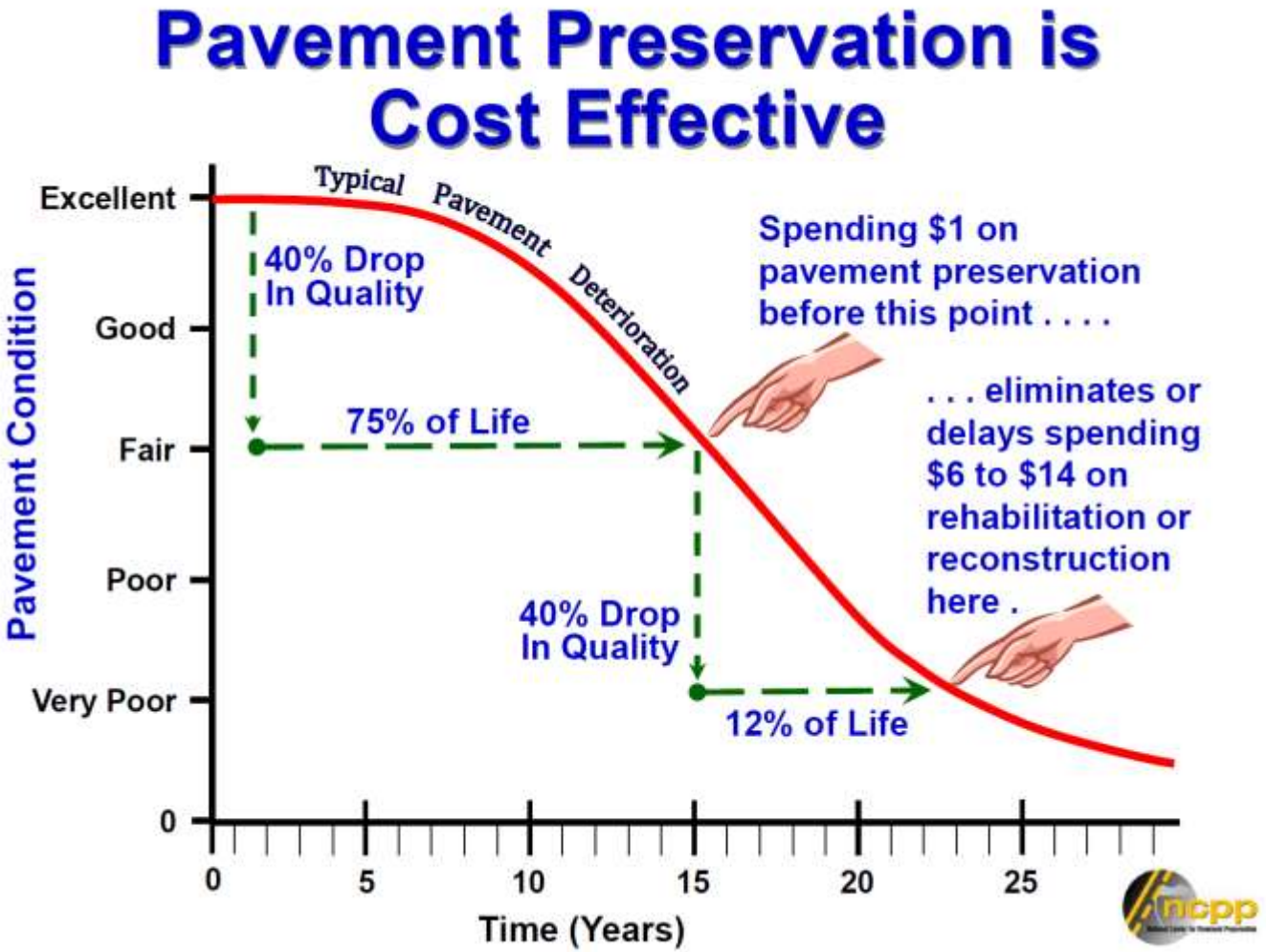
Dave Crowley
Eastern Regional Manager

High Density Polyurethane Stabilization Techniques For Asphalt Pavements

Why is it important?



How is Soil Stabilization Part of Pavement Preservation?

Extend the Life of Pavements by increasing the Load Bearing Capacity of Foundation Soils.

A process for stabilizing weak and/or poorly compacted foundation soils IN SITU by injecting High Density Polyurethane directly into the foundation soils.

“Pavement with a substantial subbase will not likely be problematic…weak underlying support (little to no subbase and soft subgrade that is often saturated) can produce marginal stability”

Source:

Chapter 3, *Program Project 04-01 Processing Pavement Stability, Airfield Asphalt Pavement Technology,* by Mark Buncher, PhD, PE, Asphalt Inst.

History of High Density Polyurethane Grouting

1975: Invented in Finland to stabilize buildings.

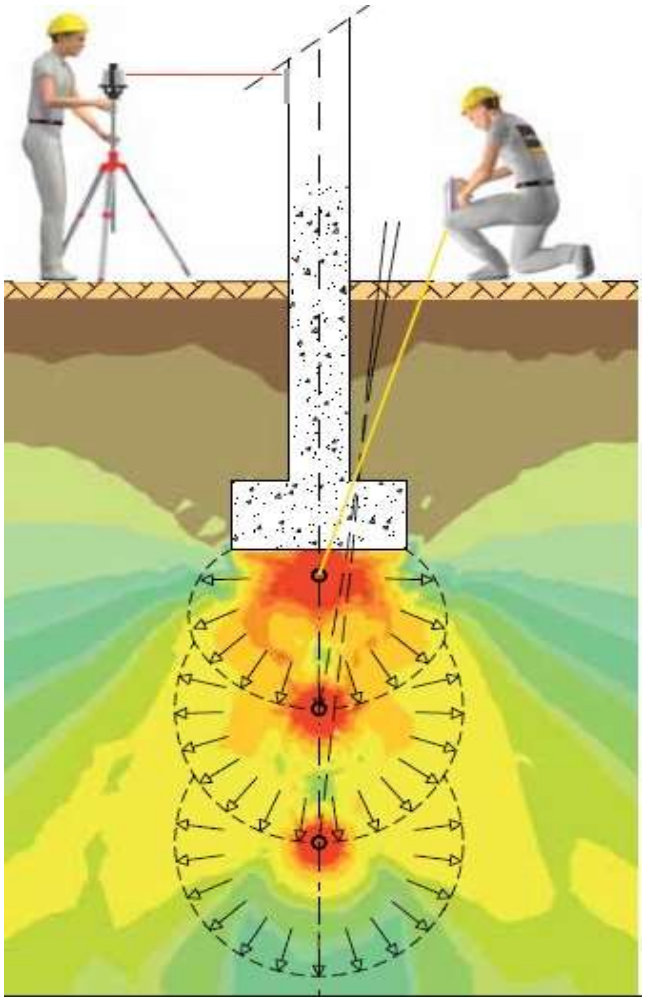
1979: High Density Polyurethane grouting was introduced in North America

2001: Soil Stabilization for Roadways was established

High Density Polymer for Pavement Stabilization

Deep Injection Process

- Method for increasing the load bearing capacity of soil using a two-part hydro-insensitive chemical grout
- Purpose
  - Strengthen Foundation Soils without Digging
  - Utilized on Ridged, Flexible, and Composite Roadways and Runways.
  - Strengthening Weakened Infrastructure and Buildings



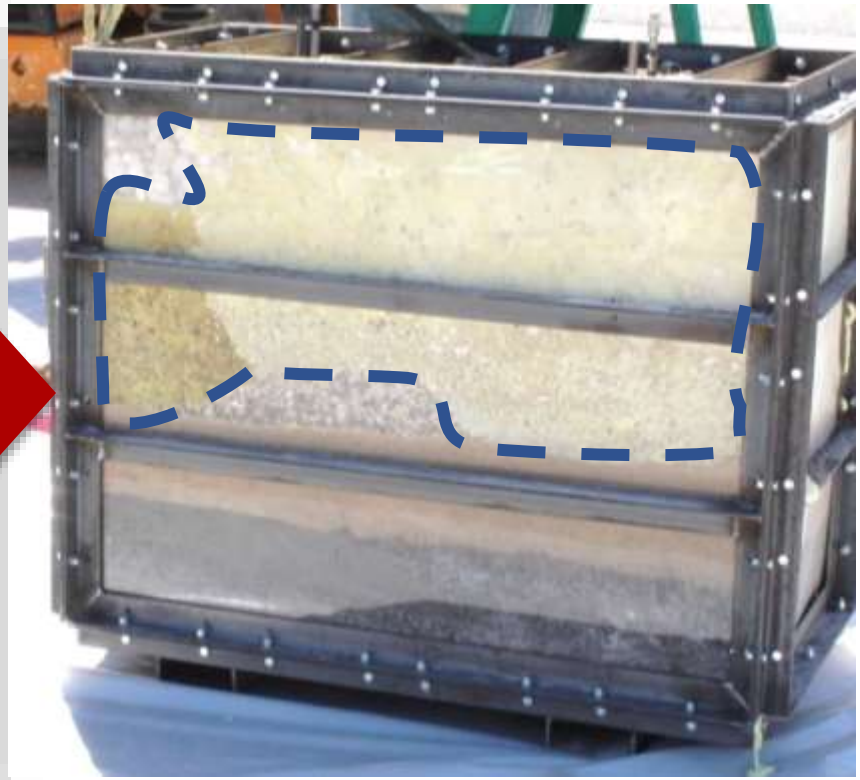
Polyurethane - Composition

Composition	**Resin & Hardener**
Mixing Ratio	**1 : 1**
Chemical Reaction	**Exothermic chemical reaction generates $C0_2$ gas and heat**
	Polyurethane interacting with INSITU soils creates a stronger matrix.
Reaction	**Fast**
	Adjustable – varying formulations and injection methods
	Controlled Reaction
Environmental Impact	**Environmentally benign material**

486 STAR Polymer - Characteristics

Rapid Cure	**Reaches 90% of strength in 30 minutes; full strength after 24 hours**
Strength	**Rigid Structural Polyurethane created as material hardens**
	Compressive Strength, Tensile Strength directly proportional to Density
Control	**Spread is limited due to speed of reaction**
Weight	**Lightweight: 4 to 10 lb/pcf (installed density)**
Water Resistance	**Hydro-Insensitive**
	Contains water insoluble diluents - can be injected into very wet soils
	Resists water intrusion into the chemical reaction that forms polyurethane

Polymer Characteristics



Soil Box Polymer Stabilization Demonstration

Injection Phase

Polymer Characteristics

One Hour after Injection

Ad-Hoc Geo-Material/Polymer Matrix Compression Test

NYSDOT – Panel Test

To pass the NYSDOT Hydro insensitivity test, the Polymer must Maintain 90% Compressive Strength while injecting into water

Panel Test Results

Hydro-Insensitivity of High Density Polyurethane Grout -
Panel Test Data Sheet

Polymer Type & Manufacturer: URETEK 02-40R-V3

Lot # & Date on Component Containers: Resin: URETEK 4R (Lot #1309LK) / 10-01-2013
Component A Isocyanate (Batch# PB93000674) / 09-20-201

INJECTION PROCEDURE - DRY

- √ (√) 5 lbs. of Material Injected into Box
- √ (√) After 10 minutes, Remove Top Cover
- √ (√) After 30 minutes, Sample the HDP Material

INJECTION PROCEDURE - Wet

- √ (√) Add 15 lbs. of Water into Box
- √ (√) 5 lbs. of Material Injected into Box
- √ (√) After 10 minutes, Remove Top Cover
- √ (√) After 30 minutes, Sample the HDP Material

MATERIAL ANALYSIS

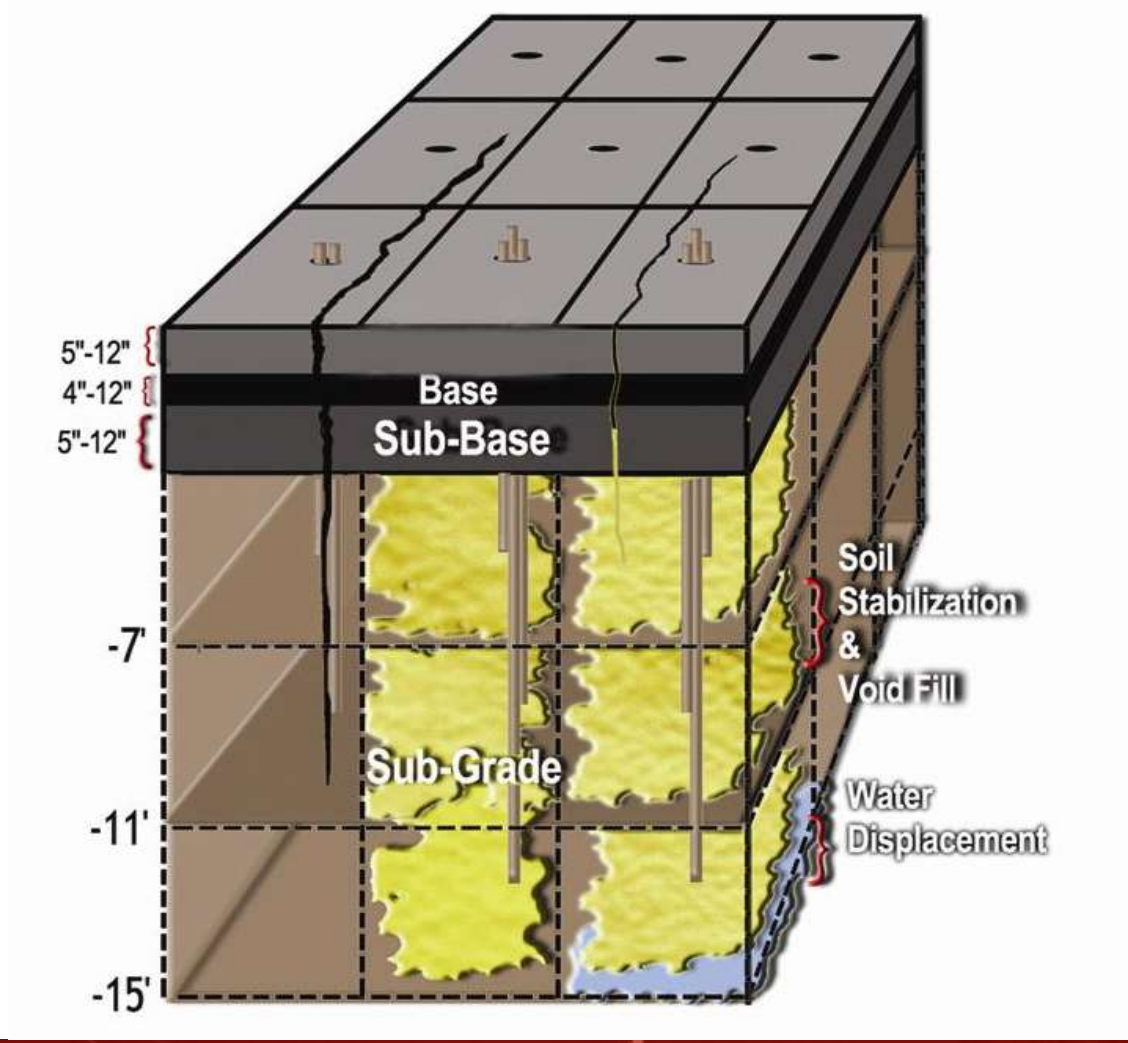
	Dry Injection Shots		Wet Injection Shots	
	Density (pcf)	Compressive Strength (psi)	Density (pcf)	Compressive Strength (psi)
Sample 1	5.31	59	5.24	64
Sample 2	5.24	67	5.03	52

	% Retention of Density
Sample 1	98.7%
Sample 2	96.0%

Technician: Richard L. Boudreau
Date: 2-Oct-13

Requirements for a Successful Project

- **Having appropriate Polymer for Highway work.**
- **Gather Soils Reports, Construction Drawings, and Visit Site to compile information to create a repair plan.**
- **Have Experienced Technicians with Robust DCP unit to test subgrade soils to minus 30 feet, so they can adjust injection plan when on site if necessary.**



The Art of the Process

URETEK USA

Working a Project

- Examine the conditions on site
  - Presence of water
  - Has the problem worsened
  - DCP tests
- Quality Control
  - Pre-injection Elevation Readings
  - Monitoring for “bump” with Laser Levels
  - Post-injection Elevation Readings

It is very important to have experienced technicians on the injection guns.

MoDOT US 65 Subgrade Improvement

URETEK USA

- US 65 is a two-lane asphalt highway with gravel shoulders; terrain = rolling hills
- Vertical re-alignment: a 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 – 2 weeks off.

MoDOT US 65 Subgrade Improvement

URETEK USA

MoDOT US 65 Subgrade Improvement

URETEK USA

MoDOT Mobilized their FWD to the Site

MoDOT US 65 Subgrade Improvement

An approximate 650-foot length of alignment exhibited excessive deformation – some in excess of 100 mils (0.1 in.)

Dynamic cone penetrometer testing with depth to identify potential weak zones. 5 locations selected based on FWD results

MoDOT US 65 Subgrade Improvement

URETEK USA

MoDOT US 65 Subgrade Improvement

URETEK USA

MoDOT US 65 Subgrade Improvement

URETEK USA

- From Site Visit to Completion – 8 working days
- Work area 540’ x 24’; Received Minimal Soils Information.
- Proposed an accepted injection pattern that was modified after the FWD and DCP testing.
- Injected at Various Elevations, Dependent on Severity of Deflections, on Precise Injection Patterns.
- Average Increase in Subgrade Modulus after Injection: 60%
- Average Decrease in Maximum Deflection after Injection: 35%
- The Roadway was Opened on Time.
- 5 Years Later the LTEs Actually Increased Slightly

MoDOT US 65 Subgrade Improvement

URETEK USA

VDOT I-81 Subgrade Improvement

URETEK USA

- Composite Pavement – Asphalt over old Concrete Slabs (originally 69’ long).
- Transverse Cracks every 10’ to 15’.
- Overlays experiencing large reflective cracks within a couple of years.
- Observable Deflection at Many Joints.
- 38 Lane Miles
- Worked in 2009, 2011, 2012, 2017; Last Phase Spring 2018

VDOT I-81 Subgrade Improvement

URETEK USA

VDOT I-81 Subgrade Improvement

URETEK USA

VDOT I-81 Subgrade Improvement

URETEK USA

- **Minimum of Two Production Units on the Project.**
- **Averaged 2/10th of a Mile per Night: 15 to 25 Transverse Cracks/Joints**
- **Were Able to Inject to Stabilize Months Before the Mill and Overlay Work.**
- **Five Years after the First Phase was Completed Less than 10% of the Injected Locations Exhibiting Reflective Cracking.**

VDOT I-81 Subgrade Improvement

URETEK USA

Project Done in 2003

MDSHA RT 410 Subgrade Improvement

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MDSHA RT 410 Subgrade Improvement

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MDSHA RT 410 Subgrade Improvement

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MDSHA RT 410 Subgrade Improvement

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MDSHA RT 410 Subgrade Improvement

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Picture Taken in 2015

MDSHA RT 410 Subgrade Improvement

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Asphalt Roadways

Rutting

Settlement at storm drains

Subsidence and Sinkholes

Asphalt Roadways

Rt 410 MD

Asphalt Bridge Approache

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Forensics: Emergency Repair at Dulles Runway 1L/19R

Dulles Runway 1L/19R Repair at Dulles Runway 1L/19R

Forensics: Emergency Repair at Dulles Runway 1L/19R

Features of using High Density Polyurethane

- ✓ **Small Energy Footprint**
- ✓ **Environmentally Friendly**
- ✓ **Increases the Compressive, Tensile, and Shear Strength of Foundation Soils Without Digging**
- ✓ Very Effective in Most Soil Types/Wet

Thank You!