A Core Strategy for Addressing Pavement Failure Related to Utility Excavations

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U.S. Utility Infrastructure

- Electrical cables
  - High and low voltage
  - Signal cables
  - Cathodic protection cabinets and cables
  - Conduit systems, cable pits and chambers

- Gas lines
  - Distribution lines (high, medium and low pressure, cast iron, steel, Polyethylene)
  - Mains and Services (fittings, valves, service joints, casings, tracer wire, cathodic protection)

- Petroleum Lines

- Communication cables
  - Phone lines -- copper and fiber optic
  - Conduit systems
  - Coaxial and data cables

- Sewer/water mains and services
  - Pits
  - Tunnels
  - Connections
  - Valves

- Steam Lines

20 million miles of pipe, cable and wire - much of it buried in the ROW
Need to Repair or Replace

- Some of this infrastructure has been in the ground for 100 years or more and needs to be replaced.
- New infrastructure needs to be installed to meet growing needs.
- Existing infrastructure needs to be inspected and repaired.
- Utility cuts need to be made to install or gain access to new or existing infrastructure buried under the roadways or sidewalks.
- This presentation discusses a Better Way to make and repair those utility cuts.
Problem: Deteriorating Road Conditions

- 27% major metropolitan roads – interstates, freeways and other critical local routes – have pavements in poor condition, resulting in rough rides.

- $377 annually in additional vehicle operating costs due to:
  - accelerated vehicle deterioration
  - additional maintenance needs
  - increased fuel consumption

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<th>Roads in Poor Condition</th>
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Outline

- Problems with Conventional Utility Cuts
- Keyhole Coring & Reinstatement – A Better Way
- Mechanics of Excavation:
  - Size, Shape, Cut and Repair Methods are Important
- Field Proven Repair Method & Testing
- The Coring and Reinstatement Process
- Environmental and Other Benefits
What’s wrong with Conventional Utility Cuts?

- They settle and crack and result in a bumpy ride.
- They reduce performance life of the pavement.
- The sealant squeezes out allowing ground water to penetrate leading to premature pavement failure.
- They result in potholes that must be repaired over and over.
- Ugly and don’t match the rest of the pavement.
- Road no longer performs as a load bearing system.
- The road may need replacement sooner.
Conventional Excavation Methods

- **Damage**: Saw cuts, jackhammers, and backhoes can result in destruction of underground facilities, pavement damage or worker injury.

- **Delays**: Road work and utility cuts cause 400 million hours of traffic delay and disruption and costs drivers $6 Billion in wasted time.

- **Reduced Worker Safety**: Higher risk of injury from jackhammers and trench work.

- **Spoils Disposal**: Need to truck tons of pavement spoils through city streets to waste disposal dumpsite.

- **Reduced Pavement Life Expectancy**: Conventional utility cuts in the roadway can increase damage to adjacent pavement and potential for groundwater penetration which can significantly reduce the life expectancy of roads.
Conventional Utility Cut Repairs
Resulting in Potholes.
Leading to the Conclusion …

“There is no such thing as a Good Utility Cut Repair”
But there is a Better Way…

Keyhole Coring & Reinstatement

Core the Pavement

Extract Pavement Core

Vacuum Excavate

Locate Infrastructure

Long-handled Tools

Reinstate Pavement Core
What is Keyhole Technology

- A minimally invasive method of accessing or viewing underground utilities through small holes or “keyholes” that are vacuum excavated through soft surfaces or through holes cut or cored through pavement.
Keyhole Pavement Cuts Mean...
Better Pavement Performance

Same Pavement Profile and Appearance
- **Perfect Match:** The reinstated core is a perfect match of profile, texture and color of the surrounding pavement … *it was cut from that pavement.*

Restores Load Transfer Capacity to Repaired Roadway
- **Mechanical Joint:** Utilibond bonding compound creates a mechanical joint with the remaining pavement to restore its load transfer capability to what it was prior to the excavation.
Reduced Traffic Delays and Disruption Means Fewer Complaints

- **Shorter Road Closure**: Road can be safely reopened to traffic within 30 minutes of reinstatement as a Permanent Repair.

- **In and out the same day.** No need for further road closings for subsequent permanent pavement repair.
Greatly Improved Aesthetics

Final Repair

Almost Invisible
The Mechanics of Excavation & Repair

- **Size:** Smaller is better
- **Shape:** Rectangular shape is problematic – Corner Cracks
- **Cut Method:** How you cut is important – Low Impact
- **Repair Method:** Waterproof joint, restore load transfer ability, aesthetically pleasing
Smaller is Better

- Smaller is better and less intrusive

### Laparoscopic Surgery
- Smaller Incision
- Short Recovery Period
- Faster Healing
- Smaller Scar
- Lower Cost

### Keyhole Operation
- Smaller Opening (keyhole)
- Faster Restoration
- Less Damage to Road System
- Smaller Repair Footprint
- Lower Cost

🌟 and safer -- no crews in the excavation
Circular Shape is Better

- Smaller Circular Shape – More Precise Excavation
  - Waterproof: No saw over-cuts at the corners
  - Environmentally friendly, reuses materials, creates no spoils and no VOCs
  - Reduced surface scarring -- 10 to 20 times SMALLER than conventional restoration (1.75 ft² vs 24 ft² to 35ft²)
  - Circular geometry with no corner cracks

- Proven Strength -- NO Failures
  Reinstated core will support 50,000 lbs wheel load

- Better Performance -- Reduced Delay
  - Reduced pavement deterioration -- no potholes
  - Reduced traffic delay -- no additional road closing for repaving -- In and Out the same day.
  - Aesthetically pleasing – perfect surface match -- invisible

- Reduces Pavement Restoration Cost by 87%
- Safer for Workers and Public
Traffic Pressure = Corner Cracks

RECTANGULAR format has FOUR TIMES MORE Traffic Pressure in corners than CIRCULAR format, causing corner pressure cracks that allow ground water penetration.
How You Cut is Important.

- Conventional excavation (Jackhammer, Backhoe, Pavement Breaker) weakens pavement well beyond the cut causing subsidence in “Zone of Influence”
- Precise coring operation eliminates Zone of Influence and reduces pavement damage

The precise coring process and vacuum excavation eliminates any “Zone of Influence”.
Proven Repair Method


- Reinstated core reunites pavement sections with mechanical waterproof joint
  - No sealants to squeeze out with action of traffic
  - No ground water penetration

- Restores load transfer capability of pavement system

“Based on trials and testing we are satisfied that Process will ensure satisfactory long term performance of the pavement reinstatement.”
Golder Report Testing & Results

Comprehensive Laboratory Testing

Effective Load Transfer

Fast Setting, Rapid Strength Gain, Convenient, Consistent, and Repeatable

Long-Term Performance through freeze-thaw cycles

Mechanical Bond No Voids
Restoration of Utility Cut Study

Joint Project of 20 North American Cities and States, 7 utility companies, AGA and GTI (2000-2005) to develop best restoration practice based on sound engineering principles

Toronto Field Experiment: Observations

CONVENTIONAL TRENCH
- Noticeable failures in conventional cut.
- Conventionally repaired joint between road and the cut opened.
- Visible settlement in trench along wheel path.
- Material used to seal joint lost under action of traffic.
- Sand cover at base of trench exposed to higher than normal levels of moisture (compared with keyhole).

ROTARY CUT KEYHOLE
- No defects in keyhole cut.
- Keyhole section established Oct. 2001 continued to perform well throughout life of project.
- Surface of restored keyhole remained level with the road profile.
- The bonding material surrounding the AC/PCC core remained intact (no cracking or separation).
- Waterproof bond.
Conventional Repair Failures:

Findings:

“The material used to seal the joint was lost under the action of traffic as a result of shear flow or pullout of the sealant, allowing groundwater penetration.”

Source: Joint Utility Cut Study: Toronto Field Experiment, US Army Corps of Engineers and NRCC.
Findings & Conclusion

Minimally Invasive Keyhole Utility Cuts

- **No Distress:** The keyhole restored October 2001 showed no distress during the inspections performed during the May 2002 and April 2003 visits. The grout remained intact and the surface is level with the road.

- **Level -- No separation:** The surface of the restored keyhole remained at level with the road profile. The grout [Utilibond] surrounding the AC/PCC plug remained intact (no cracking or separation).

- **Lower Stress Levels:** The keyhole opening is quite small (18 in., 457 mm, in diameter) compared with the area of a tire print of heavy trucks in contact with the road surface. As a result, low stresses are transmitted to the underlying sections of the restored keyhole.

- **No Pressure Cracks:** Based on basic rules of mechanics, a circular cut shape in the AC is ideal for preventing propagation of cracks into the surrounding road area.

**Conclusion:** “The keyhole construction and restoration technique should be encouraged whenever feasible to minimize the need for opening large trenches in the future.”
APWA Supports use of Keyhole Technology


“When practical, APWA supports the use of minimally invasive keyhole technology to facilitate utility exposure or daylighting.”

“Keyhole technology has been primarily used by the natural gas industry but this technology has the potential for being utilized on drinking water pipelines and service lines.”

“Keyhole technology also has the potential to be used by government agencies for subsurface utility engineering on urban reconstruction projects.”
Keyhole coring and reinstatement has been ACCEPTED and APPROVED as the “Better Way” by dozens of municipalities across North America.

- “… no jack-hammering to disrupt or damage the roadbed or the rest of the pavement and it is much quieter than other methods.”

- “It cuts the time on the road. That means less inconvenience to the public, which to a government agency responsible to the public like us, is very important!”

- “I like the smaller, circular hole and the fact that it allows you to reopen the road to traffic within 30 minutes of the repair.”

New York City DOT Officials, March 9th, 2006
Advantages for the Municipality & Public

- **Improved Appearance.** Almost invisible, matching circular core -- less than 1/10 the size of conventional road cut).

- **Reduced Damage** to the Pavement. Road restored to original design specification. No sunken patches or weakened or failed roads. *No Potholes.*

- **Cleaner, Safer, Less Intrusive Worksite:**
  - No jack-hammers or large excavation equipment
  - Less noise and mess and reduced disruption for neighbors
  - No spoil trucked through city.

- **Fewer Complaints** from Public.

- **Reduced Traffic Disruption**

- **Improved Logistics:** Restoration is immediate. Reopen road to traffic in 30 min.
Reduced Carbon Footprint

1. Coring
   - Core
   - Vacuum

Same Day
   - Reinstate
   - Finished Repair

1. Conventional
   - Saw Cut
   - Excavate Pavement
   - Dump Spoil

   - Vacuum
   - Temporary Asphalt Patch
   - Compact Patch

Months Later
   - Excavate Patch
   - Concrete Base
   - Asphalt Surface
   - Compact Surface

Excavation
Restoration
Coring and Reinstatement has an **Operating Carbon Footprint** **One-Sixth** the size of conventional excavation and restoration methods (60 lbs vs 365 lbs)

**BUT** if you add the CO₂ emitted in the production of the cement products used in each of the repairs

**Total Carbon Footprint** of the Keyhole Coring & Repair is **One-Twelfth** the size of conventional method (69 lbs vs 845 lbs)
3.6 million Utility Cut Permits
(issued by municipalities every year)
Environmental Impact of Coring

- 20-25% of utility cuts can be small holes (Gas Technology Institute)
- If 800,000 small hole utility cuts in NA were performed with keyhole coring and reinstatement:
  - **Reduction in asphalt used:** 2 million tons
    -- enough to resurface 650 miles of 4 lane highway
  - **Reduction in spoil disposal:** 27 million cu. ft.
    -- enough to fill 200,000 dump trucks
  - **Reduction in work zone delay:** 2.8 million hours
    1.9 million gal fuel
    $520 million cost
  - **Restoration Cost Savings to Utilities:** $340 to $900 million
  - **Reduction in GHG emissions,** 320,000 Tons of GHG Emissions
    ≈ equal to CO₂ emissions from avg. Power Plant (2.8 billion tons CO₂ ÷ 8000 power plants)
Summary – Maintains Pavement Life

- Precise Coring – No Heavy Equipment
  - No Zone of Influence
- No Pressure Corner Cracks or Saw Over-Cuts
  - No ground water penetration
- Restores Load Transfer Capability of Pavement System
- Reunites Pavement Sections with Mechanical Waterproof Joint
  - No sealants that can squeeze out with action of traffic needed
  - No ground water penetration
- Environmentally Friendly – Consumes Fewer Resources
  - Reuses original pavement core – no spoil to truck away – no new paving materials required.
  - No VOCs to escape -- 1/12 Carbon Footprint of conventional methods
- Reduced Public Inconvenience – Aesthetically Pleasing – Cost Effective
  - Shorter and fewer road closings -- Reduced traffic delays
  - Saves money for Taxpayer/Ratepayer.
Advancing Keyhole Coring Use

- What is needed to make this minimally invasive utility cut method used more often by utility operators and their contractors?
  - Greater **acknowledgement** and **acceptance** by the owners of the road right of way (State, City, County, etc.)
  - Incentives to encourage the use of keyhole pavement cuts
    - Reduce some of the administrative processes
    - Reduce fees for permits and/or inspections
  - Options for moratoriums for new pavement
    - Repave road or use Keyhole coring (NYC DOT)
  - Mandate its use for certain types of utility cuts (Overland Park, KS)
Questions/Comments?

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