Introduction

Utilities spend more than $2 billion per year on excavation and restoration of roads and rights-of-way to repair or install new plant.

- Conventional repair practices using backhoes, dump trucks, pavement breakers, etc. can account for 80% of total costs of repair.
- Conventional excavation and repair practices are getting more expensive, cause traffic disruption and delay — and may damage or weaken the road.
- Last year 800,000 small holes were cut through pavement — fewer than 2% involved coring and reinstatement.

Rotary coring and reinstatement of the core can:
- allow the road to be opened to traffic within 30 minutes of the repair;
- restore the road to its original load bearing capacity; and
- save the utility up to $1,000 per hole in repaving costs.
Excavation Innovation

<table>
<thead>
<tr>
<th>Pavement Access &amp; Disposal</th>
<th>Traditional Open Cut</th>
<th>Vacuum Excavation</th>
<th>Rotary Coring/Keyhole</th>
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<tr>
<td>Centralised w/ backhoe</td>
<td>Centralised w/ backhoe</td>
<td>Rotational coring</td>
<td>No jackhammers, no backhoe, no disposal</td>
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<td>Spoil disposal</td>
<td>Spoil disposal</td>
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<td>Trenching equipment</td>
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<th>Excavation Methods</th>
<th>Traditional</th>
<th>Vacuum</th>
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<tr>
<td>Backhoe</td>
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<td>Dry or wet vacuum excavation</td>
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<tr>
<td>Stepped digging</td>
<td></td>
<td>Dry or wet vacuum excavation</td>
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<tr>
<th>Working Conditions</th>
<th>Traditional</th>
<th>Vacuum</th>
<th>Rotary Coring/Keyhole</th>
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<tr>
<td>And tools</td>
<td></td>
<td>Work from surface w/ long hand tools (1 or 2 applications)</td>
<td>Work from surface w/ long hand tools (3-5+ applications)</td>
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<td>Shoring hole</td>
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<td>or in speed shored hole</td>
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<tr>
<th>Temporary Pavement Restoration</th>
<th>Traditional</th>
<th>Vacuum</th>
<th>Rotary Coring/Keyhole</th>
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<tr>
<td>Cold patch</td>
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<td>Cold patch</td>
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<td>Hot patch asphalt</td>
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<td>Hot patch asphalt</td>
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<tr>
<th>Permanent Pavement Restoration</th>
<th>Traditional</th>
<th>Rotary Coring/Keyhole</th>
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<tr>
<td>Reopen single section</td>
<td></td>
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<td>w/ concrete &amp; asphalt</td>
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Change Happens for a Reason

**Problems**

- Traffic delays and congestion affect everyone — a major political issue at local or municipal level.
- Damage to pavement and road systems from utility cuts is a major public works issue.
- Infrastructure Budget Shortfall affects all levels of Government and results in “Passing the Buck” from one level to the other. The Buck Stops at the Ratepayer/Taxpayer.
- Public Utility Commissions are more closely scrutinizing the rate-base and insisting on *internal efficiencies*.

**Keyhole Solutions**

- Reduce Congestion: Keyhole reinstatement is one-stop — can reopen road within 30 min. and no need to revisit for repaving.
- Utilibond heals the utility cut and reinstates road to original performance capability.
- Saves Money: Permanent Keyhole repairs allow municipalities to concentrate scarce paving resources on potholes and other pavement defects and eliminates justification for utility paving streets.
- Huge Savings: Construction and maintenance are 60% of operating budget. Can save up to $1000 per excavation with keyhole coring and reinatement — millions per year.

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Roadwork Delays Cost Millions

*Ontario Ministry of Transportation*

Federal Express and UPS report that “every five additional minutes of congestion or traffic disruption per day costs them $40 million a year.”

*“...road congestion in the Toronto region costs businesses approximately $2 billion per year in lost time and productivity, primarily due to delays caused to truck deliveries by road repairs and construction.”*

*“...municipal roadwork and utility repairs directly affect local merchants and shopkeepers when access to their premises is restricted or customer parking is lost.”*
Main Cause of Congestion:
Supply and Demand

Growth: 1965 - 2000
- Vehicle Miles Traveled: 39.5%
- Number of Vehicles: 25.1%
- Drivers: 24.5%
- New Lane Miles: 2.5%

- Between 1980 and 1999, route miles of highways increased 1.5 percent while vehicle miles of travel grew by 76 percent.

Source: Texas Transportation Institute and FHWA

Other Causes of Traffic Congestion

10% Delay:
Work Zones

Total delay: about 4 billion hours per year.

Cost of Traffic Congestion

Urban Mobility Report 2005 (85 US Population Areas)

Congestion Effects on Average Person (2003)

- Very Large (over 3 million)
  - Time: 4 hours
  - Fuel: 115 gallons

- Large (1 million – 3 million)
  - Time: 572 hours
  - Fuel: 21.5 gallons

- Medium (500,000 – 1 million)
  - Time: 162 hours
  - Fuel: 21.5 gallons

- Small (under 500,000)
  - Time: 36 hours
  - Fuel: 11.2 gallons

- Total:
  - Time: 4 billion hours
  - Fuel: 63.1 billion gallons

The individual cost of congestion exceeded $900 per driver in 1997, resulting in over $72 billion in lost wages and wasted fuel.

Source: 2005 Urban Mobility Report, Texas Transportation Institute
Solutions to Congestion

LONGER TERM
- More Capacity: build more roads, traffic growth rate more than 30% faster than growth in road capacity -- need to DOUBLE current levels of expansion -- very costly, 10-15 years
- Greater Efficiency: educate travelers, information technology, better communication -- time and technology
- Manage Demand: public transit, car-pooling, park-and-ride lots, HOV lanes. Public transit would have to increase by 20-40% in Very Large and Large areas and by 80-85% in Medium and Small areas -- counter cultural, long term

IMMEDIATE -- Can start today
- More Efficient Work Zone Management: better methods and scheduling of construction and utility maintenance.
- Utilities adopting less disruptive methods such as HDD and keyhole coring and reinstatement -- means no re-visits and lane closures for repairing and -- able to reopen road to traffic in under 30 minutes of repair!

What is Keyhole Technology?
- Method of accessing or viewing underground utilities or plant through small holes or "keyholes"
- Vacuum excavated through soft surfaces or through holes cut or cored through pavement.

New Keyhole Technology

NEW Keyhole technology methods can:
- Cut excavation and repair costs by more than 50%-60%
- Facilitate S.U.E. and damage prevention work on roads
- Reduce delays and public inconvenience, and
- Minimize damage to road
Why Keyhole?

**Smaller is better and less intrusive.**

<table>
<thead>
<tr>
<th>Arthroscopic Surgery</th>
<th>Keyhole Operation</th>
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<tbody>
<tr>
<td>Smaller Incision</td>
<td>Smaller Opening (keyhole)</td>
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<tr>
<td>Short Recovery Period</td>
<td>Faster Restoration</td>
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<tr>
<td>Faster Healing</td>
<td>Less Damage to Road System</td>
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<td>Smaller Scar</td>
<td>Smaller Repair Footprint</td>
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<tr>
<td>Lower Cost</td>
<td>Lower Cost</td>
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♖ and safer – no men in the hole.

Keyhole Technology is a Process

Core  Vacuum  Repair  Backfill  Reinstate

Rotary Coring Process

- Coring truck or skid-steer mounted Minicor™ unit sets up at the repair site and cores an 18” hole through the roadway at previously located maintenance sites or potential HDD conflict sites (gas, water, sewer, fiber optic cable etc.).
Rotary Coring Process (continued)

- 18" diameter hole up to 22" deep
- neat and accurate
- Time: 10-15 minutes depending on depth and composition
- Center pilot hole is cut simultaneously

Rotary Coring Process (continued)

- Once the core has been cut through …
  a core puller is used to remove the core;
- The core is set aside (to be reinstated later).

Rotary Coring Process (continued)

- The repair is made using long-handled tools.

Typical Gas Applications

- Cast iron joint repair
- Sacrificial anode installation
- Low pressure service cut off
- New service installation
- Main sectionalization
- Daylighting for directional drilling
  installation of PE pipe
- Pipeline integrity inspection
HDD -- Conflict Identification

- Better Scheduling: Pavement can be cored and vacuum excavated to show conflict in advance of drilling rig on site;
- After drilling, conflict hole is backfilled and pavement core reinstated -- as a permanent repair;
- Cost saving over conventional excavation and repair = $1,000 per hole.

Expose Multiple HDD Conflicts

- HDD to connect services on east side with new 4" PPE main on west side
- Need to identify:
  - 48" trunk water main,
  - 8" water main, and
  - 6" gas main under road
  - concrete telephone duct
  - high voltage electric conduit under sidewalk
- 5 inspection holes cored and reinstated along drill shot.

At least 2 lanes of traffic maintained at all times.

Rotary Coring Process (continued)

- After the hole has been backfilled and compacted, the Utilibond™ is mixed with water and poured in the hole...

... and the core is reinserted into the hole.
The Completed Repair

- Utilibond sets-up in 10-15 minutes
- gains sufficient strength in 30 minutes to support the single axel equivalent load equal to five transit buses
- 5 times the AASHTO standard or over 50,000 pounds.

The road can be reopened in 30 minutes!

Aesthetically Pleasing

Creates favorable impression with municipality and public

- Rotary cored and reinstated access hole almost invisible in the foreground. (Permanent)
- Conventionally repaired sidewalk cut in background. (Temporary)
- No unsightly utility cut “reminders” or potholes.
- No stress cracks or other failures.
- No “slip, trip and fall” litigation.

Operationally Superior

Process results in:

- Reduced paving budgets.
- Improved Logistics: Single crew, one-stop, same-day coring and pavement reinstatement means simplified scheduling, no temporary patching or repaving and no repeat visits.
- Fewer complaints about traffic disruption, weakened or failed roads.
- Faster and physically less demanding on work force — no jack hammers.
- Reduced potential for workplace injury.
**Functionally More Effective**

- Works better -- less damage to pavement
  - Reinstated core exactly matches the original pavement profile.
  - The pavement system is restored to its original design specifications -- no deterioration in performance.
  - No stress cracks, ground water penetration or premature failure.
  - Road re-opened to traffic much sooner -- less inconvenience to public.

**Environmentally Friendly**

- No noisy and dusty pavement breaking machines.
- No spoil to be trucked and disposed of in dumps.
- No release of Volatile Organic Compounds (VOC’s) from temporary patching material or cut asphalt.
- Re-uses existing materials

**Field-Proven Process**

Core Reinstated 1995  
Same Core 2003

"Since the initial reinstatement, more than 145,000 transit buses and more than 13 million commercial and other vehicles have passed directly over the keyhole with no apparent weakening or other degradation of the reinstated core or the adjacent road system or paved surface."

Golder Associates April 21, 2003
Proof of the Process is Reinstatement

- There are a number of coring methods -- but to the DOT or municipality the proof of the process is the reinstatement of the pavement.
- The key element is the bonding compound used to restore the roadway.
  - "To be effective, it must be able to bond the core to the remaining intact slab of pavement in a manner that allows the road to again perform as a system and to share the effect of traffic loading across the whole surface."
  - Utilibond™ was specifically designed for this application, and according to Golder Associates, which tested it in the field and laboratory:
    - The lab trials and previous demonstrations on the rotary cutting method (including Utilibond) have shown that the pavement coupon has been bonded into the slab in such a manner that the loads of traffic are effectively transmitted to the remaining intact slab."


Bond in Cross-Section

- 3" x 15" deep mini-core samples cut through opposite sides of the core or "coupon" demonstrate effective coupling between core and remaining slab of pavement.
- Light gray line is Utilibond showing excellent bonding of the asphalt-concrete core (central area) and the undisturbed pavement (outer layer) with complete infilling of the voids in the pea gravel (bottom).

Source: Golder Report, April 21, 2003.
Pavement Bonding

**Good Structural Bonding**
- Forces transmitted from one part of the structure to another through the joint.
- Good bonding is important in pavement repair where the end result is to reinstate the capacity of the pavement to perform as a load bearing system.

**Good Multiresistant Bonding**
- Joints need to withstand environmental forces – temperature cycling, vibration and resist the infiltration of water.
- Constant traffic vibration can fracture the bond of a poorly reinstated core and allow infiltration of ground water at the perimeter of the repair and lead to washout of the sub-grade causing premature degradation or failure of the pavement.

A pavement bond must not only be strong but it must be waterproof.

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Restoration of Utility Cut Study

- Objective: to develop a guide for best restoration practice based on sound engineering principles.

**Toronto Field Experiment: Observations**

**CONVENTIONAL TRANSVERSE TRENCH**
- No 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.
- Material used to seal joint lost under action of traffic.
- Material used to seal joint lost under action of traffic.

**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 grout surrounding the AC/PCC core remained intact (no cracking or separation).
- Waterproof bond.

"Keyhole construction is an effective restoration technique that should be encouraged whenever feasible to minimize need for opening large trenches in the future."

**Bond Strength**

- Tests of 3 commercially available bonding compounds were conducted in July 2003 at the Department of Civil Engineering, University of Illinois at Urbana-Champaign.
- The Utilibond™ bonded core gained sufficient strength within 30 minutes to support the combined weight of five transit buses – over 52,000 lbs.
- Safety Factor: 5 times the AASHTO H-25 standard.
Importance of Extra Bond Strength

Changes in Transportation:
- Recent regulations allow higher weights for commercial vehicles.
- Heavier loads negatively impact pavements and make it difficult to maintain current infrastructure.
- Changing trends in commerce have resulted in more local stops on neighborhood roads, which may damage pavements not designed to handle frequent truck traffic.
- AASHTO standards are based on equations, tire pressures and configurations developed in the 1960s.
- Today conditions have changed. Rather than 70 and 80 psi, tire pressures on trucks are 110 psi and 120 psi.
- Need a substantial safety factor to meet current loadings.

Key Bonding Performance Conclusions

Key Performance Elements:
1. Overall bond strength
2. Rapid strength gain

Test Results:
“The Utilibond material excelled consistently as a rapid set material, and achieved the highest punch out loads at all test times ... Only the Utilibond material demonstrated satisfactory performance in the 30 minute tests.”

David A. Lange, PhD, PE, FACI,
Department of Civil Engineering, UIUC

Fast-Strength Gain ... Time is Money!

- Utilibond’s rapid hydration and ultra-fast strength-gain allows roadways to be opened in 30 minutes.
- Resulting in crew time savings of more than $70 per hole over other bonding products with slower strength-gain.

Public inconvenience is also greatly reduced.
Summary of Advantages

FOR THE UTILITY/CONTRACTOR

- **Saves Money:** Dramatically reduced paving budgets.
- **Positive Community Relations:** Faster, less intrusive process. Fewer complaints from municipalities about traffic disruption, unsightly road cuts, sunken patches or weakened or failed roads.
- **Improved Logistics:** Single crew, one-stop, same-day coring and pavement reinstatement means simplified scheduling, no temporary patching or repaving and no repeat visits.
- **Field-Proven Process:** Zero reported failures in more than 12 years and over 10,000 successful corings in tough urban climates.

FOR THE CREW

- **Easy to Operate:** No extensive training required.
- **Easy on the Back:** Physically less demanding, no jack-hammers, shovels and backhoes. Reduces potential for workplace injury.
- **Easy to Use:** Utilibond packaged in easy-open, pre-measured polyethylene pails. Just add water, mix and pour. No awkward measuring from fragile paper bags.

FOR THE COMMUNITY

- **Reduced Traffic Disruption:** Faster, one-step permanent pavement repair means reduced traffic congestion with fewer and shorter road closings and no repeat visits.
- **Saves Tax Dollars:** Less intrusive, more precise pavement coring and reinstatement process means less structural damage to road system; longer pavement life and reduced maintenance. Saves millions of tax dollars.
- **Reduced Footprint:** Almost invisible 18 inch diameter circular core (less than 1/4 the size of conventional road cut) means less scarring of the landscape and better pavement performance (no corner cracks).
- **Environmentally Friendly:** No road-cut spoil to be disposed of and no temporary patching compounds with volatile organic compounds (VOCs) to escape into the atmosphere.
- **Cleaner, Safer, Less Intrusive Worksite:** No jack-hammers or large excavation equipment means less mess during and after excavation and reduced disruption for neighbors.

Questions and Discussion

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