Reprinted from July 2005 Issue
Trenchless TECHNOLOGY

Keyhole Technology: After 40 Years — An Overnight Success

By E. Marshall Pollock

More than 50 years ago, entertainer Eddie Cantor reminded us that it sometimes takes 20 years or more to become an "overnight success". That may also apply to new technology as well.

Small hole — or what is now called keyhole technology — which seeks to make repairs to underground plant from the road surface using long-handled tools, was first reported in the United States in the early 60's when utilities looked for ways to reduce the size and cost of utility cut excavations and avoid having to "put a man in the hole." Both the Philadelphia Electric Company (PECO) and Peoples Gas Light and Coke of Chicago were early pioneers in developing a number of small hole maintenance techniques in an effort to reduce the number of large street openings that were both a nuisance to the public and very costly to excavate and repave.

According to a report presented to the Institute of Gas Technology in August 1963 by W.E. Rosengarten, Jr., early keyhole repairs undertaken by PECO included repairs to leaking bell joints and cathodic protection through a narrow "keyhole-like" slot 4" wide and 18" long.

"The area to be excavated is laid out on the pavement with a piece of 2 by 4. On concrete highways this rectangle is cut with a diamond saw.The penetration of the highway is made using standard pavement breakers and concrete drills. The removal of the dirt can be accomplished easily using a power driven auger to loosen up the dirt and an air jet vacuum cleaner removes the spoil.A clamshell post hole digger is also a very useful tool.The hole is belled out slightly at the bottom to permit some room to maneuver around the pipe."

Although by comparison to today's rotary coring and vacuum excavation techniques, the early procedure seems a little rudimentary, it appears to have achieved the desired results.

"[The keyhole process] resulted in very substantial savings for the Philadelphia Electric Company. The excavation of this small hole can be easily accomplished with simple tools and the small volume of dirt removed, usually less than 2 cubic feet, is very easy to handle. The work site is confined to a small area reducing the interference with traffic."

In the next two decades large dedicated vacuum excavation units supplanted the "vacuum cleaners" and the clamshell post hole diggers and typical small hole sizes increased to 2-foot by 2-foot to accommodate more repair applications. During this period, rotary coring of small diameter holes using portable coring devices was introduced at Southern California Gas as an alternative to traditional pavement breaking methods.

But it was not until the early 90's, when the Consumers Gas Company of Toronto (now Enbridge Gas Distribution) experimented with reinstating an 18" diameter core back into the pavement after the repair had been completed, that the major savings potential of the keyhole process was realized. Instead of disposing of the core as spoil, Enbridge developed a bonding compound which allowed them to effectively reinstate the core in the pavement as a permanent repair — requiring no temporary patching or repaving. This resulted in huge savings in time and money.

Golder Associates, the international engineering firm that provided the engineering proof of the process for Enbridge and monitored performance over a ten-year period from 1992 to 2002, reported that they cored and reinstated more than 3,000 utility cut repairs in streets and sidewalks in Toronto with no failures. Regular monitoring of high traffic sites showed no weakening or degradation of the reinstated cores or adjacent road system, even though millions of commercial and other vehicles had passed directly over the keyhole.

As a result, Golder concluded that "the equipment, procedures and materials, including Utilibond, developed and used by Enbridge over the last 10 years, will ensure satisfactory long term performance of pavement reinstatement."

This type of long-term research has gone a long way in helping to convince skeptical municipalities and other road authorities that the coring and reinstatement process, when properly executed, was effective in minimizing damage to pavement and the underlying road bed.

Here, a bell joint encapsulation is carried out with long-handled tools.

"Nothing succeeds like success," says Buddy Secor, Manager Engineering Technical Support at Washington Gas, which implemented the coring and reinstatement program in 2004. "The Golder 10 year study was instrumental in helping us gain approval for the process from more than a dozen municipal authorities in our service area."

Today, more than 20 local gas distribution companies and their contractors in North America employ rotary coring and reinstatement in their keyhole activities and are achieving average savings of almost $1,000 per hole over conventional methods of pavement cutting and rehabilitation.

Typical utility repairs through keyholes include cast iron main joint repair, sacrificial anode installation, low-pressure service cut-offs, new service

installation and valve box replacements. In addition to utility maintenance, the process also has direct application to other underground and trenchless operations including: test holes, service drops and shallow splice pits for the telecommunications industry, daylighting and test holes for directional drilling and inspection holes for pipeline integrity and SUE.

The Gas Technology Institute estimates that, last year, more than 800,000 small holes were cut through pavement in North America but only a fraction — less than 2% — employed this innovative process.

Some of this delay in acceptance is due to resistance encountered at the municipal level where those who own the Right of Way are reluctant to move away from traditional repair methodologies. Improperly restored utility cuts can and do affect pavement performance and contribute to deterioration and reduced pavement life. We need no more proof of that than an examination of our roads following the fibre optic boom of a few years ago.

But things are changing there too. Independent studies, such as the soon to be released "Restoration of Utility Cuts Study" conducted by the National Research Council of Canada and the U.S Army Corps of Engineers, document the superiority of keyhole excavation and reinstatement over conventional methods and recommend utilization of the keyhole process whenever feasible.

"The credibility of that study, which involved a number of North American cities, utility companies and US state departments of transportation, should go a long way in dispelling some of the myths or 'conventional wisdom' that surround the restoration of utility cuts, and replace them with facts," says Colin Donoahue, Vice President of Field Operations of Utilicor Technologies, the manufacturer and distributor of the pavement coring units and bonding material developed by Enbridge.

Utilization of keyhole technology will also grow as more and more utilities, under pressure to reduce costs and improve operational efficiency, look for new procedures and methodologies to reduce construction and maintenance costs. These costs represent at least 60% of their operational budget, and the potential of multi-million dollar savings that can be realized through keyhole technologies has reached the level of utility boardrooms.

Here, an 18-in. core is removed and set aside for reinstatement later.

Obviously, keyhole technology cannot accommodate every kind of repair, and open trenching and other more intrusive methods will be around for a long time, but utilities and their contractors continue to make a strong case at the municipal level for new, less intrusive, procedures including directional drilling and pavement coring and reinstatement.

At the same time, more and more municipalities are beginning to recognize the significant advantages that coring and reinstatement can offer their citizens. The absence of jackhammers and pavement breakers makes for less disruption of the neighborhood and the replacement of conventional, low-strength cement grouts with superfast strength gain bonding agents, like Utilibond, means that the road can be safely reopened to traffic within 30 minutes of the completed repair. This results in less traffic disruption, shorter road closings, less structural damage to the road system, longer pavement life and reduced maintenance resulting in huge tax savings for local ratepayers.

The keyhole coring and reinstatement process is also a winner from an environmental standpoint. There is no road cut spoil to be disposed of, no temporary patching compounds with volatile organic compounds to escape into the atmosphere and the significantly smaller circular keyhole footprint means reduced scarring of the community landscape.

These were the key factors that persuaded the Dallas-Fort Worth Metroplex to formally approve the keyhole coring and reinstatement process and to exempt Atmos Energy TXU from having to employ pavement slurry techniques in the rehabilitation of the roadway after completing keyhole repairs.

"This was a huge step forward for us," says Marc Chapman, Atmos Energy's Manager of Repair and Construction in the Dallas-Fort Worth area. "As cities in Texas continue to upgrade their paving requirements to include flowable fill, slurry sealing entire blocks of streets, panel to panel concrete replacement and color matching of existing pavement, we need to work with them in adopting new technologies that will ease this burden on the utility and at the same time meet the needs of the municipality in maintaining its infrastructure," says Chapman.

"For us at Atmos, coring technology is certainly the way of the future and will continue to be one of our main tools in minimizing paving expense and improving relations with municipalities."

In Toronto, where the coring and reinstatement process was born 15 years ago, city officials have approved it as a permanent repair and Councilor Jane Pitfield, head of the works committee, who says the process "leaves the road in better condition than it was when they cut into it" is seeking to apply the process to other city owned utilities like the water system.

That kind of recognition, at the political level, may be what is needed to kick start the process in other municipalities. Pothole conscious politicians are beginning to recognize that taxpayers also benefit from the reduced impact that this type of pavement "microsurgery" has on the road itself and from the longer road-life and better pavement performance that results. This recognition at the municipal level bodes well for the future expansion of keyhole technology.

After 40 years, Eddie Cantor may have been right — keyhole technology has become an overnight success.

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