Keyhole Technology: Utility Microsurgery

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Background

Small-hole (Keyhole) technology in the utility maintenance industry is the equivalent of microsurgery in the healthcare industry. Those who embrace this innovation are achieving tremendous benefits and cost savings for themselves, their stakeholders, and the municipalities where they operate. The fundamental approach consists of opening the street surface using pavement coring technology, performing repair tasks through the 18" diameter cored hole with specialized extension tools, and reinstating the road surface core that was removed in the first step via a specifically formulated bonding material. This low-intrusive approach to performing routine repairs and infrastructure upgrades is packed with benefits for a company's customers, workforce and community.

Although the technology requires investments in capital equipment, specialized tooling, and retraining of the workforce, the benefits for all of the stakeholder parties clearly provide substantial returns on the investments. A street coring machine, costing from somewhat less than $30,000 to around $90,000, saws from the street surface an 18" diameter core or plug. This core is set aside to be reinstated in the opening after the work is completed. The earth over the top of the infrastructure is removed using a vacuum excavator, which will typically cost from $60,000 to $80,000, resulting in a vertical tunnel of around 18" in diameter directly down to the area of infrastructure to be repaired. Workers, standing on the street surface and not inside of an excavation pit, "operate" on the infrastructure using specialized extension tools. Most first-time implementers invest in tooling to perform an average of three to four repair types and spend about $20,000 to $35,000 initially.

When the operation is complete, the earth is replaced in the excavation and the street plug that had been set aside is reinstated using a specifically formulated bonding agent. The "healed" street surface is as strong as the original surface and the "scarring" is minimal. Depending on how the street coring and vacuum excavation components are configured on truck chassis, the investment in trucks can run from $50,000 to $100,000. Some first-time investors invest in training and consulting services to shorten the startup time and begin gaining returns on the technology quickly. Those who use these services estimate spending around $30,000 for the advice and training.

Why should one consider using Keyhole technology? Because the premise is that smaller is better. If one makes the analogy that cutting a road is like cutting one's skin, then the smaller the hole the lesser the recovery time and the less intrusive the operation. 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 by government agencies for subsurface utility engineering on urban reconstruction projects.

Coring the street

History of small-hole repair in the gas industry

The roots of small-hole work can be traced to the mid-1960s. Philadelphia Electric Company and the Institute of Gas Technology co-authored a paper, "Repair of Bell and Spigot Joints through Small Openings," which was presented at the Leak Control Symposium in August 1963. This study examined the repair of cast iron (CI) joints using encapsulation methods through a small-hole excavation utilizing vacuum technology. For the next two decades this process evolved with mostly specialized contract forces locating and repairing multiple joints, daylighting the entire joint, and using workers dipping head first into the small hole to install a boot entirely around the joint.

The core set aside

In the 1990s, anaerobic sealants made an appearance on the scene. This repair operation consisted of drilling a small hole in the top of the joint and injecting sealant to revitalize the joint material. This created a major milestone in the infrastructure surgery process, allowing the pipe to be repaired entirely from above the hole. The development of above-ground tools made the scope endless. Now the gas industry is not only making CI joint repairs, but working together with the Gas Technology Industry of Chicago (GTI) is spearheading to undertake the following operations:

- Steel Main Repairs
- Curb Valves Installations
- Anode and Test Station Installations
- New and Replacement Service Installations
- Service Cut-offs
- Plastic Service Cap Repairs
- Underground Utility Verification (UUV)

The long-term goal is that whatever can be done today in a 3'x 4' excavation will be accomplished through a small hole. Paramount to this deliverable is the increased development of sophisticated locating tools.

Twenty-First Century at PECO Energy Company

PECO Energy Company (PECO) is the former Philadelphia Electric Company, which helped develop the small-hole work in the 1960s. Their path followed that of the gas industry with primarily CI work done in small holes with vacuum excavation. But in the mid-90s the vacuum truck helped provide great cost savings in the field of pre-engineering work. It was from this that a full-time Underground Utility Verification team was formed which has helped develop precision locating tools.

The work being performed

Since workers operate at street level instead of down in excavated pits, they no longer risk potential sidewall cave-ins associated with open pits. A Keyhole process is typically performed within a work shift and traffic can resume over the repair in short order upon completion. The community suffers less from traffic disruption. Last of all, the utility company saves on street restoration costs and callback costs associated with poor street restoration. With all of these benefits, it's no wonder that many gas distribution companies have invested in the technology. PECO made an initial investment in the technology about two years ago and worked closely with Omega Tools, Inc., the vacuum equipment and extension tool provider, and GTI to launch their implementation effort.

Entry into the world of Keyhole technology is an investment of substantial dollars and effort, but several implementation strategies undertaken during a recent pilot program to implement the technology at PECO mitigated some of the investment without negatively impacting performance. Using modular equipment for coring and vacuum excavation, PECO blended the two modules onto the same truck chassis. This strategy not only eliminated one truck from the initial investment outlay, it provided a means for reassembling the modules into other truck configurations as the learning process with the technology unfolded. The flexibility of placing the modules on one or two chassis and adding accessories to enhance production, proved to be a major advantage in recovering the initial investment at a rapid pace. Since the technology implementation impacted the way work gets scheduled and managed, the modular concept allowed for restructuring the equipment relative to those issues.

Development of technology

The technology continues to develop with the growing sophistication of locating equipment, street coring, and vacuum excavation improvements. The extension tooling and the small-hole processes that can be performed with these specialized tools also continue to expand the technology's applications.

The integrity of the repaired street surface via the reinstatement of the plug is at the heart of the technology's overall viability and cost savings. GTI has been instrumental in assisting the industry in developing and testing all aspects of this technology set. GTI has been

working with over 25 companies in this effort including working directly with the major manufacturers of the cement-type bonding products that essentially secure the street plug into the original parent street surface.

In a practical assessment of the street restoration process, Omega Tools, Inc., has over 4,000 street cores reinstated in the past three years within the state of Pennsylvania, reporting zero core failures and inconsequential call-backs on repairs. Michael Berlin of Heartland Cement, one of the major manufacturers of the bonding cement, states that his product (Utili-Grout) "is a patented, rapid hardening, sulfate resistant, general purpose grout that is easily mixed for reinserting cores in either concrete or asphalt streets." He notes that his product has been used to reinstate thousands of cores (plugs) without failure. It must be understood that the failures are minimal with adherence to the reinstatement procedure. Although not difficult to perform, reinstatement requires a modest level of attention to the details of mixing the cement bonding material, pouring the bonding material into a properly prepared plug hole, maintaining the integrity of the plug itself, and finishing off the freshly-inserted core in the hole.

Core placement

The cement bonding products are designed, as Mr. Berlin points out, as a rapid hardening compound. This feature provides not only lasting durability and street integrity; it also allows traffic to resume over the repaired site in as little as 30 minutes.

The overall technology continues to advance. More and more infrastructure repairs and installation processes are being developed every year. In addition, the technology components, especially street coring equipment and vacuum excavation equipment, are improving to provide better operator ergonomics and improved operation throughout seasonal changes. These advances are increasing the technology's overall productivity and return on investment capabilities.

Recent developments in tooling and small-hole processing have focused on performing service line upgrades and repairs. On plastic mains, new service tees are installed using electrofusion technology. Once the service tee is installed on the main through the 18" cored opening, the service line is connected and pressure tested. Every step of the process is performed using newly-created extension tools. Similarly, strap on-styled tees that connect the new tee to the newly-installed plastic service line are available for steel main to plastic service line applications and all of the extension tools for this operation are available. One of the latest tooling developments allows implementers to abandon medium-pressure and high-pressure service lines through the cored holes without any "blowing" of gas. At this juncture, all processes are performed through the standard 18" diameter hole, but in some instances smaller holes can be cored and up to 24" holes can also be used.

Finished repair

Many utilities are turning to the latest developments in this technology as a major component in their total effort to improve their operating performance while improving relationships with customers and municipalities. The technology's implementation has spread throughout the United States. In the Southern region, companies such as Southwest Gas, Atlanta Gas & Light, and Atmos Energy in Texas are at the forefront of the implementation process. In the upper Midwest, Nicor in Illinois and Michcon operating in Detroit are moving forward with many of the latest small-hole processes. The Northeast, a long-time regional leader in implementing the technology, has PECO Energy, UGI, and Washington Gas as leaders with the technology. On the West Coast, NW Natural, Sempra Energy, and Pacific Gas & Electric are significantly invested in their technology implementation efforts.

Conclusion

Infrastructure management through use of small-hole technology is a process whose time is upon us. Enhancing the process through the technology transference to operations, in the area of advanced locating devices, coring and vacuum units, and varied above-hole tools, is a task of paramount importance in development through the learning curve. The advantages for the utilities and municipalities to be able to perform their core business functions safely and efficiently, while significantly decreasing the disruptions on the public, make this an operations and management tool for the 21st Century.

T. Mark Andraka will give a presentation on this topic at the 2005 APWA Congress. His session, entitled "A New Paradigm for Managing the Right-of-Way: Urban Micro Surgery," takes place on Tuesday, September 13, at 3:30 p.m. He can be reached at (215) 841-6485 or mark.andraka@peco-energy.com.

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